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<b>Title</b>	International capital mobility, shadow prices and the cost of protection
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<b>Publication date</b>	1984-12
<b>Series</b>	UCD Centre for Economic Research Working Paper Series; 32
<b>Publisher</b>	University College Dublin. School of Economics
<b>Item record/more information</b>	<a href="http://hdl.handle.net/10197/1941">http://hdl.handle.net/10197/1941</a>
<b>Notes</b>	A hard copy is available in UCD Library at GEN 330.08 IR/UNI

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INTERNATIONAL CAPITAL MOBILITY, SHADOW PRICES  
AND THE COST OF PROTECTION\*

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Working Paper No. 32

December 1984

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\* This paper was stimulated by the Workshop on Trade and Investment in a World with Internationally Mobile Factors of Production, at the Institute for International Economic Studies, University of Stockholm, August 1980, where an earlier version was presented, and the Workshop on International Trade at the University of Western Ontario, March 1983. We are grateful to Patrick Honohan, Dermot McAleese, Alasdair Smith and participants at a meeting of Dublin Economics Workshop for comments and suggestions and to Ron Jones for many stimulating discussions on this topic.

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### Abstract

This paper studies the welfare losses from tariff protection in a general model of a small open economy where some factors are internationally mobile. It is shown that, as long as the economy remains incompletely specialised, international factor mobility must raise the cost of protection. This result is illustrated in the context of the specific-factors and Heckscher-Ohlin models. In addition, its relationship to earlier work on immiserising capital inflows and on negative shadow prices for factors of production is examined, which allows us to synthesise a number of recent results within a common framework.

## 1. Introduction

This paper studies the welfare losses from tariff protection in an open economy when some factors are internationally mobile. Our principal result is that, as long as the economy remains incompletely specialized, international factor mobility must raise the cost of protection. More specifically, the welfare loss resulting from an increase in the tariff rate in a competitive small open economy is greater if tariff-induced international factor movements are permitted than if factors are internationally immobile. By contrast, an exogenous inflow of factors in the presence of tariffs may increase or reduce the welfare loss associated with protection, depending on whether or not the protected commodities use the internationally-owned factors intensively relative to domestically-owned factors.

These results are proved without imposing any restrictions on the economy's technology: in particular, no restrictions are placed on the degree of vertical integration in production, on the sectors into which factors are internationally mobile, or on the number of goods and factors. The relationship of our results to earlier work on immiserising-capital inflows and on negative shadow prices for factors of production is also examined which allows us to synthesise a number of recent results within a common framework.

The paper is organised as follows. In Section 2 we explain our framework, and derive expressions for the welfare effects of tariffs

when all factors are domestically owned and when some factors are foreign owned but not internationally mobile in response to the changes in factor rewards generated by the introduction of tariffs. In Section 3, the case where some factors are internationally mobile in response to changes in factor rewards is examined and our main result is derived. The general framework is then illustrated in Section 4 in the context of the specific-factors model with international capital mobility, which was first studied by Caves (1971). A new diagrammatic analysis of this model is presented, which allows us to extend the work of Brecher and Findlay (1983) and Srinivasan (1983). Section 5 considers the possibility that protection may lead the economy to specialise in production or in trade. It is shown that in this case protection in conjunction with tariff-induced capital flows leaves national welfare unaffected, contrary to the implications of Brecher and Diaz (1977).[1] Finally, Section 6 notes some applications of our results to issues in economic history and contemporary economic policy.

## 2. The Cost of Protection with Domestic and Foreign-owned Capital

To examine the relationship between national welfare and tariffs in the presence of foreign-owned factors of production, we employ a standard model of a competitive small open economy with any number of goods and factors. For simplicity, we only make explicit the prices ( $p$ ) of those goods which may be subject to tariffs ( $t$ ) and only those factors which may be internationally traded ( $k$ ). Throughout, to fix

ideas and relate this paper to existing literature, the internationally traded factors, which may be foreign-owned or owned by domestic residents, are collectively referred to as capital. In the absence of any foreign-owned capital, this economy may be described by the national income identity:

$$E(p,u) = g(p,k) + tM \quad (2.1)$$

which states that national expenditure, represented by an expenditure function defined over prices and utility ( $u$ ), equals gross domestic product (GDP) at factor cost (represented by a GDP function relating output to prices and factor endowments) plus tariff revenue from trade-restricted imports ( $M$ ). The volume of imports is defined as the difference between domestic demand and output, which may be written in terms of partial derivatives of the expenditure and GDP functions with respect to commodity prices:

$$M = E_p(p,u) - g_p(p,k) \quad (2.2)$$

Totally differentiating (2.1) and (2.2) we obtain an equation for the change in welfare generated by small changes in tariffs or in the capital stock [2]

$$m^{-1} dy = t[E_{pp} - g_{pp}]dt + r^S dk \quad (2.3)$$

The left hand side of (2.3) is the inverse of the tariff multiplier times the change in real income. The former is given by

$$m^{-1} = 1 - t E_{pu} E_u^{-1} = 1 - t c_M \quad (2.4)$$

where  $c_M$  is the vector of income effects on the demand for importables and real income is utility measured in money metric terms ( $dy = E_u du$ ). The tariff multiplier arises from the fact that a unit increase in GDP generates a direct increase in real income which raises additional tariff revenue (through extra spending on all commodities including imports) so further increasing domestic expenditure and utility in a multiplier chain. Stability requires that this multiplier be positive. [3]

