"INTERNATIONAL TRADE, FACTORMIGRATION
AND TRANSPORTCOSTS

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AND TRANSPORT COSTS

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I-INTRODUCTION

International trade in goods is a surrogate for international factor mobility and, under certain assumptions, as was shown in Mundell (1957), they are perfect substitutes. This result has been extended to incorporate different market structures, diversified technologies or to relax some of the assumptions necessary for factor price equalization required for the Mundellian equivalence. While retaining the ideal world of Mundell-Samuelson, we demonstrate that the perfect equivalence between trade in goods and factor mobility disappears, if one relaxes the assumption of zero transport costs. Commodity prices are not equalized, and, obviously, factor prices are not equalized either. However, if remittances of the migrant factor, taking the form of goods, incur transportation costs, one could expect to recover the Mundellian equivalence and, in this sense, factor returns to be internationally equalized. But yet, this is not the case. The analysis will show conclusively that a proper incorporation of transport costs into trade theory impacts critically on several of the theorems and insights that we normally have derived from trade theory and factor mobility.

There is clearly a need to model transportation as an added, separate activity. In sections 2 and 3, we develop such a model where transport costs are incorporated and the free trade equilibrium without factor mobility is determined. Next, in section 4 we derive graphically the non-equivalence between trade in goods and factor mobility; a rigorous proof is presented in section 5. Finally in section 6 we show the non-equivalence between capital and labor migration and the results are extended to incorporate the costs of factor mobility.

If factor mobility and trade are not perfect substitutes, then it should be possible to rank the two situations, both from the national and world welfare point of view. It is relevant to ask which country will
experience a terms of trade (t.o.t.) loss. We can make some general statements about national welfare and the choice between free trade and factor mobility, as well as, on the choice between labor mobility and capital mobility. These questions will be the concern of section 7 of this paper. In section 8 we make some concluding remarks.

2. THE PROPOSED MODEL

The proposed model follows the standard Hecksher-Ohlin model of trade. However, a third sector is introduced – the transport sector – whose services are produced using capital and labor with a CRS technology. It should be clear this is not simply a 3x2x2 model. In particular, there is no commodity price equalization, due to transport costs and, furthermore, the transport services (T, hereafter) do not enter in the utility function. It is rather the volume of international trade which determines the output of transport services. We assume that the demand for transportation services is given by

(1) \[ T = \mu E_1 + \nu M_2 \]

where T stands for transportation, \( E_1 \) and \( M_2 \) represent exports and imports of goods 1 and 2. The coefficients \( \mu \) and \( \nu \) are parameters that convert the units of traded goods (\( X_1 \) and \( X_2 \)) into units of transportation, volume or weight, for instance.\(^2\)

3. FREE TRADE EQUILIBRIUM WITH TRANSPORT COSTS

For simplicity consider the case of a small open economy. With no transport costs, the consumption possibility frontier (CPF) has a constant slope equal to the given terms of trade. In Fig.1, the CPF is represented by DME, where AMB represents the production possibility frontier of the country. With the introduction of international transport
costs, the terms of trade that the country faces are different from those
given by the slope of DME. The relationship between the domestic relative
price of good 2 \((p_2)\) and the foreign relative price \((p^*_{-2})\) will depend on
which country produces the transport services and, moreover, on the
pattern of trade.

Suppose the home country produces transport services and
exports good 1. Hence, the trade balance relations for the home and foreign
countries will be:

\[(2) \quad E_1^* p_t T = p_2 M_2\]

\[(3) \quad E_1 = p^*_{-2} M_2\]

where \(E\) and \(M\) indicate (home country) exports and imports, subscripts
indicate the good traded and where good 1 has been choosen as numeraire.
After substituting (1) into (2) and rearranging,

\[(4) \quad E_1 = M_2 (p_2 - vp_t) / (1 + up_t)\]

Comparing (4) and (3), the price relation is given by

\[(5) \quad p_2 = p^*_{-2} (1 + up_t) + vp_t\]

If the pattern of trade is to be reversed, relations (1)-(3)
become

\[(1') \quad T = uM_1 + vE_2\]

\[(2') \quad M_1 = p'_{-2} E_2 + p_t T\]

\[(3') \quad M_1 = p^*_{-2} E_2\]

Following the same procedure as before, the price relation is

\[(5') \quad p'_{-2} = p^*_{-2} (1 - up_t) - vp_t\]

From (5) and (5') it is then clear that

\[(6) \quad p_2 > p^*_{-2} > p'_{-2}\]
In other words, with the introduction of transport costs the new CPF is given by HPGI, in Fig. 1, where the slopes of HP and GI are equal to first and third terms of the inequality (6). This is the essential impact of transport costs, since relation (6) is independent of which country produces the transport services.3/

It is possible to determine the equilibrium for this economy by superimposing a map of community indifference curves. If the equilibrium is on the range HP, the home country will export \( X_1 \) and import \( X_2 \); along GI the trade pattern is reversed and on the range PMG there will be no trade. Transport costs cannot be considered as a barrier to trade similar to a tariff (see Fig.1), since the consumption possibility frontier is very different than in the tariff case. Suppose that point C is the equilibrium point of consumption, then if T services are to be imported, production is at P and the trade triangle is given by CJP.

