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Assessing the Economic Impact of North American Free Trade

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In June 1990, the president of Mexico, Carlos Salinas de Gortari, and the president of the United States, George Bush, announced their intention to negotiate a free trade agreement between their countries. In February 1991, Canada joined the process, and in June 1991, formal negotiations on a North American Free Trade Agreement (NAFTA) began.

The prospect of NAFTA generated a large amount of economic research analyzing its possible impacts on the three countries involved. The tool of choice for this sort of analysis has been the applied general equilibrium model, which traces its roots to the work of L. Johansen and to the work of J. S. Shoven and J. Whalley.[1] Applications of this type of model to analyze NAFTA tend to find small but favorable overall impacts of such an agreement on each of the three countries. The intuition behind these findings is, as we shall see, fairly obvious. Furthermore, differences in the detailed results are easily explained in terms of differences in the underlying assumptions of the different models.

The models that have been used to analyze NAFTA tend to focus on the static gains and losses from trade liberalization. These are the effects that are felt after relative prices have had time to adjust and such resources as labor and capital have had time to move from one sector to another in response to this adjustment. To adequately capture these static effects, we need to model the interactions of a large number of sectors in the economies involved. Comparing the results of a static applied general equilibrium analysis of Spain's entry into the European Community (EC) in 1986 with later data on Spain suggests that this sort of model can do a good job in analyzing and, to some extent, predicting these effects.

Although the overall impact of NAFTA is expected to be favorable for each of the three countries, some sectors are sure to benefit more than the average. Also, some sectors are likely to suffer in terms of losses of output and employment. Because applied general equilibrium models are designed to analyze the impact of policy changes like trade liberalization on

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Unless otherwise noted, "dollars" refers to U.S. dollars.

relative prices and resource allocation over a period of several years, they can help us to identify those sectors of an economy where extra care is needed in structuring the transition mechanisms that will be built into the treaty.

In addition to the static effects captured by these models, there are dynamic effects, such as the impact of NAFTA on capital flows and growth rates, that involve the evolution of the Canadian, Mexican, and U.S. economies over time. Spanish data suggest that the dynamic impact of trade liberalization can be more significant than the static effects. To adequately capture these dynamic effects, we need to model the intertemporal decisionmaking processes of the agents in the model. We want to be able to capture, for example, the effect of NAFTA on savings and investment decisions. To be sure, many models of NAFTA analyze the effect of a higher level of capital stock in Mexico, but the increase in capital stock is imposed exogenously on the model rather than being modeled as the result of the agreement.

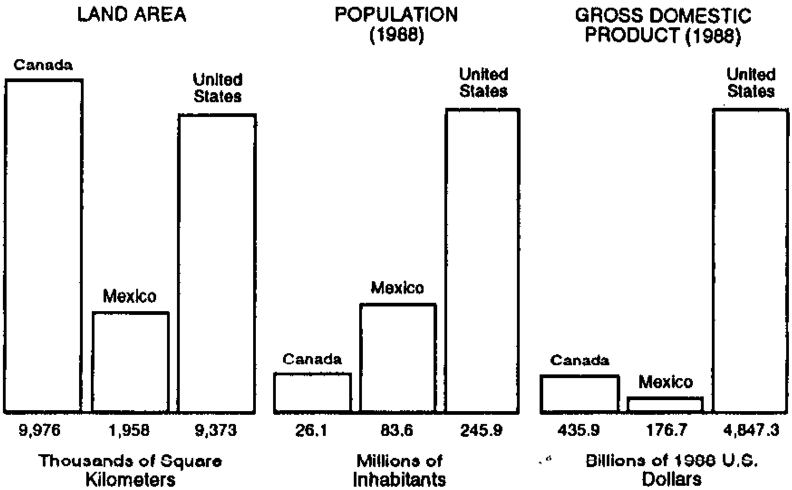
Mixing together some recent economic theory, recent data for Mexico, and empirical work on the determinants of growth rates across countries and then performing some crude calculations, we can develop rough estimates of the capital accumulation and productivity growth in Mexico that could result from NAFTA. These estimates reveal a favorable impact that dwarfs the static impact found by more conventional analyses. Although NAFTA would also be expected to have a favorable dynamic impact on Canada and the United States, we would expect this impact to be smaller given the sizes, levels of economic development, and current degrees of economic openness of these two countries relative to Mexico. In fact, the most significant dynamic impact of NAFTA on Canada and the United States could be the feedback of Mexican growth in providing favorable investment opportunities and markets for exports.

North America and NAFTA

Simply comparing the relative sizes and levels of economic development of the three North American economies goes a long way toward providing intuition for many of the predictions about the impact of NAFTA. Figure 1.1 presents several indicators of the relative sizes of Canada, Mexico, and the United States. All three countries have large land areas and are rich in natural resources. The United States is roughly ten times as large as Canada both in terms of population and in terms of gross domestic product (GDP). Although the United States has only about three times as many people as Mexico, it had more than twenty-seven times as much national income in 1988.

The disparity in this latter set of comparisons is explained by noting that Mexican income per capita, measured in 1988 dollars, was only about

Figure 1.1 Alternative Measures of Relative Size

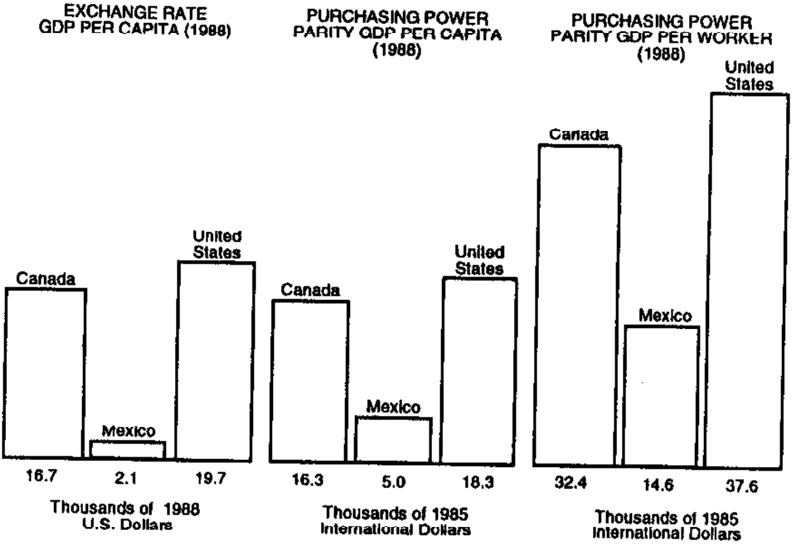


Source: World Bank, *World Development Report* (New York: Oxford University Press, 1990); and R. Summers and A. Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–88," *Quarterly Journal of Economics,* 106 (1991), 327–368.

one-ninth of that in the United States. This figure must be treated with care because it uses exchange rates to convert an income figure measured in pesos per capita into a dollars-per-capita figure. The real exchange rate, which measures the value of the peso versus that of the dollar in terms of purchasing power, has had wide swings over the past decade. These swings can unduly influence income comparisons using exchange rate conversions. In 1991, for example, Mexican income per capita was about $3,400. The 62 percent increase in income since 1988 can be roughly broken down as a 7 percent increase in terms of 1988 pesos, a 12 percent increase due to inflation in the dollar, a 36 percent increase due to a real appreciation in the value of the peso versus the dollar, and a 7 percent increase due to compounding of these various effects. Looked at another way, the U.S. dollar appreciated far less against the peso in nominal terms than would have been justified by the differences in the rates of inflation in Mexico and the United States. In another illustration of the perils of using comparisons based on exchange rate conversions, we can calculate that real U.S. income per capita fell by more than 34 percent between 1985 and 1988 when measured in 1985 Spanish pesetas; it rose by almost 8 percent over the same period when measured in terms of 1985 dollars.

