SERIE DOCUMENTOS DE TRABAJO

FACULTAD ECONOMÍA Y NEGOCIOS
UNIVERSIDAD DE CHILE

DEPARTAMENTO DE ECONOMÍA

SDT 230

SUBSTITUTION IN MARKUSEN'S CLASSIC TRADE AND FACTOR MOVEMENT COMPLEMENTARITY MODELS

Autor: Maurice Schiff

Santiago, Ene. 2007

Serie Documentos de Trabajo
N 230

SUBSTITUTION IN MARKUSEN'S CLASSIC TRADE AND FACTOR MOVEMENT COMPLEMENTARITY MODELS

Maurice Schiff[1]
Departamento de Economía
Universidad de Chile

Abstract

Two classic papers that examined the relationship between trade and factor movement are Mundell (1957) and Markusen (1983). Mundell showed that substitution holds in the Heckscher-Ohlin model. Markusen challenged the substitution result and showed in five different models that removing barriers to factor movement results in complementarity under free trade, identical factor endowments and a change in any one of the other assumptions underlying the Heckscher-Ohlin model. This paper generalizes Markusen's analysis by considering i) the elimination of barriers to factor movement under any protection level, and ii) a change in trade barriers under free factor movement. I show that substitution prevails under high protection, complementarity prevails under low protection, and either substitution or complementarity prevails for large increases (reductions) of low (high) protection rates.

[1] Thanks are due to James Markusen for his support and help with simulations, and to Mohammad Amin, Matias Berthelon, Arye Hillman, Hillel Rapoport, and participants at seminars at Bar-Ilan University and Universidad de Chile for their useful comments. The findings presented in this paper are solely those of the author and do not necessarily represent those of the World Bank, its Executive Directors or the governments they represent.

Substitution in Markusen's Classic Trade and Factor Movement Complementarity Models*

Maurice Schiff
World Bank and IZA

Jan. 2007

Abstract

Two classic papers that examined the relationship between trade and factor movement are Mundell (1957) and Markusen (1983). Mundell showed that substitution holds in the Heckscher-Ohlin model. Markusen challenged the substitution result and showed in five different models that removing barriers to factor movement results in complementarity under free trade, identical factor endowments and a change in any one of the other assumptions underlying the Heckscher-Ohlin model. This paper generalizes Markusen's analysis by considering i) the elimination of barriers to factor movement under *any* protection level, and ii) a change in trade barriers under free factor movement. I show that substitution prevails under high protection, complementarity prevails under low protection, and either substitution or complementarity prevails for large increases (reductions) of low (high) protection rates.

*Thanks are due to James Markusen for his support and help with simulations, and to Mohammad Amin, Matias Berthelon, Arye Hillman, Hillel Rapoport, and participants at seminars at Bar-Ilan University and Universidad de Chile for their useful comments. The findings presented in this paper are solely those of the author and do not necessarily represent those of the World Bank, its Executive Directors or the governments they represent.

1. Introduction

The nature of the relationship between trade and factor movement has long been of interest to economists. The two classic papers in this literature are Mundell (1957) and Markusen (1983). Mundell used the Heckscher-Ohlin framework to show that international trade and factor movement are substitutes.[1] Markusen (1983) provided a powerful challenge to the received wisdom of substitution between trade and factor movement. He presented five models in which he assumed free trade and identical endowments, and successively changed one of the other assumptions underlying the Heckscher-Ohlin model. He showed for each of the five models that eliminating barriers to factor movement results in complementarity.[2]

This paper generalizes Markusen's (1983) analysis by considering i) the elimination of barriers to factor movement under *any* protection level, and ii) a change in trade barriers under free factor movement. I show that substitution prevails under high protection levels, complementarity prevails under low protection levels, and either substitution or complementarity prevails for large increases (reductions) of low (high) protection rates.[3]

---

[1] This result appealed to policymakers and policy-analysts because it seemed intuitive and easy to explain: either labor exports labor-intensive goods or migrates and produces them in the destination country. As the then President of Mexico Salinas stated during the NAFTA negotiations: "We want to export goods, not people."

[2] The same result obtains in Markusen and Svensson (1985). Wong (1986) derives necessary and sufficient conditions for substitutability and complementarity in a general equilibrium framework where international differences in factor endowments, tastes or technologies are possible. The framework differs from Markusen's in two ways. First, the paper considers the international movement of one factor, with the other factor assumed to be immobile. More importantly, it assumes that capital moves without its owners who repatriate the income from capital abroad. This complicates the analysis because solutions depend on the assumption about the good used for repatriation.