If T is produced domestically, the PPF for goods \( X_1 \) and \( X_2 \) will shrink along the generalized Rybczynski line as resources are allocated to the production of transport services. In Fig. 1, the new equilibrium is point N (where the Rybczynski line crosses the world price line CN), which shows the production levels of \( X_1 \) and \( X_2 \). The length of PN (or FE in terms of \( X_1 \)) measures the supply of T. The quantity produced of commodities \( X_1 \) and \( X_2 \) at N are traded at world (f.o.b.) prices using domestic transportation; the trade triangle is CN. The slope of the Rybczynski line depends, naturally, on the technology of the T sector. Assuming \( k_1 > k_2 \), the home country is relatively capital abundant. If the home country has comparative advantage in the T sector this sector has to be relatively capital intensive. It is sufficient to assure comparative advantage in the T-sector to assume
Fig. 1
\( k_1 > k_2 \). The case shown in Fig. 1 where the Rybczynski line is positively sloped implies that \( k_1 > k_2 \), and thus home-country comparative advantage in the T sector is possible, but is not guaranteed.\(^4\) Note, finally, that due to the CRS technology assumption only one country, in equilibrium, will produce transport services.

4. NON-EQUIVALENCE: A GEOMETRIC PROOF

The home country wage rate is higher than abroad, because the country is assumed to be exporting the capital intensive good \( X_1 \), in other words, \( p_2 > p^*_2 \). Therefore, there are incentives for labor migration. To show that trade in goods and factor mobility are not perfect substitutes we will proceed as follows: First, assume that labor will migrate to the high wage country—the home country. Then determine the foregone earnings that labor was paid in the home country, while keeping commodity prices constant. Then, it is shown that the wage differential is larger than the cost of transportation of remittances. For simplicity, the geometric demonstration will assume that: \( k_1 = k_2 \). The general case is considered in the next section.

In the two country case, the equilibrium, before factor mobility, can be seen in Figs. 2A and 2B, which are essentially identical to Fig. 1. In Fig 2A we have the initial equilibrium for the home country (A): production at \( P_1 \), consumption at \( C \), where the world price ratio is given by \( CP_1 \) and \( PP_1 \) are the transport services produced, so that \( CP \) is the domestic price ratio (prices c.i.f.). The foreign country B, not producing transport services, produces at \( P^* \) and consumes at \( C^* \). Note that \( P^*C^* \) has to be parallel to \( CP_1 \) in Fig 2A.
Now let labor flow from the foreign country to the home country so that trade in good 2 vanishes. The PPF of country A will expand along the Rybczynski line for labor, from P to, say, P₂, while the foreign PPF contracts along the same line from P*K to P₁*K. At constant commodity prices p₂, domestic factor returns are also constant as is domestic income. Therefore, home consumption does not change and stays at C and trade in good 2 vanishes. The migrant workers in country B were earning wages equal to C*P₁*K in terms of good 1. Now, in country A, since home consumption stays at C, the gross wage is given by CP₂, which has still to be remitted to country B. Drawing a parallel to CP₁ from P the foregone wage is equal to DP₂. Noting that P*P₁*K and P*KC* are parallel, respectively to PP₂ and DP, then, C*P₁*K is equal to DP₂. Therefore, the wage gap is CD. But CD was enough to transport EP₁ units of good 1 (all trade of good 2), so it will be more than enough to transport DP₂ units of good 1 back to country B. Then a net gain accrues to the factor due to migration. The Mundellian equivalence disappears and, in the above example, the incentives for labor to migrate persist.

5. NON-EQUIVALENCE: A FORMAL PROOF

The same result can be obtained formally and, in particular, the following proposition will be proved:

**Proposition:** Under the assumptions of the model, when transport costs are present, trade in goods and international factor mobility are not perfect substitutes. Furthermore, after taking into consideration the transport costs of factor payments to the
migrant factor, the factor mobility equilibrium is preferred from the world point of view to the free trade equilibrium. The result is independent of any specific assumption on transport services.

