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**WORKING PAPER SERIES**

**Global Production Networks and  
Regional Integration**

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WP 2003-12

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# **GLOBAL PRODUCTION NETWORKS AND REGIONAL INTEGRATION\***

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## **I. Introduction**

Cross-border production sharing is probably one of the more important new elements in trade relations among countries. It occurs with or without the overlay of preferential trade liberalization. An example of the latter are the production networks of Japanese firms in Asia.<sup>1</sup> An example of the former is production sharing between Canada, the U.S., and Mexico in the North American Free Trade Area (NAFTA).

Production sharing based on intra-product specialization has been shown to be welfare-enhancing under conditions of free trade, while its effects are ambiguous in the context of a most-favored-nation (MFN) tariff regime.<sup>2</sup> This chapter examines the implications of production sharing in the context of preferential trade liberalization. Of particular interest is the case in which a free trade area which is clearly trade-diverting under traditional circumstances, becomes trade-creating with joint production.

Trade in components has important implications for the interaction between exchange rates and the trade balance. Trade tends to become less sensitive to exchange-rate changes and trade-balance accounting needs to distinguish between the value of total trade and trade in value-added.

\*(Forthcoming in Empirical Methods in International Trade Essays in Honor of Mordechai (Max) Kreinin, M. Plummer, ed.)

When production sharing takes place between advanced and emerging economies, foreign investment flows occur and capacity accumulation typically precedes the onset of joint production. This introduces cycles into the behavior of the real exchange rate and the current account. The real rate appreciates and the current balance deteriorates during the investment phase of the process, followed by real depreciation and current account improvement.

The rest of the chapter is organized as follows. Section II lays out the basic argument in a standard general-equilibrium framework, while Section III examines key welfare effects of joint production in a partial-equilibrium framework. Section IV studies the effect of production sharing on the exchange-rate sensitivity of trade and discusses alternative measurements of the balance of trade. Section V deals with the real-exchange-rate effects of an investment cycle associated with the implementation of joint production. Section VI considers exchange-rate regime choice. Section VII concludes.

## **II. Trade Liberalization vs. Economic Cooperation**

While production sharing may take place across a broad range of trade regimes, it is not welfare-enhancing in every regime. It is unambiguously welfare-improving under conditions of free trade. It increases welfare by allowing specialization to be extended beyond finished products to the level of constituent production activities. In a standard Heckscher-Ohlin framework, variations in factor-intensity across the components of a product imply potential gains from intra-product specialization, the magnitude of those gains depending on transport and coordination costs. Modern innovations in communication and transportation technologies have sharply reduced those costs and have thereby created new opportunities for profitable production sharing.<sup>3</sup>

In a tariff-ridden world, on the other hand, production sharing may reduce rather than improve welfare. A tariff on imports of the final product reduces the efficiency of resource allocation in the economy. While production sharing in that industry tends to mitigate the degree of comparative disadvantage of that industry and thus improves the efficiency of resource reallocation, it may not be able to fully offset the initial inefficiencies. Both the tariff and production sharing shift specialization toward the sector in which the country has comparative disadvantage, and the end result can be overall specialization in the wrong direction.

In Figure 1, points  $Q_0$  and  $C_0$  represent production and consumption in the presence of a tariff,  $t$ , on imports of finished product  $X$ . The size of the tariff is given by the wedge between the world price,  $P_w$ , and the tariff-inclusive domestic price,  $P_d$ . As shown in the literature cited above, production sharing in a sector has an effect similar to technical progress in that sector and shifts the production possibility curve out along the axis representing that sector. This shift is indicated by the move from point  $T$  to  $T'$  along the  $X$ -axis.

When the country is small, these changes do not affect prices; the new production and consumption equilibria are located at points  $Q_1$  and  $C_1$ , respectively, where the domestic price ratio is tangent to the new production possibility curve and an appropriate indifference curve. Output of the good subject to production sharing ( $X$ ) thus increases at the expense of the second good ( $Y$ ). Consumption falls to a lower indifference curve. The trade triangle shrinks.

It is apparent from the figure that welfare need not fall. Whether it rises or falls depends on the slope of the Rybczynski line ( $RR$ ) relative to the slope of the world price ratio.<sup>4</sup> When the line is steeper than the world price, welfare falls; it rises when the Rybczynski line is flatter than the world price.

When production sharing is introduced together with preferential tariff liberalization, welfare may rise or fall relative to the MFN level. While this is consistent with the well-known possibility that preferential trade arrangements may be net trade-creating or trade-diverting, production sharing mutes the trade-diverting tendencies of preferential trade liberalization.