Measuring different countries' incomes in terms of one country's currency can be useful for thinking about some trade issues, but it is misleading for making comparisons of standards of living. For this purpose, we should make comparisons based on real incomes in terms of a common basket of goods, comparisons that assume purchasing-power parity in exchange rates. Using data from the UN International Comparison Program, R. Summers and A. Heston have constructed such numbers.[2] As shown in Figure 1.2, they find levels of income per capita in the United States and Mexico that differ by a factor of less than four, rather than a factor of nine.

Figure 1.2 Alternative Measures of Income per Capita



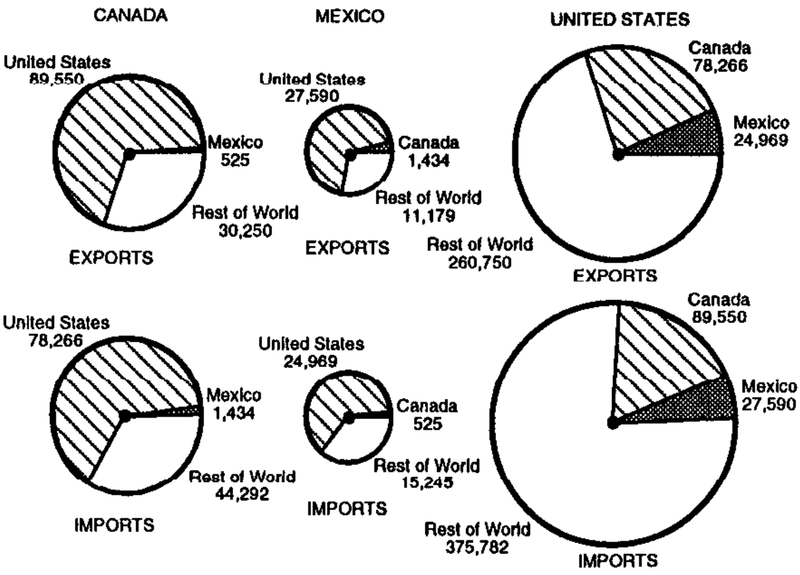
Source: World Bank, *World Development Report* (New York: Oxford University Press, 1990); and R. Summers and A. Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–88," *Quarterly Journal of Economics,* 106 (1991), 327–368.

But even these purchasing-power parity incomes per capita are misleading if we are interested in comparing productivity levels across countries. Because Mexico has a higher rate of population growth, a larger fraction of its population is very young and consequently not in the labor force, as compared to the U.S. population. When we calculate purchasing-power parity outputs per worker, we see that those in the United States and Mexico differ by a factor of less than three.

Such statistics portray the Mexican and Canadian economies as much smaller than the U.S. economy and Mexico as much poorer than either Canada or the United States. This suggests that NAFTA would have much larger impacts on Canada and particularly on Mexico than it would on the United States. Another set of statistics that suggests the same conclusion are the data on the direction of trade, reported in Figure 1.3. Although Canada is the number one trading partner of the United States, and Mexico is number three after Japan, the United States conducts only about one-quarter of its trade with its two North American neighbors. In contrast, more than two-thirds of foreign trade in both Canada and Mexico is with the United States. They have very little direct trade with each other. Put bluntly and somewhat simplistically, foreign trade for Canada and for Mexico means trade with the United States.

Table 1.1 reports the composition of that trade by sector. Although all three countries are large agricultural producers, there was relatively little North American trade in agricultural goods, other than wood products, in

Figure 1.3 Direction of Trade, 1989 (millions of 1989 U.S. dollars)



Source: International Monetary Fund, *Direction of Trade Statistics Yearbook* (Washington, DC: IMF, 1990).

Table 1.1 U.S. Merchandise Trade by Commodity, 1989 (millions of U.S. dollars)

SITC Code Number[a]	Merchandise	Exports			Imports		
		World	Canada	Mexico	World	Canada	Mexico
0	Food and live animals	29,425	1,903	1,990	22,497	3,567	2,446
03	Fish-related products	2,299	198	22	5,711	1,226	397
04	Cereals	15,457	209	976	1,017	417	27
05	Vegetables and fruits	3,808	738	140	5,686	260	1,095
1	Beverages and tobacco	5,510	83	19	4,690	583	258
2	Crude materials except fuels	26,947	2,288	1,493	16,524	8,339	675
22	Oil seeds	4,362	127	358	186	122	27
24	Cork and wood	4,965	439	143	3,733	3,333	103
25	Pulp and waste paper	4,343	184	362	3,164	2,748	8
28	Metal ores and scrap	5,313	819	225	4,205	1,257	178
3	Mineral fuels, related products	9,865	1,678	712	56,094	8,053	4,457
33	Petroleum, related products	4,828	656	518	52,411	5,126	4,359
4	Animal and vegetable fats, oils	1,350	47	143	785	91	21
5	Chemicals, related products	36,485	4,210	2,195	21,768	4,087	600
51	Organic chemicals	10,609	941	680	7,330	625	162
52	Inorganic chemicals	4,323	483	206	3,464	1,284	215
6	Manufacturing by material	27,243	5,865	2,961	65,055	16,989	2,769
64	Paper, related products	4,195	738	616	8,926	6,391	380
65	Textiles, related products	3,897	696	387	6,417	372	186
67	Iron and steel	3,278	633	451	11,376	1,678	315
68	Nonferrous metals	4,699	1,068	308	11,042	4,782	710
7	Machinery, transport equipment	148,800	33,194	10,813	210,810	39,293	12,213
71	Power-generating machinery	14,166	2,915	852	14,488	2,865	1,214
72	Specialized machinery	13,644	2,446	711	13,390	1,564	151
74	General industrial machinery	13,095	2,745	1,228	14,974	1,742	728
75	Office machines, computers	2,318	2,572	691	26,251	1,704	776
76	Telecommunications	7,669	803	1,161	23,607	953	2,675
77	Electrical machinery	23,921	3,572	3,477	33,034	2,453	4,211
78	Road vehicles	25,480	15,891	2,080	73,843	25,830	2,405
79	Other transport equipment	25,038	1,669	406	7,217	1,920	45
8	Miscellaneous manufacturing	32,637	4,326	2,469	80,470	3,637	2,766

Table 1.1 (continued)

82	Furniture	1,006	277	236	5,278	1,187	533
84	Apparel, clothing	2,087	109	375	26,026	262	596
87	Scientific instruments	10,924	1,201	656	5,964	472	471
9	Not classified elsewhere	28,388	21,011	1,222	12,820	3,909	1,237
	Total[b]	346,650	74,605	24,017	491,513	88,548	27,442

Source: Organisation for Economic Cooperation and Development, *Foreign Trade by Commodities, Series C* (Paris: OECD, 1990).

