This paper sets out the nature of the adjustments which are required in project analysis in an economy with trade distortions. It shows the implicit or explicit assumptions alternative project selection procedures make about the adjustment processes and/or various structural features of the economy, and finally evaluates the practical usefulness of the alternative procedures. It demonstrates the equivalence, on identical assumptions about the economic structure and future trade policy, of the Little-Mirlees (LM) and shadow exchange rate (SER) type procedures, and provides reasons why in practice LM methods may be easier to use than SER ones.

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ADJUSTMENTS FOR TRADE DISTORTIONS IN PROJECT ANALYSIS

by

Deepak Lal

Introduction

Given the widespread use of trade controls in developing countries for balance of payments reasons and/or for protective purposes, the domestic relative price structure is distorted compared with that which would exist in the absence of these non-optimal controls. The resulting resource allocation based on the trade distorted domestic market prices is then sub-optimal in terms of maximising potential domestic welfare, given existing resources, technology and foreign trade possibilities. As a result it has been suggested by a number of writers \( \cite{2, 4, 6, 11, 137} \) that in making future investment decisions, "shadow" prices, which reflect the true social costs and benefits of inputs and outputs be used rather than the distorted market prices. Thereby the country would be able to develop along the lines of its comparative advantage, which are obscured by the varying, inoptimal and often "ad hoc" controls on foreign trade. A number of ways in which these trade distortions can be taken into account in project analysis have been suggested in the literature \( \cite{1, 2, 3, 6, 9, 11, 12, 137} \). Some attempts have been made to try and relate these differing methods to show what differences there are, if any, in the assumptions on which they are based \( \cite{1, 2, 3, 8} \). In my view, however, these treatments are not completely satisfactory, in pinpointing (a) the

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nature of the adjustments for trade distortions which should be made in project analysis; (b) the particular assumptions underlying the different procedures which have been suggested; (c) the differences in using the procedures in practice. This paper seeks to first set out in terms of simple comparative static, trade theoretic, general equilibrium models, the nature of the adjustments which are required (Section I); secondly, to show the implicit or explicit assumptions the alternative procedures make about the adjustment process and/or various structural features of the economy (Section II); thirdly, to evaluate the usefulness in practice of the alternative methods (Section III).

I. Some Simple Theory

In this paper we are concerned with project analysis in the presence of trade distortions. As such we assume away all other distortions in the economy, which is thus assumed to correspond to the perfectly competitive neoclassical paradigm in all other respects. Abstracting from distributional problems, in the absence of all distortions (including trade distortions) and given the conditions for the existence of a competitive equilibrium, resource allocation based on market prices would be optimal. Moreover, the prices of goods and factors would equal and equate the marginal social cost (MSC) of producing and marginal social value (MSV) of using the relevant goods/factors. In general, distortions in factor and/or commodity markets (which includes the markets for foreign goods and services) drive a wedge between the MSV and MSC of a good/factor. The market price (P) of the relevant good/factor will then equal either the MSV or MSC (or neither, in some cases of rationing!) of the good, but will not equal and equate both MSV and MSC. The first best solution in such cases is always to
correct the distortion at its source, so that the relationship
P = MSV = MSC holds for all goods/factors. Resource allocation would
then be optimal at market prices and project evaluation with a system
of 'shadow' pricing would be redundant. However, especially in
developing countries, for various political and/or administrative
reasons, it may be infeasible at least in the short run, to achieve the
first best solution, and project evaluation using 'shadow' prices
may be required, as a second best method, to move the economy in the
direction of optimal resource-allocation.

Non-optimal trade controls result in two broad sets of distortions
in the domestic price structure. These are distortions in relative
prices within the traded goods sector and distortions in the relative
price of traded to non-traded goods. To demonstrate this, and to pin-
point the ensuing adjustments which have to be made to market prices,
to obtain the 'shadow' prices for project evaluation in the presence
of these distortions, we consider two highly simplified, trade-theoretic
general equilibrium models.2/

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2/ In thinking about the problems discussed in this paper I have been
much influenced by Max Corden's The Theory of Protection (CUP, 1971);
and the simple two and three good models which follow are based on
this work.
Case 1 - Two Traded goods produced and Consumed

We first consider the case where there are just two goods, an importable $M$ and an exportable $X$, being produced domestically with fixed stocks of capital $K$ and labor $L$. Making the small country assumption, the foreign (border') prices of the two goods $P_{Xf}$, $P_{MF}$ are fixed and given. If there is free trade, then (from Samuelson's theorem on the correspondence between factor and commodity prices) the relative prices of the two factors $K$ and $L$ are uniquely determined. If even a single domestic money price of the two commodities ($X$, $M$) or two factors ($K$, $L$), or the exchange rate (which converts domestic money prices into foreign money prices) is now given, all the other domestic money prices will be uniquely determined.

Moreover, a change in the foreign exchange rate would have no real effects on the economy as it would affect only the absolute level of domestic money prices, without effecting the relative 'border' price structure. Furthermore, a balance of payments deficit in this model cannot be cured by exchange rate changes, as the expenditure switching effects of a de(re)valuation are non-existent, because a de(re)valuation alters the domestic prices of $X$ and $M$ by equiproportionate amounts. The only cure for a balance of payments deficit would be expenditure reduction. Furthermore, in this case, the optimal pattern of production and of trade will be uniquely determined by the given world ('border') prices of the two commodities. The domestic market prices of goods and factors would also be their "shadow" prices, and investment decisions based on them would be optimal.
Now suppose that a tariff of t% is imposed on the importable. The exchange rate remains fixed. This will change the domestic relative price of the two commodities \((X, M)\) from their border "relative" price, which will induce changes in domestic production and consumption, and in the domestic factor price ratio. Moreover, assuming that the government maintains internal balance by appropriate fiscal and monetary policy, total domestic expenditure (measured at the domestic relative prices existing in the free trade situation) will have fallen. Both imports and exports will shrink. All this is shown in the standard two factor - two commodity international trade theory diagram in Fig. 1.

Suppose we are now asked to evaluate the relative desirability of a marginal investment project for producing \(X\) or \(M\), in the tariff distorted situation. At the existing domestic market prices, there is nothing to choose between the two projects. However, the tariff has introduced a distortion which does not enable us to maximize feasible welfare. It has, as it were, introduced a wedge between the MSC of producing and the MSV of using a unit of foreign exchange. The former is given by the domestic resource cost of a unit of exports, the latter by the domestic price (value) of a unit of imports to consumers. Valuing goods and factors in domestic currency, one unit of export earns, say, \(P_{xf}\) in foreign currency which converted at the official exchange rate, \(e\), yields a domestic value of \(eP_{xf}\). But this understates the benefit from the \(P_{xf}\) units of foreign exchange obtained by exporting.
For if the foreign currency price of $M$ is $P_{mf}$, this will enable imports of $\frac{P_{xf}}{P_{mf}}$ units, whose domestic value, given the tariff of $t\%$, is $e(1+t)P_{xf}$. The domestic social value of one unit of exports therefore is $e(1+t)P_{xf}$. If we now evaluate the project, in terms of domestic currency, taking the shadow 'price' of the $X$ good as $e(1+t)P_{xf}$, the $M$ good's domestic price is $e(1+t)P_{mf}$, and this is also its 'shadow' price, we will find that production of $X$ relative to $M$ is more profitable at the existing domestic factor prices. Production decisions taken in line with this shadow price will move the economy towards the optimal production point, $P$ in Fig. 1. This factor $e(1+t)$ is sometimes identified with the shadow exchange rate (S.E.R.). It is an exchange rate in the sense that the tariff has resulted in a non-unified exchange rate. There are two different effective exchange rates which apply to imports and exports (that is rates which convert domestic money prices into foreign money prices of the two goods $e$ for exports, and $e(1+t)$ for imports. Optimality requires a unified exchange rate. Hence the price of exports must also be multiplied by $e(1+t)$ to get the right 'investment decision, or alternatively all foreign exchange values have to be multiplied by this S.E.R., $e(1+t)$. This will restore the correct 'shadow' relative price structure of the two goods to the 'border' price one.

But equivalently, we could have taken the value of $M$ net of its tariff rate ($t$), and we would have got the same result. Whether we choose to use an exchange rate of $e(1+t)$ or $e$, to convert foreign prices into domestic prices is irrelevant, in this model, as long as we get the correct relative valuation of the two goods which is
given by the relative 'border' prices. If we had decided to use foreign
currency as our numeraire we would have just taken the foreign currency
prices of the two goods as our "shadow prices", and converted the domestic
factor prices into foreign exchange equivalents.