In Figure 2, the analysis starts with an MFN tariff, domestic price  $P_d$  and production and consumption at points  $Q_0$  and  $C_0$ , respectively. Introduction of a preferential trade agreement without production sharing generates intra-area price  $P_{pta}$  and moves production to  $Q_1$  and consumption to  $C_1$ . Welfare declines, making this a trade-diverting free trade area. Whether welfare declines or not depends on the intra-area price relative to the tariff-inclusive domestic price and the world price. As the intra-area price ratio becomes flatter and thus approaches the world price ratio, elements of trade creation expand, while the importance of trade-diverting elements declines. At a sufficiently flat price ratio, welfare improves relative to the MFN equilibrium.

This is a well-known feature of preferential trade liberalization. Suppose, however, that the partner countries engage in deeper economic integration, creating an economic area (EA) in which traditional preferential trade liberalization is combined with production sharing. The latter shifts the production possibility curve outward along the X-axis from T to T', causing output to move to  $Q_2$  and consumption to  $C_2$ . While this is still a trade-diverting arrangement, welfare falls by less than before. Thus, deeper integration, which includes production sharing, mitigates the negative welfare effects of narrow preferential trade liberalization.<sup>5</sup>

Production sharing may, however, reduce the relative price of X and thus flatten the price ratio relative to its slope under the traditional PTA. By specializing in the components

of product X in which each has comparative advantage, the two countries can improve productivity. We assume that this rise in efficiency is passed through to a lower intra-area price ratio, which is represented in Figure 2 by the flatter line  $P_{ea}$ . Production and consumption move to points  $Q_3$  and  $C_3$ , respectively. This improvement in the country's terms of trade raises welfare.<sup>6</sup>

### **III. Trade Creation and Diversion under Production Sharing**

Implementation of NAFTA led to what were at times substantial shifts in trade patterns away from non-members to Canada and especially Mexico. In the automobile sector, for example, Mexico's share rose significantly, as Chart 1 suggests.<sup>7</sup> It would be tempting to interpret these shifts as evidence of trade-diversion and hence of a welfare decline. Such a conclusion may appear warranted by the reasonable assumption that Mexico is the high-cost producer of automobiles.

While trade diversion is certainly a possible outcome in the standard model of preferential trade liberalization, such an outcome is less likely in the context of the deeper integration associated with an economic area in which preferential trade liberalization is accompanied by production sharing. In that case, automobiles made entirely in Japan are replaced by imports from Mexico which contain parts and components made in the United States, with Mexico specializing in labor-intensive assembly. With both the U.S. and Mexico specializing in activities in which they are respectively the low-cost producers, production sharing enables them to capture significant cost savings, so that trade diversion is now limited to activities in which Japan holds the edge.

Consider the situation depicted in Figure 3. In order to simplify the set-up, we assume linear supply curves for Japan, and for conventional production methods in Mexico and the United States. The term “conventional” is used to denote that the good is produced in its entirety in each country, without resort to cross-border sourcing. We assume that Japan is the low-cost producer and Mexico the high-cost producer under these conventional conditions. Curves  $S_j$  and  $S_{mx}$  in Figure 3 represent supply conditions in Japan and Mexico, respectively.

The starting situation is characterized by a specific non-discriminatory (MFN) tariff,  $t$ , imposed by the United States on all imports of product X. The full general-equilibrium set-up was discussed above; here we focus on certain features of adjustment in a partial-equilibrium context. The tariff-inclusive Japanese supply curve is given by curve  $S_{j+t}$ . The tariff-inclusive Mexican supply curve is not drawn, because the assumed magnitude of the tariff is such as to knock Mexico out of the U.S. market. The rest of the picture, which would include U.S. supply and demand curves, is not drawn in order to keep the figure simple and readable.

The initial price of X in the United States,  $P_d$ , is determined by the intersection between U.S. demand (not drawn) and the sum of U.S. and tariff-inclusive Japanese supply. At price  $P_d$ , Japanese exports to the U.S. amount to  $n_j$  in Figure 3. Tariff revenue collected by U.S. authorities is given by rectangle  $jkln$ .

Implementation of a conventional free trade area (that is, without production sharing) between the U.S. and Mexico generates a lower price, such as  $P_{pta}$ , determined by the intersection between the aforementioned U.S. demand curve and a new supply curve (not drawn) composed of  $S_{us}+S_{mx}+S_{j+t}$ . U.S. imports rise to  $mb$ , with  $mc$  units coming from Mexico and  $cb$  units from Japan. Imports from Mexico partly replace imports from Japan, as well as U.S. production. It is well known that the changes in price and output in conventional

U.S. production generate a transfer from producers to consumers and a net efficiency gain, which is a key element of trade creation.