[3] In a three-factor model with migration costs and financing constraints, Lopez and Schiff (1998) find that trade and skilled labor are substitutes while trade and unskilled labor are complements.

A standard result is that an increase and decrease in protection levels have opposite effects. This does not necessarily hold in this case.

The remainder of the paper is organized as follows. Section 2 presents Markusen's (1983) model and complementarity result. Section 3 shows the conditions under which substitution and complementarity obtain under both liberalization of factor movement and changes in tariff rates. Section 4 concludes.

2. Complementarity in Markusen's (1983) Models

The classic paper on complementarity between factor movement and trade is Markusen (1983). Markusen's objective was to challenge the received wisdom and demonstrate that trade and factor movement were as likely to be complements as substitutes.

He assumes identical relative factor endowments in both countries and successively changes one of the other basic assumptions underlying the Heckscher-Ohlin model, namely i) identical technologies in both countries; ii) identical homothetic preferences; iii) constant returns to scale; iv) perfect competition; and v) absence of domestic distortions in either country.

Markusen (1983) presents five models, each corresponding to a change in one of these assumptions. He states that the complementarity result in each of his models is based on the fact that "… each equilibrium involves a country having the relatively high price for the factor used intensively in the production of the export good" (pp. 342-343). Thus, factors move to the other country's sector that uses them intensively, resulting in an increase in trade. This implies that trade and factor movement are complements.

Given that the same finding is obtained in each of Markusen's models, I arbitrarily select the technological difference model to present the complementarity result in this section. The relationship between trade and factor movement under trade barriers is derived in Section 3.

Markusen considers a 2x2 model, with countries 1 and 2 and and sectors *X* and *Y*. Markusen assumes identical endowments, free trade and prohibitive barriers to the movement of factors. Assuming all the other Heckscher-Ohlin conditions hold, including identical technology, implies that Country 1 and Country 2 are identical and autarky prevails.

Assume now that Country 1 has a Hicks-neutral technological advantage in sector *X*, i.e.:

$$X_j = \lambda_j f(K_{Xj}, L_{Xj}), Y_j = g(K_{Yj}, L_{Yj}), \lambda_1 > \lambda_2, \qquad (1)$$

where X_j (Y_j) = output of *X* (*Y*) in Country *j* (*j* = 1, 2), K_{ij} (L_{ij}) = capital (labor) in sector *i* (*i* = *X*, *Y*) in Country *j*, and λ_j is the technology level in sector *X* in Country *j*.

Country 1 has a comparative advantage in the production of *X*. Thus, it exports *X* under free trade and imports *Y*. Assume arbitrarily that *X* is labor-intensive and *Y* is capital-intensive. Then, as Markusen has shown, $w_1 > w_2, r_1 < r_2$.

Eliminating the barriers to factor movement leads to labor flows from Country 2 to Country 1 and capital flows from Country 1 to Country 2. This increases the supply of labor and reduces the supply of capital in Country 1, and vice versa for Country 2. Thus, factors flow to the sector that uses them intensively, resulting in an increase in the production of the export sector in both countries and an increase in trade flows. Thus, factor movement and trade are complements.

3. Relationship between Trade and Factor Movement under Trade BarriersMarkusen (1983)'s complementarity result was obtained by eliminating barriers to factor movement in the absence of protection. This paper generalizes Markusen's analysis by i) examining the relationship between trade and factor movement under any trade barrier, and ii) considering the liberalization of both commodity and factor flows.

I show that substitution obtains for high trade barriers and complementarity for low barriers.[4] The latter is presented in Section 3.1 and the former in Section 3.2. Section 3.3 examines quantum changes in trade barriers.

3.1. Complementarity under Positive Tariffs

Assume that the initial tariff is positive ($t > 0$). This has no impact on goods or factor prices under identical technologies because trade is absent in this case. Since the two countries are identical in factor endowments, technology, and preferences, it follows that goods and factor prices are identical under these conditions.

Assume now that, as in Section 2 above, Country 1 benefits from a Hicks-neutral technological advantage $\lambda_1 > \lambda_2$ in its labor-intensive sector *X*. This implies that Country 1 exports *X* and Country 2 exports *Y*. Section 2 showed that the technology shock raises the wage rate and reduces capital's rental rate in Country 1 relative to Country 2, i.e., $w_1 > w_2$ and $r_1 < r_2$.

Given that trade takes place following the technology shock, a tariff in Country 2 raises the price of its labor-intensive importable *Y*, resulting in a lower rental rate r_2 and

[4] As in Mundell (1957), trade takes place at the protection levels under consideration.

a higher wage rate w_2. Whether $w_1 > w_2$ and $r_1 < r_2$ or vice versa depends on the tariff rate.