Notes: [a] Standard International Trade Classification (Revision 3), one-digit and selected two-digit. [b] Total is the sum of major SITC categories 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

1989. Canada exports significant amounts of wood, paper products, and nonferrous metals to the United States. This pattern reveals Canada's comparative advantage in raw materials compared to the United States, which itself exports large amounts of these sorts of goods to the rest of the world. Both Canada and Mexico export large amounts of petroleum to the United States. By far the biggest category of trade among North American countries, however, is machinery and transport equipment. The largest category of Canadian exports to the United States, at the two-digit Standard International Trade Classification (SITC) level, is road vehicles and parts; this is also the largest category of exports from the United States to Canada. The largest two categories of U.S. exports to Mexico are electrical machinery and road vehicles and parts; these are also the second and third largest categories of exports from Mexico to the United States, after petroleum and petrochemicals.

NAFTA would eliminate most tariffs on trade among the three countries, it would substantially reduce nontariff barriers to trade (NTBs), and it would ensure the free flow of capital throughout the region. Unlike the European Community, NAFTA would ensure neither common trade barriers against the rest of the world nor the free flow of labor. Although it would establish a dispute resolution mechanism, there are no plans to create central North American government bodies like the European Parliament and the EC bureaucracy. Neither is there serious talk about a common currency system in NAFTA like that of the EC, although both Canadian and Mexican monetary authorities carefully manage their currencies' exchange rates with the U.S. dollar.

Applied General Equilibrium Analyses of NAFTA

In 1991, Mexican tariffs on imports from the United States averaged about 11 percent when weighted by value imported; U.S. tariffs on imports from

Mexico averaged about 4 percent. There are no tariffs on most of the trade between the United States and Canada as a result of their own free trade agreement (FTA), which went into effect in 1989. Nontariff barriers are expected to be reduced substantially by NAFTA, although, given the experience of the U.S.-Canada Free Trade Agreement, we should not expect them to be completely eliminated. Currently, there are significant NTBs on agricultural imports in all three countries. There are also NTBs on imports of processed foods, particularly meat, dairy products, and sugar in the United States and Canada. The United States has significant NTBs on imports of textiles and apparel, and Mexico has NTBs on imports of chemicals. All three countries have significant NTBs on imports of automobiles and automotive parts.[3] NTBs usually take the form of import quotas, phytosanitary regulations, and licensing regulations. At present, there are few restrictions on capital flows in North America. The obvious exceptions are in Mexico, and they consist of laws prohibiting private ownership, foreign or domestic, in the petroleum industry and some parts of the petrochemical industry; laws restricting foreign ownership of banks; and laws institutionalizing ownership of much of the agricultural land—the *ejido* system, a communal form of land ownership unique to Mexico.

There are many applied general equilibrium analyses of the impacts of eliminating these barriers to trade. Although all employ multisectoral general equilibrium models, the emphasis differs across models. Brown, Deardorff, and Stern model the general impact on all three countries.[4] Bachrach and Mizrahi, who constructed their model for KPMG Peat Marwick, concentrate on liberalizing Mexican-U.S. trade.[5] Cox and Harris focus on the impact of NAFTA on Canada; Sobarzo focuses on Mexico.[6] Roland-Holst, Reinert, and Shiells pay special attention to modeling the reduction of NTBs; Hinojosa and Robinson look at modeling labor markets and migration from the rural sector to the urban sector in Mexico and migration from Mexico to the United States.[7] Hunter, Markusen, and Rutherford concentrate on the impact on the automobile industry; Trela and Whalley concentrate on textiles, apparel, and steel; and Levy and van Wijnbergen and Robinson, Burfisher, Hinojosa-Ojeda, and Thierfelder focus on agriculture.[8] Young and McCleery analyze some of the dynamic impacts of NAFTA, although neither of their models explicitly models intertemporal savings and investment decisions.[9]

It is worth noting that all these models are calibrated to pre-1989 data. In general, the policy simulations include the trade liberalization that was part of the U.S.-Canada FTA and at least some of the liberalization that has occurred in Mexico since 1985. In 1985, Mexico was one of the most closed economies in the world, with tariffs as high as 100 percent, licenses required to import all goods, and laws that prohibited foreigners from investing in the stock market or, with a few exceptions, from owning more than 49 percent of any business or private property.

Table 1.2 summarizes the overall effects of NAFTA on welfare in the Brown, Deardorff, and Stern model.[10] These results are fairly typical of those found in these models: The impact of NAFTA as a percentage of GDP is largest in Mexico and smallest in the United States, with Canada falling in between, even though the absolute gain may be largest in the United States. It makes little difference to Canada whether Mexico joins U.S.-Canada Free Trade Association. What these results also have in common with those of many of the other models is that the biggest impact of NAFTA occurs if capital is allowed to flow to Mexico from the United States or from the rest of the world. In all these models, such capital flows are exogenously imposed, either to increase Mexican capital by a fixed amount or to lower the marginal product of capital to a fixed level.

Table 1.2 Changes in Economic Welfare in Different Applied General Equilibrium Simulations of NAFTA

	Canada		Mexico		United States	
Simulation	Total[a] (%)	GDP (%)	Total[a] (%)	GDP (%)	Total[a] (%)	GDP (%)
NAFTA: Tariffs, NTBs	3.51	0.7	1.98	1.6	6.45	0.1
NAFTA: Tariffs, NTBs, Foreign investment	3.66	0.7	6.30	5.0	13.23	0.3
U.S.-Mexico: Tariffs, NTBs	0.08	0.0	1.93	1.5	3.66	0.1
U.S.-Mexico: Tariffs, NTBs, Foreign investment	0.23	0.0	6.26	4.9	10.65	0.2
U.S.-Canada	3.36	0.6	0.04	0.0	2.87	0.1

Source: D. K. Brown, A. V. Deardorff, and R. H. Stern, "A North American Free Trade Agreement: Analytical Issues and a Computational Assessment," manuscript, University of Michigan, 1991.

Note: [a]Billions of U.S. dollars.

The overall size of the impact depends on modeling assumptions. Brown presents an excellent summary and evaluation of the different results.[11] In models with constant returns to scale and perfect competition, such as that of Bachrach and Mizrahi,[12] the effects tend to be small; this is because they only pick up the traditional gains caused by countries expanding the production of goods in which they have comparative advantage and thereby increasing efficiency within North America.