The changes involving imports from Japan are the source of trade diversion. Trade diversion results from the inefficiencies associated with the switch of imports from Japan, which supplies the product along the low-cost supply curve,  $S_j$ , to Mexico's conventional producers, who supply the product along the relatively high-cost curve  $S_{mx}$ . As noted, before the PTA, U.S. customs authorities collect tariff revenues equal to the area  $njkl$ . After implementation of the PTA, tariff revenues amount to  $cbsr$ . The lost revenue encompassed by rectangle  $nabc$  is compensated by the terms-of-trade gain given by  $lqsr$ . Area  $nabc$  is thus a pure gain in consumer surplus. The revenue loss contained in rectangle  $bykq$ , on the other hand, is a pure efficiency loss and thus represents the degree of trade diversion. The revenue loss represented by area  $ajyb$  is an internal transfer to consumer surplus. It is well known that the area of trade diversion may be larger or smaller than the sum of the areas representing trade creation, which makes the welfare effect of conventional preferential trade liberalization ambiguous.

Suppose that good X is made up of two components,  $x_1$  and  $x_2$ , and that Japan possesses comparative advantage over the U.S. not only in the final product, but in the production of each of the two components. Mexico is assumed to be at a competitive disadvantage vis-à-vis both countries in overall terms and in producing the first component, but to have comparative advantage with respect to the second component. In an endowment-based model, therefore, this information, together with Mexico's relative labor abundance, would imply that the second component is the labor-intensive component (of which automobile assembly is an example).

Introduction of production sharing represents a deepening of economic integration. We refer to this, more complex, type of integration as an economic area (EA). Under the stated assumptions, production sharing in such an area would have the U.S. specializing in producing the first component and Mexico the second. Improvements in efficiency from production sharing may come in two forms. The ability to obtain certain components at reduced cost lowers production costs of the final product, which would be represented by downward shifts in both the U.S. and Mexican supply curves. In this case, each country continues to produce the final product, but each unit of the final product contains imported components.

Cost reductions of the type discussed serve to lower the price of X relative to its level in the conventional PTA and hence generate improvements in welfare. In Figure 3, curve  $S'_{mx}$  represents such a cost-improving change in supply conditions in Mexico. This is a welfare gain, which helps offset elements of trade diversion.

The decline in price to  $P_{ea}$  reduces Japanese exports to the U.S. to  $de$ , on which the U.S. authorities collect  $deuv$  in tariff revenues. The revenue loss contained in area  $cfed$  is offset by the welfare gain ( $rwuv$ ) associated with the terms-of-trade improvement of  $rwuv$ , so that  $cfed$  represents a net gain in consumer surplus, rather than an internal transfer from revenues to consumer surplus. Area  $fbxe$ , on the other hand, is an internal transfer from revenues to consumer surplus and thus does not change overall welfare. Area  $exsw$  measures the extent of trade diversion in the move from the conventional preferential trade area to the economic area. The welfare gains appear to exceed the welfare losses, particularly since the lower price at which the U.S. obtains imports from Mexico represents a pure consumer surplus gain.<sup>8</sup> The decline in the price of U.S.-produced units breaks down into the usual internal transfer from producer to consumer surplus and a pure efficiency gain.

An alternative approach to exploiting the advantages of production sharing is to establish joint production facilities, which shifts some or all production of the product to new entities.<sup>9</sup> In that event, the supply curves representing conventional production remain unchanged, but there appears a new supply curve for joint production (not shown). This supply curve would be expected to lie below the two countries' respective conventional supply curves, but may lie above or below Japan's supply curve, depending on the degree of productivity improvement embodied in joint production. The extent of improvement depends on the initial gap between the U.S. and Japan in  $x_1$ -production and on Mexico's edge in  $x_2$ -production.

The market now clears at the intersection (not shown) between the U.S. demand curve and the sum of the joint supply curve, the conventional supply curves for the United States and Mexico, and the tariff-inclusive Japanese supply curve. It is clear that the market clearing price,  $P_{ca}$ , will lie above relevant segments of the Japanese tariff-free supply curve, as shown, which implies that elements of trade diversion will persist even at this deeper degree of economic integration. As noted, imports from Japan decline to  $d_e$ , and this reduction causes the Japanese supply price to drop to the level indicated by  $v$ .

The welfare analysis then follows the discussion of production sharing which reduces costs relative to conventional production. There is an efficiency loss as low-cost Japanese imports are replaced by joint production, which supplies the product at the equilibrium price. That price lies above the tariff-free Japanese supply price, typically even if the joint production supply curve itself lies below that Japanese supply curve. The efficiency losses are given by the area  $exsw$ . It is important to note, that under conditions of increasing costs, conventional producers will lose market share, but they need not disappear altogether.<sup>10</sup>

#### **IV. The Exchange Rate and the Trade Balance**

Whether it occurs with or without preferential trade liberalization, production sharing affects the sensitivity of the trade balance to exchange-rate movements and requires additional care in interpreting changes in the trade balance.