To prove this proposition, we will proceed as above: it will be shown that the wage gap is enough to transport the foregone wage to the immigrant country. More precisely, it will be shown that

\[(7) \quad w - w^* > u_p w^*\]

where \(w\) stands for wage and \(w^*\) denotes the foreign country. The wage gap, in terms of good 1, is larger than the required transport services. The right hand side of (7) is equal to

\[(8) \quad w - w^* = a_{K_1} (p_2^-p_2^*)/d\]

where, as usual, \(a_{L_i}\) and \(a_{K_i}\) represent the quantity of labor and capital per unit of good \(i\) and \(d\) denotes the determinant of the technological coefficient matrix. Given the assumptions of the model

\[(9.1) \quad w-w^* > 0, \quad p_2^-p_2^* > 0\]

\[(9.2) \quad d = a_{L_1} a_{L_2} (k_1-k_2) > 0\]

Substituting (8) and (9) into relation to (7), we get

\[(10) \quad -a_{K_1} (p_2^-p_2^*)-(a_{K_2}^-p_2^*a_{K_1}) u_p < 0\]

By definition, as seen before,

\[(5) \quad p_2^* = (p_2^-v_p)/((1-u_p)\)

After rearranging (10) and using (5), one obtains

\[(11) \quad -a_{K_2} u - v a_{K_1} < 0\]

which is true and proves the result. Note that the proof and, therefore, the result, is independent of comparative advantage and the technology of the
transportation sector.

6. SOME EXTENSIONS

Until now, it has been assumed that factor migration was costless, which may appear too strong an assumption: this however is not the case. Moving one factor (a stock) is a once and for all cost, while transport costs associated with trade (a flow) are costs per unit of time. This model, being a one period model is not the most appropriate to incorporate this relation between costs of factor movements versus transport costs in commodity trade. However, the non-equivalence result is robust enough to be generalized to include costs on factor mobility even in the one period case. Clearly, in the multi-period case the result will not be reversed, rather it will be reinforced.

Trade in goods leads to implicit trade in immobile factors; therefore, one can determine the shadow price of trading one unit of capital or labor under free trade in commodities without factor mobility. Those shadow prices are the solution to the system:

\[ \mu_K = (u_{P1} + a_{L1} \mu_L)/a_{K1} \]
\[ \mu_L = (v_{P1} + a_{K2} \mu_K)/a_{L2} \]

where \( \mu_K \) and \( \mu_L \) are the shadow prices for transporting one more unit of capital and labor. To export one unit of \( X_1 \) costs \( u_{P1} \). The unit of good 1 exported carries \( a_{K1} \) units of capital but also \( a_{L1} \) units of labor, which have to be reimported at cost \( \mu_L a_{L1} \). Hence, the total cost of exporting \( a_{K1} \) units of capital is \( (u_{P1} + \mu_L a_{L1}) \) and \( \mu_K \) can be determined by relation (12). Equation (13) has a similar interpretation. The solution of the system (12)-(13) will then be:
(14) \[ \mu_K = \frac{p_t (a_{L2} \lambda + a_{L1} \nu)}{d} \]

(15) \[ \mu_L = \frac{p_t (a_{K2} \lambda + a_{K1} \nu)}{d} \]

where

(16) \[ d = a_{L1} a_{L2} (k_1 - k_2) > 0 \]

As expected, an increase of \((k_1 - k_2)\) reduces the shadow price of factor trade. In particular, an increase in \(a_{K2}\) will increase \(\mu_L\) and \(\mu_K\).

It can be shown now that even when labor immigration incurs at a cost equal to its shadow price \(\mu_L\), the factor migration equilibrium is not equivalent to free trade. In Fig. 2, under free trade, transport services were demanded in proportion to the length of CJ plus JN. Under labor migration, the required transport services will be in proportion to CN and the size of labor immigration, NN. CN is shorter than CJN, therefore, the demand for T services is smaller. Conversely, if one unit of labor requires \(y\) units of T-services for migration the shadow prices \(\mu_K\) and \(\mu_L\) will fall. Since labor migration can be thought as a new imported good (which is pure labor) by making use of the solution (14)-(16), if one considers a fall in \(a_{K2}\) (or an increase in \((k_1 - k_2)\)), both \(\mu_K\) and \(\mu_L\) will fall.

**Proposition 2:** Under the assumptions of the model, factor mobility is still preferred to free trade when factors are internationally mobile at a cost equal to its implicit price in the free trade equilibrium.

Moreover, it is clear that capital mobility and labor migration at the international level are not equivalent. As an example consider the case where \(\nu = 0\) but \(\lambda > 0\). An outflow of capital, instead of an inflow of labor, would lead to remittances in terms of good 2 which incur transport
costs, while labor migration would lead to zero demand of \( T \) services. That would dominate the trade equilibrium but would be inferior to an inflow of labor.