Other models—such as the Brown, Deardorff, and Stern, the Cox and Harris, the Roland-Holst, Reinert, and Shiells, and the Sobarzo models—find larger gains because they model some industries as operating under conditions of increasing returns to scale and imperfect competition.[13] In the Cox and Harris and the Sobarzo models, where domestic producers collude to set prices as high as possible, lowering trade barriers has the maximum possible procompetitive effects, forcing producers to lower prices and produce at a more efficient scale. In these models, there are relatively large gains. Furthermore, in the Cox and Harris model, Canada benefits significantly from NAFTA, over and beyond the benefits that it reaps from the U.S.-Canada FTA, because the threat of competition from Mexico forces Canadian producers to operate more efficiently, even though there may be few Mexican exports to Canada under NAFTA. The Brown, Deardorff, and Stern model treats producers as monopolistically competitive, and it obtains a lesser procompetitive effect than do the Cox and Harris and the Sobarzo models. Roland-Holst, Reinert, and Shiells model markets as contestable, which is the closest possible assumption to perfect competition in models with increasing returns. Here, the procompetitive effects are even smaller, and the results are similar to those in models with perfect competition.

The models with enough detail for this purpose point to some obvious winners and losers among the different sectors. There should be an overall expansion in agricultural trade, with grain and oil seed production expanding in Canada and the United States and contracting in Mexico. Conversely, fruit and vegetable production should expand in Mexico at the expense of that in the United States. This is obviously an area where care is needed in structuring the transition, given the large numbers of poor farmers engaged in growing corn in Mexico and of migrant farm workers engaged in picking fruits and vegetables in the United States. Sugar and apparel producers in the United States also seem likely to lose significant market shares to Mexican producers, although this depends on how far NTBs in these sectors are actually lowered by NAFTA. Effects in industries such as textiles, automobiles, and automotive parts are ambiguous. It is possible that the U.S. textile industry will expand by acting as a supplier to Mexican apparel producers. Similarly, Mexican and U.S. automobile and automotive parts producers could engage in production-sharing relations, taking advantage of the comparative advantages of each country and becoming more competitive with producers from East Asia and Europe. In cases like these, much depends on the domestic content provisions written into the treaty.

An applied general equilibrium analysis of this sort becomes even more useful when the agreement is on the table. It can then be used to evaluate the different NTBs left in place by the treaty as well as the transition mechanisms included in it.

The Spanish Experience

Although large amounts of energy and resources have gone into constructing applied general equilibrium models and using them to perform policy analyses over the past two decades, it is surprising how little effort has been made in evaluating the performance of such models after such policy changes have actually taken place. Only by showing that a model can replicate and, to some extent, predict the principal developments that occur in the economic system that it intends to represent can we justify putting confidence into the results of such models. In this chapter, I compare modeling NAFTA to modeling Spain's entry into the EC in 1986, in order to evaluate the performance of these models. Spain's recent economic experience also serves as a possible indication of what would happen in Mexico as a result of NAFTA.

One approach to empirically validating a model is to investigate how well it performs in tracking the impact of policy changes and exogenous shocks after these shocks have occurred. Such exercises have been performed by Dervis, de Melo, and Robinson; Devarajan and Sierra; and Parmenter, Meagher, McDonald, and Adams.[14] Another approach is to compare predictions with actual outcomes. The problem with this approach is that the actual data can be significantly affected by unforeseen exogenous shocks that happen concurrently with the foreseen policy change. Applied general equilibrium modelers of the U.S.-Canada FTA complain, for example, that it is difficult to compare their predictions with the economic experience of the last several years because of the recessions in both countries. Because applied general equilibrium models have very explicit structures, however, it should be possible to disentangle the impacts of different shocks and policy changes by using the model.

Kehoe, Polo, and Sancho take a step in this direction.[15] They assess the performance of a model of the Spanish economy built in 1984–1985 to analyze Spain's 1986 entry into the EC. The first column of Table 1.3 shows the percentage changes in relative prices that actually took place in Spain between 1985 and 1986. The second column shows the model predictions. In each case, the prices have been deflated by an appropriate index so that a consumption-weighted average of the changes sums to zero: These sorts of models are designed to predict changes in relative prices, not in price levels. Notice that the model fares particularly badly in predicting the changes in the food and nonalcoholic beverages sector and in the transportation sector. There are obvious historical explanations for these failings: In 1986, the international price of petroleum fell sharply, and poor weather caused an exceptionally bad harvest in Spain. Incorporating these two exogenous shocks into the model yields the results in the third column in Table 1.3, which correspond remarkably well to the actual changes.

Kehoe, Polo, and Sancho perform similar exercises comparing model results, both with and without the exogenous shocks, with the actual data

Table 1.3 **Comparison of Spanish Model's Prediction with the Data by Sector (percentage change in relative price[a])**

Sector	Actual 1985–1986	Model	Adjusted Model
1. Food and nonalcoholic beverages	1.8	–2.3	1.7
2. Tobacco and alcoholic beverages	3.9	2.5	5.8
3. Clothing	2.1	5.6	6.6
4. Housing	–3.2	–2.2	–4.8
5. Household articles	0.1	2.2	2.9
6. Medical services	–0.7	–4.8	–4.2
7. Transportation	–4.0	2.6	–6.6
8. Recreation	–1.4	–1.3	0.1
9. Other services	2.9	1.1	2.8
Weighted correlation with 1985–1986[b]	1.000	–0.079	0.936

Source: T. J. Kehoe, C. Polo, and F. Sancho, "An Evaluation of the Performance of an Applied General Equilibrium Model of the Spanish Economy," Working Paper 480, Federal Reserve Bank of Minneapolis, 1992.

Notes: [a] Change in sectoral price index deflated by appropriate aggregate price index.
[b] Weighted correlation coefficients with actual changes 1985–1986. The weights used are (1) 0.2540, (2) 0.0242, (3) 0.0800, (4) 0.1636, (5) 0.0772, (6) 0.0376, (7) 0.1342, (8) 0.0675, (9) 0.1617; these are the consumption shares in the model's benchmark year, 1980.

for changes in industrial prices, production levels, returns to factors of production, and major components of GDP. In general, the unadjusted model does somewhat better in predicting the actual changes in these variables than it does in predicting those in relative prices of consumption goods; the adjusted model does somewhat worse. Overall, however, the exercise shows that this sort of model can do a good job of predicting the changes in relative prices and resource allocation that result from a major policy change.

To be sure, the major policy change that occurred in Spain in 1986 was a tax reform that converted most indirect taxes to a value-added tax, in accordance with EC requirements. The process of trade liberalization began in 1986 and is captured in the model. Unlike the modeling exercises discussed in the previous section, however, the work on Spain did not concentrate on trade issues. Consequently, the results from the Spanish model do not help us much in discriminating among the model structures utilized in the various models for analyzing NAFTA.

One way to evaluate these different modeling strategies would be to modify the Spanish model, incorporating alternative assumptions about product differentiation, returns to scale, and market structure. Alternative versions of the model could then be used to "predict" the impact of the trade liberalization that has occurred in Spain in recent years, and the results could be compared with the data. Similarly and more to the point, the different models used to analyze the impact of NAFTA could be evaluated by using them to "predict" the impact of the policy changes and exogenous shocks that have buffeted the three North American economies over the past decade.