In the standard model, currency depreciation reduces imports and raises exports, as the domestic-currency price of imports rises and the foreign-currency price of exports falls. The net effect on the trade balance is subject to a variety of influences and conditions, including the degree of pass-through. Production-sharing changes the role of pass-through, to the extent that a country's exports enter into its imports and its imports become part of its exports. That is because the exchange-rate effect on the price of imports denominated in one currency is offset by the exchange-rate effect on the price of exports expressed in the other currency.

There are several layers of pass-through at work here, but suppose that the depreciation of the peso is passed through completely to an increase in the peso price of component imports into Mexico, which in turn is fully passed through to the peso price of the assembled vehicle. When the vehicle is priced in dollars, again assuming full pass-through, the dollar price will fall only to the extent that the vehicle contains Mexican value-added.

This is the important difference between trade involving goods of joint production and traditional trade in products made entirely at home. The smaller the share of Mexican value-added in a commodity imported into the United States, the smaller the effect of the peso depreciation on Mexican exports of the finished product and U.S. exports of the components that go into it.

These considerations have implications for the behavior of the trade balance. Conventionally, a country's demand for imports is modeled as a function of home GDP, relative prices, and the exchange rate. An increase in GDP and in relative inflation at home, and a nominal appreciation all raise the demand for imports and thus worsen the trade balance. A rise in foreign GDP, foreign inflation, and domestic currency depreciation tend to improve the trade balance. Suppose, however, that Mexican imports from the U.S. consist mainly of components for use in exports to the United States. Then, changes in Mexican GDP should have little influence on imports. Instead, it would be changes in U.S. demand for imports from Mexico which would be expected to determine the rise and fall of Mexican imports. Thus, U.S. end-product imports become an important determinant of U.S. parts exports and the importance of Mexican GDP declines.

Production sharing also affects the interpretation of changes in the trade balance, particularly with respect to the distinction between the value of trade flows across borders and the movement of value-added. When an imported automobile from Japan, valued at \$20,000, is replaced by a vehicle of equal value from Mexico, which contains U.S.-made components worth \$15,000, combined with \$5,000 consisting of Mexican components and assembly, the value of U.S. car imports does not change. Imports of foreign value-added, however, fall from \$20,000 (on the assumption that the Japanese automobile was made entirely in Japan) to \$5,000. This suggests an "improvement" in the U.S. value-added trade balance of \$15,000.<sup>11</sup>

Over time, as motor vehicle imports from Mexico expand, exports rise by \$15,000 for every \$20,000 increase in imports, for a worsening of the conventional trade balance of \$5,000 per vehicle. If the \$15,000 of U.S.-made components is netted out of the imported motor

vehicle, on the other hand, the value-added trade balance “improves” by \$10,000 for each vehicle included in joint production.

## **V. Production Sharing and Foreign Direct Investment**

Implementation of cross-border production sharing is often preceded by flows of foreign direct investment (FDI) from the advanced to the emerging economy, accompanied by shipments of capital goods and other goods and services needed for the creation of productive capacity in the emerging economy. These initial flows affect the balance of payments and the exchange rate. In the FDI-receiving country, the investment boom increases demand for both tradables such as capital goods, and non-tradables such as construction services. There is upward pressure on prices in both sectors.

But while non-tradables prices may adjust freely to such pressures, the movement of tradables prices in a small, open economy is limited by competition in the world market. With given world prices of tradables, changes in tradables prices expressed in the domestic currency are brought about by fluctuations in the nominal exchange rate.

A rise in the demand for tradables, such as capital goods, is readily satisfied through increased imports, but the rise in the demand for non-tradables, such as construction services, can only be satisfied by moving productive resources into the non-tradables sector. If there are unutilized resources in the economy, they represent an important source. When full employment prevails, the additional resources must come from the tradables sector and this shift is brought about by an increase in the relative price of non-tradables. This represents a real appreciation of the domestic currency.

In Figure 4, the real exchange rate, expressed as the ratio of tradables to non-tradables prices, is measured on the vertical axis, and quantities of tradables and non-tradables are measured horizontally in the right and left panels, respectively. Starting at an initial equilibrium in which both markets are assumed to clear, an investment boom shifts out demand for both tradables ( $D_t$ ) and non-tradables ( $D_n$ ). As noted, the rise in tradables demand can be met at the initial exchange rate by an increase in imports, which is financed by the inflow of FDI. The rise in non-tradables demand, however, creates an excess demand at the initial exchange rate which can be resolved only by appreciation of the currency in real terms from  $e_0$  to  $e_1$ . This change allows domestic production of non-tradables to increase. The real appreciation contributes to the deterioration of the trade balance.

