Environment and Development Economics 12: 379–401 © 2007 Cambridge University Press
doi:10.1017/S1355770X07003579 Printed in the United Kingdom

Economic integration, environmental harmonization and firm relocation

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ABSTRACT. As different regions of the world integrate, many questions arise regarding the effect on the location of firms. A firm's decision to relocate operations when its home country integrates with another region is in general influenced by the relative marginal cost of production between the regions, the cost of relocation, the cost of exporting its good across borders, as well as the relative size of the two regions. Except for market size, these variables crucially depend upon the degree of economic integration, ranging from simple bilateral trade agreements, to agreements that make foreign direct investment easier and cheaper, to full economic integration that harmonizes policies across the regions. We develop a model in which we explore the possible forms of integration in the context of two illustrative applications: US–Mexico under NAFTA and Central and Eastern European countries and the European Union.

1. Introduction

The aim of the following paper is to explore how economic integration, combined with environmental policy 'harmonization', may affect the plant location decisions of competing firms. This topic is of growing importance in the policy debates surrounding economic integration. One side of the debate argues that, if two countries agree to greater economic cooperation but do not adopt the same environmental policy framework and regulations, then 'dirtier' industries will relocate their plants to the country with the less stringent environmental policies. In contrast, others maintain that the case for harmonizing environmental standards and regulations to avoid the creation of 'pollution havens' is overstated, and that environmental harmonization could actually undermine some of the welfare gains from economic integration.

In the analysis and discussion presented in this paper, we hope to resolve some of the issues arising from this policy debate on integration,

We are grateful to, in particular, Charles Mason, Sherrill Shaffer, Jason Shogren, Owen Phillips and two anonymous referees for their valuable comments. We thank Lee Bailiff, Ben Rashford and Margie Reis for their assistance.

https://doi.org/10.1017/S1355770X07003579 Published online by Cambridge University Press

environmental harmonization, and firm relocation. To do this, we employ the standard modeling framework for analyzing economic integration, consisting of a world with two countries (or regions), with one firm in each country (region). Within this model, we analyze three possible scenarios, or levels, of economic integration, which we characterize as bilateral trade agreements, partial economic integration, and full integration. Only under the full integration scenario do the two countries also agree to 'harmonize' completely their environmental standards at the same level. Through numerical simulation, we apply the model to two policy contexts: (i) greater economic integration between the United States and Mexico under the North American Free Trade Agreement (NAFTA), and (ii) enlargement of the European Union to include Central and Eastern European countries (CEEC).

Thus, we explore whether a firm in America should relocate in response to NAFTA given our three distinct degrees of integration. In the case of a bilateral trade agreement, we predict that US firms will indeed relocate to Mexico as export (tariff) costs decline and the countries grow. This outcome is magnified if partial economic integration were to take place; lower export costs combined with foreign investment encouragement further induce US firms to leave America. However, if environmental harmonization is achieved as under full economic integration we do not expect to see such firm movement, although American subsidiaries may be established in Mexico. Thus the eventual effect on the location of US firms hinges crucially on the extent of environmental policy harmonization.

Results that are quantitatively similar to the NAFTA case of US firms moving to Mexico apply to the case of whether a firm within the European Union should relocate to the CEEC region. However, this is not true in the case of a CEEC firm relocating to existing European Union (EU) countries, which some models of European Union enlargement suggest is a likely scenario (Zhu and van Ireland, 2001). Applying our set-up to the location choices made by a firm in CEEC in the face of EU enlargement shows that it is unlikely to relocate within the present EU borders, unless the environmental policies in the CEEC region are brought into line with EU standards. Interestingly, if the goal is to raise production in the CEEC region, then simultaneously lowering tariff barriers and maintaining the relative environmental cost disparity may achieve this. However, if the goal is to improve the European environment, then the opposite policy choices are required, maintaining tariff barriers and harmonizing environmental policies. Achieving both goals concurrently may be difficult.

The outline of the paper is as follows. In the next section, we discuss further the prevailing views in the debate on economic integration, environmental policy harmonization, and firm relocation. In section 3, we develop our analytical model and derive the conditions for the optimal location choices of a representative firm under different economic integration scenarios. Sections 4 and 5 introduce our NAFTA and European Union applications respectively, and through these examples demonstrate how bilateral trade agreements and partial economic integration, as opposed to full economic integration with environmental harmonization, are likely to affect firm behavior. Section 6 summarizes the main analytical results and reviews the main policy implications.

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2. The current policy debate on economic integration and environmental harmonization

In recent years, increased regional economic integration between trading partners has resulted in calls for 'harmonization' of environmental policy; that is, a country that has adopted stricter environmental standards and regulation may accept greater economic integration with another country only if the latter agrees to adopt more stringent environmental policies. The reasons for this concern are twofold. Environmentalists worry that the increased trade liberalization accompanying economic integration will open a domestic market to commodities that are produced with environmentally damaging processes.[1] This is a concern often raised regarding the possibility of greater economic integration between the EU and the CEEC. In addition, business and labor interests maintain that domestic firms will relocate their plants either to 'pollution havens' abroad, or close down altogether in response to foreign competition that faces less onerous environmental regulations and hence lower production costs. This opinion is often expressed in relation to US–Mexico integration under the NAFTA. Proponents of the above views point to evidence from empirical studies that show that 'pollution-intensive' industries are more prevalent in developing countries, and that the exports of these industries have been declining in industrialized countries while rising in developing countries (Low and Yeats, 1992; Lucas *et al.*, 1992). They may also refer to evidence from the United States that provide evidence of a relocation effect of environmental regulations (Nordström and Vaughn, 1999). Thus, increasingly, economic integration and environmental harmonization are viewed as necessary complements, especially to stop the threat of plant relocation or unfair foreign competition.

However, others maintain that the case for harmonizing environmental standards and regulations as a precondition for greater economic integration is overstated. Review of empirical evidence suggests that there is not strong evidence that environmental regulations *per se* lead to reduced international competitiveness and firm relocation abroad (Beghin *et al.*, 1994; Orme, 1996; Levinson, 1996). The main reason is that in most advanced economies the costs of complying with environmental standards by industry are relatively small compared with total production costs. For example, in the United States the weighted average ratio of environmental costs to output in 1988 was 0.54 per cent across all industries, with the highest ratio being 3 per cent in the cement industry (Low, 1992). As one commentator on NAFTA has argued, 'if low environmental standards were a significant plant-siting incentive, there should be many identifiable cases of American companies moving to Mexico for that reason in the 1980s, when regulations were easier and enforcement was even spottier. But there aren't' (Orme, 1996: 162–163).

In fact, there is some empirical evidence that stringent adherence to environmental policy harmonization could undermine some of the welfare

[1] Corollaries to this are the concerns for a 'race to the bottom' and 'regulatory chill,' where the domestic government either lowers or fails to raise environmental standards in response to either foreign competition or fears of domestic firm relocation to foreign countries (see Wilson, 1996).

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gains from greater economic integration. A general equilibrium analysis of the enlargement of the European Union to include some Central Eastern European countries suggests that, if both regions try to integrate economically while simultaneously achieving the same level of emissions reductions, the overall utility of the expanded EU will be lower than if only economic integration occurs (Zhu and van Ierland, 2001). Imposing the same environmental restrictions on the EU and the CEECs limits the production possibilities in both regions, and less specialization takes place, thus reducing substantially the gains from trade liberalization. The result is the classic tradeoff between environmental quality and economic welfare.