The first term on the right-hand side of (2.3) shows the familiar consumption and production losses associated with the imposition of tariffs. For small tariff rates, the loss is only of second order ("small triangles"). [4] The second term on the right-hand side says that the change in real income arising from a change in the capital stock depends on the cum-tariff shadow prices of capital which are defined as

$$r^S = r - tg_{pk} \quad (2.5)$$

where  $r$  is the vector of factor payments (rentals) accruing to capital, assumed equal to their value marginal products at domestic prices ( $g_k$ ). The term  $g_{pk}$  is a matrix of generalised Rybczynski terms, each of which may be positive or negative, according as the protected goods are (in a general equilibrium sense) intensive or not in the individual capital factors. If the importables are capital intensive on average, the elements of the vector  $tg_{pk}$  are positive. In this case, some or all of the shadow prices  $r^S$  may be negative, and

we have the possibility of immiserising growth, i.e., a capital transfer to domestic residents which reduces welfare by driving the economy further from its free-trade production equilibrium. This general condition, which was first noted by Bhagwati and Srinivasan (1978), underlies the immiserising growth paradox noted by Johnson (1967) in the two-by-two Heckscher Ohlin model, when a tariff is placed on the capital-intensive good. More recently, the same condition has been noted by Brecher and Findlay (1983) in the specific-factors model, when the country receives a transfer of capital specific to the protected import-substituting sector.

Before turning to consider the effect of having some foreign-owned capital in the economy, we digress momentarily to derive an alternative expression for the shadow prices of capital in the case where  $p$  represents the vector of prices of all goods. Since the economy is assumed to be small and open, facing fixed world commodity prices ( $p^*$ ), it is possible to rewrite (2.5) in terms of domestic and world commodity prices as

$$r^S = r - (p - p^*) g_{pk} \quad (2.6)$$

Since the GDP function is linear homogeneous in  $p$ ,  $pg_{pk} = g_k = r$ , and so (2.6) simplifies to

$$r^S = p^* g_{pk} \quad (2.7)$$

Since  $g_{pk}$  is evaluated at domestic prices  $p$ , equation (2.7) shows that



in a project appraisal context the value of additional output resulting from an increase in the endowment of capital should be calculated using domestic techniques of production (i.e., those actually adopted in the face of domestic factor prices "distorted" by the tariffs) and world commodity prices. This result illustrates the important clarification of the Little and Mirrlees (1968) rule, first pointed out by Findlay and Wellisz (1976).[5]

Now, consider the case where some portion of capital in the economy is foreign-owned, so that capital in use exceeds capital owned by residents in the economy. [6] The national income identity (2.1) can be rewritten to include net factor payments to foreigners

$$E(p,u) = g(p,k) + tM - (k - \bar{k})r \quad (2.1')$$

where  $k$  represents capital in use in the economy and  $\bar{k}$  is capital owned by domestic residents. Totally differentiating (2.1') and (2.2) we obtain the new equation for the change in real income when capital is foreign-owned:

$$m^{-1} dy = t[E_{pp} - g_{pp}] dt + [r^s - r] dk - (k - \bar{k}) dr + r d\bar{k} \quad (2.3')$$

Since domestic rentals (the vector  $r$ ) are endogenous to the model, we rewrite (2.3') in terms of changes in exogenous variables only, where

$$dr = g_{kp} dt + g_{kk} dk \quad (2.8)$$

to obtain

$$m^{-1} dy = [t(E_{pp} - g_{pp}) - (k - \bar{k})g_{kp}] dt + [r^s - r - (k - \bar{k})g_{kk}] dk + r d\bar{k} \quad (2.9)$$

Comparison of (2.3) and (2.9) focusses attention on the differences which foreign ownership makes to the effects of tariff policy. With foreign ownership, in addition to the consumption and production losses associated with tariffs, there is a further loss in the case where the importables are capital intensive and an offsetting gain if the importables are labour intensive, as the tariffs raise and lower the returns to foreign capital respectively.[7] This outcome depends crucially on the fact that capital, though foreign-owned, is not effectively internationally mobile, so that it does not flow out of the country following the reduction in the domestic rental induced by tariffs on labour-intensive importables. This state of affairs is probably best interpreted as the short-run adjustment to the tariff changes, before foreigners have time to make the optimal portfolio adjustments to be considered in the next section. This result may be formalized as:

Proposition 1 : As long as the economy remains incompletely specialised, the cost of protection is higher or lower when some of the capital is foreign owned than when it is owned entirely by domestic residents, depending on whether importables are capital or labour intensive.

The remaining terms in (2.9) can be readily interpreted. A transfer of capital in use and in ownership to domestic residents (i.e., an equal increase in  $k$  and  $\bar{k}$ ) in the presence of tariffs is less likely to result in immiserising growth when there is foreign

capital, because there is an additional welfare gain generated by the reduction in rentals paid to the owners of foreign capital,  $(k - \bar{k})g_{kk}$ . [8]. A transfer of capital in use and not ownership (i.e., an addition to the stock of foreign-owned capital) has a further effect  $(-rdk)$  equal to the repatriated returns on the additional foreign capital employed; this increases the likelihood of a potential welfare loss. While a welfare reduction generated by a capital transfer to domestic residents may seem paradoxical, a reduction induced by a transfer of capital in use and not in ownership is not surprising.

### Section 3 The Cost of Protection with Tariff-Induced Capital Movements

In the last section we found that, in the presence of tariffs, the shadow price of capital may be positive or negative and a transfer of capital when some capital is foreign-owned may raise or lower welfare. These ambiguities might lead us to expect a similar indeterminacy of the effects of unrestricted capital mobility in the presence of tariffs. However, in this section, we show that a definite result can be obtained for the welfare effects of an unrestricted inflow of capital induced by the introduction of tariffs. Consider first the case where domestic policy takes no account of capital flows.