Thus, an investment boom created by production sharing causes the capital-receiving country's currency to appreciate in real terms, while its current account deteriorates. As new productive capacity comes on stream, the real exchange rate and the current account adjust once more. An increase in non-tradables capacity shifts that sector's supply curve out, thereby causing non-tradables prices to fall and the currency to depreciate in real terms. An increase in tradables capacity has no direct effect on the real exchange rate, but the outward shift of the supply curve in the right-hand panel tends to reduce the current account deficit. The supply-side effect of the investment boom thus runs in the opposite direction to the earlier demand-side effect: it reduces the real exchange rate and improves the current account.

The extent of the exchange-rate adjustment depends on the magnitude of the capacity build-up in the non-tradables sector. If the bulk of investment goes into tradables, there will be a sustained real appreciation. The currency will remain "strong," perhaps even "overvalued" in the view of some.

The expansion of capacity amounts to an increase in national income and wealth, which tends to raise the demand for both tradables and non-tradables. Demand in both sectors shifts out, as indicated by the arrows emanating from the outermost demand curves in the two panels. The rise in non-tradables demand tends to sustain the real appreciation and trade balance deterioration, while the rise in tradables demand leads to trade balance deterioration, but has no direct effect on the real exchange rate. How the real exchange rate and the current account evolve over time, thus depends on the distribution of supply and demand changes between the two sectors. As noted, an investment boom that is heavily biased in favor of tradables will be accompanied by sustained currency appreciation and current-account improvement over the long run.

## **VI. Fixed vs. Floating Rates**

The aforementioned movements in the real exchange rate take place under both fixed and floating rates, but the burden of adjustment is distributed differently in the two regimes. In a floating exchange-rate regime, adjustments in the real rate may be brought about by changes in nominal rates, in non-tradables prices, or in both, assuming that world tradables prices are given. When the nominal rate is fixed, the entire burden of adjustment falls on non-tradables prices, which rise to bring about real appreciation and fall to induce real depreciation. These price movements may create political difficulties for incumbent governments. Rising non-tradables prices not only risk inflaming inflationary expectations, but may reduce real incomes especially among tradables workers whose wages are held down by foreign competitive pressures.<sup>12</sup> The political difficulties probably even more severe when the real rate needs to depreciate, because then prices and wages in non-tradables industries must fall.

When the country is large, changes in tradables demand and supply affect tradables prices in the world or in the free trade area. Foreign tradables prices will tend when the large country's demand for tradables rises during the early phase of the investment boom; they will tend to fall when productive capacity comes on stream in the large country and the world supply of tradables rises.

## **VII. Concluding Remarks**

Creation of an economic area, in which trade liberalization is combined with investment liberalization and cross-border production sharing, thus has both micro- and macro-economic implications. Production sharing among members is capable of converting a trade-diverting free trade area into a trade-creating one. Observed shifts of imports from low-cost non-members to higher-cost members do not necessarily imply trade diversion. By pushing specialization to the level of components, joint production among members may generate costs that undercut the low-cost outsider, if that country's cost advantage in the end product does not carry through to *all* of the component activities.

Production sharing tends to reduce the sensitivity of the trade balance to exchange rate movements, because a country's exports are now linked to its imports, so that exchange-rate effects on one side of the trade balance are offset by changes on the other.

When production sharing takes place between advanced and emerging economies, foreign direct investment flows often precede joint production. These flows and the subsequent movement of components and products have important implications for the real exchange rate. In the FDI-receiving country, an investment boom tends to cause the real rate

to appreciate initially and the current account to worsen, followed by real depreciation and current account improvement.

## Endnotes

1. See Kimura and Ando (2003) for new evidence on the extent of production sharing by Japanese firms in Asia and Latin America.
2. See footnote 3.
3. For a detailed analysis in the Heckscher-Ohlin framework, see Arndt (1997, 1998). For an assessment of cross-border “fragmentation” in a Ricardian framework, see Jones and Kierzkowski (2001). See Deardorff (2001) for an examination of fragmentation in a multi-cone context. See also Kohler (2001). For the role of service links in international production networks, see Jones and Kierzkowski (1990). Recent empirical studies include and Egger and Egger (2001), Egger and Falkinger (2003) and Kimura and Ando (2003).
4. For details, see Arndt (2001).
5. It is clear that the first-best solution with and without production sharing is non-discriminatory trade liberalization.
6. While the overall welfare change depends on several factors, the main point is that deeper integration is welfare-improving relative to the base-line free trade area.
7. This chart is taken from Arndt and Huemer (2001).
8. From Mexico’s point of view, of course, it is a loss of producer surplus and thus a transfer of welfare to the trading partner.
9. When joint production is located in the emerging economy, direct investment inflows (FDI) may precede the onset of joint production. See Arndt (2002) for a discussion.
10. See Egger and Falkinger (2003) for a related treatment.
11. An important caveat, here, pertains to transfer-pricing practices by the multinationals involved in production sharing. These can affect the nature of pass-through and of the value of

trade. Where accounting practices distinguish between in-bond and regular exports, the distinction will be more readily apparent.

