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TARIFFS, QUOTAS AND VER'S
WHEN CAPITAL IS INTERNATIONALLY MOBILE

by

J. Peter Neary

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Abstract

This paper begins by reexamining the equivalence of tariffs and quantitative trade restrictions. It is argued that equivalence holds in extremely general circumstances but that this fact must be interpreted with care, since the tariff rates equivalent to a given set of quantitative restrictions are themselves functions of all the exogenous variables characterising equilibrium. A general framework for comparing the effects of tariffs, quotas and VER's is then presented. Among the results, it is shown that, although international capital mobility raises the welfare cost of tariff protection, it lowers the welfare cost of protection by means of quantitative restrictions.
TARIFFS, QUOTAS AND VER'S
WHEN CAPITAL IS INTERNATIONALLY MOBILE

1. Introduction

An increasing trend in the world economy is for restrictions on trade to take the form of quantitative rather than price controls. While there are many forms of policy measures which directly restrict the volume of trade, those most commonly encountered are import quotas and voluntary export restraints (VER's). Naturally, an extensive body of writings by economists has developed concerned with the effects of such measures. However, most of these writings are deficient in two important respects: they adopt an exclusively partial equilibrium perspective, neglecting the implications of quantitative trade restrictions for factor prices and industrial structure; and they ignore the effects of quotas and VER's on the international flow of mobile capital.\(^1\) The objective of the present paper is to remedy this deficiency, by developing a general framework within which the effects of tariffs, quotas and VER's may be compared both with and without international capital mobility.

One issue which immediately arises in comparing these different forms of trade restrictions is whether or not they are "equivalent" to one another. It is well known that tariffs and quantitative restrictions are not equivalent in the presence of market imperfections, uncertainty or retaliation by the foreign country.\(^2\) In this paper, I concentrate on a competitive

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1 A number of papers should be exempted from this general criticism, and their specific contributions will be noted later where appropriate. The effects of quotas and VER's have been considered in a general equilibrium context by Falvey (1975), Lizondo (1984), Buffie (1983), Dei (1985a, 1985b) and Anan (1985, 1986); and Falvey (1976) has compared the effects of tariffs and quotas when capital is internationally mobile.

2 See Bhagwati (1966), Takacs (1978), Harris (1985) and Krishna (1983) on market imperfections; Fishelson and
non-stochastic small open economy framework. It is then straightforward to show that price and quantity controls are mutually equivalent and this is done in Section 3 below, drawing on some results of rationing theory. However, even in this framework, I argue that equivalence must be interpreted with care, since the tariff rates equivalent to a given set of quantitative restrictions are in general functions of all the exogenous variables characterising equilibrium. The positive and normative effects of the different forms of trade restrictions are then compared in Sections 4 and 5. Section 4 considers the case where capital is internationally immobile, although exogenous changes in the stock of foreign-owned capital may occur. Some of the results in this section have been derived in special cases by Buffie (1985), Dei (1985a, 1985b), and Anam (1985, 1986), but a number of additional insights result from considering them in a unified and general framework. Section 5 breaks new ground by considering the effects of quantitative restrictions when capital is internationally mobile, and comparing their effects with those of tariffs, as recently considered by Jones (1984) and Neary and Ruane (1984). Section 6 then turns to consider the Heckscher-Ohlin case in which, when capital is internationally mobile, equivalence between quantitative restrictions and tariffs is not a one-to-one relationship. In spite of this, the welfare effects of the three forms of trade intervention may be easily compared, thus extending the results of Uzawa (1969), Hamada (1974), Brecher and Diaz (1977) and Neary and Ruane (1986). Finally, Section 7 summarises the principal conclusions of the paper and notes some directions for further research.

2. The Setting

The formal analysis in this paper deals exclusively with a competitive non-stochastic model of a small (i.e., price-taking) open economy. While this is a somewhat restrictive framework, it sheds considerable light on the different manner in which the three types of trade

restrictions operate. Moreover, in other respects the framework is extremely general: in particular, no restrictions are placed on the economy's production structure or on the number of goods or factors.

In specifying the model, it is convenient to make explicit only those goods which are subject to trade restrictions and only those factors which may be internationally traded. Thus, I assume that there are m imported goods, with exogenous world prices $p^*$ and domestic prices $p$. The vector of differences between domestic and foreign prices is denoted by $t \, (=-p-p^*)$, irrespective of whether these differences are exogenously fixed, as in the case of tariffs, or endogenously determined, as in the cases of quotas and VER's. In addition, I allow for n factors of production which are potentially mobile between countries; for concreteness it is convenient to refer to these as "capital", although no explicit accumulation mechanism is specified. If these factors are internationally immobile, their returns, denoted by $r$, are domestically determined. If they are internationally mobile, their returns are fixed exogenously by world capital markets, and the quantities owned by residents of the home country, denoted by $\bar{k}$, differ in general from the quantities located in the home country, denoted by $k$. In either case, I assume that the home country is a net importer of capital services and that rental payments to foreign capital owners are untaxed. (It is straightforward to relax these assumptions.