The national income identity is again given by (2.1') in this case, but into (2.3') we substitute from (2.8) the following:

$$dk = g_{kk}^{-1} [dr - g_{kp}dt] \quad (3.1)$$

to obtain

$$m^{-1} dy = t[E_{pp} - g_{pp} + g_{pk} g_{kk}^{-1} g_{kp}] dt - [(k - \bar{k}) + (r^S - r) g_{kk}^{-1}] dr + \dots$$

The cost of protection when capital is internationally mobile is given by the first expression on the right-hand side of (3.2). The first two terms in this expression repeat the static consumption and production losses from equation (2.3). The additional effect of the endogenous capital flow is therefore captured by the third term, which, since  $g_{kk}$  is negative definite, is itself negative definite. This expression in Equation (3.2) therefore says that, in the presence of endogenous capital flows, an increase in tariffs unambiguously lowers welfare, and comparison with (2.3) gives our main result :

Proposition 2 : As long as the economy is incompletely specialised, the cost of protection is always greater when capital is internationally mobile than when it is country-specific, irrespective of the relative factor intensity of importables.

This result reflects the Le Chatelier principle: relaxing the constraint that capital is internationally immobile implies a larger supply response following the imposition of tariffs and hence a greater welfare loss [9]. The result is independent of the factor intensity of the protected commodity; by contrast, when the levels of foreign-owned capital are exogenously fixed, Proposition 1 shows that tariffs on labour-intensive commodities can raise welfare. The difference between the two cases is that, in the latter, foreign

owners of capital have to bear the burden of the fall in their rentals whereas, in the former, they simply withdraw their capital if rentals fall following the imposition of a tariff. [10]

Turning to the remaining expressions in (3.2), we note that an increase in world rentals leads unambiguously to an outflow of capital, which lowers welfare if the goods protected are relatively labour-intensive ( $r^S > r$ ) and may raise or lower welfare if the goods are relatively capital-intensive. The reason for this is that the capital outflow (via the Rybczynski effect) leads to an absolute expansion of the labour-intensive sectors, which reinforces the production distortion created by the tariffs, if these are the protected sectors.

The next case to consider is where, in formulating policy, the domestic authorities take into account the endogeneity of capital flows, and tax the returns to foreign-owned capital. The general principles for choosing optimal levels of taxation of foreign-owned capital in the presence of tariffs are familiar from the detailed examination of the two-sector Heckscher-Ohlin case by Kemp (1966) and Jones (1967). Using our approach, it is straightforward to derive an expression for optimal taxes, under the small open economy assumptions of fixed world prices for internationally-traded commodities and factors. In this case, the national income identity is re-written as

$$E(p,u) = g(p,k) + tM - (k - k)r^* \quad (3.3)$$

Here  $r^*$  is the vector of rentals on capital in the rest of the world, which differ from domestic rentals by  $t_k$ , the vector of tax rates on foreign-owned capital:

$$g_k(p, k) = r = r^* + t_k \quad (3.4)$$

Totally differentiating (3.3) (holding  $r^*$  and  $\bar{k}$  constant for convenience), we obtain

$$m^{-1} dy = t[E_{pp} - g_{pp}]dt + [r^S - r + t_k]dk \quad (3.5)$$

From (3.5) we see that the vector of optimal second-best taxes on capital is

$$t_k^* = r - r^S \quad (3.6)$$

that is, the optimal taxes are simply the gaps between domestic and shadow rentals. [11] Comparison with (3.4) yields an interesting corollary; optimal second-best taxation of internationally mobile capital requires that their domestic shadow prices, rather than their domestic market prices, equal world rentals.

What if the taxes on capital are not at their optimal levels? To consider this case, differentiate (3.4) to obtain the responsiveness of capital flows to tariff and tax rates.

$$dk = g_{kk}^{-1} (dt_k - g_{kp} dt) \quad (3.7)$$

Substituting into (3.5) yields after some simplification:

$$m^{-1} dy = [t(E_{pp} - g_{pp} + g_{pk}g_{kk}^{-1}g_{kp}) - t_k g_{kk}^{-1}g_{kp}] dt + (r^S - r + t_k) g_{kk}^{-1} dt_k \quad (3.8)$$

The first expression on the right-hand side of (3.8) reveals a complicated interaction between the two policy instruments : in addition to the effects of tariffs with mobile capital given by (3.2), the presence of given taxes on capital may raise or lower the cost of protection. If imports are capital intensive, increased protection leads to an incipient rise in domestic rentals which encourages capital inflow, so raising tax revenue and domestic welfare. An alternative way of presenting this result is obtained by substituting from (3.6) and (2.5) to obtain:

$$m^{-1} dy = [t(E_{pp} - g_{pp}) - (t_k - t_k^*) g_{kk}^{-1} g_{kp}] dt + (t_k - t_k^*) g_{kk}^{-1} dt_k \quad (3.9)$$

Thus, if the tax rates are below their optimal levels, an increase in tariffs when imports are capital intensive leads to a greater cost of protection than if capital is internationally immobile. While if the taxes are above their optimal levels or if imports are labour-intensive the cost of protection is reduced. Indeed, the possibility that welfare could be positively related to tariff rates cannot be

ruled out. Finally, it should be noted that there is no asymmetry between tariffs and factor taxes in this model. This may be seen by rewriting (3.9) in terms of  $t^*$ , the optimal tariffs for given levels of factor taxation [12]:

$$m^{-1}dy = (t - t^*)(E_{pp} - \tilde{g}_{pp})dt + (t_k - t_k^*)g_{kk}^{-1} dt_k \quad (3.10)$$

where :

$$t^* = t_k g_{kk}^{-1} g_{kp} (E_{pp} - \tilde{g}_{pp})^{-1}$$

and  $\tilde{g}_{pp}$  is the matrix of price-output responses in the presence of international factor mobility : i.e.,  $\tilde{g}_{pp} = g_{pp} - g_{pk}g_{kk}^{-1}g_{kp}$ .