Figure 1 depicts the relationship between the tariff rate and factor flows. The figure shows two distinct regions which are separated by the tariff rate t^*. At t^*, $w_1 = w_2$ and $r_1 = r_2$, the level of factor movement $M = 0$, and the impact on M of an infinitesimal change in t is $\partial M / \partial t = 0$.

The region where complementarity prevails is defined by the range of tariff rates $t < t^*$ for which $w_1 > w_2$ and $r_1 < r_2$. In that range, tariff rates are too low to change the relationship between factor prices generated by the technological advantage in good X in Country 1.

We examine the impact of changes in barriers to both trade and factor movement. Eliminating barriers to factor movement implies that capital flows to Country 2 and labor flows to Country 1. This raises output of the export sector in both countries and reduces that of the import sector. Since trade increases as well, it follows that factor movement and trade are complements.

Second, a reduction in the tariff increases trade. It also lowers the price of good Y in Country 2, thereby reducing the wage rate w_2 and raising the rental rate of capital r_2. Given that $w_1 > w_2$ and $r_1 < r_2$, it follows that the tariff reduction *raises* the international wedge in factor prices. This results in an increase in the movement of labor from Country 2 to Country 1 and an increase in the movement of capital from Country 1 to Country 2. Since both trade and the movement of labor and capital increase, trade and factor movement are complements.

This is shown in Figure 1. The derivative $\partial M / \partial t < 0$ in the region where $t < t^*$ and a reduction in the tariff, say from t_2 to t_3, raises both factor movement (from M_2 to M_3) and trade.

The same result obtains with a tariff in Country 1. For a low tariff rate, the international factor price relationship is $w_1 > w_2$ and $r_1 < r_2$. A reduction in the tariff rate lowers the price of the capital-intensive importable good, resulting in a reduction in r_1 and an increase in w_1, thus *raising* the international wedge in factor prices. This increases factor flows and results in complementarity between trade and factor movement.

3.2. Substitution under Positive Tariffs

The region where substitution prevails is defined by the range of tariffs $t > t^*$ for which $w_1 < w_2$ and $r_1 > r_2$. These tariff rates are sufficiently high to overturn the relationship between international factor prices generated by the technological advantage in good *X* in Country 1.

This section assumes that trade continues at $t = t^*$, with the prohibitive tariff t_P where trade reaches zero being higher than t^* ($t_P > t^*$). It is of course possible for the prohibitive tariff t_P to be lower than t* ($t_P < t^*$). This case is examined in Section 3.4.

Liberalization of factor movement results in a movement of labor to Country 2 and capital to Country 1. The factor movement reduces the output of the export sector in both countries and increases that of the import-competing sectors, resulting in a decline in trade. This implies that trade and factor movement are substitutes.

It is important to note that the pattern of trade is the same whether $t > t^*$ or $t < t^*$. What does change is the pattern of factor movement, with labor moving from Country 2

to Country 1 in the complementarity case and from Country 1 to Country 2 in the substitution case. Similarly, capital moves from Country 1 to Country 2 in the complementarity case and from Country 2 to Country 1 in the substitution case.

A reduction in the tariff in Country 2 from t to t' ($t > t' > t^*$) raises the level of trade and, as before, lowers the wage rate w_2 and raises capital's rental rate r_2 in Country 2. This *reduces* the international wedge in factor prices, thereby reducing factor flows. In terms of Figure 1, $\partial M / \partial t > 0$ in that region and a reduction in the tariff, say from t_0 to t_1, reduces factor movement (from M_0 to M_1) and raises trade. Thus, trade and factor movement are substitutes. The same result obtains for a tariff in Country 1.

Thus, a technology shock in one of the two sectors in one of the two countries reduces the international wedge in factor prices under sufficiently high tariff rates and results in substitution between trade and factor movement.

Markusen (1983) showed that complementarity holds under free trade. This paper generalizes Markusen's analysis to the case of protectionist trade policy and shows that substitution holds for $t > t^*$ and complementarity for $t < t^*$. The latter includes the free trade case examined by Markusen.

Note that the standard result that an increase and decrease in protection levels have opposite effects does not necessarily hold here. For instance, at $t = t^*$ an increase and a decrease in protection both raise factor movement. Similarly, a decrease in protection for $t > t^*$ and an increase in protection for $t < t^*$ both reduce factor movement.

