COMMERCIAL POLICY AND THE PRODUCT CYCLE: THE EFFECT OF IMPORT QUOTAS ON LDC MANUFACTURES IN THE SHORT RUN AND IN THE LONG RUN

by

David Dollar

Department of Economics
University of California, Los Angeles
405 Hilgard Ave.
Los Angeles, CA 90024

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There has been some concern in recent years that the United States and other industrial countries are becoming "deindustrialized." The locus of production in industries like steel, textiles, and electronics is shifting increasingly to the less developed countries, and this relocation is blamed for high unemployment and falling real wages in the developed countries.[1]

The key implication of Vernon's (1966) product cycle thesis is that the departure of any particular industry from the developed countries should not be a matter of great concern as long as new industries or branches of industry are arising as the result of product innovation. And indeed the shifting of manufacturing production to the less developed countries has been going on for a long time; already during the 1960s there was a major shift in the production of textiles and clothing to East Asia. The experience of the 1960s demonstrates that this process can be consistent with low unemployment and rising real wages in the developed countries. Hence the transfer of production to the less developed countries <u>per se</u> is not a problem; the key issue rather is the <u>balance</u> between innovation in the developed countries and the transfer of technology to the LDCs.

Formal models of the product cycle are constructed in Krugman (1979) and Dollar (1984). In these models it is taken as given that there is introduction of new products in the developed region. The distinctive feature of Dollar (1984) is that the transfer of technology to the LDCs is driven by differences in costs of production in the two regions. Also, there is international capital mobility which over time tends to equalize the return to capital in the regions. Any difference in production costs must then be attributed to differences in wages. Hence in the model innovation in the developed region enables workers there to earn more than their counterparts in the LDCs; this difference in costs in turn provides the incentive to move production to the LDCs, driving the product cycle.

In this version of the product cycle it is possible that the demand for labor in the developed region, the North, is stable even though at each point in time the manufacture of some goods is being moved to the less developed region, the South. An important implication of the model, though, is that the demand for labor in the North will not be stable if the labor force in the South increases. In the short run this increase lowers wages in the South and raises the North's terms of trade by increasing demand for its products. The latter effect leads to increased wages in the North. The increase in labor costs in the North relative to labor costs in the South speeds up the flow of technology to the South.

Eventually capital is drawn to the South as well. This is one of the hallmarks of this model, that capital and technology tend to move together. This is not the result of technology being embodied in capital; rather it comes about because, other things being equal, an increase in the number of goods that a region produces improves its terms of trade, raising the marginal revenue product of capital in that region relative to the marginal revenue product in the other region and hence attracting capital.

The long-run effect of labor force growth in the South is to reduce the North's terms of trade by eroding its relative monopoly of technology and to lower the capital-labor ratio in the North. Both of these effects lead to lower real wages in the North.

The process generated by the model is consistent with casual empiricism. In the 1950s and 1960s rapid labor force growth and industrialization in the South generated demand for the North's output and helped to keep real wages there high. In the past fifteen years, on the other hand, the transfer of capital and technology to the South has been at a pace that tends to reduce the demand for labor in the North.

Workers (and some capitalists as well) in the North have responded to the high levels of unemployment and falling real wages in the 1970s and 1980s with calls for protection from imports. This protection has often taken the form of formal or informal quotas on imports of manufactured goods from the LDCs.

In this paper I examine the effect of a quota system in the short-run and in the long-run within the context of the product cycle model. The dynamic assumptions about innovation, technology transfer, and capital mobility are the same as in Dollar (1984); thus the quotas are assumed to have no <u>direct</u> effect on these processes. Their effect rather is indirect, coming through their influence on the prices in the system.

With free trade the product cycle model leads to complete specialization in production between North and South. Import quotas change this, creating a class of goods produced in both regions. Since costs of production for these goods are lower in the South than in the North this means that rents are earned on the imports into the North of quota goods produced in the South; I make the (fairly realistic) assumption that the North allows these rents to accrue to the South.

In Section 1 of the paper it is shown that in the short run the import quotas lead to an increase in Northern wages relative to the price of Southern goods not affected by the quotas. Wages in the North, however, fall relative to the price of goods on which quotas are imposed. Real wages in the North would only increase unambiguously as a result of the protection if the workers themselves could somehow collect the quota rents.

The dynamic implications of the quotas are examined in the second section. Here it is shown that the change in relative labor costs caused by the quotas speeds up the flow of technology to the South; as noted before this leads eventually to a flow of capital from North to South as well. The long-run effect of the import quotas is a reduction in the North's terms of trade and a fall in the capital-labor ratio in the North, so that wages in the North decline in terms of all goods in the system.

The intuition of this result can be seen by noting that real living standards for workers in the North in this model depend on the capital-labor ratio and on the North's terms of trade, which in turn depend on the number of goods that the North exclusively can produce. Real wages are undermined to the extent that capital leaves the North and to the extent that the flow of technology to the South exceeds the pace of innovation in the North.

Import quotas exacerbate the problems of the North's workers in the long run because in the short run they raise wages artificially, speeding up the transfer of technology to the South without increasing the rate of innovation in the North. This eventually reduces the North's terms of trade, drawing capital out of the North as well since the marginal revenue product of capital increases in the South and decreases in the North.

A different approach to protection, which gets to the root of the problem for Northern workers, is to levy a tax on the overseas earnings of Northern capital in an effort to get some of that capital to repatriate. In Section 3 it is demonstrated that over time such a tax leads to an increase in the capital-labor ratio in the North and to an improvement in the North's terms of trade. This results in an increase in real wages for Northern workers. It is also shown through the indirect utility function that in the special case where factors of production in the North are owned equally the welfare-maximizing policy for the North is to impose this kind of tax.

1. Effect of a Quota System in the Short Run

The model divides the world into two regions, North and South. There are a large number of goods in the system, all of which can be produced using three factors of production: capital, labor, and know-how. Capital and labor are homogeneous throughout the world. The know-how to produce each good originates in the North.

The defining characteristic of "region" is differential speeds of factor mobility between regions as compared to within regions. The know-how to produce a good diffuses instantaneously throughout the North, but only becomes available to the South with a lag. Thus at a point in time all goods fall into one of two categories: "old" goods, whose technology of production is available in both regions, and "new" goods that have recently been developed in the North and can only be produced there.

The movement of capital between regions also takes place slowly over time, so that at each moment the stock of capital in each region is fixed. There is no movement of labor between regions even in the long run. Within each region there is instantaneous perfect mobility of labor and capital. Finally, goods can move between regions with zero transportation costs.