Measuring in units of domestic currency, in the post protection
situation, we have the following cost conditions:

\[ \begin{align*}
A_{lm}W + A_{km}R &= e_{mf}(1 + t) \\
A_{lx}W + A_{kx}R &= e_{xf}
\end{align*} \] ............... (1)

where \( A_{ij} \) is the input of the \( i^{th} \) factor \( (i = K, L) \) in the \( J^{th} \) industry
\( (J = X, M) \) and \( W \) and \( R \) are the wage and rental rates.

Then using an SER of \( e(1 + t) \), we get the 'social' costs

\[ \begin{align*}
A_{lm}W + A_{km}R &= e_{mf}(1 + t) \\
A_{lx}W + A_{kx}R &= e_{xf}(1 + t)
\end{align*} \] ............... (2a)

If we had used an SER of \( e \), we would get the 'social' costs as

\[ \begin{align*}
A_{lm}W + A_{km}R &= e_{mf} \\
A_{lx}W + A_{kx}R &= e_{xf}
\end{align*} \] ............... (2b)

In both cases we get the production of \( X \) as more profitable than \( M \).

Alternatively working in foreign currency, and using the
official exchange rate, we would have from (1)

\[ \begin{align*}
A_{lm}W/e + A_{km}R/e &= P_{xf} \\
A_{lx}W/e + A_{kx}R/e &= P_{xf}
\end{align*} \] ............... (2c)

whilst if the SER of \( e(1 + t) \) had been used,

\[ \begin{align*}
A_{lm}W[e(1 + t)] + A_{km}R[e(1 + t)] &= P_{mf} \\
A_{lx}W[e(1 + t)] + A_{kx}R[e(1 + t)] &= P_{xf}
\end{align*} \] ............... (2d)

and again \( X \) is more profitable.
In this simple model, where only traded goods are produced and consumed, therefore, the only adjustment required to get the right investment decisions, for moving the economy to the optimal production point P, in Fig. 1, is to correct the distortion in the relative price of the two traded goods. This can be done by 3 equivalent methods.

(1) Use domestic currency as the numeraire and use the effective import exchange rate (that is, the rate which converts the foreign currency price of imports into domestic prices $e(1 + t)$) as the S.E.R., for valuing all foreign currency transactions. This is the method suggested by a number of writers, UNIDO (13), Harberger (57), Schydowsky (127).

(2) Use foreign currency as the numeraire, and use the foreign currency 'border' prices as the shadow prices of the traded goods, and deflate the domestic factor prices by either the S.E.R. or official exchange rate to get their foreign exchange equivalents. This will be the Little-Mirrlees procedure (11), in this case.
(3) Work out the domestic resource cost per unit of their foreign exchange earned/saved by producing another unit of \( X/M \), and compare the two ratios with (in this case) the official exchange rate. From (1) for \( M \) this is:

\[
\frac{A_{lm} W + A_{km} R}{e} > e
\]

for \( X \), it is:

\[
\frac{A_{lm} W + A_{km} R}{P_{xf}} = e
\]

and again \( X \) will be preferred. This is the procedure suggested by Bruno \( \sqrt{47} \) and Kruger \( \sqrt{79} \). Comparing eqtns. 2(e) and (2b) it is obvious that the \( Bk \) ratio is a straightforward transformation of the SER cost benefit test.

Case 2: Two Traded, One Non-Traded Good Produced and Consumed

The above model has however been extremely simplified, as it did not include non-traded goods. The introduction of these radically changes the effects of exchange rate alterations on resource allocation, and introduces another distortion which is caused by the protective structure. In addition to the distortion of the relative prices within the traded good sector (which was the only distortion we had in Case I), we now have a further distortion as between the relative price of traded to non-traded goods. To see this, and the relevant adjustments necessary for project evaluation, we expand the previous model, by including a non-traded good \( N \),
which is domestically produced and consumed. We maintain our assumptions of the absence of intermediate inputs and the lack of any domestic distortions apart from the tariff on M. (There are no distortions in foreign trade given our assumption of fixed and constant terms of trade). We now observe the economy, with domestic prices, \( e\_P \), \( e\_P (1 + t) \), and \( e\_n \) of the three goods I, M, and N, in the post-protective situation, with an exchange rate \( e \). The economy is in internal and external balance, with \( W \) and \( R \) as the domestic money wage and rental rates of the two factors of production \( K \), and \( L \) (Row 1, Table 1). We now have the following production relationships:

\[
\begin{align*}
A\_m \dot{W} + A\_k \dot{R} &= e\_P (1 + t) \\
A\_x \dot{W} + A\_x \dot{R} &= e\_P \_x f \\
A\_n \dot{W} + A\_n \dot{R} &= e\_n 
\end{align*}
\]

At the existing domestic market prices, producers are indifferent as to whether a marginal increase in domestic resources is invested in X, M or N. However, as we have noted in Case 1, valuation at domestic prices underestimates the relative social benefit from the production of X relative to M. Hence the adjustment discussed for Case 1, is necessary to correct this; either of the three methods outlined will give the correct investment decisions, comparing X to M. What of the comparison of investments in N and M or N and X? This depends crucially upon what we expect will happen in the future to the protective structure.
(A) First let us assume that the existing protective structure will remain unchanged. As 'ex hypothesi' a marginal investment project will not change the W's and R's in (3), the MSC's of production are given by the costs at market prices, on the LHS of (3), and the only correction we need to make is for the value of the outputs (the RHS of (3)) to reflect the MSV's of the 3 goods. In domestic currency, the MSV of M is ePmf (1+t), the MSV of X (for the reasons given in Case 1 above) is ePxf (1+t), the MSV of N is Pn. Thus, in this case, the only adjustment which is required is, still, just the correction for the distortion between the MSV and MSC of using and producing a unit of foreign exchange. It is the same as in Case 1 above, and the use of an S.E.R. of e (1+t) on the lines of Case 1, will again give the right answer - the production of X, at 'shadow' prices, will be more profitable, relative to both M and N.

If on the lines of the LM procedure, we were using foreign currency as our numeraire, the value of the two traded outputs would be given by Pmf and Pxf. The values of the inputs and the non-traded good would be obtained by deflating the market W, R, and Pn, by the S.E.R. of e(1+t), as in Case 1 above. Equivalently, the 'shadow' price of N could have been derived directly from the cost data in Eqtn. 2 above once the values of W and R were given. This MSC of producing the non-traded good (from the cost data) is in our models also equal to its MSV (Pn/e(1+t)), as we are assuming that there are no distortions in the market for N. It should also be noted that in the LM procedures it is the MSC of the non-traded goods which is normally calculated. Thus, we get the result, that, to get the correct MSV's and
MSC's in terms of foreign currency, the values of the domestic factor (W, R) and goods (P_n) must all be deflated implicitly by e(1+t). This is also the SER to be used to convert foreign goods valuations into domestic currency using the domestic currency as numeraire method. The two methods (UNIDO/HS, and LM) are therefore equivalent in this case too, as they are in Case 1, and involve nothing more than a change in numeraire.

What of the third method (B/K)? As before the B_K ratios can be derived in all 3 cases as straightforward transformation of SER cost-benefit tests.

(B) Let us next assume that we expect that the protective structure will be removed in the future. What will be the relevant 'shadow' prices we should use, in evaluating current investment projects for producing X, K or N?

This is clear for X and M as can be seen from comparisons of Eqtns (2a) and (2e), using an SER of e(1+t). Whilst the B_K ratio for N will be: \[ \frac{A_{en}}{P_n e(1+t)} \leq e(1+t) \] which is again a straightforward transformation of Eqtn (3) using an SER of e(1+t).
Clearly, the relevant shadow prices will now be the prices of the goods and factors in the free trade situation.