Under this specification, the equilibrium of the economy is easily determined. Firstly, the household sector is assumed to spend all its income:

$$e(p,u) = I.$$  \hspace{1cm} (2.1)

Here, $e(p,u)$ is an expenditure function and $u$ is aggregate welfare. (The household sector could be disaggregated without difficulty, but this would add nothing which is specific to the issues under consideration.) Income in turn equals gross national product (i.e., gross domestic product less factor payments to foreign capital owners) plus any revenue which accrues from
trade restrictions. The precise form which the latter takes depends on the particular type of
trade restriction which is in operation. With tariffs, all the revenue is assumed to be costlessly
redistributed to the household sector, so that its total income is:

\[ I_t = g(p,k) - r'Z + r'M, \]  

(2.2)

where a prime denotes the transpose of a vector. Here, \( g(p,k) \) is a GDP function, giving the
value of total production in the home country at given domestic prices and endowments of
mobile factors. From this must be subtracted the rentals which accrue to foreign capital own-
ers; I use \( Z( = k - \bar{k}) \) to denote the vector of foreign-owned stocks of capital. Whether or not
capital is internationally mobile, the domestic rental and capital stock are related by the
standard condition:

\[ r = g_k(p,k). \]  

(2.3)

In addition, households also receive the tariff revenue, where \( M \) is the vector of imports:

\[ M = e_p(p,u) - g_p(p,k), \]  

(2.4)

invoking standard properties of the expenditure and GDP functions. If imports are restricted
by quotas rather than tariffs, the determination of income is unchanged, although the inter-
pretation is rather different. Imports are now fixed at the given quota levels, \( Q \), and the
implicit tariff rates are determined endogenously:

\[ I_Q = g(p,k) - r'Z + r'Q. \]  

(2.5)

In this case I assume that all the quota rents accrue to the household sector. Finally, the key
difference between quotas and VER's is that in the latter case the rents accrue to foreign rather
than to domestic residents. Hence income in this case equals:

\[ I_V = g(p,k) - r'Z. \]  

(2.6)
Note that I am assuming a strong version of the small open economy assumption here: although foreign producers receive a price which differs from the world market level, this does not induce them to alter their behaviour and the world price itself does not change. A more complete analysis of the effects of VER's would endogenise their effects on world prices; work by Dei (1986b) suggests that the effects considered below continue to apply in such an analysis.3

3. The Tariff Equivalence of Quotas and VER's

I now wish to derive conditions under which the effects of a given set of quantitative restrictions on trade can be replicated by the imposition of an equivalent tariff vector. It turns out that extremely weak sufficient conditions for equivalence can be stated as a direct application of recent work on the theory of household behaviour under rationing by Neary and Roberts (1980) and on trade utility functions by Woodland (1980).

**Proposition:** Sufficient conditions for the existence of a vector of tariffs equivalent to a given set of quantitative restrictions on imports, $\overline{M}$, are that: (a) preferences are convex, continuous and strictly monotonic; and (b) the aggregate production constraint is convex.

**Proof:** The assumptions on preferences ensure that there exists a quasi-concave utility function defined over home consumption of importables, $u(x)$. From Woodland (1980), the existence of such a utility function plus the convexity of the aggregate production constraint, $F(z,k) \leq 0$ (where $z$ is the domestic production of importables), ensures that there exists a *direct trade*...

3 My assumption is also consistent with the empirical evidence of Tarr (1986). He estimates that the change in the world price of Korean steel following a voluntary restraint on exports to the U.S. and the European Community is only nine per cent of the change in the differential between the world price and the price of Korean steel in the U.S. and E.C. markets.
utility function, giving the maximum utility attainable for given levels of imports and factor endowments:

\[ U(M,k) = \max_x [u(x) : F(x - M,k) \leq 0] . \]  

(3.1)

(Recall that I suppress non-tradeable factors and goods which are not subject to trade restrictions.) For given \( k \), this function exhibits all the properties of a standard utility function; in particular, it is quasi-concave in \( M \). Hence, by direct analogy with consumer theory, I may now define a trade expenditure function which equals the minimum cost of attaining a target utility level at given prices and endowment levels:⁴

\[ E(p,k,u) = \min_M \{ p'M : U(M,k) \geq u \}, \]

\[ = e(p,u) - g(p,k). \]  

(3.2)(3.3)

Given the assumptions made, this function is concave in \( p \) and its partial derivatives with respect to \( p \) are the economy's utility-compensated import demand functions. Hence the results of Neary and Roberts (1980) characterising household behaviour in the presence of ration constraints may be invoked directly. The equilibrium induced by any pattern of quantitative restrictions on imports, \( \bar{M} \), could equivalently be attained by altering the domestic prices to \( \bar{p} \), where the implicit tariffs \( \bar{p} - p' \) are defined by the equation:⁵

\[ \bar{M} = E_p(\bar{p}, k, u). \]  

(3.4)

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⁴ The function \( E(p,k,u) \) is called an "excess expenditure function" by Dixit and Norman (1980, pp. 90-91) and a "trade expenditure function" by Neary and Schweinberger (1986), while the negative of this function is called the "maximum net revenue function" by Woodland (1982, p. 170). The detailed properties of this function and further applications are discussed in these references.

⁵ I assume throughout that the utility level \( u \) is actually attainable in the presence of the quantitative restrictions \( \bar{M} \) and the endowments \( k \). See Neary and Roberts (1980), especially footnote 5.
Hence the tariffs $p - p'$ are equivalent to the quantitative restrictions $\overline{M}$.

Q.E.D.