Once a region has the know-how to produce a good, the know-how is freely available within the region, so that from the point of view of costs only capital and labor need be considered as inputs into the production process. I assume that the capital and labor input into the production of each good can be represented by the same neoclassical production function with constant returns to scale.[2]

Despite the neoclassical production function this is essentially a classical model in which the marginal rate of transformation between two types of goods is constant and different in the two regions: the opportunity cost of a new good in terms of an old good is 1 in the North and infinite in the South. This creates a basis for trade. Note that the prices of all goods produced in a region must be the same. There is only one relative price that can vary, the price of a good produced in the North relative to the price of a good produced in the South. In long-run equilibrium this price must be greater than 1, and with free trade there is complete specialization so that the North produces only new goods and the South produces only old goods.[3]

Assume that the system is at a long-run equilibrium and that import quotas are imposed. The quota system takes the following form: the North imposes quotas on a fraction α of the n_S number of goods that the South is producing and exporting to the North, restricting imports of each of these goods to a fraction γ of the North's market for the good. The South of course continues to supply all of its own needs for these goods.

The quotas necessarily create excess demand for the quota goods in the North at the South's original export price. For the quota goods to be produced in the North their price must rise to the level of new goods. This means that rents will be earned on the imports of quota goods, and I assume that the North allows these rents to accrue to the South.

Thus with the quota system there are three types of goods in the model: new goods produced only in the North, quota goods produced in both regions, and nonquota old goods produced only in the South. Choose one of the latter as numeraire and let p denote the price of a new good. Then new goods will have a price p in both regions; quota goods will have a price p in the North and a price of 1 in the South; and nonquota old goods will have a price of 1 in both regions. The North pays a price p for its imports of quota goods.

Now we are in a position to specify formally the static equilibrium with the quota system in place.

A. The Demand Side

All individuals in both regions have the same utility function:[4]

$$U = \left(\sum_{i=1}^{n} c_i^{\theta}\right)^{1/\theta}, \quad 0 < \theta < 1,$$

where c_i is consumption of the i^{th} good and n is the total number of goods available to consumers. Note that while the quota system will affect some prices it will not alter n, at least in the short run.

The utility function indicates that all goods enter demand symmetrically; two goods with the same price will be consumed in the same quantity by all consumers. This enables us to speak of representative new, quota, and nonquota old goods.

From the point of view of consumers in each region all goods fall into one of two categories: those with a price p and those with a price of 1. Thus the demand side can be summed up by the two equations

$$c_N^N/c_S^N = p^{-(1/1-\theta)} \tag{1}$$

$$c_N^S/c_S^S = p^{-(1/1-\theta)} \tag{2}$$

where c_N^N is consumption in the North of any good produced there (new and quota goods), c_S^N is consumption in the North of any good produced <u>only</u> in the South (nonquota old goods), c_N^S is consumption in the South of any good produced <u>only</u> in the North (new goods), and c_S^S is the consumption in the South of any good produced in the South (all old goods). Thus a representative quota good is consumed in the North in the same quantity as a new good and in the South in the same quantity as an old good.

B. The Supply Side

Within each region perfect competition prevails. This means that all goods produced in a region have the same price, which is equal to average cost. Given our choice of numeraire, these relationships can be expressed for each region as

$$a_{LN}(w_N/q_N)w_N + a_{KN}(w_N/q_N)q_N = p \tag{3}$$

$$a_{LS}(w_S/q_S)w_S + a_{KS}(w_S/q_S)q_S = 1 \tag{4}$$

where a_{ij} is the input of factor i per unit of output in region j, w_j is the wage in region j, q_j is the return per unit of capital in region j, and p is the price of a good produced in the North relative to a nonquota old good. The constant returns to scale in production mean that the factor coefficients are functions of relative factor prices only. Obviously the derivatives of the labor coefficients are negative, and the derivatives of the capital coefficients are positive.[5]

The other element on the supply side is the assumption that factor prices will adjust to bring about full employment of resources in both regions. Equating supply and demand for each factor yields

$$a_{LN}(w_N/q_N)X_N = L_N \tag{5}$$

$$a_{KN}(w_N/q_N)X_N = K_N \tag{6}$$

$$a_{LS}(w_S/q_S)X_S = L_S \tag{7}$$

$$a_{KS}(w_S/q_S)X_S = K_S \tag{8}$$

where L_j and K_j are the supplies of labor and capital in region j and X_j is aggregate output in that region; output can be treated as a composite commodity since the relative prices of all goods produced in each region are constant and equal to 1.

Aggregate output in the North is equal (in equilibrium) to the world's total consumption of new goods plus a fraction $(1-\gamma)$ of the North's consumption of quota goods. At a point in time the number of new goods, n_N, and the number of old goods, n_S, are fixed. Given α, the number of quota goods is also determined. Hence aggregate output in the North can be expressed as

$$X_N = (c_N^N + c_N^S)n_N + c_N^N(1-\gamma)\alpha n_S. \tag{9}$$

Aggregate output in the South is equal to the world's consumption of nonquota old goods, of which there are $(1-\alpha)n_S$, plus the South's consumption of quota goods, plus a fraction γ of the North's consumption of quota goods:

$$X_S = (c_S^N + c_S^S)(1-\alpha)n_S + (c_S^S + \gamma c_N^N)\alpha n_S. \tag{10}$$

Note that with the quota system the total number of goods produced in the North is now $n_N + \alpha n_S$. The total number produced in the South is still n_S; and the total number of goods in the system, n, remains equal to $n_N + n_S$.

To close the model we need one more equation, which could be one of the regions' budget constraints or, equivalently, the requirement that trade be balanced. The latter requirement takes the form

$$c_N^S n_N p = \gamma c_N^N \alpha n_S p + c_S^N(1-\alpha)n_S; \tag{11}$$

the value of the North's exports of new goods to the South must equal the value of its imports of quota and nonquota old goods from the South.[6] Note that the equation reflects the fact that the North pays a price p for its imports of quota goods, so that the North's terms of trade lie somewhere between 1 and p.

Equations (1)-(11) provide 11 equilibrium conditions in the 11 variables c_N^N, c_S^N, c_N^S, c_S^S, w_S, w_N, q_S, q_N, X_N, X_S, and p. In the case of free trade (α=0) there exists a unique solution that satisfies the Marshall-Lerner condition.