To determine these prices, we consider what would happen to the prices of goods and factors in our model economy with the removal of the tariff on M. The resulting changes are best considered in two distinct stages. In the first stage, we assume that all other domestic prices, the exchange rate, and domestic expenditure, remain unchanged. With a reduction in the price of M by t% (the tariff rate), the relative domestic prices of the 3 goods X, M and N will change. With a fall in the price of M relative to both X and N, there will be a shift in domestic consumption from X and N towards M, and in domestic productive resources from M to X and N. Now consider the markets for M, X and N. In the market for M there will be excess demand, whilst in the markets for X and N there will be excess supply. Unless the excess demand for M is matched by an equivalent excess supply of X (an exceptional circumstance) there will tend to be a balance of payments deficit, given by the difference between the excess demand for M and excess supply of X. What is more, from Walras' law, this net excess demand for traded goods must be exactly equal to the excess supply of the non-traded good N. In the next stage therefore, to restore equilibrium it will be necessary to cure the balance of payments deficit, that is to eliminate the net excess demand for tradeables which is equivalent to curing the excess supply for the non-traded good N. This requires a fall in the relative price of the non-traded to the two traded goods.
The change can be brought about by two alternative adjustment mechanisms (or a combination of both). The first is with the exchange rate fixed, but with the domestic money price of N flexible. (This is the 'classical' adjustment mechanism). The other is with the price of N fixed, but with the exchange rate flexible. In the first case, the price of N, will fall from \( P_n \) to \( P_n^* \), with the domestic prices of \( X \) and \( M \) given by \( eP_x \) and \( eP_m \), at the fixed exchange rate \( e \) (see Table I, Rows I and II). If the adjustment mechanism is via exchange rate flexibility, then at the new equilibrium free trade exchange rate \( e^* \), the domestic prices of \( X \) and \( M \) will be \( e^*_x \) and \( e^*_m \) (\( e^* > e \)), and the price of the non-traded good will be the same as in the protection situation, \( P_n \). (See Table I, Row 3.) It is shown in Appendix I, that the necessary fall in the price of N, (with the exchange rate fixed) is equal to the required devaluation (change in the exchange rate from \( e \) to \( e^* \)), with the price of N fixed. As a result the domestic relative prices of the three goods will be the same in the free trade situation on both adjustment mechanisms. Hence they will lead to identical resource allocation effects, and factor price changes from the protection situation. Let these free trade factor prices be \( W^* \) and \( R^* \) (see Table 1, Row II and III). Clearly the relative rankings of the three goods in the free trade as compared with the protection situation will be the same with either of the adjustment mechanisms for altering the relative price of traded to non-traded goods.

Assuming, that, we know or can guess at the price changes (in \( W, R \) and \( e \) or \( P_n \)), and assuming the same adjustment mechanism, then either of the two alternative methods of using domestic currency as the numeraire and a
'shadow' exchange rate, or foreign currency as the numeraire and the LM method, will give the same ranking of the relative social profitability of investments in the three industries M, X and N. The third method (Bruno), is again a straight-forward transformation of the relevant SER test.

This model can be expanded to include traded and non-traded inputs. Appendix II, considers the changes in a model with Two Traded Goods Produced and Consumed and One Non-Traded Good Produced and Used as an Intermediate Input. It is shown that this case is similar to Case 1. The intermediate good merely serves as an indirect means of using the domestic factors capital (K) and labor (L). Domestic relative factor prices are again uniquely determined by the fixed and given relative commodity prices, which are given by "border" prices. A tariff on K, again, merely distorts the domestic relative prices of traded commodities. Given this distortion, the relative factor prices are still uniquely determined, independently of domestic demand conditions, by the domestic prices of traded goods alone. With the removal of the tariff the relative factor prices will change. Then, if the exchange rate is fixed, the price of N will be uniquely determined. Alternatively if the price of N is fixed, the necessary exchange rate change will again be uniquely determined by the production relationships alone. All these points are proved in Appendix 2.

The adjustments in project analysis which are necessary in this case will be similar to those in Case 1 above. Once again exchange rate changes will not have real resource allocation effects. Balance of
payments disequilibrium can only be cured by expenditure reduction, and not by expenditure switching.

We could go on to consider more complex and general models with traded and non-traded intermediate goods, and complex systems of taxes and subsidies on exports. However, for our purpose of comparing alternative procedures for project selection, the above two models are sufficient to bring out the essential points which we consider in the next section.

II

Alternative Procedures - Theory

We now compare the various procedures which have been suggested for project evaluation in an economy with sub-optimal trade controls.

1) The UNIDO, Harberger, Schydlowsky (UHS) shadow exchange rate \( \sqrt{(10, 6, 12, 13)} \). These procedures only correct for the distortions in relative prices within the traded goods sector. Thus, implicitly, the relevant model for these procedures\(^1\), is our Case 2, (A), with the protective structure unchanged (which as we saw above, reduces to Case 1, in terms of estimating shadow prices).

The SER is derived as the MSV of foreign exchange in the protection situation which, in our simple model, is \( e(1 + t) \). The general formula for this case is provided in Bacha and Taylor (1), and it is "the weighted sum of domestic prices of traded goods, divided by a similar

weighted sum of world prices, the weights in each case being the marginal changes in imports and exports induced by the project" (1, p. 205).

2) The Bacha and Taylor (BT) 'equilibrium' exchange rate (1) - The relevant model for this procedure is our Case 2(b), with the protective structure removed and equilibrium maintained by variations in the exchange rate and with the price of the non-traded good ($p_n$) fixed. This procedure takes account of the distortions within the traded good sector and those between the traded and non-traded goods sector, caused by the sub-optimal trade controls.

From our discussion in the preceding section of this case, it is clearly not sufficient just to calculate this equilibrium exchange rate; we also have to determine the new relative factor prices ($w^*, r^*$) in the new free trade situation. Without calculation, and use of these, in conjunction with the 'equilibrium' exchange rate, the resulting project evaluation rules would be incorrect. These points are obscured in the discussion by Bacha and Taylor.

3) The Bruno - Kruger (BK) test (4, 9) - This computes the domestic resource cost of the net foreign exchange earned/saved by a project. If the net foreign exchange saved/earned (taking account of direct and indirect inputs) by the project (in foreign currency) is $F$ dollars and if the total (direct and indirect) resource cost is $D$ rupees the BK ratio is $D/F$ Rs. per $,$ and this is clearly like an exchange rate. It gives the exchange rate at which the project would be acceptable. If the economy was in equilibrium in free trade (with no distortions domestically or in foreign trade), and the market exchange rate were $e^*$, then projects could be selected by using $D < e^* \frac{F}{P}$ as an investment criterion for tradeable goods, the $D$ and $F$ terms being valued at market prices. If, however,
as is our concern, we want to evaluate projects in an economy with
sub-optimal trade controls, there is the problem of what prices to use
in determining $D, \sum F$, given the small country assumption, being still
determined by given world prices $\gamma$, and what cut-off exchange rate ($e$)
to use to select projects. This clearly depends upon what alternative
assumptions we make about (i) whether there will be trade liberalization
in the future and (ii) whether with trade liberalization, external balance
will be maintained by exchange rate flexibility or domestic price flexi-
bility, as discussed in Case 2, in Section I above.

Firstly, if it is assumed that the protective structure will
remain unchanged, then clearly Case 2 (A) is the relevant model, and we
will, because of the distortion within the traded good sector, have
$\frac{D_x}{F_x}$
for exports less than $\frac{D_m}{F_m}$ for imports, the $D_1$ naturally being evaluated
at the domestic prices in the protection situation. Comparisons of
$\frac{D_x}{F_x}$ and $\frac{D_m}{F_m}$ with the official exchange rate are clearly irrelevant
in this case, for choosing projects. The relevant comparison would seem
to be the effective exchange rate for exports $\frac{D_x}{F_x}$. If, however, the
supply curve for exports is upward sloping $\frac{D_x}{F_x}$ will rise towards $\frac{D_m}{F_m}$
with an increase in production of exports. So that, in each case we would
have to recalculate the marginal $\frac{D_x}{F_x}$, with which the project to be
appraised must be compared. A rough and ready method would take an
average between $\frac{D_m}{F_m}$ and $\frac{D_x}{F_x}$ as the cut-off exchange rate for selecting
projects. Note that both these alternative methods of determining the
cut-off rate will give different answers for project selection from those
derived by using the UHS shadow exchange rate. The latter, would multiply
the F component by the UHS SER, \( e(1 + t) \). The criterion for acceptance would be \( e(1 + t)F - D > 0 \), or equivalently \( D F < e(1 + t) \). The Bruno and UHS methods would thus only give identical answers if \( e(1 + t) \) was taken as the cut-off exchange rate for the Bruno test. But from our discussion of the UHS, we know that \( e(1 + t) = D_m/F_m \), so that, for the two procedures to be equivalent the effective import rate would have to be taken as the cut-off rate for the Bruno ratio, in project selection.\(^5\)