This proposition shows that equivalent tariffs exist under rather general circumstances. In the light of the widespread view that tariffs and quantitative restrictions are not in general equivalent, some explanatory remarks are in order. Firstly, the proof of the proposition focusses only on the substitution effects of quantitative restrictions, ignoring their income effects. Hence no distinction is made between quotas and VER's in the proof. This is not a limitation, however; the tariff rates equivalent to any particular form of quantitative restrictions may be derived by substituting the indirect utility function $v(p,1)$ for $u$ in equation (3.4), with income given by either (2.5) or (2.6) as appropriate.

Secondly, the assumption of competitive equilibrium, with both consumption and factor input levels optimally chosen in the face of parametric prices, is clearly crucial for the equivalence result. In the absence of competition, whether because of monopoly (as in Bhagwati (1965) and Tacaks (1978)) or oligopoly (as in Harris (1985) and Krishna (1983)), quantitative restrictions may be expected to have results which could not be replicated by any set of linear tariff schedule. By contrast, other reasons which have been adduced for non-equivalence might be better described as implying non-invariance rather than non-existence of equivalent tariffs. Equation (3.4) shows clearly that equivalent tariffs are functions of all the exogenous variables determining a particular equilibrium, and so a change in any one of these will alter the tariff rates equivalent to a given set of quantitative restrictions. Many of the alleged "non-equivalence" results in the literature may be attributed to the assumption that tariff rates are fixed in the face of changes in exogenous variables such as the money supply (see Blejer and

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Of course, the fact that tariffs and quantitative restrictions are in general equivalent in Walrasian equilibrium is intuitively obvious from a dual perspective, as noted, for example, by Dixit and Norman (1980, p. 165).
Hillman (1982) and Daniel, Fried and Tower (1985)), the level of foreign capital (see Falvey (1976), Buffie (1985), Dei (1985a and 1985b) and Anam (1985)) or the state of nature (see Fishelson and Flatters (1975), Pelcovitz (1976) and Dasgupta and Stiglitz (1977)).

Thirdly, I have assumed here that both tariffs and quantitative restrictions are applied to the same category of imports on a commodity-by-commodity basis. In practice, all forms of trade intervention are typically applied to aggregate commodity groups and so incentives for within-group differential adjustment may emerge. In some respects this does not affect equivalence. For example, Falvey (1979) shows that both quotas and specific tariffs encourage "upgrading" within the protected commodity category: imports of higher-priced grades are likely to increase at the expense of lower-priced grades. However, when applied to a heterogeneous group of commodities, an aggregate quota is unlikely to be applied efficiently and so will not be equivalent to a uniform tariff rate applied to the same commodity group. Anderson (1985) presents a case-study of this issue in which the resulting dissipation of quota rents substantially raises the welfare cost of a quota system relative to an import-volume-equivalent tariff.

Finally, the proposition shows that the effects of a given set of quantitative restrictions can be mimicked by an equivalent tariff vector but does not guarantee that the converse holds. The essential requirement for a one-to-one correspondence between tariffs and quantitative restrictions is that equation (3.4) can be inverted to give $\bar{P}$ as a function of $\bar{M}$; in other words, that the matrix $E_{pp}$ be non-singular. An important case in which this does not hold is

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7 Feenstra (1984) documents the importance of this effect in the case of VER's on U.S. automobile imports.

8 One set of circumstances outside the scope of the proposition where this poses a problem is when the home country faces an inelastic foreign offer curve. As shown by Falvey (1975), in this case a small tariff imposed in an initial free-trade equilibrium raises the volume of imports. There is no import quota which will replicate the tariff equilibrium, although an export quota will do the trick.
the Heckscher-Ohlin model with international capital mobility, to be considered in Section 6. For the present, I confine attention to cases where $E_{pp}$ is non-singular, so that there is a one-to-one correspondence between tariffs and quantitative restrictions.

4. The Effects of Trade Restrictions with Immobile Capital

In this section, I wish to compare the effects of the three different kinds of trade restrictions under the assumption that capital is internationally immobile. For ease of reference, the results from this and the next section are summarised in Tables 1 and 2 below. As already noted, these results hold for the general case of $m$ imported goods and $n$ traded factors. However, in order to provide intuitive explanations for the results, I will discuss them in terms of a single import and traded factor only, while the additional issues raised by the general $m$-by-$n$ case will be noted in footnotes as necessary. The interested reader can determine from Tables 1 and 2 how the results need to be modified in the general case.

Note firstly that, whatever the form of trade restrictions considered, home consumers and producers are assumed to be trading voluntarily. Hence the price and volume of imports must be related at all times by the import demand equation, (2.4). Totally differentiating this (setting $t = p \cdot p^*$) gives the following:

$$dM = -Sdt + x_t \, dy - g_{pk} \, dk.$$  \hfill (4.1)

Here, $S$ equals $g_{pp} - e_{pp}$, the elasticity of excess supply of importables, with real income held constant. Under the assumptions made, this must be positive.\(^9\) The income effect on the demand for imports is captured by the next term in (4.1), where $x_t$ (equal to $e_{pu}/e_u$) is the income derivative of demand and $dy$ (equal to $e_u \, du$) measures changes in real income. Finally,

\(^9\) With many imports, $S$ is a positive definite matrix. Note that it equals $-E_{pp}$, as defined in Section 3.
$g_{pk}$ measures the relative factor intensity of importables, and is positive if they are capital intensive (in the general equilibrium sense that an increase in the amount of capital employed in the whole economy raises the output of importables).