The above contrasting views on the relationship between economic integration, environmental harmonization, and firm relocation suggest that any economic analysis of this possible link must be mindful of three key factors.

First, it is important to distinguish the costs of complying with environmental regulations from other economic determinants of plant relocation; that is, a firm's decision to relocate some or all of its operations when its home country integrates with one or more countries is in general influenced by the relative marginal cost of production between the countries, the cost of plant relocation, the cost of exporting goods across borders, and the relative size of the markets in the respective countries. Although environmental costs have some effect on relative marginal production costs, they are clearly only one of several economic factors affecting the relocation decision.

Second, when analyzing the influence of greater regional economic integration on a firm's decision to relocate, it is important to distinguish between *bilateral trade agreements* (i.e. agreements on bilateral tariff reductions, or 'trade liberalization'), *partial economic integration*, which includes a reduction in the cost of plant relocation, and *full economic integration*, which also involves the harmonization of environmental regulation.[2] In most real-world examples of regional cooperation and agreements, increased bilateral trade liberalization is likely to be the initial step of economic integration, later to be followed by reduced costs of firm relocation from one market to the other, and possibly eventual environmental policy harmonization. For example, NAFTA includes both investment clauses that lower plant relocation costs (chapter 11 on national treatment) and a side agreement regarding environmental cooperation (North American Agreement on Environmental Cooperation (NAAEC)). In fact, although both NAFTA and EU enlargement state that environmental harmonization is a long-term goal under an 'ideal' full economic integration strategy, it is not apparent that this will be achieved immediately under either case. For further details see our discussion in sections 4 and 5.

[2] Traditionally, theories of economic integration define five types of integration: (1) free trade area, (2) customs union, (3) common market, (4) economic union, and (5) total economic integration. Since our three categories do not perfectly match these categories we choose to denote them as in the text. However, superficially the three correspond to categories (1), (3), and (4) in order of increasingly deeper levels of integration.

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Finally, it is rare that greater economic cooperation will bring together two homogeneous economies. For example, the two regional agreements of interest to this paper, NAFTA and EU enlargement, clearly involve greater integration between economies of unequal size. In such a case, it is important to recognize that important differences between the integrating economies, such as market size, may also influence a firm's decision to relocate its operations.

3. Theoretical model and general results

The modeling approach of this paper is related to two types of recent analyses of the effects of environmental regulation on the location decisions of firms, although there are important differences in the model we develop here. One branch of theoretical research on plant location considers a game in which, in the initial stage, possible firm entrants view government action, and then, in the later stage, decide where to locate their operations depending upon, for example, environmental policies (Markusen *et al.*, 1993; Ulph, 1994). A second branch considers that at least one firm is located initially in its home country, before environmental regulation changes (Motta and Thisse 1994). In this situation, plant relocation is less likely, since establishing a foreign subsidiary involves fixed costs that are already incurred (i.e., a sunk cost) for the domestic firm.

The model developed in this section to analyze the relationship between economic integration, environmental harmonization, and firm relocation is more closely related to the second branch of plant relocation research. In particular, our model considers two countries or regions that can be of unequal size, each containing one representative firm initially, which in turn makes location, production, and export decisions in an effort to maximize its joint profits from selling both at home and abroad. The variables that affect these choices are the marginal costs of production that are influenced by environmental policies, export costs (including any tariffs), the cost of relocation, and the market size of each country.

In order to study economic integration, we view export costs as being endogenous and environmental policy as being exogenous. This reverses the approach by Motta and Thisse (1994) that viewed environmental policy as being endogenous and export policies exogenous, which is the natural approach in their study of eco-dumping. In fact, the focus of Motta and Thisse on eco-dumping is a special case of our model; e.g., see the US–Mexico application under the partial economic integration scenario (figure 3). Further differences between our model and that of Motta and Thisse (1994) stem from the choice of inverse demand function and our application of the model to the illustrative examples of US–Mexico and CEEC–EU.

Our model proceeds as follows: Imagine a world with two countries and two firms, where initially firm 1 is located in country A (e.g. an American firm located in the US, or a CEEC firm located in the CEEC) and firm 2 is located in country B (e.g. a Mexican firm located in Mexico, or an EU firm located in the European Union). As we assume a standard Cournot imperfect competition game, each firm responds to government policies

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and to the decisions made by its foreign competitor. To focus our analysis on the influence of environmental cost differentials, we make the simplifying assumption that all other marginal costs are constant and identical across the two countries. This assumption does not affect the qualitative conclusions derived in the paper. For tractability and to reflect the commonly expressed concerns, we assume that only firm 1 has the choice to relocate (e.g. the US firm decides whether or not to move to Mexico, and the CEEC firm contemplates relocation to pre-enlargement EU countries).[3] Thus firm 2 will always remain in its initial location (e.g. Mexico or the EU), possibly because for this firm the cost of relocation is always too high.

The two competing firms produce a homogeneous good. All fixed costs associated with home country production are sunk and do not affect the cost of production for the domestic plants.[4] Each country j ($j = A, B$) has an inverse demand function given by $p_j = a(S_j) - b(S_j)\,Q_j$, where Q_j is total output sold in country j, p_j is the market clearing price, and S_j is a scale parameter corresponding to the market size of country j, which may influence the inverse demand function through both the intercept and the slope. We assume that the number of consumers in each market determines the market size so that relative population sizes of the two countries or regions give the relative size of the two markets. However, we ensure that market size is not so large as to eliminate all strategic behavior of the two firms. Marginal production costs, c_j, are assumed constant and identical across countries, except for possible environmental cost differentials, which are defined as $e_A - e_B = e$. For example, if country A (the US) has a more stringent environmental policy, then its marginal cost is higher than marginal cost in B (Mexico), so that $e > 0$, otherwise $e < 0$. We therefore assume that marginal costs only differ due to the relative stringency of environmental regulations. When a firm exports to the foreign country it incurs a cost per unit of output due to a combination of transportation costs and tariff barriers equal to t, where $t \geq 0$.[5]

In our applications we explore four possible location configurations for a firm: Case (A, 0) where firm 1 continues to supply both markets, A and B, from its domestic plant; Case (A, B) where firm 1 decides to establish a subsidiary in country B to supply each market locally; Case (0, B) in which firm 1 shuts down its original domestic plant and relocates to country B, thus serving both markets from this new plant; and Case (0, 0) when firm 1 stops producing altogether. If firm 1 decides to establish a plant in country B, it incurs a fixed set-up cost (F) that is independent of output and markets served. Fixed costs of production abroad include both start-up costs (build a plant, establish a distribution network) and fixed-rate charges (additional

[3] This simplifying assumption may in particular affect our empirical analysis of the European Union and Central and Eastern European Countries application.

[4] Thus all costs associated with establishing a plant in the home country are already incurred and do not affect a firm's decision in any way.

[5] Throughout the paper we refer to the cost of exporting a good from one country to another as a tariff cost. However, whereas a tariff may become zero, the cost of exporting a good is always positive.

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lump-sum taxes or infrastructure costs). As some fixed costs are continuous, they can never be discounted to zero.

For example, in the US–Mexico case, $(A, 0)$ denotes an American firm producing domestically for both the US and Mexican markets, while, say, $(0, B)$ denotes the case where the American firm moves to Mexico and supplies both markets from there. Similarly, in the EU–CEEC application, $(A, 0)$ denotes the case of a CEEC firm producing within its home region and supplying both the EU and the domestic market from this plant. In the case of (A, B), the CEEC firm establishes two plants, one in each region and supplies each region locally.