Secondly, if it is assumed that the protective structure will be removed and equilibrium maintained by exchange rate changes with the price of N fixed, then the relative cut-off effective rate is the "equilibrium" exchange rate (our \( e^* \), Table 1), and in calculating the D, primary factors should be valued at their prices in the free trade situation, and not at the existing market prices in the protection situation. The procedure would now be a straightforward transformation of the BT procedure. Alternatively, if the exchange rate is inflexible but the domestic price of N is flexible, then the relevant cut-off rate for the Bruno criterion will be the existing official exchange rate \( e \), but it will be necessary to estimate the prices of N, and the primary factors, when the protective structure is removed. The BK ratio, therefore, is merely a straightforward transformation of the relevant SER cost/benefit tests. Thus even though it was not originally formulated to deal with non-traded good outputs, a BK ratio for these goods can be derived on either assumption about future trade policy, with the foreign exchange value of the output of the non-traded good being obtained by converting the relevant domestic price of the non-traded good into foreign currency at the appropriate SER, and using the same SER as the cut-off rate.\(^6\)

\(^5\)/ This point is again obscured in Bacha & Taylor's survey (1).

\(^6\)/ See footnote 3 above.
4) The Little Mirrlees (LM) Method - takes foreign currency as its numeraire, values tradeable inputs and outputs at their border prices (given and constant in our models) and those of non-tradeables by breaking them down into tradeables and primary factors. The foreign exchange value equivalents of the latter are determined by valuing the marginal product of these factors in terms of foreign exchange. Its validity is not dependent on the particular assumptions made about trade liberalization.

Thus, firstly, if it is envisaged that the protective structure will remain unchanged (Case 2 (A)), the LM method will give the same results as the UHS method. In the simple model of Section I (Case 2 (A)) the LM method involved a mere change in numeraire compared with the UHS method. Domestic factor and non-traded good 'shadow' prices would be deflated implicitly by $e(1 + t)$, on the LM method, and traded good prices would be taken at their foreign currency values. On the UHS method, domestic factor and non-traded good 'shadow' prices would be their domestic market prices, and the foreign currency values of traded goods would be multiplied by $e(1 + t)$ the UHS shadow exchange rate.

7/ One of the purposes of the previous section was to show how the LM procedures can be extended to cases when the future protection structure is assumed unchanged. Though the LM Manual places its main emphasis on the future trade liberalisation assumption, the authors are aware that their rules are applicable also in cases where non-optimal trade policies are followed. See (11), p. 69, footnote 1.

8/ The deflation is implicit because non-traded good prices are derived from the MSC of their production with the relevant factor prices expressed in terms of foreign exchange. See the following discussion of the determination of the non-traded good price with trade liberalisation and footnote 10, to see the implicit nature of the SER determined on the LM procedures. The remarks in Part III, which refer to the BT SER, and show why an implicit determination of the BT SER on LM procedures may be better in practice than an explicit, determination apply equally to comparisons of the UHS SER and the relevant LM procedures.
If it is assumed that trade liberalization will take place, then with the exchange rate fixed and the prices of non-traded goods flexible, the LM procedure would take the foreign prices of tradeables as given, and work out the implicit prices of the non-traded goods and factors in the free trade situation, in terms of their foreign exchange equivalents. With trade liberalization, the exchange rate were to be changed, the LM method would again take the foreign prices of tradeables as given, and determine the free trade foreign exchange equivalent prices of the non-tradeables and domestic factors at the 'new' exchange rate.

The adjustment mechanism with trade liberalization, which is implicit in LM, however, is of the second sort, namely, with the prices of domestic goods inflexible and a flexible exchange rate (11, p. 53, 135). The method is therefore similar in its aims to the HT procedure. Unlike the latter, however, the LM procedures provide a way of estimating not only the relative price of traded to non-traded goods, but also for approximate calculation of the factor price ratio in the free trade situation. To see this it is necessary to briefly consider the estimation of the 'shadow' wage rate in the LM method.

As we are assuming no other distortions apart from trade distortions, two aspects of the LM shadow wage are redundant for our purposes, namely, the distortion due to a higher industrial wage than the social opportunity cost of labor given by the value marginal product of labor in agriculture, and the distortion due to the government's inability to directly legislate the optimum savings ratio. The shadow wage in the LM method for our purposes, therefore, is given by the value
marginal product of labor in agriculture \( (m) \), whose value in foreign currency is, say, \( P_{Lf} \). If agricultural output consists of tradeables whose 'border' prices are given and constant, \( P_{Lf} \) is determined from the world market in terms of foreign currency. Assuming that there is an elastic supply of labor at this 'shadow' wage, the value of \( W \) in terms of foreign currency, in Table II, is fixed for all the 3 cases (Rows I to III) considered. The removal of the tariff and the subsequent adjustment process will still change the wage rental ratio from that in the protection situation, but given that the wage is constant (in terms of foreign currency) this will be the result entirely of changes in \( R \) (the rental rate). Looking at Row II, Table II, we have, in terms of foreign currency, the price of \( M \) as \( P_{mf} \), of \( X \) as \( P_{xf} \) and of \( L \) as \( P_{Lf} \) (all given by constant 'border' prices). The foreign exchange equivalent of the rental rate \( R \) is \( R^* / e^* \). We could estimate or guess the value of \( e^* \) and this will immediately give us the value of \( P_n / e^* \), but in addition we still have to estimate or guess the value of \( R^* \). Suppose instead the value of \( R^* / e^* = P_{kf} \) is estimated or guessed (and not of \( R^* \) and \( e^* \) separately), then from equation (3), of Part 2, we have

\[
a^{LN} P_{Lf} + a^{KN} P_{kf} = P_n^{**} \ldots (3a)
\]

and the price of the non-traded good in the free trade situation in foreign currency will be determined as soon as \( P_{kf} \) has been estimated or guessed. Thus given the input/output coefficients (\( a_{ij} \)) and with \( P_{Lf}, P_{xf} \) and \( P_{mf} \) determined by the 'world' market, the only estimate we need to make is of \( P_{kf} \) that is the rental rate in terms of foreign currency in the free trade situation. 9/

9/ As this will give the value of \( P_n / e^* \), implicitly, the value of \( e^* \) would have been determined. There are, however, practical advantages in not having to estimate \( e^* \) explicitly, as outlined in Part III.
Now note that $P_{ki}$, in our simple neo-classical model, is also the rate of return on investment. Suppose, in guessing $P_{ki}$, we guess a number which is less than the true number, this will mean that more investment will be undertaken in the economy than is feasible in equilibrium. The excess of investment will spill over into a balance of payments deficit on the lines of the absorption approach of balance of payments theory. Assuming that consumption cannot be cut (ex hypothesis the wage rate is fixed and is all consumed), the only way in which the balance of payments deficit (actual or incipient) can be cured is with a rise in $P_{ki}$, and a consequent cut in investment. Iteratively, therefore, the $P_{ki}$ which will maintain equilibrium would be determined. This shows why in the LM procedures, once $P_{lf}$, $P_{xf}$ and $P_{mf}$ are determined by 'border' prices, balance of payments deficits can be only cured by changing absorption, by changing the level of investment via changes in $P_{ki}$. (In LM terminology the ARI, see [11] pp. 89, 138, 139). Thus, on the LM procedures, given no domestic distortions, the only 'price' the project evaluator would have to 'guess' is the $P_{ki}$ in terms of foreign currency (the ARI) in the free trade situation. The $P_{lf}$, $P_{xf}$, and $a_j$'s (assuming fixed coefficients) would be known directly from the protection situation.