A second equation which must hold irrespective of the type of trade restriction considered is (2.3), which links the domestic rental and the level of capital employed. Totally differentiating this yields:

$$dr = g_{kp} dt + g_{kk} dk.$$  \hspace{1cm} (4.2)

Once again, relative factor intensities determine the sign of the relationship between the domestic goods price and the rental, while an increase in the usage of capital must reduce the rental, since $g_{kk}$ is negative.

It is now necessary to distinguish the different types of trade restrictions and we concentrate for the present on tariffs and quotas: although the mechanisms whereby they affect the economy are very different, they are similar in that the equations determining the level of income, (2.2) and (2.5), have the same form. Differentiating either of these equations (and using (2.4) to simplify) yields:

$$dy = t'dM - Z'dr.$$  \hspace{1cm} (4.3)

This shows that, in the presence of a tariff, imports have a "volume-of-trade" effect on welfare but, with fixed world prices, no "terms-of-trade" effect; whereas the converse is true of international capital movements since they are untaxed.\textsuperscript{10} As already noted, I assume throughout that the home country is never a net creditor on capital account, so that $Z$ is always non-negative. An increase in $r$ thus lowers welfare since it raises the amount of rental income due

\textsuperscript{10} This type of equation is familiar from Jones (1967).
to foreign capital-owners. Substituting from (4.1) and (4.2) with the amount of foreign-owned capital held constant (dk=0) therefore gives an expression for the cost of protection:

\[(1 - t'x_t)dy = -(t'S + Z'e_kp)klt.\]  

(4.4)

The implications of this equation are familiar. (See Neary and Ruane (1984) for a more detailed discussion.) The coefficient of dy is the inverse of the "tariff multiplier", which arises because any exogenous shock induces changes in the demand for imports which alter tariff revenue and thus feed back on income. We assume that this multiplier is positive.\(^{11}\) The right-hand side of (4.4) therefore shows that the cost of protection is greater, the more elastic is the excess supply of importables when the tariff is already in place, and the more capital intensive are importables, since this leads to a larger increase in the domestic rental and so a larger increase in factor payments to foreigners.

Now, consider instead the welfare cost of a quota. To evaluate this, we again solve (4.1), (4.2) and (4.3), but this time eliminating dt rather than dM (which I write as dQ). This gives:

\[(1 + Z'e_kpS^{-1}x_t)dy = (t'S + Z'e_kp)S^{-1}dQ.\]  

(4.5)

Note that there is no tariff multiplier as such in this case. The only feedback effect on income arises when Z is positive, so that a change in income indirectly affects the rental and thus changes payments to foreigners. As for the right-hand side, it is identical to that of (4.4) except that -dt is replaced by S^{-1}dQ. This reflects the equivalence between tariffs and quotas: the latter operate through exactly the same channels as tariffs, except that their initial impact depends on the elasticity of domestic excess supply of importables. Another way to view equivalence

\(^{11}\) Sufficient conditions for this are that the equilibrium is stable under plausible adjustment mechanisms or that both importables and non-importables are normal in demand. (See Neary and Ruane (1984) for further discussion.)
in this context is to solve (4.1), (4.2) and (4.3) for the relationship between imports and domestic prices (holding constant the stock of foreign-owned capital):

\[ [I_m - x_1 t'] dM = - [S + x_1 Z' g_{kp}] dt. \] (4.6)

The coefficient of \( dt \) is an amalgam of substitution and income effects which must be positive if the market for importables is stable.\(^{12}\) Equation (4.6) may be interpreted either as the import demand equation or as an equation defining the tariff rate equivalent to a given import quota. That the two forms of trade restriction have exactly equivalent effects is shown by the fact that (from (4.4), (4.5) and (4.6)), \( dy/dQ = (dy/dt)/(dt/dQ). \)^{13}

Consider next the case of a VER. Since the disbursement of rents is very different in this case (foreign producers rather than domestic consumers benefit), a VER is not equivalent to the same tariff rate as the one I have been considering so far. Of course, the general result of Section 2 implies that there must be some equivalent tariff rate, and I shall calculate it shortly.\(^{14}\) Note first that the expression (4.3) does not give the change in income in this case, since the relevant national budget constraint is now (2.6) rather than (2.2). Totally differentiating (2.1) and (2.6) gives:

\(^{12}\) The inverse of the coefficient of \( dM \) is a "matrix tariff multiplier" in the general case, with \( I_m \) equal to the identity matrix of order \( m \). With only a single import good, this obviously reduces to \( 1 - x_1 t \).

\(^{13}\) This result necessarily holds when there is only one import good and one factor which is partly foreign-owned. I conjecture that it must also hold in the general \( m \)-by-\( n \) case, although I have so far been able to demonstrate this only when either \( t \) or \( Z \) is zero.

\(^{14}\) An alternative approach is to note that a VER is exactly equivalent in its effects to a tariff when none of the proceeds are redistributed. One set of circumstances in which this occurs is where competitive lobbying for the revenues generated by a tariff takes place, so that all of the revenues are dissipated. See Krueger (1974) and Bhagwati and Srinivasan (1960).
\[ dy = - V' dt - Z' dr. \] (4.7)

This shows that, when the revenue from restricting trade does not accrue to domestic residents, international transactions in both goods and capital have terms-of-trade effects only. Using (4.1) and (4.2) to eliminate \( dr \) and \( dt \), yields:

\[ [1 + (V' + Z' g_{kp}) S^{-1} x_I] dy = (V' + Z' g_{kp}) S^{-1} dV. \] (4.8)

Comparing this with (4.5), the most striking difference is that, even when there is no foreign-owned capital \( (Z = 0) \) and the initial situation is one of free trade \( (t = 0) \), the introduction of a VER has a first-order effect on welfare, whereas the introduction of a quota does not. This difference arises from the very different income effects of the two forms of trade restriction, as the presence of the term \( V' S^{-1} \) in (4.8) demonstrates.