The model is solved as a standard Cournot competition game and the profit function for a firm (i) is defined as total revenue minus total cost in each of the two markets[6]

$$\Pi_i = \sum\nolimits_{k,j=A}^{B} [(p_j - c_k - e_k - t_{ij}) \cdot q_{ij}] - F_k. \tag{1}$$

Total output sold in country j, Q_j, is replaced by q_{1j} and q_{2j}, which denotes quantity of goods sold by firm i $(i = 1, 2)$ in country j $(j = A, B)$. In equation (1) subscript k represents the market where the commodity is produced, while subscript j represents the market where the commodity is sold. The fixed cost, F_k, represents the cost of moving production from a firm's home market (e.g. region A for firm 1) to another region; F_k is thus equal to zero if k corresponds to firm i's home region. Also, the composite of transport costs and tariffs, t_{ij}, will be zero if the production and sales markets correspond. Maximizing each firm's profit function with respect to the relevant quantity yields the firms' reaction functions that are solved simultaneously to find the optimal quantities and optimal profit levels for the three location configurations; that is, the US and Mexican firms (alternatively, CEEC and EU firms) attempt to maximize their profits in the two markets given trade, environmental, and investment policies, as well as the action of their competitor. To focus the analysis we assume that $c_A = c_B = 0$ so that the only difference is the environmental cost, e. We further assume that $e = e_A - e_B$, where $e_B = 0$. For each location choice, a strategy for firm i $(i = 1, 2)$ is a pair of quantities (q_{iA}, q_{iB}) of the homogeneous good sold in countries A and B respectively. In order to solve the model for optimal location choices for firm 1 we need to adopt a specific functional form of the inverse demand function. We choose to assume that $a(S_i) = S_i$ and $b(S_i) = (1/S_i)$, which means that the inverse demand function both shifts out as the market size increases and becomes more elastic.[7] The inverse demand

[6] See, for example, chapter 5 in Tirole (1993).

[7] This choice of functional form further distinguishes our model from the one used in Motta and Thisse (1994), as the latter only view market size as influencing the slope parameter. In fact, having the market size in the intercept is more important than the choice of how total quantity enters inverse demand (Q, Q^2, or $Q^{1/2}$). Also, since the elasticity of the demand function is given by $\eta = 1 - a(S)/(b(S)Q)$, from which we see that whether market size enters the intercept $(a(S) = S)$ or the slope $(b(s) = 1/S)$, the elasticity will be the same $(\eta = 1 - S/Q)$, but if they enter both, market size affects the elasticity more $\eta = 1 - S^2/Q$.

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function becomes $p_j = S_j - (\frac{Q_j}{S_j})$, where $Q_j = q_{1j} + q_{2j}$, $j = A, B$. Thus in order to determine where firm 1 should locate we compare the four optimal profit conditions (see appendix for derivation)

$$\Pi_1^*(A, 0) = \left[\frac{S_A}{9}\right][S_A - 2e + t]^2 + \left[\frac{S_B}{9}\right][S_B - 2e - 2t]^2 \tag{2}$$

$$\Pi_1^*(A, B) = \left[\frac{S_A}{9}\right][S_A - 2e + t]^2 + \left[\frac{S_B}{9}\right][S_B]^2 - F \tag{3}$$

$$\Pi_1^*(0, B) = \left[\frac{S_A}{9}\right][S_A - t]^2 + \left[\frac{S_B}{9}\right][S_B]^2 - F \tag{4}$$

$$\Pi_1^*(0, 0) = 0. \tag{5}$$

Consider how these four equations relate, in general, to our US–Mexico application. According to (2) an American firm will only export to Mexico if $t \leq \frac{S_B}{2} - e$ (from the second right-hand side term in (2)); that is, given Mexico's market size and the fact that environmental costs are higher in the US ($e > 0$), the exporting costs facing the US firm must be sufficiently low. Similarly, according to (2) again, the US firm will only sell domestically if $t \geq 2e - S_A$; that is, if US tariffs are sufficiently low relative to its environmental cost disadvantage, the US firm will be out-competed by its Mexican counterpart (holding US market size constant). This implies that if tariffs are reduced and/or the Mexican market increases, the American firm will export a greater amount. However, this tariff reduction will simultaneously lead to less domestic sales.

From equations (2) and (3) we see that the US firm will decide to open a subsidiary in Mexico if $\frac{S_B^3}{9} - F > \left[\frac{S_B}{9}\right][S_B - 2e - 2t]^2$; that is, if Mexico's market size is sufficiently large compared with both the cost of relocating to Mexico and the relative per unit cost disadvantages due to tariffs and environmental regulations in the US. If the American firm is already operating a subsidiary in Mexico, then equations (3) and (4) show the condition for when it may decide to move all its production to Mexico and then export back to the US: $[S_A - t]^2 > [S_A - 2e + t]^2$; that is, complete relocation might occur if tariffs were very low, while environmental costs in America relative to Mexico make US production more expensive.

From this initial analysis we note that lower tariff rates make concentrated production more profitable, a higher cost of relocation makes moving production abroad less likely and economic integration without environmental harmonization makes firm exodus more likely. Note that a large domestic market does not necessarily imply that a US firm ought to remain in the US. Instead, the firm should produce where its marginal cost is the lowest, which is often dictated by a tradeoff between higher tariff rates and environmental costs, taking into account the cost of relocation. As different degrees of integration change the parameters that determine the location choices of American (and CEEC) firms, our discussion may shed light on the policy debates associated with regional trade agreements.

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For example, are labor unions and environmentalists in America correct in their prediction of large US firm migration? How is the answer to this question related to the NAAEC side agreement? What are the likely effects on European production patterns as EU enlarges to the east? Will long grace periods regarding environmental harmonization given to the CEECs affect the predicted outcome?

Although the general discussion above provides insights into the factors that affect the magnitude of domestic exports and some necessary conditions for firm relocation, they are only indicative of the entire story. In the next section we explore the model in its entirety by quantifying the model parameters and employing various scenarios for our two examples, US–Mexico economic integration under NAFTA and enlargement of the European Union to include Central and Eastern European countries.

4. US–Mexico economic integration under NAFTA

Increased US–Mexico economic integration through NAFTA represents an intriguing application of our model for several reasons. First, closer economic cooperation between the United States and Mexico is unique in that it is the first extensive bilateral trade agreement between a large, advanced market economy and a rapidly industrializing but still relatively less developed and smaller market economy. Thus our model, in which the relative market size of countries plays a prominent role in determining firm relocation, is highly relevant. Second, through environmental side agreements, such as the NAAEC, it is clear that improvement of environmental regulations in Mexico as well as in the whole NAFTA trading region will be an important long-term objective of continued economic integration. In fact, the NAAEC Secretariat has stated that 'upward regulatory convergence' in environmental policy 'toward a regional norm' is a likely by-product of continued regional economic cooperation and integration (Commission for Environmental Cooperation, 1999: 10–11). Third, NAFTA itself appears to guard explicitly against the use of differential environmental policy to encourage plant relocation, such as from the US to Mexico. As one commentator has noted, 'NAFTA ... formally recognizes that the three countries have a legitimate interest in the detail of environmental enforcement within each other's borders. In its most innovative provision, the signatories promise not to entice outside investment 'by relaxing health, safety or environmental measures'' (Orme, 1996: 154–155). Finally, it should also be recognized that neither NAFTA nor the NAAEC side agreement mandate that environmental policy harmonization should be explicitly pursued by the three signatories, and in fact there is considerable discretion for, in particular, Mexico to decide unilaterally how it should pursue its own national environmental policy. As Kotvis (1995: 173) has emphasized on this issue, 'one must keep in mind that NAFTA is a trade agreement first and only second an environmental policy agreement ... Mexico's need to attract investment could force it to neglect environmental protection. Its less than fully democratic political structure may allow it to do so.'