C. Comparative Statics

The short-run effect of imposing a quota system can be inferred by allowing α to increase from zero in the vicinity of the free-trade equilibrium. Obviously the number of goods produced in the North will increase and there will now be a range of goods produced in both regions. The impact effect of the quota system on the price of a new good (holding factor supplies and the numbers of new and old goods constant) is

$$(12) \qquad dp/d\alpha = p(1-\theta)n_S \left[\frac{c_N^N(1-\gamma)}{X_N} + \frac{c_S^N - \gamma c_N^N}{X_S}\right] > 0.$$

This is positive since $c_S^N > c_N^N$ and $\gamma < 1$.

Since factor supplies are unchanged, relative factor prices remain the same in each region; w_N and q_N must rise in the same proportion as p. Both factor rewards in the North rise relative to a nonquota old good, fall relative to a quota good (since its price rises from 1 to the new p), and remain unchanged relative to a new good.

Since there is no redistribution of income in the North we can use the indirect utility function (identical for all consumers) to measure the effect of the quota system on welfare in the North. Utility as a function of prices and income in the North is

$$(13) \qquad V = V(p, p_Q, X_N p)$$

where p_Q is the price of a quota good in the North. When the quota system is imposed this price changes from 1 to p.

This latter change is discrete even when the increase in α is marginal. To examine the change in utility take a first-order Taylor approximation around the original utility point, V_0:

$$(14) \qquad V - V_0 \simeq \frac{\partial V}{\partial p}\,\Delta p + \frac{\partial V}{\partial p_Q}\,\Delta p_Q + \frac{\partial V}{\partial y}\,X_N \Delta p$$

where $\frac{\partial V}{\partial y}$ is the partial derivative of the utility function with respect to income. From equations (5) and (6) it is clear that X_N does not change in the short run since factor supplies and relative factor prices in the North are unchanged. Dividing through by $\partial V/\partial y$ and employing Roy's identity yields

$$(15) \qquad \frac{V - V_0}{\partial V/\partial y} \simeq (X_N - c_N^N n_N)\Delta p - c_S^N \alpha n_S \Delta p_Q.$$

$c_S^N \alpha n_S$ is demand in the North at prequota prices for the goods that become quota goods when α increases from zero; the term does not drop out even though we are considering a change from an initial situation in which $\alpha = 0$.

The expression can be simplified further by noting that, prequota, $X_N - c_N^N n_N = c_N^S n_N = c_S^N n_S/p$, so that

$$(16) \qquad \frac{V - V_0}{\partial V/\partial y} \simeq c_S^N n_S(\hat{p} - \alpha \hat{p}_Q)$$

where the symbol "^" denotes a relative change. Thus the change in utility in the North (denominated in units of the numeraire) is of ambiguous sign since $\alpha < 1$ and the change in p_Q is relatively greater than the change in p ($p > p_Q = 1$ initially, and they rise to the same level).

This expression is intuitively appealing since $(\hat{p} - \alpha \hat{p}_Q)$ is the relative change in the North's terms of trade: $\hat{p}$ is the change in its export price while $\alpha \hat{p}_Q$ is an index of the change in its import prices. Thus welfare in the North is improved by the quota system in the short run if the North's terms of trade improve, that is, if the increase in its export price relative to a nonquota old good outweighs the decrease in its export price relative to a quota good.[7]

In the South factor prices are unchanged while the price of the region's imports, p, rises. However, the South's income increases by the amount of the quota rents, so that the net welfare effect in this region is ambiguous as well. And, in fact, if the South's terms of trade improve and the quota rents are distributed evenly by the government to all citizens then welfare in the South improves as a result of the quota system.

These ambiguous welfare results are of course completely dependent on the assumption that the quota rents accrue to the South. If the North were able to keep the rents, a marginal increase in α would unambiguously improve welfare in the North in the short run; this case is analogous to the optimum tariff argument. Allowing the rents to accrue to the South is fairly realistic, however; using a quota system rather than tariffs as a form of protection is often defended as a good compromise between the interests of the North and South specifically because it does allow the supplier countries to capture the rents.

2. Effect of a Quota System in the Long Run

In the static model the numbers of new and old goods in the system and the supplies of factors in each region are parameters. The hallmark of this kind of product cycle model is that over time these parameters change in a predictable way. The introduction of new products will increase the number of goods produced in the North. The transfer of technology, on the other hand, will change new goods into old goods, increasing the number of goods that the South can produce. The movement of capital between regions will affect the supply of capital in both regions. In this section I introduce assumptions about these processes that characterize a long-run equilibrium. Altering α and examining how the terms of trade and factor prices change in moving from one long-run equilibrium to another enables us to infer the long-run effect of imposing the quota system.

A. Innovation, Technology Transfer, and Capital Movement

The dynamics of innovation, technology transfer, and capital movement are embodied in the following three equations:

$$(17) \qquad \dot{n} = in_N, \quad 0 < i < 1,$$

$$(18) \qquad \dot{n}_S = f(p)n_S, \quad f' > 0, \quad f(1) = 0,$$

$$(19) \qquad \dot{K}_S = g(q)K_S, \quad g' < 0, \quad g(1) = 0,$$

where the symbol "." indicates a time derivative.[8]

It is taken as given that there is continual introduction of new goods in the North, increasing n, the total number of goods in the system. Equation (17) specifies that the rate of introduction is a constant fraction i of the current number of new goods.

The rate of transfer of technology, which increases the number of goods that the South is able to produce, is not constant, but rather depends positively on the difference in the costs of production in the two regions. This difference in costs is conveniently summed up by the variable p, which indicates the ratio of the minimum cost of production in North and South of any good that can be produced in both regions. Equation (18) states that there is no technology transfer when costs are equal $(p=1)$, and that the rate of transfer increases as p increases.

The number of new goods in the system, n_N, is equal to $n - n_S$, so that from equations (17) and (18) it follows that the time derivative of n_N is

$$(20) \qquad \dot{n}_N = in_N - f(p)n_S.$$

In each period the change in the number of goods that the north can produce exclusively is equal to the number that the North introduces minus the number that the South has learned to produce in that period.

Finally, equation (19) specifies that capital flows to the South when q, the ratio of the return to capital in the North to the return in the South, q_N/q_S, is less than 1.

To simplify the dynamic system define $r = n_N/n_S$ and $k = K_N/K_S$; r is the ratio of the number of new goods to the number of old goods and k is the ratio of the capital stock in each region.