#### 4. An Illustration: The Specific-Factors Model

In this section we present a new diagram to illustrate our proposition - that international capital mobility unambiguously raises the cost of protection - in the context of the two commodity specific-factors model. The effects of capital mobility in this model were first studied by Caves (1971) and more recently by Brecher and Findlay (1983) and Srinivasan (1983). Our objective is to show that the output response of the protected sector following the introduction of a tariff is greater when capital is internationally mobile, and hence, the welfare cost is greater.

Consider the case where a small open economy has two sectors producing an exportable good (X) and an importable good (M) which are traded internationally at fixed world prices. Output in the two sectors is



produced subject to constant returns to scale using two factors of production : capital which is sector-specific and may or may not be internationally mobile, and labour which is intersectorally mobile and country specific. For given stocks of capital and commodity prices, we can draw labour demand schedules for the two sectors ( $L_X^0$  and  $L_M^0$ ) which determine the allocation of the fixed stock of labour between the two sectors at the competitive equilibrium wage,  $w^0$  (Point  $A^0$  in Figure 1(a)). We can also draw unit cost curves for the two sectors, which show the combinations of the wage rate and the rental which are consistent with zero profits in each sector. The locations of these curves ( $C_M^0$  and  $C_X^0$  in Figures 1(b) and 1(c) respectively) are determined by technology in each sector and the exogenously given output prices. Since the wage determined in Figure 1(a) must be identical to that in Figures 1(b) and 1(c), the rentals in the two sectors must be  $r_M^0$  and  $r_X^0$  respectively. At the initial equilibrium these rentals are assumed to be identical to the world rentals for both types of capital.

Consider first the case where capital is immobile. The imposition of the tariff on the M-sector shifts the labour demand schedule in Figure 1(c) from  $L_M^0$  outwards to  $L_M^1$  and the unit cost curve in Figure 1(b) outwards from  $C_M^0$  to  $C_M^1$ . For labour market equilibrium, the economy-wide wage must rise from  $w^0$  to  $w^1$ , as the protected sector expands its demand for labour. Given the post-tariff relative prices, the wage rate determines the rentals in the two sectors  $r_M^1$  and  $r_X^1$ , which are now greater and less than their pre-tariff levels respectively.

What happens if capital is internationally mobile? We consider alternatively the cases where there is international capital mobility into the protected and non-protected sectors.[13] When capital in the import-substituting sector is internationally mobile, the effect of the tariff is to induce sufficient capital inflow to maintain the domestic return on that sector's capital at the international level, assumed equal to the pre-tariff level,  $r_M^0$ . Since  $r_M^0$  and  $C_M^1$  are fixed, the only wage which is consistent with a zero profit equilibrium in the import-competing sector is  $w^2$ . Thus the inflow of capital must be sufficient to shift the M-sector's labour demand curve further to the right from  $L_M^1$  to  $L_M^2$  with the new labour-market equilibrium at  $A^2$ . Clearly the output response of the M-sector at  $A^2$  is far greater than that at  $A^1$ . This is the tariff-factory case, where the tariff results in foreign-owned import-competing industries being established.

In the case where capital is mobile into the exporting sector,  $r_M$  is endogenously determined, but the economy must adjust so that the rate of return on X-sector capital remains at  $r_X^0$ . Since  $C_X^0$  is unchanged, this means that the wage cannot rise above  $w^0$ . In terms of Figure 1(a) the new equilibrium must lie at the wage  $w^0$  on the post-tariff demand curve for labour by the import-competing sector, i.e., at  $A^3$ . To accommodate this, there must be a capital outflow from the X-sector sufficient to shift its labour demand curve rightward to  $L_X^3$ . This is the case where there is "capital flight" from the non-protected sector following the introduction of the tariff. In this case too, it is

clear that international capital mobility raises the output response of the protected sector and so raises the welfare losses resulting from protection.

### 5. International Capital Mobility in the Heckscher-Ohlin Model

So far, we have considered the case where "small" changes in tariff rates result in "small" changes in the international allocation of capital. A feature of this case is that the economy remains incompletely specialized following tariff changes. In terms of our analysis in Section 2, this means that the matrix  $g_{kk}$  in (2.9) must be non-singular; in particular, the numbers of internationally immobile factors must be at least as great as the number of productive activities. However, it is necessary now to turn to the case where even small changes in tariffs are sufficient to generate a major reallocation of capital so that the economy is driven to specialise. This possibility was first noted by Mundell (1957) in the context of the two-sector, two-factor version of the Heckscher-Ohlin model. [14] This model has been used extensively to analyse the welfare effects of international capital mobility, most notably by Brecher and Diaz (1977), and our analysis takes their work as its starting point. For ease of exposition, both text and diagram focus on the two-good, two-factor case, but the equations we derive apply more generally.