**Proposition 3**: Under the assumptions of the model, international capital mobility and labor migration are imperfect substitutes. Which one is preferred from the world point of view, depends on the transport costs specific to each factor and on parameters \( \mu \) and \( \nu \), the transport costs of the goods.

7. WELFARE CONSIDERATIONS FROM THE NATIONAL VIEW POINT

At constant prices, domestic income does not change with an influx of labor, but the foreign country's income will be larger due to the higher wages of the migrant labor. As seen above, there is an excess supply of transport services. As the market for transport services begins to clear through a reduction in its supply, the home country production point will move along \( \text{NP} \) in Fig 1. The relative price of good 1 will fall if the relative marginal propensity to consume \( X_1 \) in the foreign country is smaller than the relative marginal propensity to produce \( X_1 \) along \( \text{NP} \). In particular, the home country will experience a terms of trade loss if

\[
(\text{d}X_1 / \text{d}T) / (\text{d}X_2 / \text{d}T) > (\text{d}X_1^* / \text{d}I^*) / (\text{d}X_2^* / \text{d}I^*)
\]

where \( I^* \) stands for foreign income.

The likelihood for there to be a t.o.t. loss depends on the parameters. We can, however make some general statements: If \( k_1 > k_1 > k_2 \) and inferior goods are ruled out, the deterioration of the t.o.t. always takes place. As the \( T \)-sector contracts, so will the quantity supplied of good 2, while the production of good 1 expands. At constant prices, an excess demand (supply) for good 2 (good 1) emerges, the relative price of
good 2 rises and the deterioration of the t.o.t. is inevitable. If \( k_1 > k_t > k_2 \) and the home country has comparative advantage in the T-sector it means that \( k_t \) is relatively high. This implies that, while the T-sector reduces its supply, both sectors will expand, but sector 1 will tend to expand relatively more than sector 2. This effect tends to lead to a deterioration of the t.o.t. In other words, there is always some bias on the supply side that, eventually, is compensated by demand, so that the T-producing country will not experience a t.o.t. loss.\(^5\)

The same exercise can be performed using an outflow of capital instead of immigrant labor. Now, the home country will experience the increase of income, at constant prices. The possibility of terms of trade loss would be governed by the same expression (17) where \( I^m \) is now domestic income.

From this analysis, we derive the following conclusions:

**Proposition 4:** Under the assumptions of the model, starting from a free trade equilibrium, each country has an incentive to induce emigration of the abundant factor and to prevent an inflow of the scarce factor.

**Proposition 5:** Under the assumptions of the model, starting from a free trade equilibrium, when factors become internationally mobile there is a presumption that the transport producing country will experience a t.o.t. loss. The precise condition for this occurrence is given by expression (17).

8. OTHER RESULTS AND CONCLUSION

As seen above, factor migration is Pareto superior, from the world point of view, to free trade, because transportation costs, which are
dead weight losses, are minimized. The imperfect substitutability between trade and factor mobility emphasizes, once again, the fundamental difference between transport costs and tariffs. As one recalls, in Mundell (1957), the analysis considered the case of a tariff.

We can also consider the integration of several economies in a common market. A movement towards free trade, in general, increases trade volume. However, a movement from free trade towards a common market with free factor mobility will eliminate trade (apart from remittances), because factors have incentives to migrate. In particular, capital will tend to flow out to produce the home exportable near the consumer's market.

Throughout the paper, we have assumed that factors would migrate but their ownership would not. This assumption is particularly appealing if one thinks about capital movements, though in international labor migration, one might consider the case in which ownership also moves. If that is the case, the previous results would be reinforced. Although, in this case, national welfare has to be reinterpreted in the line of Bhagwati and Brecher (1980), since the nationality of the immigrant labor is not clear and does matter. Nevertheless, before labor moves in, propositions 4 and 5 would apply, if factor tax-cum-subsidies are ruled out.
NOTES

1/ This approach has indeed been recently adopted in Falvey (1976) and Casas (1981) who model transport costs in a method similar to that in this paper. But their analyses are incomplete with respect to some relevant matters. These papers have, nevertheless, the merit of calling attention to transport services as an open issue in trade literature, but none of those addresses the issues we deal with in this paper.

2/ If insurance is taken into consideration the value of trade should enter in the above demand function. But, then, uncertainty should be explicitly modelled and this is beyond the scope of this essay.

3/ This can be seen by inverting relations (5) and (5c) and considering the home country as the foreign country.

4/ The exact condition can be found in Cunha (1985).

5/ As shown in Cunha (1985), when by choice of units $u=v$ then the Rybczynski line for the $T$ sector has to be flatter than the 45 degree line. Then if there is no bias on demand, in the sense that the right hand side is equal to one, the deterioration of the t.o.t. will also take place, because the left hand side of the expression is larger than 1.
REFERENCES