12. See Robertson (2003) for a study of Mexico

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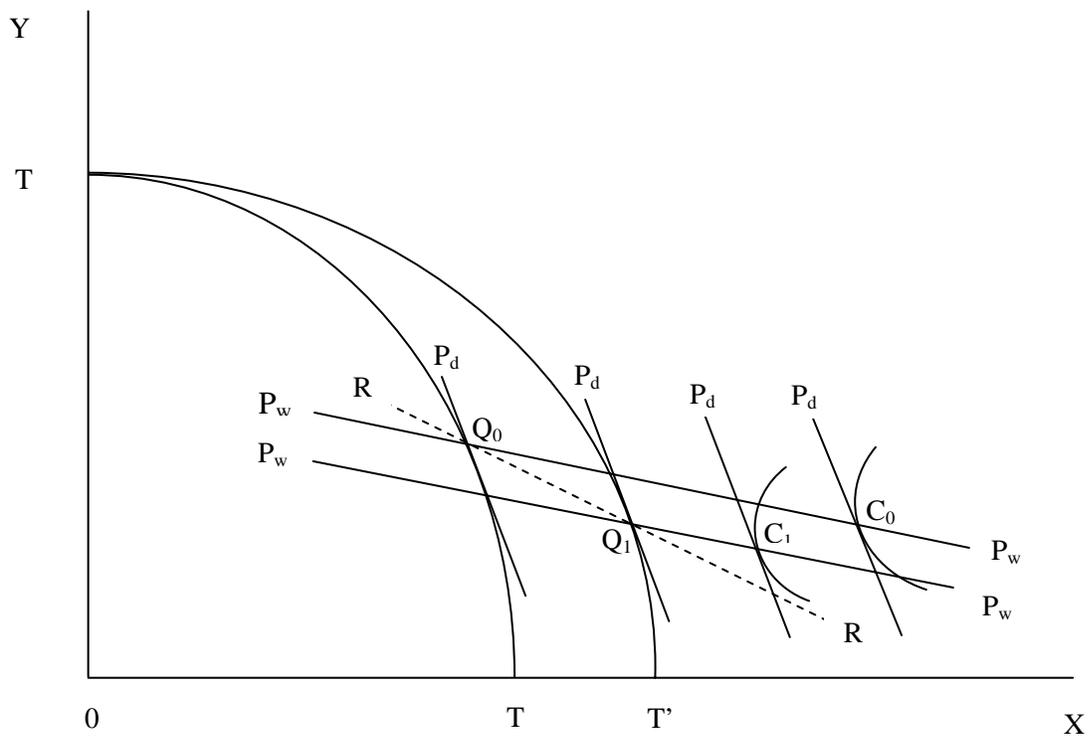