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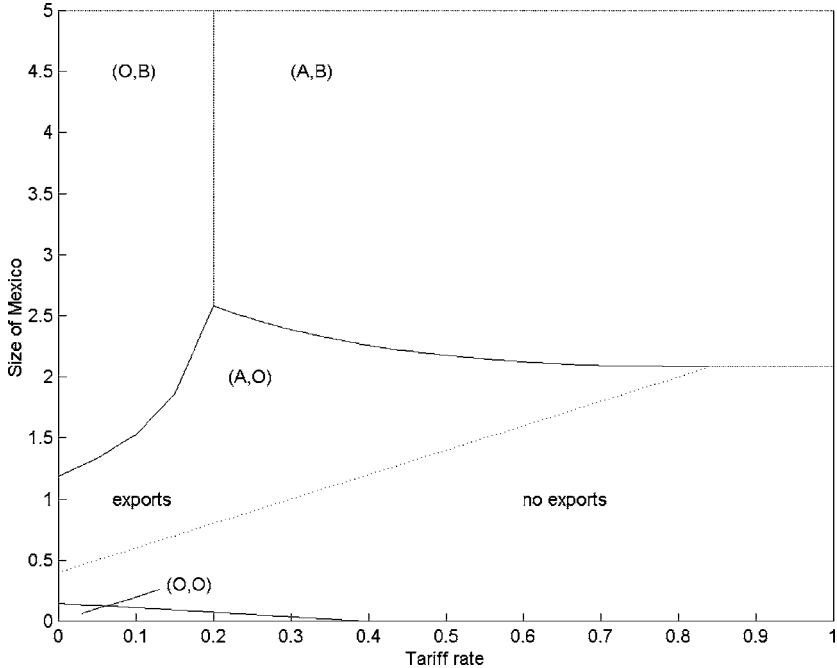


Figure 1. *Bilateral trade agreement between the US and Mexico*
Note: Optimal location choice for firm 1 initially located in country A: $S_A = 2.75S_B$, $e = 0.2$, $F = 1$.

This suggests that there are three plausible scenarios for US–Mexico economic integration under NAFTA that our model is well suited to explore. The first scenario, which we designate as our base scenario, assumes that NAFTA functions simply as a bilateral trade deal, where neither environmental costs nor cost of relocation are altered as a consequence of the agreement. The second scenario, named the 'ideal' NAFTA scenario, involves full economic integration, including both a lowering of the cost of investing in Mexico and harmonization of environmental regulations, as well as tariff reductions. We call this the 'ideal' scenario as it describes the present NAFTA and its accompanying NAAEC side agreement working the way proponents intended, which is to promote 'upward regulatory convergence' in environmental policy 'toward a regional norm'. The final scenario, which we term 'partial' economic integration, includes a reduction in both tariff levels and the cost of relocation. However, in this scenario environmental costs are not only not equalized but actually deteriorate, under the assumption that NAFTA and its environmental side agreements fail to deter Mexico from lowering its environmental standards, or failing to keep up with even stricter standards imposed in the US, in order to attract foreign investment.

We present the results of our model simulations for these three NAFTA scenarios in figures 1–3. Following the discussion of conditions (2) to (5)

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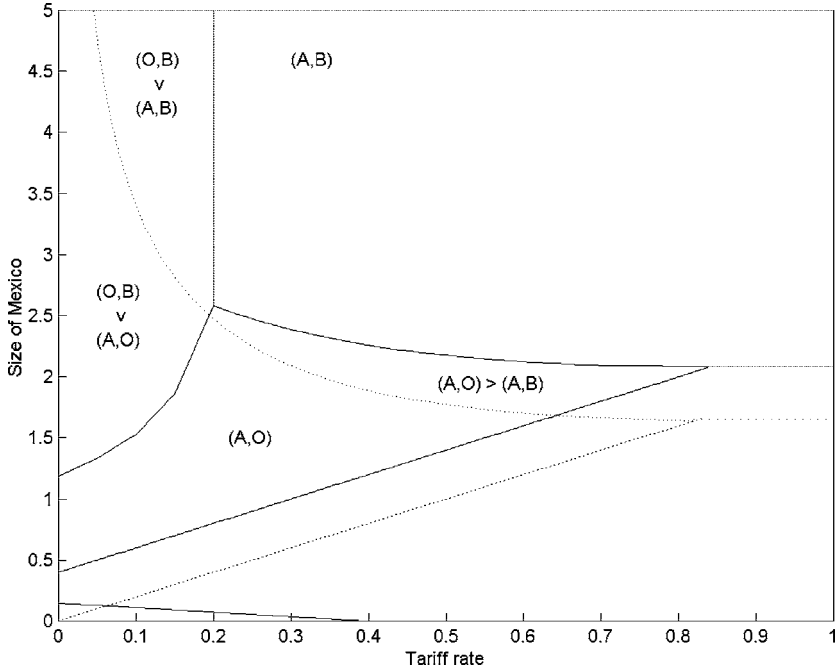


Figure 2. *Full economic integration between the US and Mexico*
Note: Optimal location choice for firm 1 initially located in country A: $S_A = 2.75S_B$, $e = 0.2$, $F = 1$. Environmental costs (e) decrease to 0 and fixed costs (F) decrease to 0.5.

derived from our model, we represent each of the simulations of the optimal location choice of a firm in terms of the influence of variations in the tariff rate, t, which also includes any transport costs, and in the market size of both countries. In all scenarios, we treat the relative market size of the countries as fixed, $S_A = 2.75S_B$, and so changes in the domestic market of Mexico readily translate into changes in the market size of the US as well. This assumption that the US market is assumed to be 2.75 times larger than the market in Mexico is based on the relative population sizes of the two countries. Note as well that as t incorporates transportation costs between the two countries, in the following simulations 'trade liberalization' (i.e. the elimination of tariffs) corresponds to a reduction in t but not necessarily to a zero value.