If NAFTA is implemented, it will be possible, in less than a decade, to go back and see which models performed better in predicting its effects. One difficulty with doing this involves comparing sectoral disaggregations across models. Modelers have an obligation to provide a correspondence between the sectors in their models and accessible statistical sources. The consumption goods sectors in the Spanish model, for example, correspond to those in the consumer price index published by the Spanish government, and the industrial sectors correspond to those in the national income accounts. Furthermore, details on this correspondence have been published; see Kehoe, Manresa, Polo, and Sancho.[16]

Spanish experience also indicates that real exchange rate movements can swamp the effects of lowering tariffs. Table 1.4 recounts the history of the real exchange rates of Mexico, Spain, and the United States over the past twelve years. The real exchange rate is an index of the rate at which a domestic basket of goods trades for an international basket of goods. A large number indicates a high price of foreign goods relative to domestic goods; this would tend to encourage exports and discourage imports. Notice in Table 1.4 how Spain's real exchange rate appreciated up to 1991 after that country joined the EC. A similar phenomenon already seems to be taking place in Mexico.

Table 1.4 Real Exchange Rate Indices[a] (1980 = 100): 1980–1991

	Mexico	Spain	United States
1980	100.0	100.0	100.0
1981	84.2	110.6	81.9
1982	115.2	112.4	82.9
1983	125.4	130.4	80.1
1984	102.9	127.1	74.3
1985	99.1	125.3	72.7
1986	144.6	108.3	81.5
1987	157.5	100.4	87.0
1988	130.1	97.8	90.3
1989	118.3	93.6	86.7
1990	114.5	80.9	88.1
1991	109.9	94.4	102.5

Source: Data from Banco de México, Mexico; Instituto Nacional de Estadística and Banco de España, Spain; and Department of Commerce, Bureau of Economic Analysis, United States.

Note: [a] The real exchange rate of country i is defined as:

$$Q_i = (P^*/P_i) \times (E_i/E^*) \times 100$$

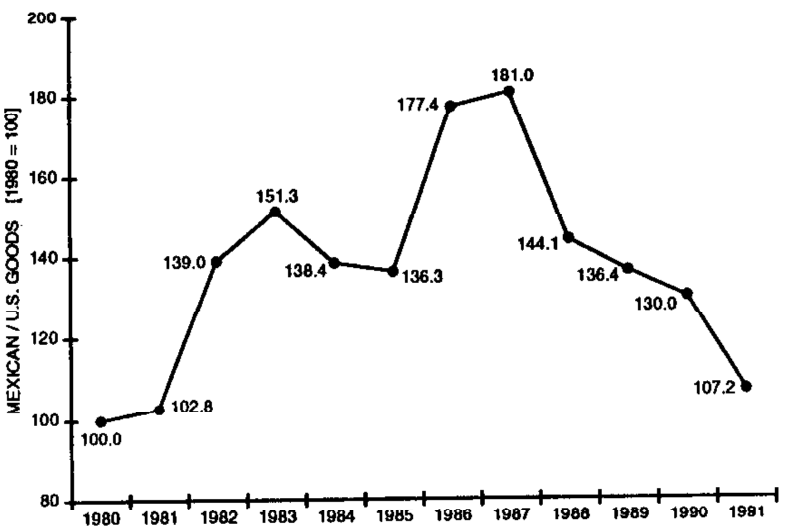
where P^* is an international price index, expressed in units of a basket of currencies of 133 countries, per an international basket of goods; P_i is the domestic consumer price index expressed in domestic currency per domestic basket of goods; E_i is the exchange rate in domestic currency per dollar; and E^* is an international exchange rate in baskets of currencies per dollar. Q_i is therefore expressed in units of domestic baskets of goods per international basket of goods.

Figure 1.4 illustrates the large swings in the real peso–U.S. dollar exchange rate (obtained by dividing the figures in the first column of Table 1.4 by those in the third column and multiplying by 100). Notice that the movements in this exchange rate overwhelm the reduction of the existing tariffs to zero. A glance at these sorts of numbers explains why efforts to establish a common currency have made so much progress in Europe. It is hard not to speculate about the pressures that will build up in North America to at least smooth out fluctuations like those pictured in Figure 1.4.

One obvious explanation for the sharp real appreciations of the Mexican peso and the Spanish peseta, captured by the statistics in Table 1.4, is the large amount of foreign investment flowing into each country as trade liberalization has taken effect. In each case, investment in the stock market has expanded more rapidly than direct investment (see Table 1.5).

As Kehoe stresses, the dynamic impact of NAFTA is likely to dwarf the static impact analyzed by most applied general equilibrium models.[17] Perhaps the major impact that entry into the EC has had on the Spanish economy has been the sharp increase in foreign investment, shown in Table 1.5. This foreign investment is closely related to increases in GDP and imports. From 1980 to 1985, investment in Spain actually fell by 1 percent per year, as shown in Table 1.6. In contrast, since Spain's entry into the EC in

Figure 1.4 Real Exchange Rate Index, Mexican/U.S. Goods



Source: Data from Banco de México and U.S. Department of Commerce, Bureau of Economic Analysis.

Table 1.5 Foreign Investment[a] in Mexico and Spain, 1980–1991 (millions of U.S. dollars)

	Mexico			Spain		
	Direct Investment	Portfolio Investment	Total	Direct Investment	Portfolio Investment	Total
1980	2,155	—[b]	2,155	1,182	—	1,182
1981	3,836	—	3,836	1,436	103	1,539
1982	1,657	—	1,657	1,272	–68	1,204
1983	461	—	461	1,379	42	1,421
1984	391	—	391	1,523	54	1,577
1985	491	—	491	1,718	232	1,950
1986	1,522	—	1,522	3,073	1,228	4,301
1987	3,248	—	3,248	3,825	3,799	7,624
1988	2,595	—	2,595	5,786	2,291	8,077
1989	3,037	493	3,530	6,955	7,989	14,944
1990	2,633	1,995	4,628	10,904	5,368	16,265
1991	4,762	7,540	12,302	5,721[c]	19,385[c]	25,106[c]

Source: Data from Banco de México and IMF, International Financial Statistics.
Notes: [a] Does not include investment in real estate. [b] — indicates no investments.
[c] Preliminary estimates.

Table 1.6 Growth Rates of GDP and Various Components in Mexico and Spain, 1980–1991 (real change in percent per year)

	Mexico				Spain			
	GDP	Investment	Exports	Imports	GDP	Investment	Exports	Imports
1980	8.3	14.9	6.1	31.9	1.5	1.3	0.6	3.8
1981	8.8	16.2	11.6	17.7	–0.2	–3.3	8.4	–4.2
1982	–0.6	–16.8	21.8	–37.9	1.2	0.5	4.8	3.9
1983	–4.2	–28.3	13.6	–33.8	1.8	–2.5	10.1	–0.6
1984	3.6	6.4	5.7	17.8	1.8	–5.8	11.7	–1.0
1985	2.6	7.9	–4.5	11.0	2.3	4.1	2.7	6.2
1986	–3.8	–11.8	5.3	–12.4	3.3	10.0	1.3	16.5
1987	1.7	0.1	10.1	2.0	5.6	14.0	6.1	20.2
1988	1.4	5.8	5.0	37.6	5.2	14.0	5.1	14.4
1989	3.1	6.5	3.0	19.0	4.8	13.8	3.0	17.2
1990	3.9	13.4	5.2	22.9	3.6	6.9	3.2	7.8
1991	3.6	8.5	5.1	16.6	2.4	1.6	8.4	9.4

Sources: Data from Instituto Nacional de Estadística Geografía e Informática, Mexico, and Instituto Nacional de Estadística, Spain.