Figure 1

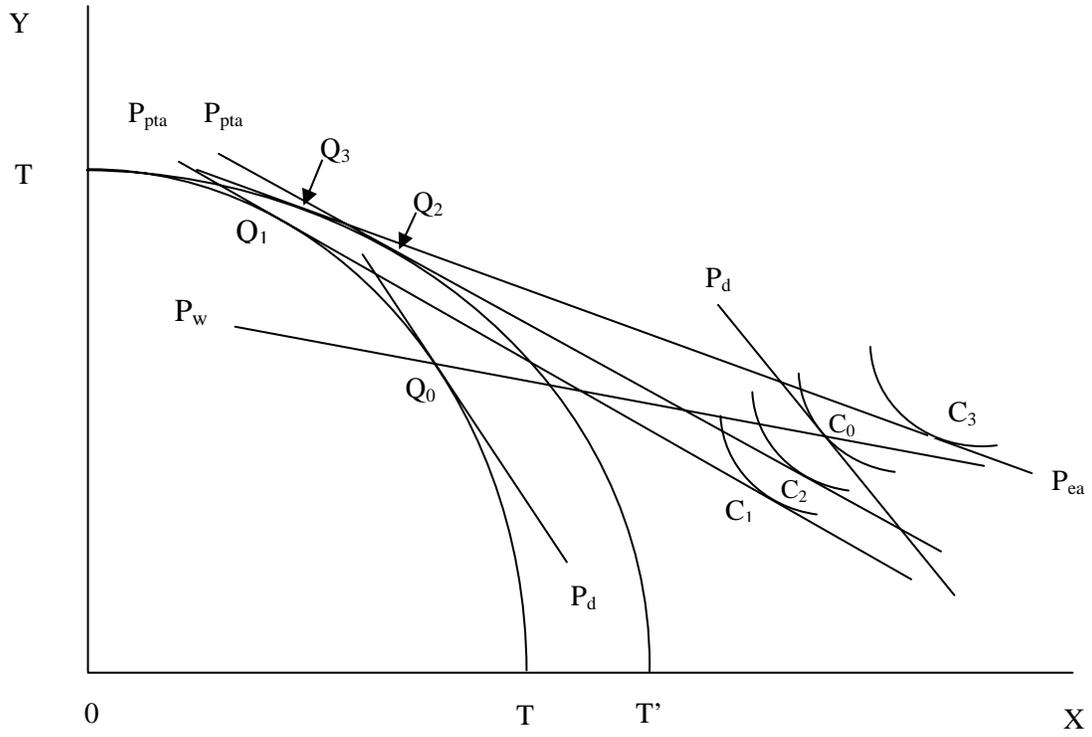


Figure 2

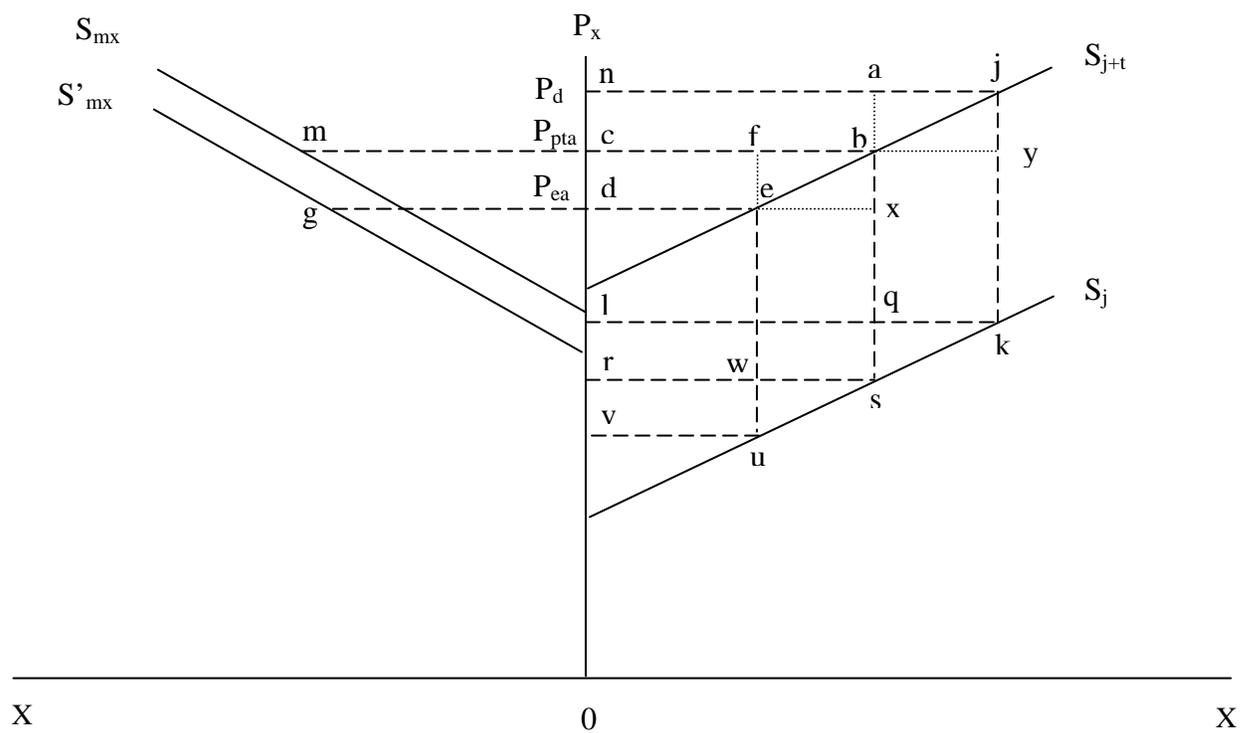