Figure 1 illustrates the base simulation, which assumes that NAFTA operates solely as a bilateral trade deal between the US and Mexico. In our base scenario, the model is parameterized so that $e = 0.2$ and $F = 1$; that is, environmental costs are higher in the US and there is a relatively high cost associated with relocation to Mexico.[8] In this case the possibility

[8] We conducted a sensitivity analysis on these baseline values chosen for the e and F parameters. The results of the sensitivity analysis for the Mexico–US case

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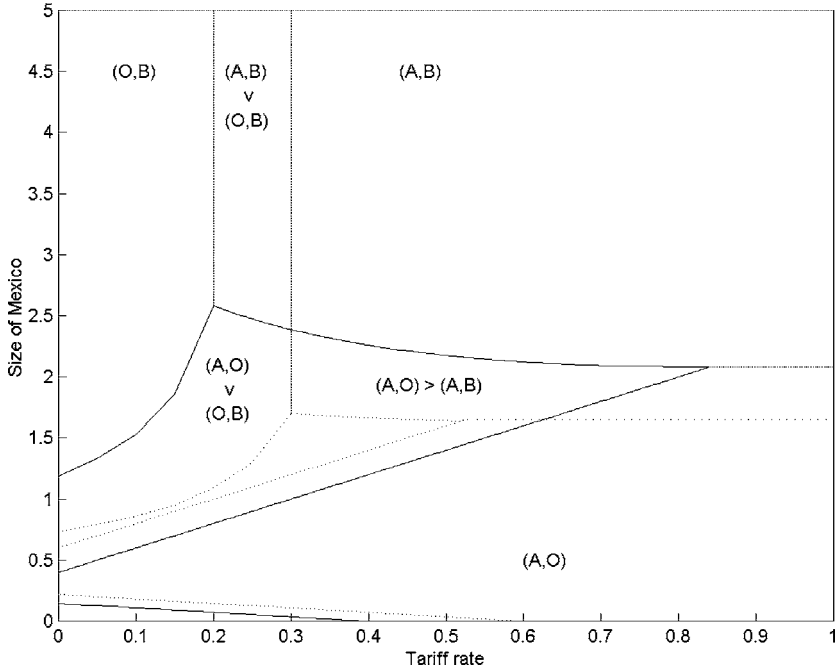


Figure 3. *Partial economic integration between the US and Mexico*
Note: Optimal location choice for firm 1 initially located in country A: $S_A = 2.75S_B$, $e = 0.2$, $F = 1$. Environmental costs (e) increase to 0.3 and fixed costs (F) decrease to 0.5.

exists that the US firm stops producing completely, region (0, 0), if market sizes are very small and tariff rates are very low. The explanation for this result is that small market sizes reduce the profits of the American firm in both markets, and the environmental cost makes it unprofitable in Mexico, while the low tariff rate makes the Mexican firm more competitive in the US, given its initially lower cost of production. Although region (0, 0) is a possibility, it is not a likely outcome. As market sizes increase, the US firm first produces for its domestic market and then begins to export to Mexico (see equation (2)). The volume of production and exports increases with the market sizes of the two countries. Naturally, higher tariff rates lower the

study show that as environmental costs become more similar, location choice (0, B) becomes less likely, while location choice (A, 0) becomes more likely. Part of the loss in (0, B) goes to (A, B) while part of the gain in (A, 0) comes from (A, B). The overall effect on (A, B) is ambiguous. The intuition is that without environmental cost differences, a firm in the US would not relocate to Mexico and export back (0, B). It will be easier, however, for a firm in the US to compete against Mexican firms (A, 0). The reverse is true for the case of environmental costs becoming less similar. The sensitivity analysis further shows that as the cost of relocating a plant (F) from the US to Mexico decreases (increases), it becomes more (less) likely that location choices (0,B) and (A,B) will be pursued by an American firm.

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volume of exports from the US to Mexico. However, the effect of growing economies eventually leads the US firm to relocating its operation as regions (A, B) and $(0, B)$ become viable. For high rates of tariffs, the US firm is likely to remain at home and establish a subsidiary in Mexico. The reason is that the high demand for its product makes exporting (per unit tariff) less profitable than absorbing the cost of relocation and supplying each market locally. If tariff rates are low, however, then a firm in the US is better off moving its entire operation to Mexico in order to take advantage of the lower variable cost of production due to lax environmental standards, and then shipping the good back to the US. An important result of this base scenario is that it shows that, if NAFTA were simply a bilateral trade agreement between the United States and Mexico involving only tariff reductions, then over time as tariffs are reduced and the two countries grow we should expect that US firms do in fact relocate to Mexico.

If the above bilateral trade agreement was accompanied by both environmental harmonization and reduced costs of relocation we would have our 'ideal' NAFTA scenario. The effect in our simulation can be seen in figure 2. Several nontrivial results can be observed, the most important being that the region $(0, B)$ is now eliminated; that is, with environmental harmonization, an American firm will never decide to relocate completely to Mexico. It is still a possibility that it establishes a subsidiary in Mexico in order to avoid the tariff rate of selling in that market, but it is never optimal to produce only in Mexico. The reason is that, with the removal of any differences in environmental costs, any positive tariff rate (including transport costs) makes it unprofitable to move all production to Mexico in order to export the good back to the US. Also, at low tariff rates it is better to remain in the home country and export to Mexico compared with producing for both markets locally. Finally, the volume of exports, if the US firm decides to remain in the United States, increases as environmental harmonization occurs. This scenario then paints a vastly different picture regarding the likely outcome of NAFTA on firm relocation. In fact, as tariffs are reduced it is possible that US firms will never find it optimal to relocate to Mexico. If tariff (or transport) costs do remain sufficiently high, then the most we should expect is that US firms spread their operations across both countries. Since this 'ideal' scenario encompasses the stated goals of NAFTA, and is the objective that the environmental side agreements such as the NAAEC hope to help foster over the long term, it is quite possible that US producers will benefit from the agreement, as well as both the US and Mexico having a cleaner environment.[9]

However, what if NAFTA opponents are correct in assuming that Mexico will not improve their environmental regulations and standards to the 'regional norm', or fail to enforce their existing laws, or perhaps even lower them in order to attract foreign direct investment? As seen in figure 3, if the

[9] The cost to all this, which is absent in our simple Cournot model, is that consumers might have to pay higher prices for the goods purchased. Thus the increase in producer surplus and social benefits will be offset by a loss in consumer surplus. Also, as production for exports is shifted to Mexico, less production will be done in the United States, thus some transitional unemployment should result.

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environmental cost differential widens, possibly because Mexico attempts to attract foreign direct investment and the United States continues on its path toward ever more stringent environmental policies, it now becomes very likely that a US firm will relocate to Mexico. As the economies grow, the volume of American exports increases initially and then falls dramatically when the firm relocates. If tariff rates are reduced sufficiently, it will be a complete relocation. Otherwise, US firms will simply establish subsidiaries in Mexico to accommodate their local demand. In this case US producers are hurt, together with the environment. In terms of the environment, the effect is magnified by the fact that not only will Mexican producers use 'dirty' technologies, US producers will have an incentive to do the same. In this case we could expect a backlash from US industries and labor groups, and NAFTA is likely to be amended and possibly even jeopardized.

This partial economic integration result is very important since it is in fact the outcome predicted by the chapters included in the North American Free Trade Agreement; that is, chapter one of NAFTA establishes a Free Trade Area between the US and Mexico (and Canada) consistent with article XXIV of the General Agreement on Tariffs and Trade (GATT). Article XXIV condones regional trade agreements incorporating complete elimination of tariffs on trade between member countries; that is, all tariffs on trade between the US and Mexico should be removed. In addition, chapter 11 deals with national treatment of investments within the trade area. In particular, article 1102 states that '(e)ach party shall accord to investors of another party treatment no less favorable than that it accords, in like circumstances, to its own investors …'. Thus, barring the workings of side agreements, NAFTA proper establishes what we have called partial economic integration. Given this, and our analysis, it is less surprising that many special-interest groups within the US expressed concern regarding the potential exodus of American firms to Mexico. These concerns were indeed the catalysts for the NAAEC side agreement, which according to our full economic integration analysis may have addressed their fears.