1986, investment has grown by 10 percent per year on average. Similarly, GDP growth has increased from a 1.4 percent yearly average in 1980–1985 to 4.1 percent in 1986–1991, and import growth has increased from 1.3 percent to 14.2 percent. A similar pattern has emerged in Mexico with the *apertura,* or openness policy, that began to take effect in 1988 and 1989.

NAFTA could be expected to reinforce this pattern, with substantial increases in GDP fueled by foreign and domestic investment and with even more substantial increases in imports leading to large trade deficits. In both Spain and Mexico, many (if not most) of the current discussions of economic openness in the press, among academic analysts, and in policy circles concentrate on the sustainability of these investment booms and the corresponding trade deficits.

There are, of course, many differences between Spain's experience after joining the EC and Mexico's experience in joining NAFTA. Some commentators like to stress the regional development funds that the EC allocates to its poorer members. As a percentage of GDP, however, these numbers are trivial: In 1990, for example, the funds Spain received from the EC amounted to 0.28 percent of GDP for regional policy, 0.11 percent for social policy, and 0.57 percent for agricultural policy. It must be remembered that these funds are generated by member state contributions; Spain's net receipts from the EC in 1990 amounted to only 0.23 percent of GDP. These sorts of numbers are typical for the poorer members of the EC. Rather than regional or social policy, the major component of the EC budget is the Common Agricultural Policy, and the principal beneficiary of this policy is France, one of the richer members.

A far more significant difference between the Spanish experience and the Mexican experience is the lack of labor mobility between the two countries. Table 1.7 shows estimates of workers' remittances from abroad for Mexico, three relatively poor EC countries, and Turkey. Even though the Mexican number is hard to estimate because of illegal immigration and even though it may be underestimated, it is clear that the lack of legal labor mobility would affect Mexico in NAFTA in ways that it has not affected the poorer countries in the EC.

Another area in which Spain's experience differs from Mexico's is in population growth (see Figure 1.5). Table 1.8 reports population growth numbers in Mexico that are astonishing in comparison with those in Spain and the United States. Although this population growth has slowed significantly in recent years, Mexico has been left with a large baby boom

Table 1.7 Net Workers' Remittances, 1990, from Various Immigrant-Sending Countries

	Total[a]	Percent of GDP	Per Capita[b]
Greece	1,775	3.07	175.74
Mexico	2,020	0.85	23.43
Portugal	4,271	7.52	410.67
Spain	1,747	0.36	44.79
Turkey	3,246	3.36	57.86

Source: World Bank, *World Development Report* (New York: Oxford University Press, 1992).
Notes: [a] Millions of U.S. dollars. [b] U.S. dollars.

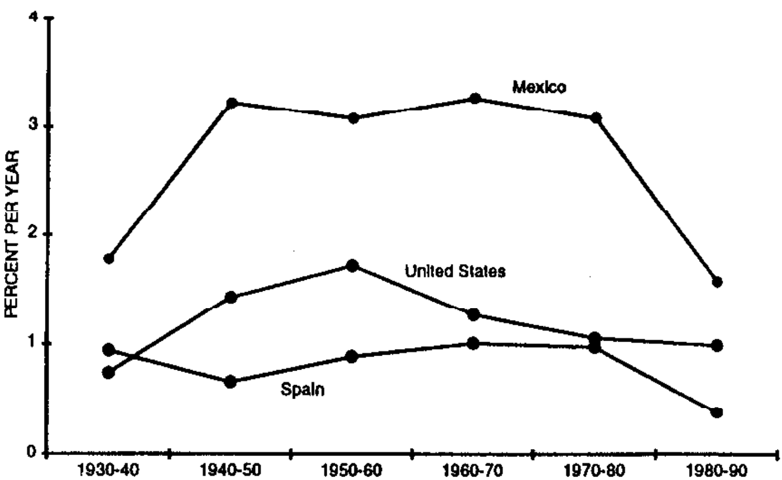
generation entering into the work force. These new workers must be equipped with capital, both physical and human, if levels of output per worker are to be increased—or even just maintained.

Capital Flows

Lack of labor mobility in NAFTA could be largely offset by capital flows. One would expect capital to flow from the relatively capital-rich Canada and the United States to the relatively capital-poor Mexico. Indeed, it is by exogenously imposing a substantial capital flow of this sort that many of the static models are able to show a significant welfare gain to Mexico. Two points about capital flows should be stressed, however. First, differences in capital-labor ratios between Mexico and its northern neighbors cannot be the sole explanation for the large differences in output per worker. Consequently, simply equalizing capital-labor ratios cannot be the solution to the problem of eliminating income differences. Second, when analyzing the savings and investment decisions that determine capital flows, we must take into account the significant differences in the age profiles of populations in Mexico and its neighbors.

The argument that differences in capital-labor ratios cannot be the sole explanation of differences in output per worker across the three countries

Figure 1.5 Growth Rate of Population in Mexico, the United States, and Spain, 1930–1990



Source: Data from Nacional Financiera, *La Economía Mexicana en Cifras* (Mexico: Nacional Financiera, 1991); Instituto Nacional de Estadística; and U.S. Department of Commerce, Bureau of the Census.

Table 1.8 Total Population of Mexico, Spain, and the United States, 1930–1990 (population in millions and average yearly growth rate per decade)

	Mexico		Spain		United States	
Decade	Total	Growth Rate	Total	Growth Rate	Total	Growth Rate
1930	16.7	—	24.0	—	122.7	—
1940	19.9	1.78	26.4	0.94	132.1	0.74
1950	27.4	3.23	28.2	0.66	152.3	1.43
1960	37.1	3.08	30.8	0.89	180.7	1.72
1970	51.2	3.28	34.0	1.01	205.1	1.27
1980	69.4	3.09	37.5	0.98	227.8	1.06
1990	81.3	1.59	39.0	0.39	251.5	1.00

Source: Data from National Financiera, *La Economía Mexicana en Cifras* (Mexico: Nacional Financiera, 1991); Instituto Nacional de Estadística, Spain; and Department of Commerce, Bureau of the Census, United States.

Note: — indicates no data for the decade from 1920 to 1930.

of North America is fairly simple: If capital is relatively scarce in Mexico, then its marginal product should be much higher there than in the United States or Canada. Therefore, we should observe much higher real interest rates in Mexico than in the United States or Canada. Based on the output per worker figures of Summers and Heston for Mexico and the United States in 1988, which differ by a factor of 2.6, simple calculations in the Technical Appendix to this chapter show that real interest rates in Mexico should have been more than 86 percent per year.[18] During the period 1988–1990, the real return on bank equity in Mexico (and banks are the major source of private capital there) averaged 28.2 percent per year, as compared to 4.7 percent in the United States.[19] Because 28 percent is far lower than the 86 percent that we would expect if differences in capital-labor ratios were the principal determinants of the differences in output per worker between Mexico and its neighbors, we must look elsewhere for an explanation.