In Figure 2, the upper panel is identical to Figure 2 in Brecher and Diaz, with one significant amendment which will be explained below. The diagram shows the relationship between national welfare ( $y$ ) and

the amount of capital located in the home country ( $k$ ). For simplicity, it is assumed in the diagram that, at the initial pre-tariff equilibrium, all capital used in the economy is domestically owned (i.e.,  $k$  and  $\bar{k}$  are equal) [15]. Point F represents the free-trade welfare level and point T the post-tariff welfare level, when the amount of capital located in the economy is unchanged. (The difference between F and T reflects the consumption and production losses given in (2.3)). Suppose now that there is a steady increase in capital located in the economy with no change in domestic ownership (i.e., no change in  $\bar{k}$ ). The curve TAMSD traces out the changes in national welfare associated with these hypothetical levels of capital inflow. The equation corresponding to the segment TA may be derived from (2.9) and (2.5), recalling that  $g_{kk}$  is zero in this model:

$$m^{-1} dy = -tg_{pk}dk \quad (5.1)$$

This equation states that, if the imported commodity is capital intensive ( $g_{pk} > 0$ ), a capital inflow in the presence of a tariff reduces welfare, as long as factor intensities are not reversed. However, the continuing inflow of capital leads to a steady increase in the domestic production of the importable good, so that eventually at A domestic production is sufficient to satisfy domestic demand. In the diagram this is assumed to occur at point A where trade in the importable ceases, with the economy specialised in trade in exports, which finance the repatriated earnings on foreign capital.

What happens if there is further capital inflow beyond A? Beyond A domestic supply and demand for the importable are equal, so we can differentiate the market-clearing equation

$$E_p(p, u) = g_p(p, k) \quad (5.2)$$

to solve for endogenously-determined commodity prices:

$$dp = [g_{pp} - E_{pp}]^{-1} (dy - g_{pk}dk) \quad (5.3)$$

Since there is no tariff revenue in autarky, the national income identity is

$$E(p, u) = g(p, k) - (k - \bar{k})r, \quad (5.4)$$

which when totally differentiated gives us an expression for the change in welfare as

$$dy = -(k - \bar{k})dr. \quad (5.5)$$

Using (2.8) with  $g_{kk}$  equal to zero, (5.5) may be written in terms of changes in commodity prices as

$$dy = -(k - \bar{k}) g_{kp} dp, \quad (5.6)$$

and, substituting for  $dp$  from (5.3), we have the following expression for the change in welfare arising from an increase in the capital

stock:

$$m^{-1}dy = (k - \bar{k}) g_{kp} (g_{pp} - E_{pp})^{-1} g_{pk} dk, \quad (5.7)$$

where:

$$m^{-1} = 1 + (k - \bar{k}) g_{kp} (g_{pp} - E_{pp})^{-1} c_M. \quad (5.8)$$

As before, stability requires that  $m$  be positive. Except for the term  $(k - \bar{k})$  which we have assumed to be positive, the right-hand side of (5.7) is a quadratic form in a positive definite matrix. Equation (5.7) therefore shows that an increase in capital unambiguously raises welfare, irrespective of the relative factor intensity of the importable. This result is not surprising as the increased production of the importable resulting from the capital inflow leads to a reduction in its price and consequently in the domestic rental, so that factor payments to foreigners are reduced. This process continues until the expansion in the output of the importable is sufficient to drive its price down to the world level. In the diagram, this occurs at point M, which illustrates Mundell's result that, in this Heckscher-Ohlin framework, international capital mobility restores welfare to its pre-tariff level.

Starting at M, additional capital inflow leads the economy to increase its production of the capital-intensive commodity. At internationally determined commodity prices, this process will continue with no

effects on aggregate welfare until the economy eventually specialises completely in the production of the capital-intensive commodity, importing the labour-intensive commodity to satisfy domestic demand; i.e, domestic production of the commodity formerly exported has ceased and it is now an imported commodity. We denote the point at which there is complete specialisation in production as S in Figure 2.

Once the economy is completely specialised in production, further capital inflow unambiguously raises welfare, as pointed out by MacDougall (1960). Such a point is illustrated by D in Figure 2. The equation for the change in welfare beyond S may be obtained by totally differentiating the national income identity where production is limited to the M-sector only:

$$E(p,u) = g^M(p,k) - (k - \bar{k})r, \quad (5.9)$$

to obtain:

$$dy = -(k - \bar{k}) g^M_{kk} dk. \quad (5.10)$$

The above analysis is broadly similar to Brecher and Diaz, but differs from them in one important respect, namely, their drawing of TAM as a smooth curve. In fact, as equations (5.1) and (5.7) make clear, the curve is kinked at A where domestic prices switch from being exogenously to being endogenously determined. Moreover, the segment AM (given by (5.7)) is independent of the tariff rate, whereas there

is a family of curves such as TA (given by (5.1)), each one corresponding to a different tariff rate.

However, it cannot be too strongly emphasised that this upper panel as just described analyses the welfare effect of different levels of exogenous capital inflow (i.e., different levels of foreign-owned capital) in the presence of a tariff and not the effects of tariff-induced capital inflows. To focus on tariff-induced inflows, it is necessary in addition to consider the incentives for foreign capital to reallocate, and this is done in the lower panel of Figure 2 by examining the path of the domestic rental associated with the capital flows in the upper panel. Assuming that the economy is small and open in capital as well as commodity markets, the world supply of capital can be represented by a horizontal line at the world rental given by  $F'$ . If the pre-tariff domestic rental equals the world rental at  $F'$ , then the effect of a tariff on the capital-intensive commodity is to raise the domestic rental to  $T'$ . The higher rental creates an incentive for capital to flow into the economy and, as long as domestic prices are unchanged, this gap between the domestic and world rental persists and is unaffected by capital flows. This result follows simply from (2.8) since  $g_{kk}$  is equal to zero.