Equations (18) and (20) imply that the time derivative of r is

(21) $$\dot{r} = ir - (1+r)f(p).$$

Holding constant the total stock of capital in the world, the time derivative of k is

(22) $$\dot{k} = -(1+k)g(q).$$

These two equations show how r and k change continuously as functions of their own values and the values of p and q. The static model, however, implies that p and q are functions of r and k and the other parameters of the static model, α, γ, L_N, L_S, θ, and $\bar{K}$, where the latter is the total stock of capital in the world. Since all of the parameters except r, k, and α are held constant in the subsequent analysis we can for simplicity write these functions as $p(r,k,\alpha)$ and $q(r,k,\alpha)$. (The variables p and q are functions of $r = n_N/n_S$ but not of the absolute levels of n_N and n_S since equiproportionate changes in these numbers leave the price variables of the static system unchanged.)

Inserting these functions into equations (21) and (22) yields

(23) $$\dot{r} = ir - (1+r)f(p(r,k,\alpha))$$

(24) $$\dot{k} = -(1+k)g(q(r,k,\alpha)),$$

two differential equations in the variables r and k and the parameter α. Thus, given α, the numbers of new and old goods and the stock of capital in each region at a point in time determine factor prices and the terms of trade. The values of these price variables in turn affect the processes of innovation, technology transfer, and capital movement, which result in changes in the values of r and k. As long as r and k are changing, factor prices and the terms of trade will be constantly changing.

Setting these equations equal to zero defines the long-run equilibrium in which the ratios of the numbers of new and old goods and the capital stock in each region are constant. With r and k stable, the terms of trade and factor prices attain stable values as well.

Before proceeding it is necessary to establish the signs of the partial derivatives of p and q with respect to r, k, and α. Given α, an increase in r increases the number of goods produced in the North relative to the number produced in the South. Because of the special form of the utility function this leads to increased demand for the North's output at the existing p and p must rise to equilibrate the system. With factor supplies unchanged in both regions q_N must rise in the same proportion as p while q_S is unchanged, so that

(25) $$\frac{p_1}{p} = \frac{q_1}{q} > 0$$

where the subscript indicates the partial derivative of the function with respect to that argument.

If k increases, other things (including the total stock of capital in the world) constant, the North's (South's) aggregate output increases (decreases) so that there is excess supply of the North's output at the existing p and p must fall to equilibrate the system. The increase (decrease) in the capital-labor ratio in the North (South) implies that q_N/p (q_S) falls (rises); thus

(26) $$\frac{q_2}{q} < \frac{p_2}{p} < 0.$$

Finally, it was established in the previous section that the partial derivative of p with respect to α is positive; also, q_N increases in proportion with p while q_S is unchanged, so that

(27) $$\frac{p_3}{p} = \frac{q_3}{q} > 0.$$

B. The Effect of a Change in α on Long-Run Equilibrium

For any given value of α the long-run equilibrium conditions $\dot{r}=0$ and $\dot{k}=0$ each define a locus in the r,k plane. Their intersection gives the long-run equilibrium values of r and k corresponding to that α. In the vicinity of a stable equilibrium both schedules are upward-sloping and the $\dot{r}=0$ locus (RR schedule) is flatter than the $\dot{k}=0$ locus (KK schedule), as in Figure 1.[9] The dynamics of adjustment are indicated by the arrows in the figure.

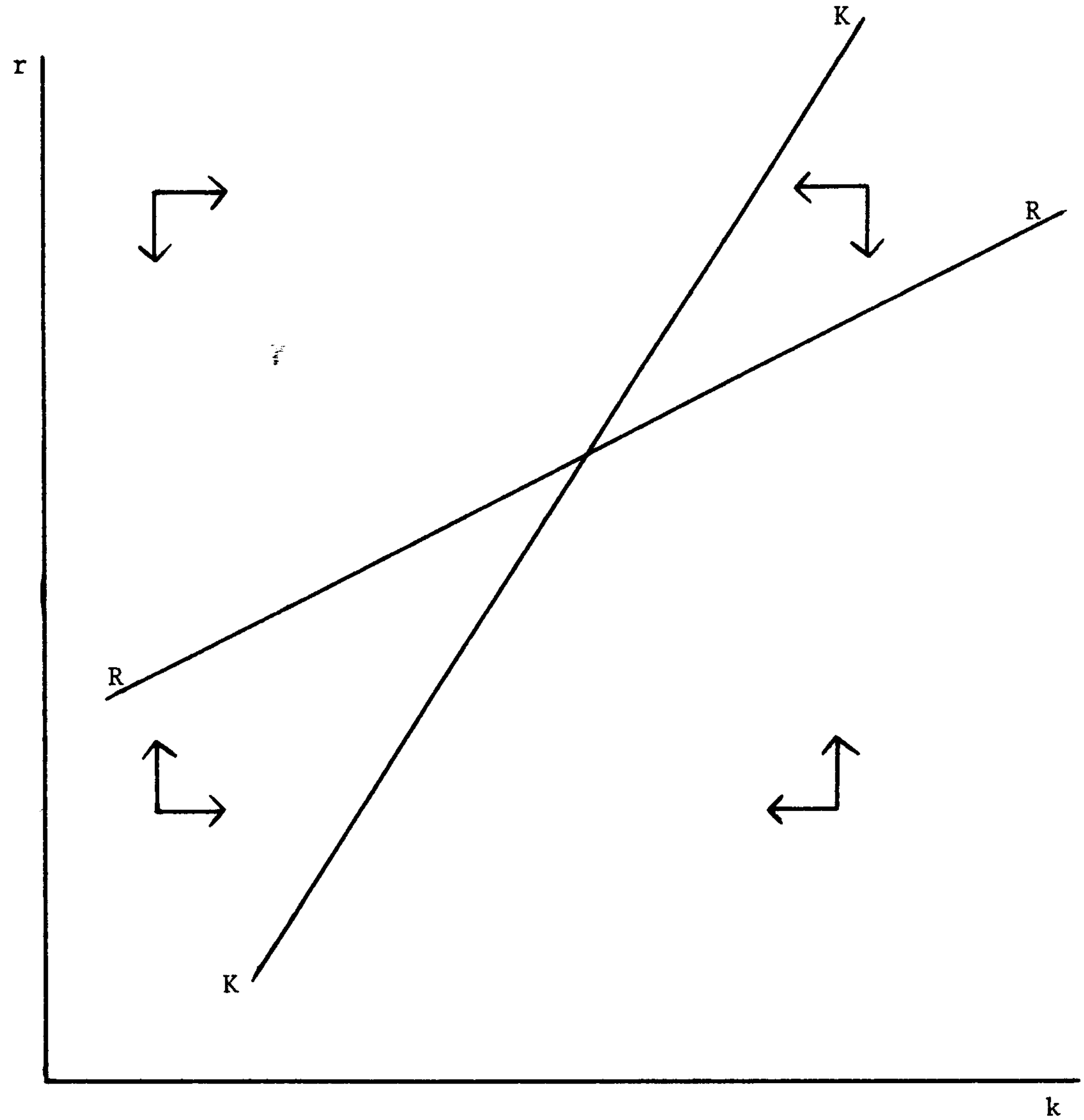
Increasing α around the free-trade equilibrium will shift both schedules. The increase in α increases p, speeding up the process of technology transfer and making $\dot{r}$ negative; the RR schedule shifts down to the right.