To conclude, the debate regarding the likely long-term effect of the location of US firms is shown to hinge critically on the harmonization of environmental costs in Mexico and the United States. As of today, side agreements such as NAAEC aim to promote a rise in Mexican standards to match those in the United States. If this is the eventual outcome, then NAFTA is likely to provide benefits to both US producers and the North American environment. Note, however, that the effects on consumers are likely to be more ambiguous, as the lower tariff rates will be offset by higher marginal costs of Mexican producers due to more stringent environmental regulations. Another possibility is that environmental harmonization is achieved through lowering of US standards, in the classic 'race to the bottom'. In this case producers will benefit, while the global environment is hurt. However, if the critics of NAFTA are right in assuming that Mexico will fail to raise its environmental standards as a deliberate strategy to attract foreign investment, then we are in fact likely to observe a shift of US production towards Mexico to a large degree.

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5. Central and Eastern European integration with the European Union

The application of our model to the case of the enlargement of the European Union to include Central and Eastern European Countries provides an interesting contrast to the NAFTA case study. First, according to the 1992 EU Maastricht Treaty, enlargement of the European Union to include new members requires that these countries accept the EU's Common Environmental Policy (EEA, 2001). However, past EU expansion to include new countries, notably Greece, Spain and Portugal, has led to considerable concessions to these countries in adopting EU environmental policies (Kuik and Oosterhuis, 2001). An equally long if not longer 'grace period' before full environmental harmonization will also occur for the new CEECs that have joined the European Union more recently. The Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia joined in 2004; Bulgaria and Romania expect to follow in 2007. Second, most of the CEECs have been undergoing significant restructuring of their industries as a result of their overall transition to full market economies that started in the 1990s. Today many CEECs are developing highly competitive and more advanced sectors of industry, especially in the light industry and services sectors, which may be comparable to those found in Western Europe. For example in Poland, the trend is toward more efficient light industries and a nascent service economy (Kuik and Oosterhuis, 2001). These rapid industrial developments and economic transitions in the CEECs raise the possibility that accession to the EU and its customs union policies of capital and labor mobility provide opportunities not only for increased foreign direct investment from Western Europe in the CEECs but also for relocation of some competitive industries from the CEECs in the larger EU markets.[10]

Once again we need to consider three scenarios. The first is that, starting in the 1990s, most CEECs began negotiating and agreeing various bilateral trade agreements with the European Union that include only reductions in tariff rates. We need to start with analyzing this baseline scenario, with no effect on environmental regulations or the cost of relocation. Secondly, we need to explore the scenario in which the CEECs and the EU achieve 'ideal' full economic integration, where the reduction of tariffs is accompanied by both environmental harmonization and lower costs of investing abroad. If the two regions are only able to achieve 'partial' integration, then environmental harmonization does not occur.

As a contrast to the NAFTA application, our discussion here will focus on whether or not a firm in Eastern Europe should relocate to within the larger European Union. The equally interesting case of whether a firm within the EU should relocate to within CEEC is similar to our previous NAFTA case. The main difference would be that $S_A = 1.25S_B$ with A and B representing the EU and CEECs, respectively, with the outcome of a slightly greater likelihood compared with our NAFTA discussion

[10] A recent general equilibrium analysis of trade and environment influences of the enlargement of the European Union to include some Central Eastern European countries also ran scenarios allowing for labor and capital mobility between the two regions (Zhu and van Ierland, 2001). The results showed considerable movement of labor, and to a lesser extent capital, from the CEECs to the EU.

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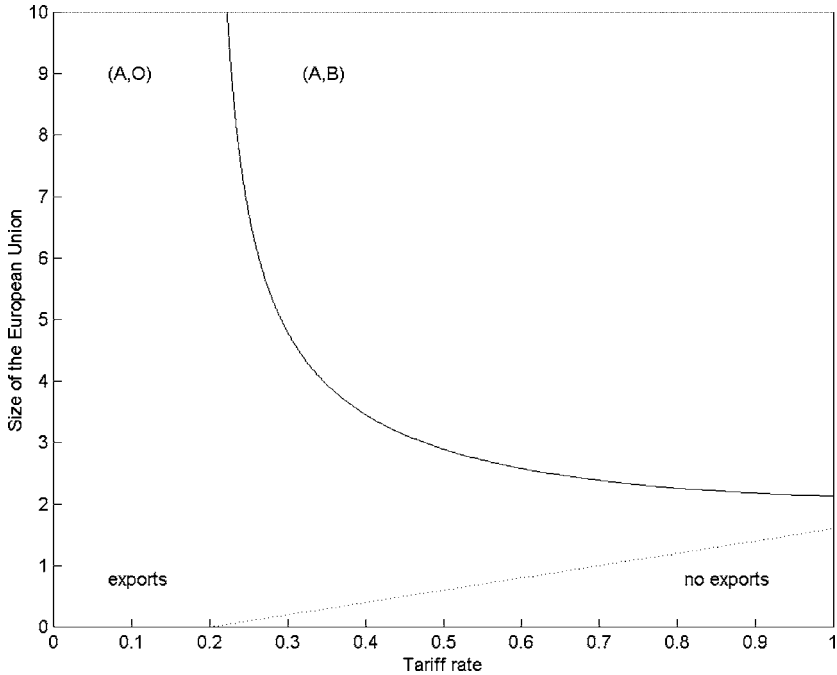


Figure 4. *Bilateral trade agreement between Central and Eastern European Countries and the European Union*
Note: Optimal location choice for firm 1 initially located in country A: $S_A = 0.80S_B$, $e = -0.2$, $F = 1$.

(figure 1) of a firm choosing location choice (A, 0) at the expense of (0, B) at low tariff levels. As essentially the same outcomes would result as from the NAFTA simulation, there is no need to discuss this case further here. Once again we view the relative size of the two regions as based on the population so that $S_A = 0.80S_B$, where now countries A and B represent Central and Eastern Europe and the European Union, respectively. In this scenario the environmental cost differential is a negative number in the model, since initially CEECs have a cost advantage based on their less stringent environmental laws. Thus in figure 4 we have as our base case $e = -0.2$ and $F = 1$; that is, environmental costs are lower in Eastern Europe and fixed costs of relocation are relatively high prior to any economic integration beyond simply a bilateral trade agreement.[11] As should be expected, firms

[11] We also conducted a sensitivity analysis for these baseline values chosen for the e and F parameters in the CEEC–EU case. The results of the sensitivity analysis show that a smaller environmental cost differential leads to a greater likelihood that a firm in CEEC will relocate to within the EU in order to take advantage of the larger market without being subject to tariff and transportation costs. The same is true when the cost of relocation declines. The reverse outcomes are obtained when environmental cost differences increase and relocation costs are augmented. Notably, changes in the assumed relative size between the EU and CEEC do not affect the boundary between location choices (A, 0) and (A, B) shown in figure 4 in any way.