However, after  $A'$ , corresponding to the autarkic point in the upper panel, the domestic price of the importable and consequently the domestic rental become endogenous. Substituting into (2.8) for  $dp$  from (5.3) and  $dy$  from (5.5) we obtain the equation for the change in the rental when prices are endogenous [16]



$$m^{-1}dr = -g_{kp} (g_{pp} - E_{pp})^{-1} g_{pk}dk \quad (5.11)$$

Equation (5.11) shows that the effect of capital inflow on the rental is unambiguously negative, i.e., it drives the domestic rental down towards the world level. Once the domestic rental equals the world rental at M' the country faces the perfectly elastic international capital supply curve, and up to the complete specialisation point, S', capital will flow freely into and out of the economy.

The difference between autonomous capital inflows in the presence of a tariff and tariff-induced capital inflows is particularly apparent beyond S'. While the upper panel shows that any addition to the capital stock beyond S' is unquestionably welfare-raising, it is abundantly clear from the lower panel that such an inflow will not take place if capital is freely mobile internationally, because the domestic rental at, for example, D' is below the world rental. With specialisation in production, diminishing marginal productivity ensures that the economy's demand curve for foreign capital is downward-sloping.

The Brecher-Diaz analysis correctly draws attention to the loss in welfare which results from a capital inflow in the presence of a tariff. This is the loss described by Proposition 1 in the case where the importable is capital-intensive so that the domestic rental rises following the imposition of the tariff. However, the path which they describe is an adjustment path: at no point between T and M is

the international capital market in equilibrium, for the higher rental in the home country continues to induce capital inflow until the economy is back to the initial pre-tariff welfare level. In particular, with perfect international mobility of capital, the economy will not rest at an equilibrium involving a loss in welfare, and any immiserization which takes place will be purely temporary. Thus, to examine the welfare effects of the introduction of a tariff when capital is internationally mobile, we must compare points F and M in Figure 2. This comparison shows us that the case where there are equal numbers of goods and factors is an exception to Proposition 2 in Section 3, giving us:

Proposition 3 : With equal numbers of goods and factors, international capital mobility exactly offsets the static production and consumption costs of protection.

However, the empirical significance of this qualification, and hence the relevance of Proposition 3, may be doubted. If capital is indeed freely mobile and the economy has no effect on the world prices of commodities or factors, then the initial equilibrium at F and F' is a knife-edge one. Any small disturbance of this equilibrium would drive the economy to specialise. Consequently, conclusions which rely on the assumption that capital is internationally mobile and the economy is initially at F are of limited real-world relevance.

Finally, the point made by Mundell is clearly shown in the diagram:

while there is a family of curves like  $F'M'$  corresponding to different tariff levels, the level of the tariff imposed does not affect the crucial stretch of the curve  $M'S'$  along which domestic and international rentals are equalized. Since this is the only segment along which the international capital market is in equilibrium, a tariff of any magnitude must drive the economy to specialise. In particular, this is true of an initially prohibitive tariff, which on impact lowers welfare to  $P$  and raises the domestic rental to  $P'$ , in the upper and lower panels of Figure 2 respectively. In this case, the induced capital inflow, along curves given by (5.7) and (5.11), leads the economy to the same specialised equilibrium at  $M$  and  $M'$  as in the non-prohibitive case examined above.

## 6. Conclusion

In this paper we have presented a general analysis of the implications of international mobility of capital and foreign ownership of capital for the cost of protection in a small open economy. In particular, we have proved a new and extremely general result : **international capital mobility always raises the cost of protection**, except in cases where the economy is driven to specialise in production or trade.

At a theoretical level, the paper synthesises and extends a great many results in the recent literature, for example, Johnson's (1967) demonstration that capital accumulation may be immiserising in the presence of a tariff; the analyses of shadow prices in a tariff-distorted economy by Findlay and Wellisz (1976) and Srinivasan and

Bhagwati (1978); and the studies of foreign ownership of capital by Bhagwati and Tironi (1980) and Brecher and Bhagwati (1981). All of these papers emerge as interesting special cases of the general analysis in Sections 2 and 3. [17] Moreover, the confusing diversity of results in earlier works is seen to derive from their modelling of international capital mobility in terms of exogenous changes in the stock of capital. As equation (2.3') shows, the welfare effect of such changes depends on the difference between the market and shadow rentals and so is necessarily ambiguous in sign. By contrast, if the stock of capital located in the home country is genuinely endogenous, so that international capital movements may be correctly described as "tariff-induced", [18] we have shown that they will in general raise the cost of protection.

As far as applications are concerned, our results are also relevant to the understanding of a number of policy issues. To take just one specific historical example, traditional studies of Irish economic experience in the 1930s have tended to blame the new government of 1932 for both introducing high tariffs and prohibiting foreign investment, in what was until then one of the most free trading economies in the world. By contrast, a re-examination of the period in the light of our results suggests that, given the political commitment to protection, the prohibition of foreign investment may have been actually welfare-improving. [19].

A different application of our results is to contemporary debates on

the appropriate phasing of a program of goods and factor market liberalisation. [20] The general theory of the second best warns that, if some distortions are left in place, the removal of others need not raise welfare. Comparison of equations (2.3') and (3.2) enables us to be more specific in this context since it shows that allowing foreign capital to penetrate domestic markets while tariffs are still in place will in general lower welfare.