The increase in α also increases q, attracting capital to the North so that $\dot{k}$ becomes positive; the KK schedule also shifts to the right.

The changes in r and k in the movement to the new long-run equilibrium depend on the magnitudes of these shifts.

Algebraically, the change in r is

Figure 1



$$\text{(28)} \qquad \frac{dr}{d\alpha} = \frac{(1+r)f'(q_2p_3 - p_2q_3)}{(i-f)q_2 - (1+r)f'(p_1q_2 - q_1p_2)} .$$

The denominator on the right-hand side of equation (28) is positive in the vicinity of a stable equilibrium, and the numerator is negative given the relationships among the partial derivatives of p(.) and q(.) established in inequalities (26) and (27). Hence the long-run change in r resulting from the quota system is negative.

The change in k is

$$\text{(29)} \qquad \frac{dk}{d\alpha} = \frac{-(i-f)q_3 + (1+r)f'(p_1q_3 - q_1p_3)}{(i-f)q_2 - (1+r)f'(p_1q_2 - q_1p_2)} .$$

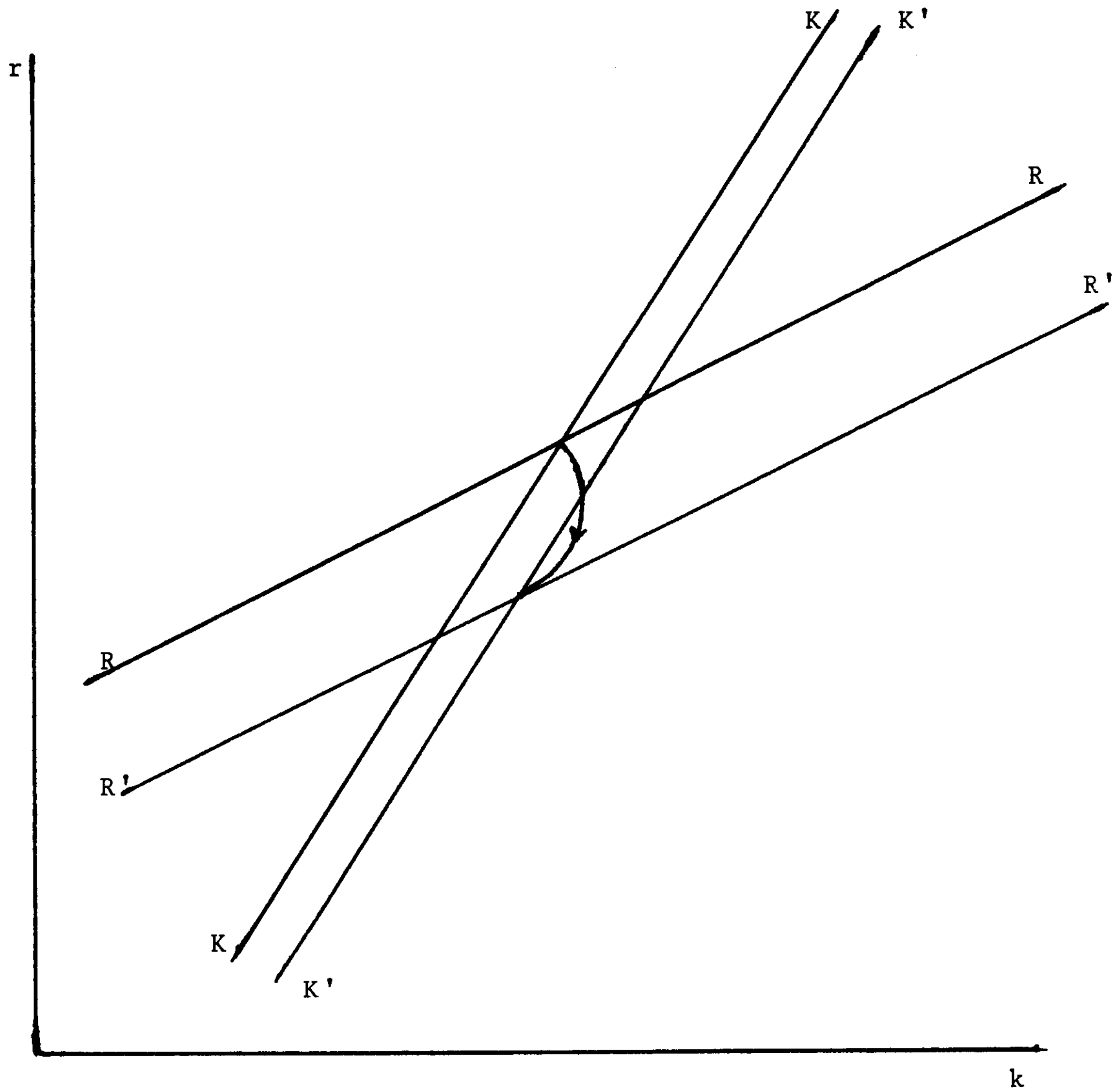
From inequalities (25) and (27) it follows that $p_1q_3 = q_1p_3$, so that the numerator reduces to $-(i-f)q_3$; this is negative since $q_3 > 0$ and $(i-f)$ must be positive in the vicinity of the long-run equilibrium. Thus the overall expression is negative since the denominator is positive: k also falls in the long run as a result of the quota system.

In terms of the phase diagram in Figure 2, the shift in the RR schedule (to R'R') is relatively greater than the shift in the KK schedule (to K'K') so that both r and k are smaller at the new equilibrium.

Intuitively, the short-run changes in prices caused by imposing the quotas lead in the long run to an increased flow of technology to the South. This results from production costs being inflated in the North in the short run without any corresponding increase in the rate of innovation there.