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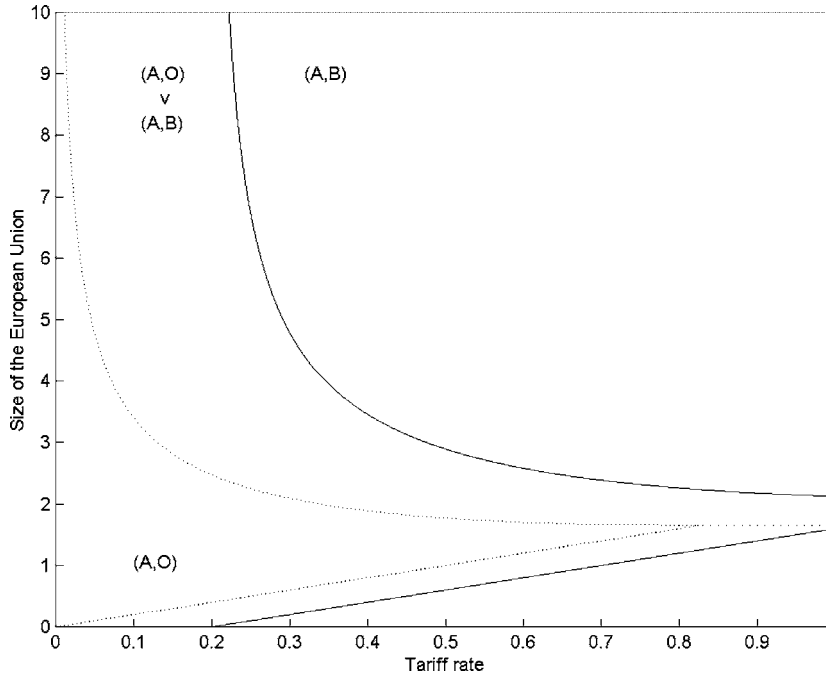


Figure 5. *Full economic integration between the Central and Eastern European Countries and the European Union*
Note: Optimal location choice for firm 1 initially located in CEEC: $S_A = 0.80S_B$, $e = -0.2$, $F = 1$. Environmental costs (e) increase to 0 and fixed costs (F) decrease to 0.5.

in the CEECs are likely to export large volumes to the European Union, if tariffs are sufficiently low. In fact, a CEEC firm will never move from its domestic location if tariff rates are reduced sufficiently under a bilateral trade agreement. The interesting policy implication under this scenario is that production in the CEEC increases, using 'dirty' techniques, which may lead to a deterioration of the environment. If tariffs remain relatively high even after such an agreement, then it is possible that the CEEC firm decides to produce in the larger European Union market as the EU becomes sufficiently large due to population (or economic) growth. The interesting question then is what happens to this base scenario as bilateral trade agreements turn to 'partial' or 'ideal' economic integration.

The latter scenario requires both that relocation costs are reduced and environmental harmonization is achieved, which in this case means that the CEECs raise their presently low environmental standards. This scenario is depicted in figure 5, which suggests that it is now much more likely that the CEEC firm relocates. In fact, here we see that for even very low tariff rates, it is very likely that such a firm will establish a subsidiary in the larger EU market. However, a CEEC firm will never completely relocate to within the European Union, as the cost of exporting goods back to Central and Eastern Europe (combined with the fixed costs) will always

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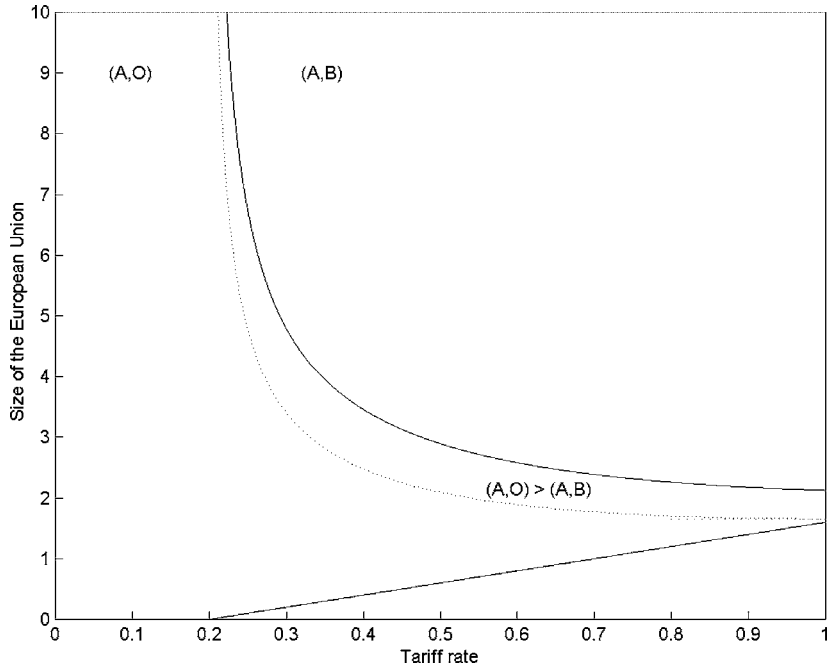


Figure 6. *Partial economic integration between Central and Eastern European Countries and the European Union*
Note: Optimal location choice for firm 1 initially located in country A: $S_A = 0.80S_B$, $e = -0.2$, $F = 1$. Fixed costs (F) decrease to 0.5.

make it profitable to supply that market locally. The overall effect of this scenario is ambiguous as CEEC producers move some production abroad, while the overall European environment benefits. CEEC firms appear to bear the additional environmental costs of moving production to a cleaner production site in order to be close to the larger EU market. On the other hand, the effect on consumers (not modeled) is uncertain due to the lower tariff being matched by higher marginal environmental costs. This case also presents interesting implications since it represents the stated goals under the Maastricht treaty, which predict a movement of production away from the CEEC, thereby improving the environment at the expense of CEEC production.

Figure 6 indicates the outcome if environmental harmonization does not take place, or if Central and Eastern Europe are given a long grace period to comply with EU environmental standards and regulations. As the cost of relocation is reduced, the CEEC firm is more likely to relocate to the European Union. This scenario then matches what we discussed above, where a reduction of production in Central and Eastern Europe is accompanied by an increase of production within the European Union. The result should be an overall improvement in environmental benefits. An interesting implication here is that, as the European Union expands

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eastward, if one is concerned about the environment, the first best approach is to raise standards in Central and Eastern Europe, but the second best alternative is to keep tariffs sufficiently high.

For the European integration application, we conclude that the environment is the likely winner if environmental harmonization is achieved. However, as perfect harmonization might never occur, or be delayed for some time, there is an interesting tradeoff between lower tariff rates and environmental degradation; that is, as tariff rates are lowered and CEECs retain some marginal cost advantage, firms in that region are unlikely to relocate. This then benefits Central and Eastern Europe industries at the expense of the overall European environment. Of course, if tariffs were raised sufficiently, then CEEC firms would reduce their 'dirty' production significantly, as they would be unable to export to the rest of Europe, with obvious negative impacts on CEEC industries.

6. Conclusions

The model we develop in this paper helps to clarify how the process of economic integration, including environmental policy harmonization, will affect firm relocation from one region to another. The application of this model to the Mexico–US and the CEEC–EU case studies under the three scenarios of bilateral trade agreement, partial integration, and full economic integration with environmental policy harmonization helps to clarify these various effects.

Nonetheless, the model and its application are subject to several limitations. First, only qualitative relationships are developed in the model; it is not possible to calibrate the scenarios here to conform to real-world data on critical parameters.[12] Thus, our results do not simulate and predict the actual movement of firms from one region to another and should therefore be viewed as producing likely direction of effects only. Second, our analysis is necessarily atemporal; in our model and case study scenarios, firms relocate instantaneously in response to the changes in relative costs and market size that arise from the three types of economic integration. In real world cases of economic integration, there may be a significant time lag before firms relocate in response to such changes. One reason is that there may be a long delay before the policy changes implied by different economic integration scenarios are implemented throughout an economy. This is particularly relevant in the full integration scenario as usually a substantial adjustment time is allowed before all environmental policies are brought into line with the agreed 'harmonized' standards.