A more general point is that differences in capital per worker cannot be the sole explanation of differences in output per worker across countries. This is supported both by historical evidence, such as that of Clark, and by even more extreme examples of differences in output per worker: According to Summers and Heston, for example, real GDP per worker in Haiti in 1988 was 4.9 percent of that in the United States.[20] Calculations like those in the Technical Appendix would suggest that interest rates in Haiti should be over 11,000 percent per year if differences in the capital-labor ratio were the sole explanation of the differences in output per worker. Furthermore, historical evidence indicates that Mexico has not always been starved of funds for investment. The problem has often been that investments abroad, particularly in the United States, have been more attractive. Between 1977 and 1982, for example, $17.8 billion of private investment flowed into Mexico, and $18.7 billion flowed out.[21]

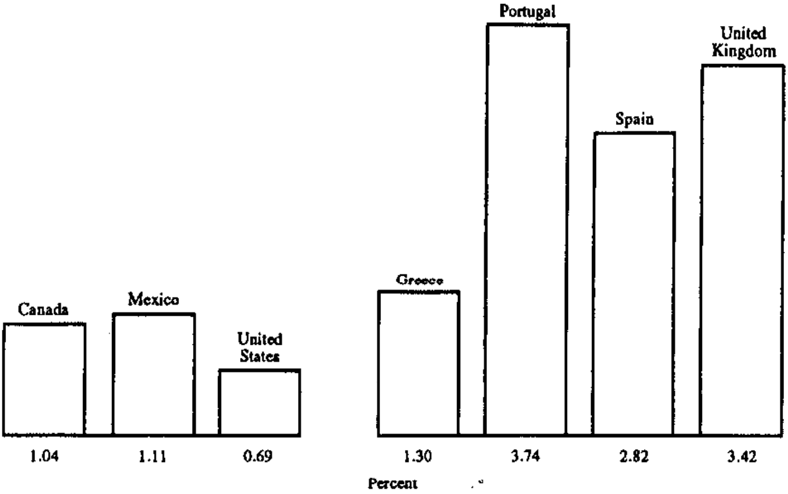
Although capital flows cannot provide all the answers to Mexico's problems, they are important. If capital flows could lower the net interest rate in Mexico from 28 percent to 5 percent per year, we would estimate that the capital-labor ratio in Mexico would increase by a factor of about 5.5 (see Technical Appendix for details). This would increase Mexican output per worker to about $24,300, which would close the current gap with the U.S. level by about 42 percent.

Some of the current high return on capital in Mexico can be accounted for by an inefficient and oligopolistic financial services sector. NAFTA might increase the efficiency of this sector. Even more significantly, NAFTA would create a stable economic environment that would encourage private investment in Mexico. It would do this in at least two ways. First, it would lock the Mexican government into the free trade policy and the liberal policy toward foreign direct investment that it is currently pursuing unilaterally. Second, it would shield Mexican producers from protectionist tendencies in the United States, which fluctuate with the business cycle and are sensitive to a variety of special interest groups. Direct foreign investment in Mexico has increased dramatically in recent years, as seen in Table 1.5. Some of this increase had been due to the liberalization of Mexican laws regarding such investments, and some has undoubtedly resulted from improvements in the expectations for Mexico's economic future.

One point to be stressed about capital flows into Mexico is that they are now—and probably will be in the future—tiny in comparison with capital flows into the United States over the past decade: In 1989, for example, the United States absorbed $71.9 billion in foreign direct investment, $59.2 billion in investment in equities, $35.0 billion in investment in corporate bond purchases, and $128.2 billion in government bond purchases.[22] Mexico still has a long way to go in terms of receiving foreign direct investment before it becomes a major recipient by international standards (see Figures 1.6 and 1.7).

A sensible analysis of capital flows must model consumer savings decisions. In this instance, we must take into account demographic differences between the countries of North America. To illustrate the importance of demographic differences, I note that half the population of Mexico is currently under the age of twenty, but the populations of Canada and the United States are currently aging as the postwar baby boom generation reaches middle age; see Table 1.9. These differences would be very important in an overlapping-generations context in which life-cycle consumers dissave when young and build up human capital; save during the middle years of their lives; and dissave again when old, during retirement. An example of an applied general equilibrium model with overlapping generations is provided by A. J. Auerbach and L. J. Kotlikoff.[23] Modeling demographic differences in an overlapping-generations framework would

Figure 1.6 Foreign Direct Investment as Percentage of GDP, 1990



Source: World Bank, *Global Economic Prospects and the Developing Countries* (Washington, DC: World Bank, 1992), and World Bank, *World Development Report* (New York: Oxford University Press, 1992).

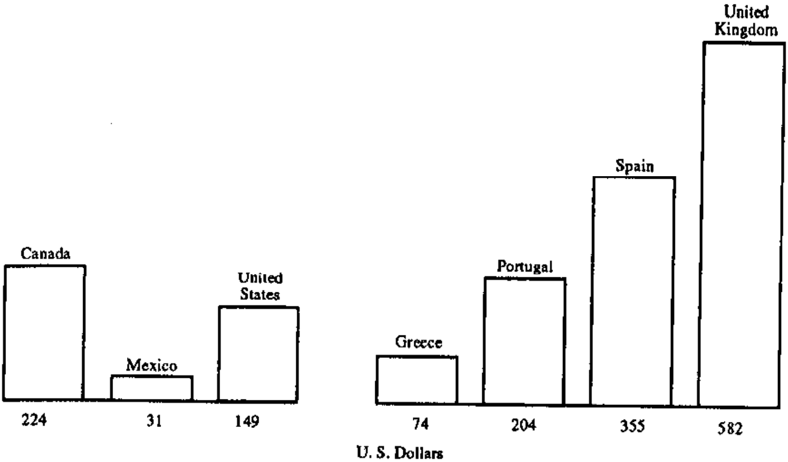
be especially important in a model in which the accumulation of both human and physical capital plays an important role.

Productivity Growth

As we have seen, a low capital-labor ratio cannot be the only factor in explaining the low level of output per worker in Mexico compared to that in a country like the United States. It is in this area that the new, endogenous growth literature, which follows P. M. Romer and R. E. Lucas and focuses on endogenous technical change, may provide potential answers.[24] This literature is still at a tentative, mostly theoretical level. In this section, I use preliminary empirical work at an aggregate level to estimate the impact of free trade on growth rates in Mexico.

Although my calculations are fairly crude, they suggest that the dynamic impact of NAFTA could dwarf the static effects found by more conventional applied general equilibrium models. R. Baldwin has done similar kinds of suggestive calculations to estimate the dynamic gains from the European Community's 1992 Program.[25] Unlike Baldwin's analysis, however, the results presented here are based on theories and empirical

Figure 1.7 Per Capita Foreign Direct Investment, 1990



Source: World Bank, *Global Economic Prospects and the Developing Countries* (Washington, DC: World Bank, 1992), and World Bank, *World Development Report* (New York: Oxford University Press, 1992).