Also, though the short-run effect of the quotas on q leads to an initial flow of capital to the North, eventually the movement is reversed. The impact of the increased technology transfer, raising q_S relative to q_N, draws capital to the South, so that the capital stock in the North declines in

Figure 2



moving from one long-run equilibrium to another. This is one of the special features of this model, that capital and technology tend to move together. This is not the result of technology being embodied; rather it comes about because, other things being equal, an increase in the number of goods that a region produces improves its terms of trade, raising the return to capital there relative to the return in the other region.

As noted, the impact effect of the increase in α is to raise p. Eventually, however, the decline in r is sufficient to reduce p to a level below its initial value. This follows because the $\dot{r}=0$ equilibrium condition implies that $f(p) = ir/(1+r)$, so that long-run equilibrium p is monotonically increasing in r.

While p declines in the long run as the result of the quotas, it must still be greater than 1 at the new long-run equilibrium. Since there continues to be innovation in the long-run equilibrium increasing n_N, there must also be a flow of technology increasing n_S in order for r to be stable; for there to be an incentive for this flow p must be greater than 1.

From this it follows that the North's terms of trade unambiguously decline in the long run as the result of the import quotas: the North's export price relative to the import price of nonquota old goods (p) falls, and its export price relative to the import price of quota goods falls even more since the price of the latter rises from 1 (prequota) to p, which remains greater than 1 even after the quota is imposed. The North's terms of trade would decline in the long run even if it captured the quota rents!

In addition, there is redistribution of income in each region. The long-run decrease (increase) in the capital-labor ratio in the North (South) together with the decline in p implies that the long-run changes in prices resulting from the quotas satisfy

$$(30) \qquad \hat{w}_N < \hat{p} < \hat{q}_N = \hat{q}_S < 0 < \hat{w}_S.$$

Workers in the North come out the worst; their income declines in terms of all three types of goods. The return to capital in terms of old goods declines in both regions: the marginal physical product of capital increases in the North but p falls proportionally more, while in the South the marginal physical product of capital falls. Workers in the South are the surprise beneficiaries of the quota system: the transfer of capital and technology that results in the long run from the quotas increases their marginal productivity and raises their wages in terms of both types of goods available in the South.

Thus the effort to protect the wages of workers in the North through the quota system is frustrated in the long run because the protection makes the North a less attractive location in which to engage in production and thus increases the incentive for capital and technology to leave the North.

One final welfare consideration: one feature of the utility function employed in this model is that, for a given income, welfare increases if the number of different goods available increases. In long-run equilibrium the relative rate of increase of the number of goods in the system is equal to $f(p)$; by reducing p the quota system thus reduces the rate of introduction of new products, which has a negative impact on welfare in both regions.

3. Effect of a Tax in the North on Capital Earnings Overseas

A different approach to protecting wages in the North is to try to limit the movement of capital and technology to the South. In this model there is no obvious policy instrument for affecting the flow of technology; the flow of capital, on the other hand, can be influenced by taxes and subsidies. In this section I examine the short-run and long-run effects of a tax imposed in the North on capital earnings overseas.

Assume initially that the system is at a long-run equilibrium with free trade. At the equilibrium there is no current flow of capital, but assume, realistically, that over time there has been a net flow of capital to the South, so that the South's capital stock, K_S, can be divided into that part owned by domestic residents, K_S^S, and that part owned by residents of the North, K_S^N. The earnings on this latter capital are $q_S K_S^N$; taking this into account in the North's budget constraint changes the balance of payments condition, under free trade, to

$$c_N^S n_N p + q_S K_S^N = c_S^N n_S. \tag{31}$$

The North's imports are equal to its exports plus its earnings on expatriate capital. The static equilibrium then consists of equations (1)-(10), with α set equal to zero, and equation (31).

Suppose now that the government in the North takes a fraction t of its citizens' overseas earnings and distributes this evenly to all consumers in an effort to encourage some of the expatriate capital to return home. This program will not alter equation (31) at all; the North will continue to earn q_S for each unit of capital it has in the South. The only change is in the distribution of this income in the North, and since demand is identical and homothetic for all consumers the redistribution has no effect on the equilibrium. Thus the tax has no immediate effect on prices in the system; this result makes sense since capital cannot move between regions in the short run.

The imposition of the tax, however, will change the long-run equilibrium conditions. With no government intervention capital flows between regions over time until the return to capital is equal in the two regions. Once the tax is imposed the flow of capital should continue until the <u>after-tax</u> return is equalized, so that capital movement ceases when

(32) $$q = (1-t).$$

The tax on capital earnings overseas has no direct effect on innovation or technology transfer so that the $\dot{r}=0$ equilibrium condition is unchanged.

The long-run effect of the tax can be inferred by allowing t to increase from zero in the vicinity of the free-trade long-run equilibrium. The changes in r and k in the movement to the new long-run equilibrium are

(33) $$\frac{dr}{dt} = \frac{-(1+r)f'p_2}{(1-f)q_2 - (1+r)f'(p_1q_2 - q_1p_2)} > 0$$

(34) $$\frac{dk}{dt} = \frac{-(1-f) + (1+r)f'p_1}{(1-f)q_2 - (1+r)f'(p_1q_2 - q_1p_2)} > 0.$$