The same difference in income effects is apparent from the expression for the effect of a VER on the difference between home and world prices:

\[ [S + x_I (V' + Z' g_{kp})] dt = - dV. \] (4.9)

Comparing this with (4.6), note the absense of a "tariff multiplier" and the presence of the additional income effect \( x_I V' \) in the coefficient of \( dp \).

These results for the effects of quotas and VER's on welfare and domestic prices are summarised in Figure 1, where I simplify by assuming that all the capital stock is domestically owned \( (Z = 0) \). As the diagram shows, the two measures must have identical effects if they eliminate trade (at the autarky points \( A \) and \( A' \)) or if they are non-binding (at the free trade points \( F \) and \( F' \)). Starting from free trade, tighter values of the quota initially have smaller effects on income but larger effects on prices than a VER set at the same level. The direct effect of the VER in driving up the home price is diluted by the loss of rent income. However, as the
two types of restrictions are progressively tightened, their effects on income and prices tend to converge. Progressive tightenings of the quota have larger effects on income whereas the effect of a tightening of the VER depends on the volume of imports and so falls steadily. It is possible (though not inevitable) that for some level of import restriction, the two measures have identical effects on domestic prices, as point B in the lower quadrant of Figure 1 illustrates. At this level, GDP is the same under both types of trade restriction, and so income under the quota must still exceed income under the VER. However, a still more restrictive policy may lead to a level of income which is identical under the two measures, as point D in the upper quadrant illustrates.

5. Trade Restrictions when Capital is Internationally Mobile

The general expressions derived in the last section allowed for the possibility that some of the domestic capital stock was foreign-owned. However, the extent of foreign ownership was assumed to be invariant to changes in the level of trade restrictions. As noted by Neary and Ruane (1984), this makes sense only as a description of a short-run equilibrium, before foreign capital-owners have had an opportunity to reallocate their portfolios in response to the changes in incentives brought about by changes in trade policy. In this section, we turn to the more interesting case where capital moves internationally in response to deviations between the domestic and the world rental. Since we confine attention to a small open economy, the world rental is assumed to be exogenously given throughout. Moreover, we continue to assume that repatriated capital earnings are untaxed.

The case of tariff protection has been extensively considered by Neary and Ruane (1984) and need not detain us. (See also Jones (1984).) As shown in Tables 1 and 2, protection in the presence of internationally mobile capital leads to a larger domestic supply response which reduces imports and income by more than when capital is internationally immobile. (i.e., $\tilde{S}$
Note that in this and subsequent comparisons between the mobile and immobile capital cases, I simplify by assuming that there is no foreign-owned capital in the initial situation: \( Z \) is zero.) This unambiguous conclusion is independent of the relative factor intensity of the protected sectors.

Turning next to the quota case, Table 1 shows that (ignoring foreign-owned capital in the immobile capital case), the effect of a tightening of the quota constraint is the same whether capital is internationally mobile or not: \( dy = t' dQ \). However, the greater supply response when capital is internationally mobile continues to play a role, since it implies, as shown in Table 2, that a tightening of the quota raises domestic prices by less when capital is internationally mobile than when it is not: \( dp = - S^{-1} (I_m - x_t') dQ \) in the former case and \( - S^{-1} (I_m - x_t') dQ \) in the latter. Thus, while international capital mobility raises the cost of tariff protection, it lowers the welfare cost of protection by means of a quota.

The outcome in the VER case is similar, although the chain of causation is different. As equation (4.7) showed, the effect of a VER on domestic welfare depends solely on the response of domestic prices, whether capital is mobile or not (given that \( Z \) is assumed to equal zero). But as the last row of Table 2 shows, a VER raises prices by less when capital is internationally mobile than when it is not, once again because the greater supply response arising from capital mobility requires a smaller price rise to reduce imports to the constrained level. Hence income also falls by less, implying that international capital mobility reduces the welfare cost of a VER as well as of a quota.

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15 With many internationally mobile capital goods, \( S - S \), which equals \( -\delta_{px} \delta_{xp}^{-1} \delta_{pp} \) is a positive definite matrix.

This is, of course, an example of the Le Chatelier effect and is subject to the well-known qualification that the two matrices must be evaluated at the same point. See Neary (1985), especially footnote 13.
The difference which international capital mobility makes to the welfare costs of the three kinds of trade restriction may be illustrated in Figure 2. This is only a partial equilibrium diagram, and so it fails to capture all aspects of the comparison (such as the tariff multiplier for example). Nevertheless, it illustrates adequately the different ways in which the three measures lower welfare. The curves labelled $p^*$ and $D$ are the foreign supply and home demand curves respectively, while $S_{NCM}$ and $S_{ICM}$ are the home supply curves without and with international capital mobility respectively. Both pass through the initial free-trade production point $A$, and the curve with international capital mobility is the more elastic. A tariff raises the supply price of imports to $p^* + t$ and imposes a consumption welfare cost equal to the triangle $DEF$. If capital is immobile the production welfare cost equals the triangle $ABC$, whereas if it is internationally mobile the production cost is $AGH$; the latter is clearly larger, which illustrates the result of Neary and Ruane (1984). Now consider the effects of a quota which raises the domestic price to $p^* + t$ when capital is internationally immobile. It therefore has the same welfare cost as the equivalent tariff, i.e., the sum of the areas $ABC$ and $DEF$. However, if capital is internationally mobile, the same restriction of imports requires a smaller rise in the home price. The precise price rise necessary is derived by drawing through $B$ a curve parallel to the home demand curve $D$; this intersects the $S_{ICM}$ curve at $I$, and so the import volumes $IL$ and $BE$ are equal. The welfare cost of a quota with international capital mobility therefore equals the sum of the areas $AJI$ and $KLF$, which is clearly less than that when capital is internationally immobile.\(^{16}\) Finally, the same comparison applies in the case of a VER, since the only additional cost is the rent rectangle, $CBED$ when capital is internationally immobile and $JILK$ when it is internationally mobile.