10/ If the protection situation is assumed to continue, then given an invariant, $P_{lf}$, it will only be necessary to estimate/guess the $R$ in terms of foreign currency in the protection situation to get the shadow price of $N$. As this will give the value of $P_{n}/e(1 + t)$, again implicitly, the UHS SER $e(1 + t)$ would have been estimated, though again there will be practical advantages in not having to estimate the UHS SER explicitly (See Part III).
We can contrast the LM procedure with the BT procedure which works in terms of an 'equilibrium' exchange rate. Making the same assumption of an elastic supply of labor at a constant wage in terms of the alternative value marginal product of labor in terms of tradeables (whose foreign currency value is P LF) we have (Table II, Row III) in the free trade situation, the price of I, M and N, as eP xf, eP mf and P n, and

11/ It may seem odd that we are assuming that the LM procedure assumes that the wage rate is constant in terms of a constant value marginal product of labor valued in foreign currency. Whereas the normal assumption is of a fixed money wage. The reason why the latter is eliminated from our discussion is because of our perfectly competitive assumptions, which necessitate that labor is paid its alternative value marginal product. In the general IM discussion, it is assumed, both that the money wage paid by the industrial sector (W) is constant, and that the value marginal product of labor (LM) in terms of foreign currency (M) is constant. The LM, SWR then is SWR = C - \frac{1}{2}(C-M), where S reflects the premium on savings relative to consumption, and C is the value of 'W' in terms of foreign exchange, and with C > M. With an exchange rate change, say a devaluation, with the money wage, W constant, C must fall, but M will remain the same. In the general IM case, therefore, exchange rate changes, for instance, those accompanying trade liberalization, will involve (or reflect) changes in the SWR (assuming S > 1, and C ≠ M) and vice versa. (That is, if an exchange rate change is anticipated in the future, the SWR will be lower, see 11, p. 138). However, as we are assuming perfectly competitive labor markets C = M, and as the value of M is assumed constant in terms of foreign currency, for our purposes the SWR cannot change. (For the necessary assumptions about peasant farming implicit in assuming M constant, see IIA (10)). Also from the general SWR formulation it can be seen that, whilst on the one hand, for a balance of payments deficit to be cured, the SWR will tend to be lower as C will be lower because of the necessary exchange rate change, on the other hand, there will also have to be some reduction in domestic absorption, which (assuming consumption cannot be cut) will mean a reduction of investment and hence a rise in R (the LM, ART), this set par. will tend to raise S, and hence raise the SWR. Given M, the net change in the SWR will thus depend upon these two opposing effects of a fall in C and a rise in S. These two opposing tendencies are caused by the two instruments which are normally necessary to cure a balance of payments deficit to achieve internal and external balance, namely, a combination of expenditure switching (the exchange rate change) and expenditure reduction (the cut in investment and rise in R).
the factor prices as $W^* = e^* P_{Lf}$, and $R^*$. Comparing rows II and III in Table II, it is obvious that given a correct estimate of $e^*$, and the same values for $P_{xf}$, $P_{mf}$, $P_{lf}$, the $a_{ij}$'s and $R^*$, both the LM and BT procedures, are equivalent. These points are given obscured in the BT survey (1).

5) It may be noted that so far we have not considered rankings according to effective protective rates (1, 3) as a project selection procedure. This is because, in principle, rankings according to effective protective rates (kR's) cannot in general indicate the social desirability of investment projects. For instance, consider two industries I and II. An investment of Rs 100 in both produces returns to primary factors other than capital of $10 for industry I and $3 for industry II, so that if the social return to capital is 10%, and the free trade exchange rate is $1 = Rs 1, the value added at world prices ($V^*$) is Rs 20 in I ($V_{I}^*$) and Rs 18 in II ($V_{II}^*$). (As there are no other distortions assumed apart from trade distortions, the market prices of the primary factors are their shadow prices in both the protection and free trade situations). The returns to primary factors other than capital, at domestic prices in the protection situation, are Rs 40 in industry I and Rs 10 in industry II. The social rate of return is assumed to be the same in both the free trade and protection situation viz. 10%. (The changes in the factor price ratio in the free trade from the protection situation will thus be due to changes in the wage rate). Hence the value added at domestic prices in the protection situation ($V$) is Rs 50 in I ($V_{I}$) and Rs 20 in
II (\(V_{II}\)). The net EPR (Z's) defined as \(Z = (V - V^*)/V^*\) for the two industries are

\[
Z_I = \frac{50 - 20}{20} = 1.5 \\
Z_{II} = \frac{20 - 18}{18} = 0.1
\]

Ranking and choosing projects according to EPR's and taking a zero Z as our benchmark, industry II would be preferred to I. Though the rate of return (R) at world prices of the two industries is

\[
R_I = \frac{10}{100} = 10\% \\
R_{II} = \frac{8}{100} = 8\%
\]

that is I is clearly socially more profitable than II. There are, however, obvious links between EPR's and the ZER or LM procedures (see 1), and between EPR's and the B/K ratio (see 3). But as the above example demonstrates, ranking by EPR's cannot in general be used as an investment criterion.\(^{12}\)

\(^{12}\) Formally, assuming for simplicity (a) no other distortions apart from the distortions resulting from non-optimal tariffs and subsidies, so that market prices of factors of production are then shadow prices, and (b) that any domestically produced intermediate goods are treated as importables, then for any industry \(i\), the following competitive cost conditions will hold under

(i) protection: \(eP_i(1 + t_i) - e \sum_{j} a_{i j} P_j(1 + t_j) - \sum_{j} a_{i j} \cdot w_{j} = 0\)

(ii) free trade: \(eP_i - e \sum_{j} a_{i j} P_j - \sum_{j} a_{i j} \cdot w_{j} = 0\)

where \(e(s^{*})\) is the protection (free-trade) exchange rate; \(P_i(p_i)\) is the foreign currency price of the output of the \(i\)th industry (the \(j\)th intermediate input); \(t_i(t_j)\) is the tariff on the \(i(j)\)th good; \(w_i(w_j)\) is the market-shadow price of the \(i\)th factor of production in the protection (free trade) situation; \(a_{i j}(s_{i j})\) are the input coefficients of the imported inputs and the primary factors respectively in the protection (free-trade situation). Ranking industries on the
Ki¶ criterion

z = \left( \frac{1}{\xi_1} \frac{\xi^*_{11} \nu_1}{\nu^*_{11}} \right) - 1 \quad \text{---------}(9.2)

will not in general order them according to their comparative advantage, unless the strict assumptions of the Hecksher-Ohlin model of trade, viz. "the identity of technology and demand patterns (further required to be 'homothetic') in the trading countries", hold. See Findlay (14) p. 199-202. From the data collected for the EPR's however, the relevant (and correct) BK ratio can be derived, and this will be

B = \frac{\xi^*_{11} \nu_1}{(p_i - M_j p_j) \xi^*} \quad \text{---------}(9.3)

Thus contrary to the assertions of Balassa and Schydlowsky (BS)((3), and more recently, in the Journal of Political Economy, January-February 1972) their 'social' EPR's cannot be used as a general investment criterion. It may however be noted that Findlay, and it seems at times BS interpret the BK criterion to be a transformation of (9.2) above, that is as \frac{\xi_{11} \nu_1}{(p_i - M_j p_j) \xi^*}. We have however argued that the correct BK ratio (assuming trade liberalization) is given by 9.3, which is a valid investment criterion as it is a straightforward transformation of the ET SER benefit/cost test. However, if the BK ratio is interpreted as 9.2, then the same criticisms will apply to it as the EPR criterion.
III.

Alternative Procedures - Practice

We now turn to the practical application of the various procedures. Their practicality and usefulness will depend upon (a) the realism and relevance of the assumptions on which they are based and (b) the practical problem of obtaining the data for making the adjustments which the different methods envisage.

From Section II, it is clear, first, that the BK ratio is merely a straightforward transformation of the SER procedures. It requires the same information but gives a measure which whilst ranking industries identically to the SER procedures, is less clearly linked to capital theory than rate of return measures. There would therefore seem to be no advantage in using it in preference to the rate of return measures. Secondly, that except for the LM procedure, the other two procedures, the UHS and BT SER's are only valid on two mutually exclusive assumptions about the future course of the economy. They make diametrically opposed assumptions about future trade liberalization. However, given (i) that trade controls are seldom fixed; (ii) that most developing country governments have at some stage or another actually moved towards trade liberalization; and (iii) that trade liberalization would often maximize feasible welfare, it is important to know the impact of projects on potential welfare. For this purpose the BT SER (and the appropriate LM procedure) is the relevant adjustment procedure. However, if in some countries the likelihood of future trade liberalization appears remote, it may be desirable to do two sets of calculations for every project. The first with the UHS SER (or the appropriate LM procedure) which shows the relevant social profitability of investment projects assuming the continuance of existing sub-optimal trade controls. The second with the BT SER (or the equivalent LM procedure) which would show how potential welfare is affected by the various investment projects. The purpose of the latter calculation being in part to persuade the decision makers to move to a more optimal trade policy.
Moreover, these potential effects may be the only effects which can be calculated with any precision in practice, given that the actual effects are dependent upon the vagaries of government trade control policy - something which is often an unknown for the government itself, leave alone an outside project evaluator.