3.3. Moving Across Substitution and Complementarity Regions

This section examines quantum changes in trade policy. Assume that Country 2 starts with a tariff $t > t^*$ and liberalizes its trade to the point where the new tariff $t' < t^*$. Thus, trade liberalization moves the economy from the substitution to the complementarity region, for instance in the case of a reduction in the tariff rate from $t = t_0$ to $t' = t_2$.

Such a move does not necessarily imply that migration increases. For instance, with a reduction in the tariff rate from $t = t_0$ to $t' = t_2$, migration falls from M_0 to M_2 and substitution obtains over that tariff range. If the tariff declines from $t = t_0$ to any tariff level $t' < t_3$, migration increases, so that migration and trade are complements. Similarly, a quantum increase in protection may either increase or reduce the level of factor movement.

Hence, whether trade and factor movement are substitutes or complements depends on the initial tariff rate and the extent of its change. This leads us to the issue of the prohibitive tariff

3.4. Prohibitive Tariff

The prohibitive tariff rate t_P at which a country no longer trades has been assumed to be higher than t^*. However, the outcome $t_P < t^*$ may also prevail, in which case substitution between trade and factor movements would not hold. In that case, Markusen's result of complementarity between trade and factor movement would generalize to all tariff values $t \leq t_P$.

A few simulations were performed to obtain a better sense of the conditions under which $t_P > t^*$ and under which $t_P < t^*$.[5] The simulation results depend of course on the choice of functional forms and parameter values used. The results showed great sensitivity to the values of the elasticity of substitution of demand between the two goods, to the extent of technological advantage, and to the difference in factor intensities across sectors.

These results indicate that the likelihood that $t_P > t^*$ -- i.e., that a range of tariff rates exist where substitution prevails – is inversely related to the extent of technological advantage, to the cross-sector difference in factor intensities, and to the elasticity of substitution in demand. These results are in accordance with those obtained analytically.

4. Policy Implications

These findings have important policy implications. First, most of the OECD destination countries have liberal trade policies and find themselves in the region where complementarity prevails (such as point t_2 in Figure 1). Assume that an OECD country (group of OECD countries) decides (decide) that a free trade agreement (FTA) with a source country or group of countries is beneficial and favors the formation of such an FTA (e.g., CAFTA between the US and Central American countries, or the agreements between the EU and Southern Mediterranean countries). Since these OECD countries happen to be located in the complementary region, an FTA would result in an increase in South-North migration. Assuming the OECD countries consider an increase in migration

[5] I would like to thank Jim Markusen for help with the simulations which are available from the author upon request.

to be undesirable, they might decide not to form an FTA once the migration consequences are taken into account.

A superior alternative might be to change the complementarity relationship to a substitution one. This would entail moving the curve depicting the migration-trade relationship to the left (e.g., moving the curve in such a way that the point on the curve corresponding to t_1 becomes the point on the curve corresponding to t_2). How could such a shift be achieved? Recall that the location of the curve depends on the extent of the technological advantage in Country 1, i.e., on the ratio λ_1 / λ_2. One way to achieve a leftward shift in the trade-migration curve would be to reduce the technological difference between the two countries by raising λ_2.

This could be achieved through a technology transfer from the OECD (Country 1) to a developing source country (Country 2). Thus, the model examined in this paper might provide a justification for a policy of technology transfer.

Second, assume that policymakers have been briefed, in the case of factor mobility, of the impact of a liberalization of the trade regime on factor movement. Given that they are unlikely to be indifferent vis-à-vis that movement of factors, policymakers are likely to select a different trade policy than in the case where factors are immobile. The impact of factor mobility on the degree of trade liberalization would likely depend on the direction and extent of the associated change in factor movement and whether or not the authorities viewed this change as desirable.

The optimum would be to select the two policies simultaneously. This would enable the authorities to maximize their objective function, whether it consist of national welfare or some political economy function.

4. Conclusion Comments

Mundell (1958) used the Heckscher-Ohlin model to demonstrate that trade and factor movement are substitutes. Markusen (1983) challenged the received wisdom and showed that complementarity holds under free trade in models with identical endowments and a change in any one of the other assumptions of the Heckscher-Ohlin model. This paper generalizes Markusen's (1983) analysis by considering i) the elimination of barriers to factor movement under *any* protection level, and ii) a change in trade barriers under free factor movement.

I show that:

a) substitution obtains under high trade barriers in the presence of trade,

b) complementarity obtains under low trade barriers, and

c) a change in trade barriers from the low to the high tariff region or vice versa may result in either substitution or complementarity.

Finally, I present some policy implications which are derived from the model examined in this paper.