\(^{16}\) This may be seen as follows:

\[
\begin{align*}
AJI + KLF &= ABC + CBJ = ABI + KLF \\
&= ABC + DELK - ABI + KLF \text{ (since $BI$ is parallel to $D$)} \\
&= ABC + DEF - ABI.
\end{align*}
\]
Returning to the general equilibrium case, an illuminating way of viewing the effects of international capital mobility is to consider the economy's aggregate demand for capital, written as a function of the rental and whichever form of trade restriction is in force. This is set out for the three types of trade restrictions considered in Table 3. Ignoring foreign-owned capital, it may be checked that the aggregate demand for capital is a less elastic function of the rental in the presence of quantitative restrictions than of a tariff; this is because with quantitative restrictions the domestic price bears part of the adjustment to any exogenous shock, and so a smaller change in the capital stock is required. Moreover, the adjustment in price is greater with a quota than a VER, since the rents arising from the VER are not spent domestically. Hence, the aggregate demand for capital is a less elastic function of the rental in the presence of a quota than of a VER. Summarising these results:\(^{17}\)

\[
\bar{g}_{kk} < \bar{g}_{kk} < \bar{g}_{kk} < 0. 
\]

(5.1)

6. Trade Restrictions, International Capital Mobility and Specialisation in the Heckscher-Ohlin Model

The concluding discussion in the last section draws attention to a class of models in which the approach used so far to examine the effects of international capital mobility breaks down. This class is that where the economy's aggregate demand for capital is not a strictly decreasing function of the rental, so that the matrix \(g_{kk}\) is singular. Since \(g_k\) is the vector of factor returns, one way of describing this class of models is as the class which exhibits the "local factor-price equalization property", in the sense that factor returns are invariant with respect to small changes in factor endowments. If capital is internationally immobile or if there is an exogenous

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17 This equation continues to hold with n internationally mobile capital goods, provided the matrix expression "A < B", where A and B are n-by-n matrices, is interpreted to mean "the matrix B-A is positive definite."
level of foreign-owned capital, the expressions in the first column of Tables 1 and 2 continue to apply; however, most of those in the second column of these tables are now degenerate, since they involve terms in $g_{33}$. Hence a different approach to examining the properties of models in this class is necessary when capital is internationally mobile.

Confining attention to the case of a single import good and a single type of mobile capital, the properties of these models may be illustrated geometrically. Figure 3 reproduces some of the results of Brecher and Diaz (1977) and Neary and Ruane (1986) for the tariff case (indicated by solid lines) and superimposes upon them the effects for the quota case (indicated by dashed lines). This diagram is drawn under the assumptions that there is no foreign-owned capital in the initial free-trade equilibrium (denoted by $F$, $F'$ and $F''$ in the three panels of the figure), and that importables are relatively capital-intensive. The consequences of relaxing these assumptions may easily be deduced from the general expressions in Tables 1 and 2.

Consider first the effects of imposing a tariff starting from an initial free-trade equilibrium. Prior to any capital inflow, this lowers the levels of income and imports as indicated by the drops from points $F$ and $F'$ to points $T$ and $T'$ in the first and second panels of the diagram. However, since importables are relatively capital-intensive by assumption, it also raises the domestic rental, as indicated by the jump from $F''$ to $T''$ in the third panel. This creates an incentive for capital to flow into the economy, which raises the domestic output of importables and so lowers both income and imports. (Note that the terms $B$ and $D$ are positive in the first equation in Tables 1 and 2 respectively.) However, because domestic prices are fixed, the capital inflow has no effect on the domestic rental: see the third panel of Figure 3. The capital inflow therefore continues until imports are eliminated, at points $A$, $A'$, $A''$, and $A'''$. Only then do further inflows of capital begin to depress the domestic rental; moreover, they now raise home income. This process continues until the levels of income, goods prices and factor
prices are restored to their free trade levels, at the points M, M' and M''. It may be noted that this final equilibrium is independent of the level of the tariff, as was first noted by Mundell (1957). For example, a prohibitive tariff will initially move the economy to the equilibrium indicated by the points P, P', P'' and P'''; and induced capital inflows will then cause the economy to converge towards the points M, etc., as before.