The remaining practical question then is: whether it is better/easier to use the relevant SER or LM procedures for the two sets of calculations.

From our discussion in the last section it is clear that, in practice, LM, BT and UHS procedures require a knowledge of \( P_x, P_f, P_L, \) and the rental rate (\( R \)) in terms of domestic or foreign currency in the free trade protection situation. The foreign prices, are assumed given from 'border' prices; this means 'guessing' or approximately estimating the likely rental rate in the free trade protection situation.

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13/ In our analysis in this paper we have implicitly assumed that the trade distortions were in the form of unchanging tariffs/subsidies. In practice, however, most developing countries make extensive use of quantitative restrictions (QRs) along with tariffs. The correct shadow price of a good subject to a QR will depend upon how the QR regime is operated. In one limiting case, the QRs could be operated in a manner equivalent to a tariff, whereby the full impact of any increased supply or demand for the good subject to QR is on trade. The same considerations we have discussed in our models with fixed tariffs, would in that case be relevant in determining the shadow price of the good. The other limiting case would be with a rigidly fixed QR, so that the impact of increased demand and supply is purely on domestic production and consumption. In this case the good will be equivalent to a non-traded good, and the methods for valuing non-traded goods on the alternative procedures, will be relevant in determining its shadow price. The difficult problems arise in intermediate cases where the working of the QR regime falls between these two limiting cases. In that case the increased use or production of the good subject to a QR may in part be on trade, in part on domestic production, and in part on domestic consumption. The shadow price of the good will then be the appropriately weighted sum of the producer's and consumer's surpluses associated with these changes in trade, production and consumption.
Once this has been done, the relevant LM procedure would immediately give the social returns to the project under consideration, without any further computation. In the case of BT and UHS, however, there would have to be the additional step of calculating the 'equilibrium' 'shadow' exchange rate \( e^*/(e(1+t)) \). The essential simplicity and superiority of LM procedures, in practice, depends upon its cutting through the need to estimate \( e^*/(e(1+t)) \), even though in principle the LM and SER methods are equivalent.

To see this, compare the estimation procedures on the BT and LM (with trade liberalization) methods. The following line of argument applies, mutatis mutandis to comparisons of estimation procedures on the UHS and LM (with unchanged protection) methods.

Write, \( R^*/e^* \), the foreign currency equivalent of the rental rate in free trade as \( P_{k_f} \), and \( P_n^*/e^* \) as \( P_{n}^{**} \). Then at the protection exchange rate \( e \), the values of the domestic relative prices of the 3 goods and two factors in domestic currency with free trade will be given by Row II in Table II. While Row III gives the prices in domestic currency at the BT 'equilibrium' exchange rate. Consider Row II. We have \( P_{x_f}, P_{m_f}, P_{l_f} \), given by 'border' prices. Suppose we can guess \( P_{k_f} \). Then from the equation (3a) in Section II, \( P_{n}^{**} \) is determined, and the relative prices to be used in project evaluation on the LM procedures are determined without any need to estimate \( e^* \). Remembering that we have guessed \( P_{k_f} \), what are the results of errors in this guess? First, if the K input in \( N \) is large (that is, non-traded goods are relatively capital-intensive), then the \( P_{n}^{**} \) we have derived will tend to be wrong, as the correct MSC of \( N \) (which is its 'shadow' price) will depend upon the correct valuation of the capital (K) input in its production. If, however, either \( N \) is relatively more labor-intensive (hence errors in valuing the relatively small component of the MSC of \( N \) -- the K input will not affect the correct MSC of \( N \)), and/or, the proportion of non-traded goods to traded goods is small (in the limiting case we have only traded goods as in Case I, Section II) the error in the estimate of \( P_{n}^{**} \)
as a result of errors in estimating $P_{kf}$, will not be very important in practice for evaluating and ranking projects. The second effect of a mistake in estimating $P_{kf}$ will be to provide an incorrect cut-off rate for the IRR of projects. This will imply that the volume of investment will be too large (small) relative to the 'equilibrium' level if $P_{kf}$ is underestimated (overestimated) and this will imply a balance of payments deficit (surplus). However, as soon as it appears that a particular cut-off rate ($P_{kf}$) implies an excess (deficiency) of domestic investment, then the cut-off rate will be raised, and thus the correct $P_{kf}$ will be iteratively approximated. Thus, in a relatively open economy, the LM procedures will give a good approximation to the 'true' relative prices to be used in project evaluation without the need to estimate $e^*$. In fact, as Table III shows, if $P_{kf}$ is known, $e^*$ is redundant.

The last statement seems to imply that it is equally irrelevant that we do not have an accurate estimate of $e^*$ on the BT procedures. This would be true if the LM procedures of identifying and estimating $P_{lf}, P_{kf}$ and thereby determining $p^{**}$ were also followed on BT procedures. In practice, however, this is not likely to be done, and only the prices of $X$ and $N$ will tend to be 'shadow' priced with $e^*$ and the domestic price of $N$ ($P_n$) will be taken as its 'shadow' price (see 2). But in that case, especially in a relatively open economy, a correct estimate of $e^*$ becomes essential. For consider Rowe III of Table II, we will now have $p_n, W^*, R^*$, $p_x$, and $p_{mf}$ given. To get the correct relative price of the traded goods ($X, M$) to the domestic goods and factors ($N, L, K$), the whole burden falls on the estimate of $e^*$. However, as can be seen from an examination of the BT formula for calculating $e^*$. 
(see 1, p. 216) getting a reasonably accurate estimate of this variable is going to be extremely difficult in an open economy (one with even a relatively small number of traded goods, say, 100) in which there are complex trade controls, including quotas and multiple exchange rates (factors not taken into account in the BT formula). Further complications arise in calculating the BT rate as the system of trade controls is changed, and hence the weights (imports and export shares of different commodities) and the effective protective rates which enter the formula change, thereby altering the estimate of $e^*$. All these complications can be cut through by the use of LM procedures, which would (in a relatively open economy) only require the estimation of the MSC's of a few non-traded goods. Therefore, in practice, LM methods are likely to be easier to apply than a correct application of the BT procedures. (This conclusion is the reverse of that reached by BT(1)!)  

\[ e^* = \left( \frac{1}{1+s} \right) \frac{E_x + (1+t_1) M_1}{m_1 (M_1 + M_2)} + \left( \frac{1}{1+t_2} \right) \frac{M_2}{m_2 (M_1 + M_2)} \]

where

- $e$ = is the protection exchange rate
- $(1+e)$ - is the export subsidy to $X$
- $(1+t_1)$ - is the tariff on imports of $M_1$
- $(1+t_2)$ - is the tariff on imports of $M_2$
- $M_1, M_2$ - total imports of $M_1$ and $M_2$
- $m_1, m_2$ - the elasticity of demand for imports of $M_1$ and $M_2$
- $E_x$ - the elasticity of supply of exports of $X$.

Studies done at Nuffield College, Oxford, show that for example for Ceylon and Kenya, it has only been necessary to estimate the MSC's of about 15 non-traded goods when applying LM procedures. Naturally, for relatively closed economies (where the number of non-traded goods is large relative to traded goods) it will be easier to apply SBR rather than LM methods. Whilst in completely closed economies there would be no problem of adjustments for trade distortions!
Another argument for favoring the use of LM rather than BT procedures is one of diplomacy. Even though in principle the two methods are equivalent, governments are not likely to take kindly to the calculation (and publication!) by the project evaluators, of the 'shadow' exchange rate for their countries (especially if these calculations are done by 'outsiders') as this would be an open acknowledgment that the 'official' exchange rate was wrong! Thus, whilst achieving the same ends for the purposes of project evaluation, the LM procedures are likely to be more palatable.

Finally, it should be noted, that all the methods we have discussed, if applied properly, need estimates of the 'border' prices of tradable commodities. Thus the common impression that LM procedures require any extra information, beyond that required by other evaluation procedures is completely mistaken. For relatively open economies, the LM methods provide the simplest methods for taking proper account of trade distortions, and enabling countries to choose projects in line with their comparative advantage.