Figure 3

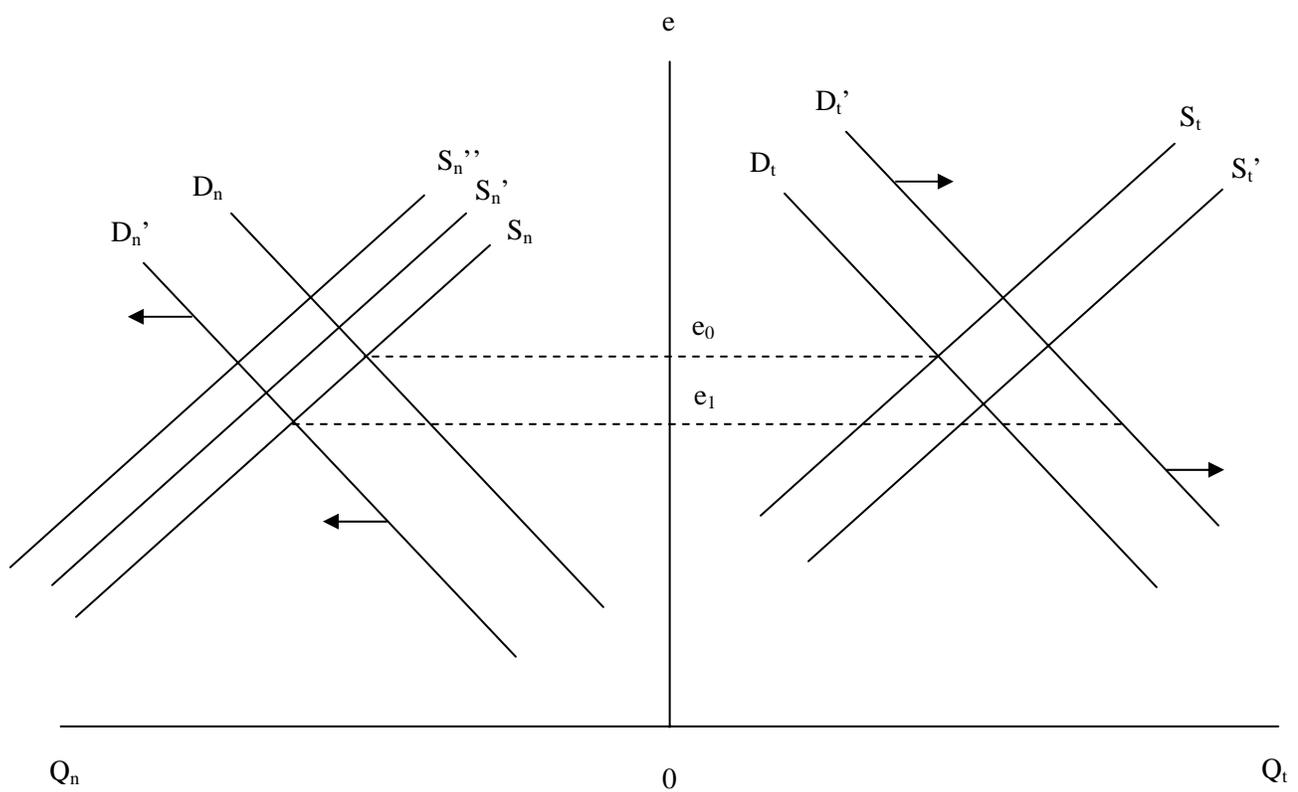


Figure 4

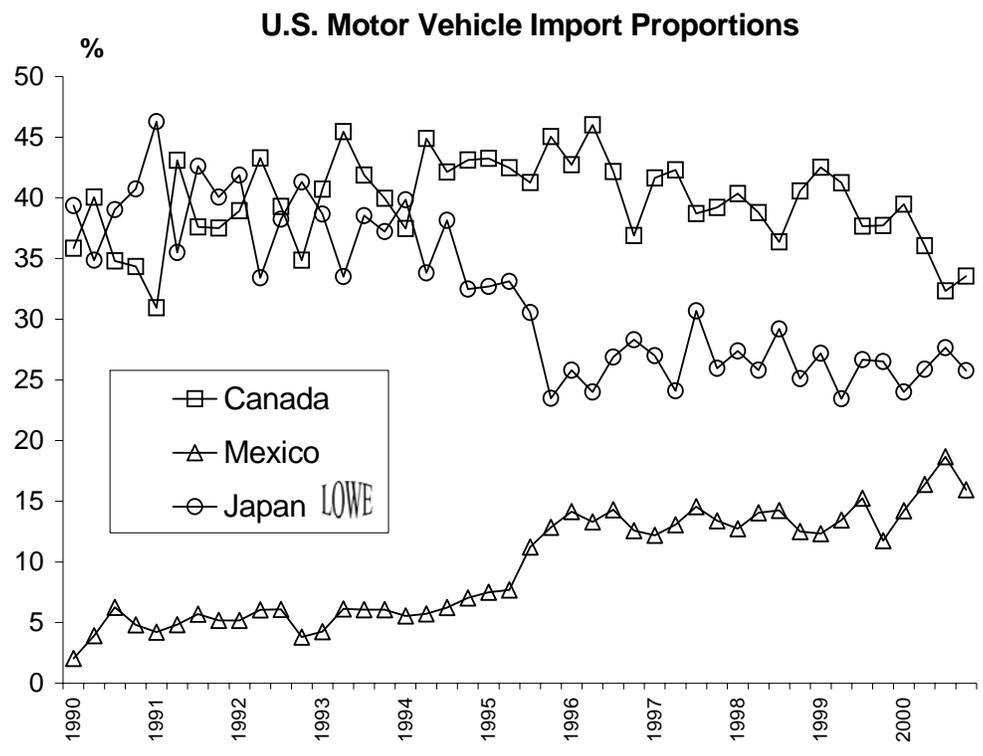


Chart 1