Consider now the effects of a quota which is set at such a level as to have the same effects as the tariff just considered in the absence of capital movements. In the immediate post quota equilibrium, there is once again therefore an incentive for capital to flow into the economy. However, the effects of this inflow are very different from the tariff case, as the relevant term in Table 1 indicates. Firstly, an infinitesimal capital inflow has no effect on welfare: by assumption it cannot alter the volume of imports and, with no foreign-owned capital, it cannot increase the required payments to foreign capital-owners. Further capital inflows raise domestic output of importables and so lower their price and the rental on capital. The effect of this is to reduce the rental payments which must be made to foreigners and so to raise income. Capital continues to flow into the country until the rental is restored to the world level, but unlike the tariff case, this occurs before the point M is reached. Hence, under a quota, the final equilibrium is that denoted by the points Q, Q' and Q''. While the effects on welfare, import volumes and prices are the same as under a tariff, a quota has the potential to exert an influence over the scale of the domestic import-competing sector. This is also illustrated in

18 All three import restrictions are redundant for further capital inflows, whose effects are also illustrated in the diagram: at point R the trade pattern is reversed, as the previously imported good is now exported; and at S and S' the economy specialises in its production, so that further capital inflows would raise real income and lower the domestic rental.

19 This result was noted by Dei (1985a), Buffie (1985) and Anam (1985).

20 This was noted by Falvey (1976).
Figure 4, where the relationships between income and the level of capital inflow are illustrated for different levels of the tariff and quota. Obviously, a prohibitive quota will have exactly the same effect as a prohibitive tariff, initially reducing income to the level indicated by the point P and then leading to a capital inflow which drives the economy to the point M. However, any less than prohibitive quota brings about a final equilibrium between points F and M, as indicated by the points Q₁, Q₂ and Q₃. Note that there is no necessary relationship between the capital inflow induced by a given quota and the capital inflow just sufficient to eliminate imports in the face of the (at the initial capital stock) equivalent tariff.

Finally, what can be said about the effects of a VER as opposed to those of a quota? A stylized depiction of the differences between the effects on welfare of the two measures is given in Figure 5. With no foreign-owned capital, the quota lowers income by less than does the VER, as indicated by the points O and V. Induced capital inflows initially have no effect on welfare when a quota is in place (since Z is zero) but must raise it when a VER is in place. Finally, the total capital inflow required to restore equilibrium in the capital market, and so to return income to its free-trade level, is necessarily greater under a quota than a VER. This may be checked from Table 3: the capital inflow induced by a tightening of a quota is:

\[- \frac{dk}{dQ} = - \frac{\bar{\kappa}}{\bar{\epsilon}_{kk}} \frac{1}{\bar{\epsilon}_{kp}} S^{-1} C = \frac{1}{\bar{\epsilon}_{pk}} (1 - tx), \]

(6.1)

whereas that induced by a tightening of a VER is:

\[- \frac{dk}{dV} = - \bar{\kappa} \frac{1}{\bar{\epsilon}_{kp}} (S + x_V)^{-1} = \frac{1}{\bar{\epsilon}_{pk}}. \]

(6.2)
Once again, the key difference between the two is the absence of an income effect in the VER case, as indicated by the absence of the tariff multiplier term in equation (6.2).\textsuperscript{21}

7. Summary and Conclusion

This paper has presented a general framework for the analysis of different types of trade restrictions, within which the general equilibrium effects of tariffs, quotas and voluntary export restrictions have been compared. The paper first looked at the issue of equivalence between tariffs and quantitative trade restrictions. It was demonstrated that equivalence holds in extremely general circumstances but, at the same time, that it is a less useful property than is often realised. In other words, in competitive non-stochastic environments, it is always possible to specify a vector of tariff rates which will replicate the equilibrium induced by any given pattern of quantitative restrictions. However, these equivalent tariffs are themselves functions of all the exogenous variables characterising the economy's equilibrium. Thus a change in any exogenous variable will in general alter the vector of equivalent tariffs.

The paper then derived a number of comparative statics results concerning the effects of different types of trade restrictions, both with and without international capital mobility. These results are summarised in Tables 1 and 2, to which the interested reader is referred for details. Some of the principal results which deserve mention include: starting from a situation of free trade, a VER has a finite effect on welfare whereas a quota set at the same level has not; by contrast, as the two types of restriction become progressively more restrictive, welfare tends to fall faster with a quota than with a VER; whereas international capital mobility raises the welfare cost of tariff protection, it reduces the welfare cost of protection by means of quanti-

\textsuperscript{21} Note that in the general case the expression $\hat{\beta}_{pk}$ is only invertible when the number of imported goods and internationally mobile factors is the same.
tative restrictions; and, in models of the Heckscher-Ohlin type, all three kinds of trade restriction leave equilibrium welfare unchanged, but quantitative restrictions (by contrast with tariffs) do not altogether eliminate trade.

While the paper has hopefully succeeded in its aim of synthesizing and extending our understanding of tariffs and quantitative trade restrictions in a general equilibrium framework, there are a great many issues which it has ignored. As already noted, all issues relating to uncertainty and departures from competitive behaviour have been assumed away. The latter omission is particularly crucial, since the work of Harris (1985) and Krishna (1983) in a partial equilibrium context has shown that quantitative restrictions alter the strategic interdependence between oligopolistic firms in ways which are fundamentally different from the effects of tariffs. A different limitation of the present paper is its exclusive concern with a small open economy. The assumption that world prices are exogenous means that the only difference between quotas and VER's is that the home country loses the implicit rents from VER's but not from quotas. Of course, this is an important difference, and the work of Dei (1985b) shows that the effects of VER's when the terms of trade are endogenous are similar to the effects considered here. However, this is only one aspect of the difference between quotas and VER's; as Greenaway (1983) and Hamilton (1986) note, VER's in practice are usually discriminatory between countries and form part of a package of trade policies negotiated between governments. The short-run effects of VER's are also likely to differ significantly from those of tariffs if there is unemployment in the exporting country. Finally, the identification of the effects of the different kinds of trade restrictions on aggregate welfare needs to be supplemented by an examination of their effects on the welfare of individual agents, if our understanding of the political economy of trade restrictions is to be furthered. These are only some of the directions in which further research is badly needed.
References