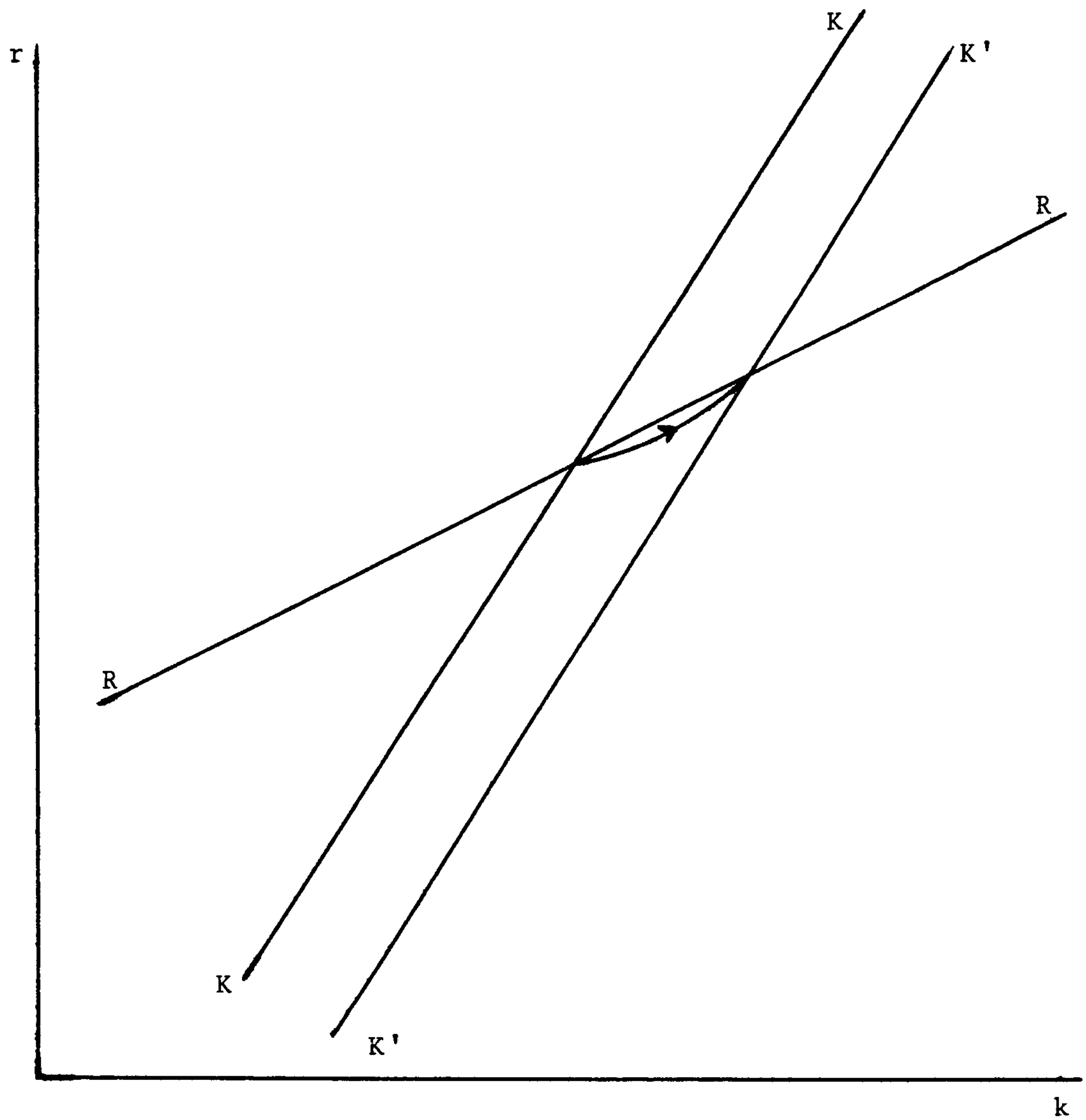
The denominator in each fraction is positive if the initial equilibrium is stable. The numerator in (33) is positive since $f' > 0$ and $p_2 < 0$. The two terms in the numerator of (34) are of opposite sign, but their sum is positive if the initial equilibrium is stable.

Hence in the long run the tax draws some of the expatriate capital back to the North; this tends initially to reduce p, slowing down the rate of diffusion of technology to the South and making $\dot{r}$ positive. As r increases innovation speeds up, so that p must then rise to restore balance between innovation and diffusion. At the new long-run equilibrium, p, which is equal to the North's terms of trade when there is free trade in goods, will be greater than at the initial equilibrium.

In terms of the phase diagram in Figure 3, the imposition of the tax shifts the KK schedule to the right to K'K'; the RR schedule is unchanged. Both r and k increase to the new equilibrium.

Given that in the long run the tax leads to an increase in p and an increase (decrease) in the capital-labor ratio in the North (South), the

Figure 3



changes in factor prices in the movement from one long-run equilibrium to the other satisfy the following inequalities:

(35) $$\hat{w}_N > \hat{p} > 0$$

(36) $$\hat{q}_S > 0 > \hat{w}_S$$

(37) $$\hat{q}_S > \hat{q}_N.$$

The change in q_N is of ambiguous sign.

In terms of welfare, it is clear that if capitalists and workers in the North are distinct groups the latter gains unambiguously as a result of the tax. Wages rise relative to both types of goods; and workers also receive some of the tax collected on overseas earnings, assuming that some Northern capital remains deployed in the South. The change in the welfare of capitalists is unclear since their income decreases relative to new goods but may increase relative to old goods.

Some insight into the net welfare effect in the North is gained by looking at the special case of equal ownership of all factors in the North; in this case social utility is a function of p and the North's aggregate income, including earnings on overseas capital:[10]

(38) $$V = V(p, X_N p + q_S K_S^N).$$

Differentiating this and employing Roy's identity yields

(39) $$\frac{dV}{\partial V/\partial y} = c_N^S n_N dp + pdX_N + q_S dK_S^N + K_S^N dq_S.$$

This expression can be simplified by noting that the change in X_N is the result of capital returning to the North, so that $pdX_N = p\frac{\partial X_N}{\partial K} dK_N$. But $p\,\frac{\partial X_N}{\partial K}$ (marginal revenue product of capital in the North) is equal to q_N, and the increase in the North's capital stock, dK_N, must be equal to the decrease in expatriate capital in the South, $-dK_S^N$, so that the change in the

North's welfare is

$$\frac{dV}{\partial V/\partial y} = c_N^S n_N dp + K_S^N dq_S + (q_S - q_N)dK_S^N. \tag{40}$$

When the tax is first imposed q_S equals q_N so that the third term in (40) drops out. The other two terms are positive since both p and q_S increase in the long run as the result of the tax on overseas earnings. Hence welfare in the North unambiguously improves as a result of the tax.

The argument in favor of limiting the outflow of capital from a nation is often couched in terms of externalities: without government intervention a less than optimal amount of capital will be maintained within a capital-rich country since capital outflow will continue until the direct benefit (return) to capital deployed in different areas is equalized, ignoring the beneficial externality that is gained by employing capital at home and hence raising the marginal productivity of domestic labor.

The problem with this argument is that it ignores the fact that when one unit of capital returns home it generates a beneficial externality for all workers and a <u>detrimental</u> externality for owners of all other capital employed in the country; the increase in the capital-labor ratio increases the marginal productivity of labor and reduces the marginal productivity of capital.

What equation (40) demonstrates very nicely is that the net effect of these externalities depends on the movement in the terms of trade. In this dynamic model the repatriation of capital leads to an improvement in the North's terms of trade because of the connection between capital movement and the flow of technology. Since the North's terms of trade improve, the gain in labor's real income must exceed the fall in capital's real income; and in fact the real income of capital may not fall at all.