Despite these limitations, our analysis provides several insights into the likely effects of greater economic integration between the US and Mexico, as well as between Eastern Europe and the European Union.

[12] As an illustration, empirical evidence suggests that the average cost of environmental regulations is approximately 1 per cent of firms' cost of production, but since we assume in our model that all other production costs are equal this information is not helpful in choosing a baseline value of e in our case study applications. Thus it is difficult to rely on empirical data to justify a relation between e and F.

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Both these illustrative examples represent integration between a smaller country/region with less environmental regulations and a larger region with more stringent environmental regulations. In our first application we explore the choices facing a firm located in the large country with stringent environmental policies (the US) and in the second application we study the implications of a firm being located in the smaller region with lesser environmental standards (the CEEC). The first distinction that has to be made is on the degree of economic integration, and these results also differ between our two applications. In our 'ideal' scenario of full economic integration, where tariffs and costs of relocation are reduced together with environmental harmonization, US firms are unlikely to choose to relocate to Mexico. On the other hand, Central and Eastern European firms are very likely to move production to within the European Union as their economies grow and as their environmental policies are eventually modified to conform to the EU harmonized standards. Although the amount of firm relocation differs significantly, the basic principle remains the same: firms tend to locate where the largest demand is if no marginal cost differentials exist. Another similarity is that in both cases the overall regional environment should benefit.[13]

With only 'partial' economic integration, as defined by a lack of environmental harmonization, very different conclusions must be made. In this case, US firms are very likely to move some or all production to Mexico. In fact, if tariffs are low enough, then we should expect a very large outflow of US firms relocating to Mexico, especially if the environmental cost differential between the US and Mexico widens as the result of the latter reneging on its promises to improve environmental regulations and standards to US levels. In contrast, the CEEC firm responds differently to 'partial' economic integration; it is rather unlikely that such a firm will move if tariff rates are reduced substantially, assuming no change in environmental policies in the CEECs. In addition, the result is a negative overall impact on the European environment. The reason is that more production will take place in CEECs, and in these locations the lack of change in environmental regulations will encourage the use of relatively 'dirty' production techniques.

In the light of our results, it certainly appears as if environmental harmonization ought to be a part of any decision between countries or regions to integrate, if the main concern is the environment and holding all other factors constant. For NAFTA, attaining environmental harmonization is also important if we are concerned with keeping US firms located domestically. However, in Central and Eastern Europe there is a hard tradeoff between what is good for the environment and preserving CEEC industries. In addition to these issues, the effect on consumers should be

[13] Hultberg and Barbier (2004) address a separate but related issue as to whether firm location and regional welfare are affected by environmental harmonization if the country with less stringent environmental regulations also is afflicted by problems of government corruption and rent-seeking behavior. We show that if a corrupt government sets environmental standards, it is possible that environmental harmonization is welfare-enhancing to both countries that integrate.

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considered before any decision is made about integration efforts; that is, as environmental harmonization occurs (unless it is achieved through a 'race toward the bottom'), the cost of production will increase, and some reasons for specialization according to comparative advantage are removed. In cases of partial integration and trade liberalization, the net effect on consumers is also often uncertain, due to the lower tariff being matched by higher marginal environmental costs. Analysis of these effects is, of course, beyond the scope of the model of this paper.

With regard to the controversy over environmental regulations and the incentives for an industry to relocate plants abroad, the bottom line appears to be that environmental harmonization does matter, especially if two countries or regions are pursuing greater economic integration. However, what appears to matter *per se* is not the imposition of stricter unilateral regulations and standards in the domestic economy, but whether the difference in environmental policies between the domestic economy and a foreign country with which it is integrating translates into greater *relative* difference in the environmental costs of production in the two countries.

What is the likelihood that environmental harmonization will eventually occur through either NAFTA or the accession of the Central and Eastern European economies to the European Union? Preliminary evidence suggests that, at least in the years leading up to the agreement and immediately after its implementation, environmental regulation in Mexico has received a boost from NAFTA, and in particular monitoring of the *maquiladora* industry along the Mexico–US border is proceeding well (Kotvis, 1995). Some evidence also suggests that the NAFTA-influenced environmental commitment in Mexico was sustained during the 1995 financial crisis, and continues to have momentum (Husted and Lodgson, 2001). Perhaps our 'ideal' full economic integration scenario may yet be realized for US and Mexico. In the case of European Union enlargement, accession of the CEECs is still in the early stages. The European Union welcomed ten new countries in 2004: Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia. Bulgaria and Romania expect to follow in 2007. Some commentators have noted a marked improvement in overall environmental regulations throughout Central and Eastern Europe as they have prepared for joining the EU, and there are grounds for some optimism. For example, as Kuik and Oosterhuis (2001: 17) note in the case of Poland, 'Most of the chosen indicators point at convergence: in areas where Poland's environmental record was worse than the EU's (such as air and water pollution and energy use), it is improving; on the other hand, it is deteriorating in areas where Poland used to be "greener" than the EU (such as waste and transport).'

However, in its 2004 Environmental Policy Review, the Commission of the European Communities (2005: 8) acknowledges that: 'Although EU legislation has done much to improve environmental quality, to create a level playing field for companies across the EU. Full implementation of EU environmental legislation by Member States remains a challenge, including in the new Member States. Environment cases continue to account for a third of all open cases for non implementation of EU law.' Again, this suggests that our 'ideal' full economic integration scenario may still be

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some ways off even though EU enlargement is proceeding rapidly, and, as discussed above, there may be a considerable lag time before new members are required to change their environmental policies to the 'harmonized' EU standards.

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Appendix

Our equation (1) in the text, $\Pi_i = \sum_{k,j=A}^{B}[(p_j - c^k - e^k - t_{ij}) \cdot q_{ij}] - F_k$, shows profits for firm i ($i = 1, 2$) in both markets ($j = A, B$). We assume that the inverse demand function takes the following form, $p_j = a(S_j) - b(S_j)\, Q_j$. Our assumption that $a(S_i) = S_i$ and $b(S_i) = (1/S_i)$ allows us to explicitly solve the model for optimal location choices for firm 1. By differentiating our profit expression with respect to quantities we can then solve for each firm's reaction functions. These can then be solved simultaneously, again for each market, to give a pair of optimal quantities for each location choice. As an example, below we show firm 1's two optimal quantities for our $(A, 0)$ location choice

$$q_{1A^*} = \left(\frac{S_A}{3}\right)(S_A - 2e + t) \qquad q_{1B^*} = \left(\frac{S_B}{3}\right)(S_B - 2e - 2t).$$

Substituting the optimal quantities into the profit function, equation (1), under the appropriate assumptions yields the optimal profits for firm 1 for each location configuration

$$\Pi_1^*(A,\, 0) = \left[\frac{S_A}{9}\right][S_A - 2e + t]^2 + \left[\frac{S_B}{9}\right][S_B - 2e - 2t]^2,$$

$$\Pi_1^*(A,\, B) = \left[\frac{S_A}{9}\right][S_A - 2e + t]^2 + \left[\frac{S_B}{9}\right][S_B]^2 - F,$$

$$\Pi_1^*(0,\, B) = \left[\frac{S_A}{9}\right][S_A - t]^2 + \left[\frac{S_B}{9}\right][S_B]^2 - F,$$

$$\Pi_1^*(0, 0) = 0.$$

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