Table 1: Changes in Welfare

<table>
<thead>
<tr>
<th>Type of Trade Restriction</th>
<th>Capital Internationally Immobile</th>
<th>Capital Internationally Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariff</td>
<td>((1 - t' x_I) \ dy = -Adt - Bdk)</td>
<td>((1 - t' x_t) \ dy = -t' \ddot{S} dt - B \bar{g}_{kk}^1 \ dr)</td>
</tr>
<tr>
<td>Quota</td>
<td>((1 + Z' \bar{g}<em>{kp} S^{-1} x_I) \ dy = AS^{-1} dQ - Z' \bar{g}</em>{kk} dk)</td>
<td>(dy = t' dQ - Z' \ dr)</td>
</tr>
<tr>
<td>VER</td>
<td>[1 + (V' + Z' \bar{g}<em>{kp}) S^{-1} x_I] (S^{-1} dV + [V' S^{-1} \bar{g}</em>{kp} - Z' \bar{g}_{kk}] \ dk)</td>
<td>((1 + V' \ddot{S}^{-1} x_I) \ dy = V' \ddot{S}^{-1} dV + [V' \ddot{S}^{-1} \bar{g}<em>{kp} - Z' \bar{g}</em>{kk}] \bar{g}_{kk}^1 \ dr)</td>
</tr>
</tbody>
</table>

Symbols:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(t' S + Z' \bar{g}_{kp})</td>
</tr>
<tr>
<td>B</td>
<td>(t' \bar{g}<em>{kp} + Z' \bar{g}</em>{kk})</td>
</tr>
<tr>
<td>(\bar{g}_{kk})</td>
<td>(\bar{g}<em>{kk} = \bar{g}</em>{kk} - \bar{g}<em>{kp} S^{-1} \bar{g}</em>{pk})</td>
</tr>
<tr>
<td>S</td>
<td>(\bar{g}<em>{pp} - \bar{c}</em>{pp})</td>
</tr>
<tr>
<td>(\ddot{S})</td>
<td>(\bar{c}<em>{pp} = S - \bar{g}</em>{pk} \bar{g}<em>{kk}^{-1} \bar{g}</em>{kp})</td>
</tr>
</tbody>
</table>

Table 2: Changes in Imports or in Domestic Prices

<table>
<thead>
<tr>
<th>Type of Trade Restriction</th>
<th>Capital Internationally Immobile</th>
<th>Capital Internationally Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariff</td>
<td>(CdM = -[S + x_I Z' \bar{g}_{kp}] dt - Ddk)</td>
<td>(CdM = - \ddot{S} dt - D \bar{g}_{kk}^{-1} \ dr)</td>
</tr>
<tr>
<td>Quota</td>
<td>([S + x_I Z' \bar{g}_{kp}] \ dp = -CdQ - Ddk)</td>
<td>(\ddot{S} dp = -CdQ - D \bar{g}_{kk}^{-1} \ dr)</td>
</tr>
<tr>
<td>VER</td>
<td>([S + x_I(V' + Z' \bar{g}_{kp})] \ dp = -dV - Ddk)</td>
<td>([\ddot{S} + x_I V'] \ dp = -dV - D \bar{g}_{kk}^{-1} \ dr)</td>
</tr>
</tbody>
</table>

Symbols (additional to those in Table 1):

- \(C \equiv I_m - x_I t\)
- \(D \equiv \bar{g}_{kp} + x_I Z' \bar{g}_{kk}\)
- \(I_m\): The identity matrix of order \(m\).
Table 3: The Aggregate Demand for Capital

Tariff
\[ d k = \varepsilon_{\text{atk}}^{-1} [d r + \varepsilon_{kp} \, d t] \]

Quota
\[ d k = \varepsilon_{\text{atk}}^{-1} [(I_n + \varepsilon_{kp} S^{-1} x_i Z')dr + \varepsilon_{kp} S^{-1} CdQ] \]

VER
\[ d k = \varepsilon_{\text{atk}}^{-1} \{[(I_n + \varepsilon_{kp} (S + x_i V')^{-1} x_i Z')dr - \varepsilon_{kp} (S + x_i V')^{-1} dV} \]

Symbols (additional to those in Tables 1 and 2):
\[ \varepsilon_{\text{atk}} = \varepsilon_{\text{atk}} - \varepsilon_{kp} (S + x_i V')^{-1} \varepsilon_{pk} \]
Figure 1: Effects of Quota and VER on Welfare and Domestic Prices
Figure 2: Partial Equilibrium Illustration of the Welfare Costs of Tariffs, Quotas and VER's, with and without International Capital Mobility
Figure 3: Effects of Capital Inflow on Welfare, Imports, Domestic Prices and Domestic Welfare in the presence of a Tariff (solid lines) and a Quota (dashed lines).
Figure 4: Effect of Capital Inflow on Welfare for Different Levels of Tariff and Quota
Figure 5: Effects of Capital Inflow on Welfare in the Presence of a Quota and a VER