Equation (40) also shows that there is another externality which is beneficial from the point of view of the North: when some capital returns to the North the marginal productivity of the Northern capital that remains in the South is increased. This effect is captured by the term $K_S^N dq_S$, which is positive.

Finally, it should be pointed out that when the tax is in place $q_S > q_N$. If there is then a further increase in the tax the term $(q_S - q_N)dK_S^N$ in (40) will be negative; an increase in the tax causes capital to be reallocated from the high-return to the low-return region, tending to reduce aggregate real income for the North's factors. Thus an optimal policy from the point of view of the North may well involve the deployment of some capital in the South.

While the tax on capital earnings overseas may be a good policy from the point of view of the North, it is interesting to inquire about the effect of the tax on world welfare. Again, some insight can be gained by making the unrealistic assumption that world social welfare is a function only of p and aggregate world income:

$$V = V(p, X_N p + X_S). \tag{41}$$

Differentiating this and making use of the fact that capital earns its marginal revenue product in each region yields

$$\frac{dV}{\partial V/\partial y} = (q_S - q_N)dK_S^N. \tag{42}$$

Surprisingly, there is no change in world welfare when a marginal tax is imposed; but any further increase in the tax will reduce welfare since it encourages capital to relocate to the region where it is less productive.

This implies that any gain in the North's welfare comes at the expense of the South; and it is clear from inequality (36) that it is workers in the South who suffer the most from the tax since it leads to a fall in their earnings in terms of both types of goods.

The South may then want to counter any tax imposed by the North with a subsidy to attract Northern capital. Holding the North's tax constant, a subsidy per unit of Northern capital employed in the South will shift the K'K' schedule in Figure 3 back to the left, tending over time to reduce r, k, and p.

Note that the subsidy differs from the tax in that the tax costs the North nothing while for the South the subsidy amounts to a transfer out of the region. If a subsidy equal to the North's tax is paid by the South, all of the price variables will have the same values as at the free-trade equilibrium with no capital movement restrictions; the South, however, will be making a transfer payment to the North equal to the tax collected by the North.

4. Conclusions

The model employed in this paper is a highly stylized representation of the world that abstracts from two important sources of real wage growth: capital accumulation and process innovation. With international mobility of capital and technology both of these factors tend over time to raise real wages in all countries. The model here instead focuses on two important determinants of real wages in the developed region relative to wages in the less developed region: the capital-labor ratio as determined by the *share* of a fixed world stock of capital employed in the region and the region's terms of trade. The terms of trade in turn are determined by the number of goods that a region produces, which is a function of product innovation and technology transfer.

These two determinants of real wages are distinctive in that, with fixed supplies of labor in each region, any increase in real wages in one region must be matched by a decrease in real wages in the other region. Thus, given the terms of trade, any movement of capital increases real wages in the receiving region and decreases real wages in the other region. Similarly, given the distribution of capital, changes in the terms of trade caused by innovation or diffusion raise real wages in the region whose terms of trade improve and reduce real wages in the other region. Furthermore, the dynamics of the model are such that capital and technology tend to move together, so that both forces generally operate in the same direction.

Thus the model highlights the divergence of interests between workers in the North and workers in the South. In addition, the zero-sum aspect of the model only holds as long as the labor forces in each region are constant. If the labor force in the South increases, this depresses wages in the South and leads to a flow of technology and capital from the North that eventually reduces wages in the North as well. (In this sense it can be said that workers in both regions have a common interest in moderating population growth in the Third World.) The continuing rapid labor force growth in the South that we observe in reality thus poses a serious threat to the living standards of workers in the North.

The comparative dynamics carried out in this paper suggest that for workers in the North to try to combat the erosion of their real wages caused by labor force growth in the South by lobbying for import quotas on LDC manufactures is a losing strategy in the long run. In the short run the quotas artificially inflate production costs in the North without dealing with the underlying problem. The inflated costs speed up the process of technology transfer, which in turn draws capital out of the North, so that real wages in the long run are reduced by the import protection.

A tax on the overseas earnings of Northern capital, on the other hand, attacks directly the forces that are undermining wages in the North. The tax leads over time to an increase in the capital-labor ratio in the North and to an improvement in the North's terms of trade. As noted above, though, this increase in wages in the North must come at the expense of wages in the South.

The welfare of each region's workers depends on the region's ability to attract capital and technology. To the extent that a disproportionate share of the owners of capital live in the North that region has an advantage in this struggle: it can use political means to keep capital at home or tax the overseas earnings of its capitalists. This of course will be controversial politically since it generally will not be in the interest of capitalists, who are also a political force in the North.

The South, on the other hand, can only respond to the government intervention in the North by offering special tax incentives and employment conditions to foreign capital that amount to subsidies. This is certainly being observed around the world as different countries compete to get capital to locate on their soil.

Notes

[1]See, for instance, Bluestone and Harrison (1982).

[2]The economic implication of the assumption that all goods have the same neoclassical production function is that for given factor prices the capital-labor ratio will be the same in all industries, as is assumed implicitly or explicitly by the classical economists. With perfect competition within each region the relative prices of all goods produced in a region must then be constant, and it is possible to choose units so that these relative prices are equal to 1.

[3]These aspects of the model are discussed in detail in Dollar (1984).

[4]This utility function is borrowed from Dixit and Stiglitz (1977).

[5]The labor coefficients, a_{LN} and a_{LS}, are the same function, as are the capital coefficients, a_{KN} and a_{KS}. This follows because all goods have the same production function.

[6]It is possible that at the initial equilibrium some of the capital employed in the South is owned by the North, or vice versa. For simplicity I am assuming that the income earned by any capital that has moved between regions is consumed in the region of employment. The more realistic assumption that some of the capital income earned in the South is consumed in the North complicates the algebra without changing any of the results.

[7]Note that including in equation (13) income on Northern capital employed in the South does not change the analysis. In the short run the quantity of such capital is fixed, and its remuneration, q_S, does not change as a result of the change in α. Hence the term would drop out in moving from (13) to (14).

[8] Though strictly speaking n, n_N, and n_S can only take on integer values, I will treat them as continuous variables.

[9] Necessary and sufficient conditions for stability of long-run equilibrium are derived in the mathematical appendix to Dollar (1984).

[10] Utility is also a function of the number of goods in the system. The long-run increase in p caused by the tax raises the relative rate of introduction of new goods, which in equilibrium is equal to $f(p)$, tending to increase welfare everywhere. The indirect utility function in equation (38) expresses utility for a given number of goods in the system.

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