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BD is the foreign price ratio.

P and C' are the production and consumption points with free trade.
P_1 and C_1 are the production and consumption points with a tariff (given by differences in the slopes of EF and AC).

EF is the domestic price ratio with the tariff.

I_1 I_1 is the indifference curve giving the welfare level at the free trade consumption point.

I_0 I_0 is the indifference curve giving the welfare level at the tariff-distorted consumption point.

OB/OD is the value of domestic expenditure at foreign ('border') prices, in the free trade situation, with X/M as the numeraire.

OA/OC is the value of domestic expenditure at foreign ('border') prices, in the tariff situation, with X/M as the numeraire.

C' is the Engel's curve assuming a constant tariff (given by differences in the slopes of EF and AC).
Table I

Goods and Factor Prices

<table>
<thead>
<tr>
<th>Goods</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Protection</td>
<td>X M N L K</td>
</tr>
<tr>
<td>Prices</td>
<td>$e^p_{xf}$ $e^p_{mf}(1+t)$ $p_n$ W R</td>
</tr>
<tr>
<td>II. Free Trade, Fixed Exchange Rate and $p_n$ Flexibles</td>
<td></td>
</tr>
<tr>
<td>Prices</td>
<td>$e^p_{xf}$ $e^p_{mf}$ $p^<em>_n$ W</em> R*</td>
</tr>
<tr>
<td>III. Free Trade $p_n$ Fixed and Variable Exchange Rate</td>
<td></td>
</tr>
<tr>
<td>Rate</td>
<td>$e^<em>_{xf}$ $e^</em>_{mf}$ $p_n$ W* E*</td>
</tr>
</tbody>
</table>

Table II

Comparison of Goods and Factor Prices on the LM and BT Procedures

<table>
<thead>
<tr>
<th>Goods</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Protection Situation (domestic currency)</td>
<td>X M N L K</td>
</tr>
<tr>
<td>$e^p_{xf}$ $e^p_{mf}(1+t)$ $p_n$ $e^p_{Lf}(-w)$ R</td>
<td></td>
</tr>
<tr>
<td>II. Free Trade, LM (foreign currency)</td>
<td>$p_{xf}$ $p_{mf}$ $p^<em>_n = \frac{p_n}{e^</em>}$ $p_{Lf}$ $p_{kf} = \frac{R^<em>}{e^</em>}$</td>
</tr>
<tr>
<td>III. Free Trade, MT (domestic currency)</td>
<td>$e^<em>_{xf}$ $e^</em><em>{mf}$ $p_n$ $e^*</em>{Lf}(-w^<em>) R^</em> = e^*_{P_kf}$</td>
</tr>
</tbody>
</table>

Note:
- $e$ is the exchange rate
- $p_{xf}$ is the foreign currency price of X (the exportable)
- $p_{mf}$ is the foreign currency price of M (the importable)
- $p_n$ is the price of the non-traded good N
- $R$ is the rental rate on capital
- $W$ is the wage rate
APPENDIX I

Case 2: Two Traded, One Non-Traded Good Produced and Consumed

We want to show that the relative prices of the three goods, the importable (M), exportable (X) and non-traded (N), (in domestic currency), and hence the wage rental ratio (w/r) in the post protection situation is the same whether the adjustment mechanism is with the exchange rate fixed and the price of the non-traded good flexible, or with the price of N fixed and the exchange rate flexible.

Let the production relationships (assumed homogenous of degree one) be given by:

\[ M = L_m f_1(k_m) \]
\[ X = L_x f_x(k_x) \]
\[ N = L_n f_n(k_n) \]

where \( L_i \) is the quantity of labor employed in the \( i^{th} \) industry (\( i = M, X \)) and \( k_i = K_i/L_i \), that is the capital (K) - labor ratio in the \( i^{th} \) industry.

Under competitive conditions we have

\[ r = p_1 f_1 \]
\[ w = p_1 (f_1 - k_1 f'_1) \]

where \( r \) is the rental rate, \( w \) is the wage rate, \( p_1 \) is the price in domestic currency of the \( i^{th} \) good, and the prices refer to first derivatives of the respective functions.

(2) determines a unique relationship between the wage-rental ratio (w/r) and \( k_1 \). Given the wage rental ratio, the relative supply prices of any two commodities \( (p_1/p_2) \) will be given by

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1/ For this derivation and the method of analysis adopted see Kemp: The Pure theory of International Trade, p. 1343-136.
\[ \left( \frac{p_1}{p_2} \right) \left(\frac{\text{w/r}}{\text{w/r}}\right) = \frac{w/r + k_1 (w/r)}{f_2 (k_2 (w/r))} \cdot \frac{w/r + k_2 (w/r)}{f_1 (k_1 (w/r))} \]

Differentiating logarithmically with respect to \((\text{w/r})\) yields:

\[ \frac{w/r}{(p_2/p_1)} \frac{d(p_2/p_1)}{d(w/r)} = \frac{w/r (w/r + k_2 - w/r - k_1)}{(w/r + k_1) (w/r + k_2)} \]

\[ \text{Taking the price of the exportable (in domestic currency) as the numeraire, we define,} \]

\[ R_0 = \frac{p_n}{p_x} \quad \text{and} \quad R_1 = \frac{p_m/p_x} {R_1} \]

and writing \(\text{w/r}\) as \(W\), we have form (3) the necessary change in \(W\), as a result of a change in \(R_1\) (or vice versa), as

\[ \frac{dR_1}{R_1} dW = \frac{(k_m - k_x)/(W + k_x)}{(W + k_m)} (W + k_x) \]

But clearly given \(dW\), that determines the \(dR_0\) at which it is profitable to produce \(N\), (given that all three commodities are produced in the post protection situation), and hence we also have from (3)

\[ \frac{dR_0}{R_0} dW = \frac{(k_n - k_x)/(W + k_n)}{(W + k_n)} (W + k_n) \]

Dividing (5) by (4) yields:

\[ \frac{dR_0}{R_0} dR_1 = \frac{(k_n - k_x)/(W + k_m)}{(k_m - k_x)/(W + k_m)} (W + k_n) \]

Let the prices of the three goods \((M, X, N)\) be \(e p_M (1 + t), e p_{MF}, \) and \(p_n\) respectively in the protection situation, where \(e\) is the protection exchange rate, \(p_M\) and \(p_{MF}\) are domestic currency prices of \(M\) and \(X\) (which are assumed to remain constant), and \(t\) is the tariff rate.

With the removal of the tariff and with the adjustment mechanism via exchange rate flexibility and with the price of \(N\) fixed, let the prices of the three goods in domestic currency in free trade be \(e^* p_{MF}, e^* p_{XF} \) and \(p_n\). Denoting the relative price ratio's (\(R^n\)) in the free trade situation, with exchange rate flexibility by single primes we have:

\[ R'_0 = p_n'/e^* p_{XF} \]

\[ R'_1 = e^* p_{MF}'/e^* p_{XF} = p_{MF}'/p_{XF} \]

\[ \text{(7)} \]
Alternatively, with the removal of the tariff, let the adjustment mechanism be via flexibility in the non-traded good price, and with the exchange rate fixed, and the prices of the three goods in the free trade situation $e_{mf}$, $e_{xf}$, and $p_n^*$, where $p_n^*$ is the price of the non-traded good, $s$ is the protection exchange rate, and the $p$ terms are the given constant foreign currency prices of $M$ and $X$. Denoting the relative price ratios with this alternative adjustment mechanism, in the free trade situation by double primes we have:

$$R''_0 = \frac{p_n^*}{e} p_{xf}$$

$$R''_1 = e_{mf}/e_{xf} = \frac{p_{mf}}{p_{xf}}$$

From (7) and (8) it follows that $R'_1 = R''_1$, and hence $dR'_1 = dR''_1$.

Hence from (6) it follows that,

$$\frac{dR'_0}{R'_0} = \frac{dR''_0}{R''_0}$$

which from (7) and (8), and substituting the relevant values of $R_0$, from the prices in the protection situation, namely, $R_0 = p_n/e_{xf}$, yields after simplification:

$$\frac{\sigma^*}{s} = \frac{p_n^*}{p_n}$$

from which it follows from (7) and (8) that $R'_0 = R''_0$.