Finally, some further applications of our results are suggested by the observation that, while the paper has focussed throughout on import tariffs, the results are easily modified to apply to export subsidies. The granting of export subsidies in conjunction with the relaxation of controls on capital inflows is characteristic of many countries which switch from "inward-looking" to "outward-looking" development strategies. Clearly, the merits of such policies raise many issues which go beyond the competitive framework we have used. On the one hand, foreign capital may give rise to externalities, for example as a result of improved training, the introduction of better management practices, etc.; on the other hand competition between different countries for a limited stock of internationally mobile capital may bid away the rents which might otherwise accrue to a capital-importing country. However, confining attention to a competitive economy which faces a given world rental, our analysis suggests that the static welfare losses from such an outward-looking strategy are actually greater than from a policy of export subsidies combined with a prohibition on the repatriation of foreign capital earnings.

These examples suggest just some of the potential applications of our results.

### Footnotes

1. The method of proof is based on the work of Neary (1985).
2. For a similar derivation, see Smith (1982), equation (37).
3. See Hatta (1977) for a fuller discussion of the stability issue. Rather than invoking stability, note that, if the tariff multiplier were negative, the imposition of a lump-sum tax on consumers would raise welfare. See Smith (1985).
4. Here and throughout the paper we interpret expressions where the change in a vector of tariff rates is premultiplied by a negative definite matrix such as  $(E_{pp} - g_{pp})$  as implying that higher tariffs must lower welfare. Of course, this need not be true with many protected goods. However, it necessarily follows in one important special case, that of a uniform percentage tariff change,  $dt = tdz$ , which allows us to treat all importables as a single Hicksian composite commodity. In this case the loss is  $t[E_{pp} - g_{pp}] dz$ . The coefficient of the scalar  $dz$  is a negative definite quadratic form and so an increase in  $z$  is welfare-reducing. See Bruno (1972).
5. If  $k$  are all factors,  $p$  are prices of all commodities, and there are the same number of goods as factors, then  $p^* = r^S(g_{pk})^{-1}$ , where  $(g_{pk})^{-1}$  is the matrix of input-output coefficients in use in the actual (distorted) situation. This is the method of calculating shadow prices in

the two-by-two Heckscher-Ohlin model used by Srinivasan and Bhagwati (1978) and elegantly diagrammed by Mussa (1979).

6. All the analysis in this section can be easily adapted to take account of the case where domestically-owned capital exceeds capital in use in the economy so there is net factor income from abroad.
7. In other words, in the case where the tariff is small, a tariff policy which protects production of commodities which use domestic factors intensively relative to foreign factors can raise welfare. Bhagwati and Tironi (1980) consider the extreme case of this in the two-good, two factor Heckscher-Ohlin model where all capital is foreign-owned and all labour is domestic, while Brecher and Bhagwati (1980) consider cases where some capital is both foreign and domestically owned.
8. In the first case  $\bar{r}dk$  and  $\bar{r}dk$  cancel, and in the second  $\bar{d}k$  is zero.
9. See Neary (1985) for a further discussion of this issue.
10. A similar result has been independently derived in a much less general model by Jones (1984).
11. This result is identical to but much more general than that obtained by Brecher and Findlay (1983), using the two



commodity, specific-factors model. This result is also obtained by Grossman (1984), although he interprets it very differently and uses it only to derive conditions under which the optimal second-best policy requires a prohibitive tax on international capital mobility.

12. As Alasdair Smith has pointed out to us, it may also be shown that an equal radial reduction in both  $t$  and  $t_k$  must raise welfare.
13. Simultaneous capital mobility in both sectors leads the economy to specialise. The issue of specialisation is discussed in Section 5.
14. Neary [1985] shows in a much more general framework how specialisation may take the form of specialisation in production or of specialisation in trade, in the sense that, as a result of the tariff, a previously traded good becomes non-traded.
15. The consequences of relaxing this assumption may be easily established with the help of (2.9).
16. If  $k$  is a scalar, the term  $m^{-1}$  is identical to (5.8). If there are  $N$  internationally mobile factors,  $m^{-1}$  is a matrix of order  $N$  by  $N$ , given by

$$I_N + g_{kp} (g_{pp} - E_{pp})^{-1} c_m (\bar{k} - k)$$

where  $I_N$  is the identity matrix of order  $N$  by  $N$ .

17. Similar syntheses, though with little discussion of

international factor mobility, are given in Dixit (1983) and Smith (1980, 1982).

18. Tan (1969) appears to have been the first to describe exogenous changes in the stock of capital as "tariff-induced", a usage which is both linguistically incorrect, and (in the light of our finding that they have different effects) analytically misleading. Grossman (1984) is a recent exception to the general neglect of endogenous tariff-induced factor movements.
19. See Neary and O'Grada (1984) for a discussion of this period and further references.
20. This issue is considered from a somewhat different perspective by Edwards and Van Wijnbergen (1984).