References

Lopez, Ramon and Maurice Schiff. 1998. "Migration and the Skill Composition of the Labor Force: The Impact of Trade Liberalization in LDCs." *Canadian Journal of Economics* 31 (2): 318-36.

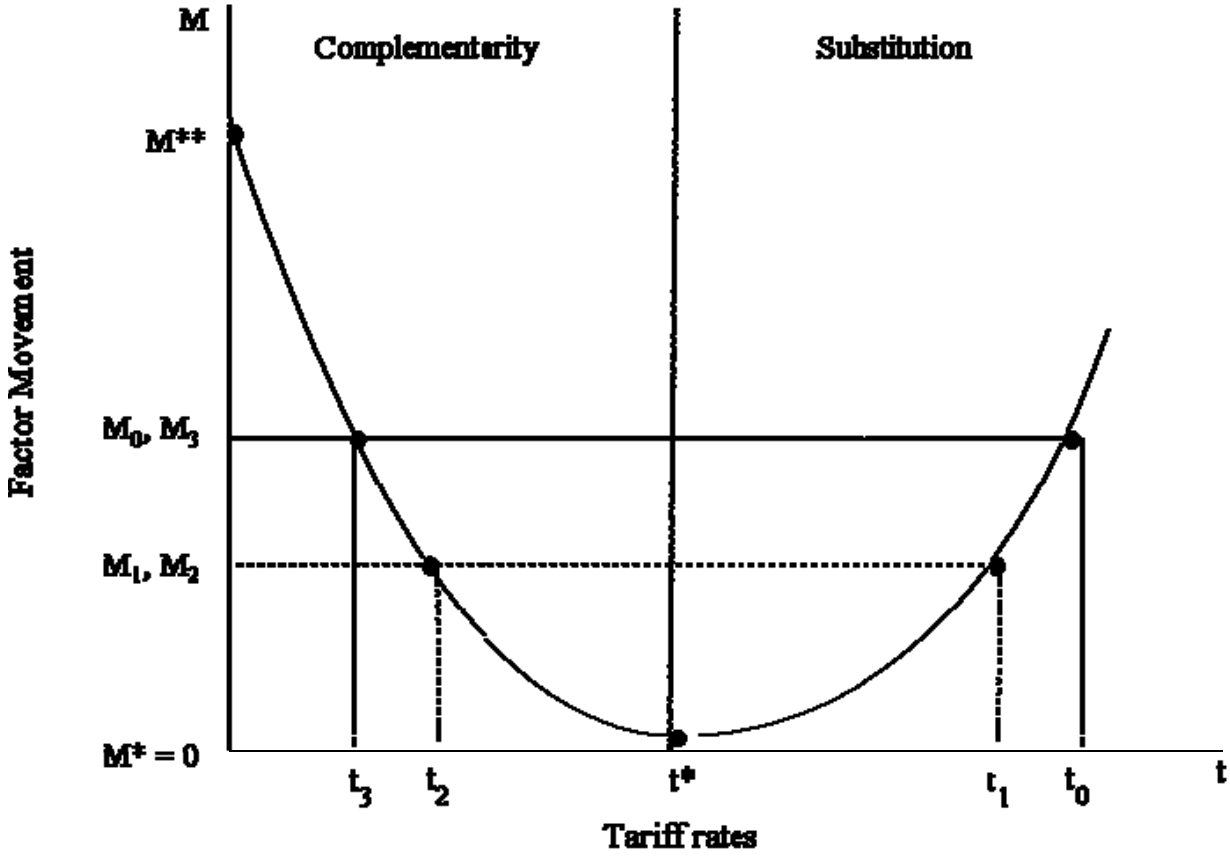
Markusen, James R. 1983. "Factor Movements and Commodity Trade as Complements." *Journal of International Economics.* 14 (3-4): 341-356.

Markusen, James R. and L. E. O. Svensson. 1985. "Trade in goods and factors with international differences in technology." *International Economic Review* 26: 175-92.

Mundell, Robert A. 1957. "International Trade and Factor Mobility." *American Economic Review* 47(3): 321-335.

Wong, Kar-yiu. 1986. "Are International Trade and Factor Mobility Substitutes?" *Journal of International Economics* 21: 25 – 43.

Figure 1. Relationship between Factor Movement and Trade Policy in Markusen's Models



Note $t = t^*$: $W_1 = W_2$; $r_1 = r_2$
$t < t^*$: $W_1 > W_2$; $r_1 < r_2$
$t > t^*$: $W_1 < W_2$; $r_1 > r_2$