Hence the relative prices of the three commodities will be the same with both adjustment mechanisms, and hence from (3) the change in the wage rental ratio, will be the same under both mechanisms.
Case 3: Two Traded Goods Produced and Consumed, and One Non-Traded Intermediate Good Produced

The production relations are given by:

\[ a_{LM}w + a_{KM}r + a_{NM}n = P_m \]  
\[ a_{LX}w + a_{KX}r + a_{MX}n = P_x \]  
\[ a_{LN}w + a_{KN}r = P_n \]

Where \( a_{ij} \) is the coefficient of the \( i^{th} \) factor (\( i = K, L \)) used in the \( j^{th} \) industry (\( j = M, X, N \))

\( w \) is the wage rate,

\( r \) is the rental rate, \( P_m \), the price of the importable \( M \), \( P_x \), the price of the exportable \( x \), and \( P_n \), the price of the non-traded good \( N \), all in the protection situation.

Defining \( \theta_{ij} \) as \( \frac{a_{ij}P_j}{P_j} \) where \( i = L, k \)

\[ \theta_{Lj} \hat{L}_j + \theta_{Kj} \hat{K}_j = 0 \]

that is input \( i \)'s distributive share in industry (\( j \))

and \( \hat{\theta} = \frac{dx}{x} \),

then, totally differentiating (1) through (3), and remembering that from the cost-minimization requirement,

\[ \theta_{Lj} \hat{L}_j + \theta_{Kj} \hat{K}_j = 0 \]

where \( (j = X, M, N) \)

yields,

\[ \theta_{LM} \hat{w} + \theta_{KM} \hat{r} + \theta_{NM} \hat{n} = \hat{P}_m \]  
\[ \theta_{LX} \hat{w} + \theta_{KX} \hat{r} + \theta_{MX} \hat{n} = \hat{P}_x \]  
\[ \theta_{LN} \hat{w} + \theta_{KN} \hat{r} = \hat{P}_n \]

Substituting (6) into (4) and (5), we get

\[
(a_{LM} + a_{NX}a_{LN})\hat{w} + (a_{KM} + a_{NM}a_{KN})\hat{r} = \hat{p}_m \tag{7}
\]

\[
(a_{LM} + a_{NX}a_{LN})\hat{w} + (a_{XX} + a_{NX}a_{KN})\hat{r} = \hat{p}_x \tag{8}
\]

Subtracting (8) from (7), and after simplification we get

\[
(\hat{w} - \hat{r}) = \frac{(\hat{p}_m - \hat{p}_x)}{(\epsilon_{XX} - \epsilon_{KM}) + \epsilon_{KN}(\epsilon_{NX} - \epsilon_{NM})} \tag{9}
\]

Irrespective of the adjustment mechanism for bringing about the equilibrium price of traded to non-traded goods, the relative factor prices in the free trade situation, with the removal of the tariff will be given by (9).

Suppose the adjustment is with the exchange rate fixed and the price of H.

Then \( \hat{p}_m = t \), and \( \hat{p}_x = 0 \), and

\[
(\hat{w} - \hat{r}) = \frac{t}{(\epsilon_{XX} - \epsilon_{KM}) + \epsilon_{KN}(\epsilon_{NX} - \epsilon_{NM})} \tag{9'}
\]
What will be the change in price of \( N, \) \( \hat{p}_n \) in the movement to the free trade position?

Solving for \( \hat{w} \) and \( \hat{r} \) from (7) and (8) we get

\[
\hat{w} = \frac{\hat{p}_m (\theta_{KK} + \theta_{NX} \theta_{KH}) - \hat{p}_x (\theta_{KM} + \theta_{LM} \theta_{KN})}{(\theta_{KK} + \theta_{NX} \theta_{KH}) - (\theta_{KM} + \theta_{LM} \theta_{KN})} \tag{10}
\]

and

\[
\hat{r} = \frac{\hat{p}_m (\theta_{LX} + \theta_{NX} \theta_{LN}) - \hat{p}_x (\theta_{LM} + \theta_{SN} \theta_{LN})}{(\theta_{LX} + \theta_{NX} \theta_{LN}) - (\theta_{LM} + \theta_{SN} \theta_{LN})} \tag{11}
\]

Substituting (10) and (11) in (6) and after simplification yields,

\[
\hat{p}_n = \frac{\hat{p}_m \left[ \theta_{LK} \cdot \frac{\theta_{KN}}{\theta_{LN}} - \theta_{LX} \right] - \hat{p}_x \left[ \theta_{LM} \cdot \frac{\theta_{KN}}{\theta_{LN}} - \theta_{XN} \right]}{\left[ \theta_{LK} \cdot \frac{\theta_{KN}}{\theta_{LN}} - \theta_{LX} \right] - \left[ \theta_{LM} \cdot \frac{\theta_{KN}}{\theta_{LN}} - \theta_{XN} \right]}
\]

\[
\hat{p}_n = \frac{\theta_{KN} \left[ \hat{p}_m \theta_{LK} - \hat{p}_x \theta_{LM} \right]}{\theta_{LK} \theta_{LX} - \theta_{LM} \theta_{XN} - [\theta_{LX} - \theta_{XM}][\theta_{KN} - \theta_{KL}]} \tag{12}
\]

We know \( \hat{p}_x = 0 \), and \( \hat{p}_m = \hat{t} \), from (12) we have

\[
\hat{p}_n = \frac{\theta_{KN} \left[ \theta_{LK} \theta_{LX} - \theta_{LM} \theta_{XN} \right]}{\theta_{LK} \theta_{LX} - \theta_{LM} \theta_{XN} - [\theta_{LX} - \theta_{XM}][\theta_{KN} - \theta_{KL}]} \tag{12'}
\]

The change in the non-traded good price will be the same as that of the importable, if,

\[
\hat{p}_n = \hat{t}, \text{ that is when,}
\]

\[
\frac{\theta_{KN}}{\theta_{LN}} \theta_{LX} - \theta_{KM} = \frac{\theta_{KN}}{\theta_{LN}} \left[ \theta_{LM} - \theta_{XN} \right] - \theta_{XN} + \theta_{KM}
\]

or

\[
\frac{\theta_{KN}}{\theta_{LN}} = \frac{\theta_{KM}}{\theta_{LM}}
\]

or

\[
\frac{\hat{a}_{KN}}{\hat{a}_{LN}} = \frac{\hat{a}_{KM}}{\hat{a}_{LM}} \tag{13}
\]
That is if the M and N industries have the same factor intensities. Next consider the adjustment mechanism with the price of M fixed and with the exchange rate variable.

Then in (4) to (6) $\hat{P}_M = 0$

and

$$(\hat{w} - \hat{r}) = \frac{(\hat{P}_M - \hat{P}_X)}{\hat{e}}$$

where

$$|\hat{e}| = \theta_{LM} \theta_{KN} - \theta_{KM} \theta_{NX}$$

Also from (6)

$$\hat{w} = \frac{\theta_{KN}}{\theta_{LN}} \hat{r}$$

$$\hat{P} = \frac{\theta_{LM}}{\theta_{KN}} \hat{w}$$

Substituting either the value of $\hat{w}$ or $\hat{r}$ in (4) and (5), yields

$$\frac{\hat{P}_M}{\hat{P}_X} = \frac{\theta_{KN} \theta_{LN} - \theta_{KM} \theta_{LM}}{\theta_{KN} \theta_{LN} - \theta_{KM} \theta_{NX}}$$

Given that the needed devaluation rate is $\hat{e}$, and that the tariff was $t$, we have

$$\frac{\hat{P}_M}{\hat{P}_X} = \frac{(t - \hat{e})}{\hat{e}(1 + t)}$$

Substituting this in (16) and simplifying yields

$$\hat{e} = \frac{t (\theta_{KN} \theta_{LN} - \theta_{KM} \theta_{LM})}{(1 + t) (\theta_{KM} \theta_{LN} - \theta_{KN} \theta_{LM}) + (\theta_{KN} \theta_{LN} - \theta_{KM} \theta_{NX})}$$

As is to be expected in this model, as the domestic price of N, has been fixed, this immediately determines the requisite devaluation, that is the correct relative price of traded to non-traded goods, from the domestic
production relationships (the $\theta$'s) and the change in the relative commodity price of the two traded commodities. As the relative commodity prices, which are fixed from world trade, determine the relative domestic factor prices, once the domestic money price of the only domestic good is fixed, all money prices, including the exchange rate in the free trade situation are determined.