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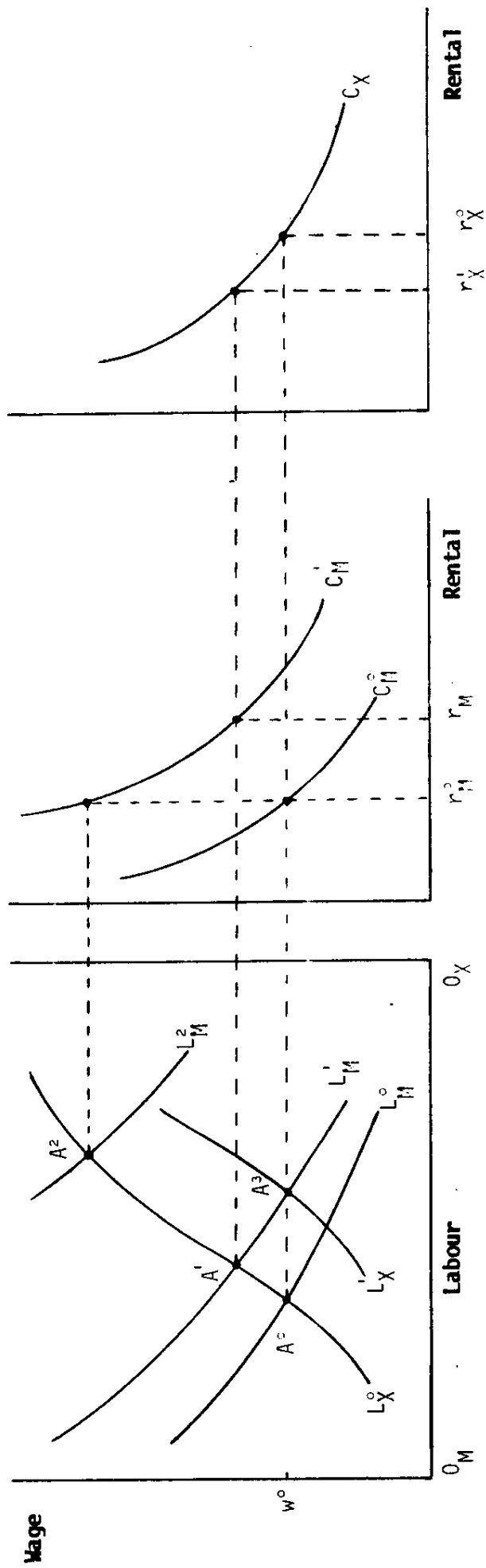
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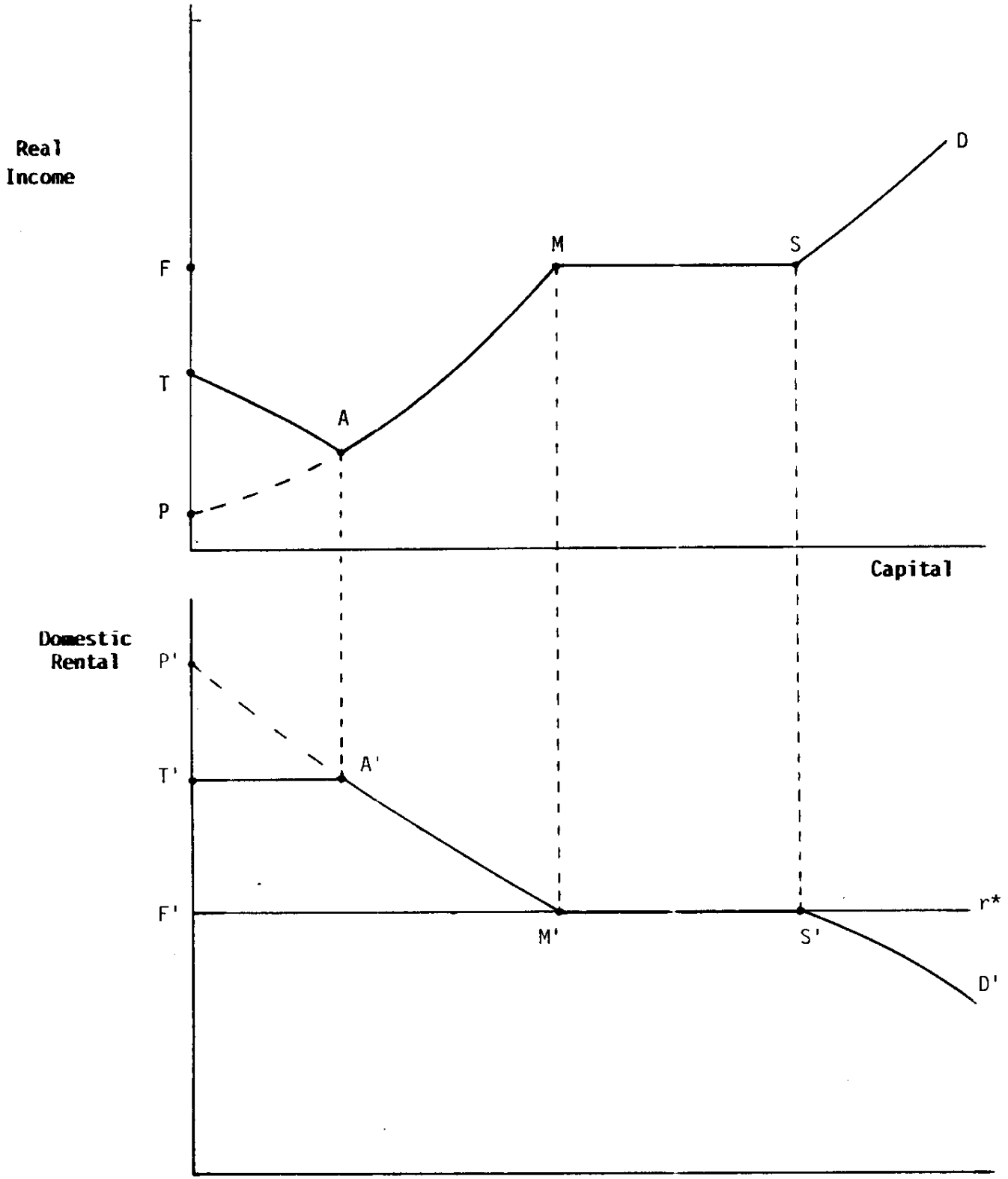
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**Figure 1** : Output Effects of Protection under Alternative Assumptions about International Capital Mobility in the Jones-Caves Specific-Factors Model.



**Figure 2** : Effects of Foreign-Owned Capital on Domestic Real Income and Rental in the Heckscher-Ohlin Model