Table 1.9 Population of Mexico, Spain, and the United States by Age Groups, 1990 (percentage)

Age	Mexico	Spain	United States
0–15	41.0	21.4	23.2
16–24	19.2	15.2	13.0
25–64	35.6	50.0	51.2
65 and over	4.2	13.4	12.6

Source: Data from Instituto Nacional de Estadística Geografía e Informática, Mexico; Instituto Nacional de Estadística, Spain; and Department of Commerce, Bureau of the Census, United States.

estimates that deal with trade directly. Baldwin obtains his numbers by multiplying estimates of static gains from trade obtained by other researchers by a multiplier derived from a highly aggregated growth model with dynamic increasing returns but without any explicit role for trade. Neither Baldwin's analysis nor that presented here takes into account phenomena like unemployment or underutilization of capacity. It is possible that a free trade agreement would provide dynamic gains based on a more traditional macroeconomic analysis; S. Fischer has some suggestive results in this regard.[26]

Although endogenous growth literature is still at a tentative stage, the intuition behind it is fairly simple. Increased openness can alter the growth rate in clear ways: Economic growth is spurred by the development of new products. New product development is the result of learning by doing (where experience in one product makes it easier to develop the next product in the line) and of direct research and development. On the final product side, increased openness allows a country to increase specialization, achieving a larger scale of operations in those industries in which it has a comparative advantage. On the input side, increased openness allows a country to import, rather than develop itself, many technologically specialized inputs to the production process.

The potential that learning by doing has in accounting for productivity growth has been recognized since the pioneering work of K. J. Arrow.[27] The long history of micro-evidence goes back to T. P. Wright, who found that productivity in airframe manufacturing increased with cumulative output at the firm level.[28] Later studies have confirmed this relationship at both the firm and industry level. Recent research that incorporates learning by doing into models of trade and growth includes that of Stokey and Young.[29]

Consider the following simple framework, as presented by D. K. Backus, P. J. Kehoe, and T. J. Kehoe. Output in an industry in some country depends on inputs of labor and capital, country- and industry-specific factors, and an experience factor that depends, in turn, on previous experience and output of that industry in the prior period.[30] Keeping constant the rates of growth of inputs, the crucial factor in determining the rate of growth of output per worker is the rate of growth of the experience factor. Output per worker grows faster in industries in which this experience factor is higher. The level of growth of output per worker nationwide is a weighted average of the rates of growth across industries. One way increased openness promotes growth is by allowing a country to specialize in certain product lines and attain more experience in related industries.

Modeling dynamic increasing returns as the result of learning by doing is a reduced form specification for a very complex microeconomic process. It captures the effects of the learning curve documented by industrial engineers and, to some extent, the adoption of more efficient production techniques from abroad and from other domestic industries. The learning that takes place is not solely related to physical production techniques but also to the development of complex financial and economic arrangements between producers of primary and intermediate goods and producers of final goods. The ability of a country to benefit from learning by doing depends on the educational level of the work force. It also depends on whether a country is at the frontier of development of new products and production techniques or if it can import these from abroad: It is easier to play catch-up than to be the technological leader.

Increased openness also allows a country to import more specialized inputs to the production process. Stokey and Young have proposed models in which new product development is still the result of learning by doing but in which the primary impact of learning by doing is in the development of new, more specialized inputs.[31] Trade allows a country to import these inputs without developing them itself. P. Aghion and P. Howitt, G. M. Grossman and E. Helpman, L. Rivera-Batiz and P. M. Romer, and others have proposed similar models in which it is research and development that leads to the development of new products.[32] (Here, of course, the relationship of trade and growth is more complicated if one country can reap the benefits of technological progress in another country by importing the technology itself without importing the products that embody it.)

The most interesting aspect of this theory, however, is the perspective it gives us on trade and growth. The natural interpretation of the theory that emphasizes specialization in final products is that technology is embodied in people and is not tradeable. Trade may influence the pattern of production, including both the scale of production and the pattern of specialization, and in this way, it affects growth. In the model with specialized inputs, technology is embodied in product variety, and there is a more subtle interaction between trade and growth. Recall that increases in the number of varieties of intermediate goods raise output. Therefore, if these varieties are freely traded, a country can either produce them itself or purchase them from other countries. By importing these products, a small country can grow as fast as a large one. When there is less than perfectly free trade in differentiated products, we might expect to find that both scale and trade in differentiated products are positively related to growth.

Using cross-country data from a large number of nations over the period 1970–1985, Backus, Kehoe, and Kehoe analyze the determinants of growth.[33] Various other researchers have used similar cross-country data sets to estimate the parameters of endogenous growth models; R. Levine and D. Renelt offer a survey of this work.[34] Typically, researchers in this area find that their results are very sensitive to the exact specifications of the model and the inclusion or exclusion of seemingly irrelevant variables. Backus, Kehoe, and Kehoe find, however, that in explaining rates of growth of output per worker in manufacturing, results related to the theory sketched out in this section are remarkably robust. Using their methodology, we can estimate some parameters for a model in which both specialization in final output and the ability to import specialized inputs foster growth. The results of this estimation are found in the Technical Appendix. In terms of trade policy, the crucial variables in this analysis are a measure of specialization in exports and a measure of the extent to which a country is open to trade in highly specialized inputs. For the first measure, I use a specialization index for exports, and for the second, I use the

Grubel-Lloyd index, a common measure of intraindustry trade; both are described in the Technical Appendix.[35]

My results indicate that changes in the manufacturing productivity growth rate correspond to changes in these two measures given by the following formula:

$$g' - g = 0.309 \log\left(\frac{ES'}{ES}\right) + 0.890 \log\left(\frac{GL'}{GL}\right)$$

Here, g' and g are the new and the old productivity growth rates measured in percent per year, ES' and ES are the new and the old export specialization indices, and GL' and GL are the new and the old Grubel-Lloyd indices.

To illustrate the dramatic impact of trade liberalization possible in a dynamic model that contains the endogenous growth features discussed in this section, let us suppose that NAFTA allowed Mexico to increase its level of specialization in production of final manufactured goods and imports of specialized inputs. The average values over 1970–1985 of the specialization indices and Grubel-Lloyd indices for the three North American countries follow. The values of the same indices for South Korea, a country with about the same output per worker as Mexico, are also included for comparison.

	Export Specialization Index	Grubel-Lloyd Index
Canada	7.10×10^{-2}	0.638
Mexico	5.93×10^{-4}	0.321
United States	1.92×10^{-3}	0.597
Korea	5.43×10^{-2}	0.362

Suppose that free trade allows Mexico to increase its specialization index to 1.0×10^{-2} and its Grubel-Lloyd index to 0.6. Dramatic increases of this sort are possible: In 1970, for example, Ireland had a Grubel-Lloyd index for manufactured goods of 0.150; in 1980, seven years after joining the European Community, this index was 0.642.

Using that relationship, we would estimate the increase in the growth rate of manufacturing output per worker of 1.43 percent per year:

$$1.430 = 0.309 \log\left(\frac{1.00\times10^{-2}}{5.93\times10^{-4}}\right) + 0.890 \log\left(\frac{0.600}{0.321}\right) = 0.873 + 0.557$$

It is clear that much is at stake in the issues discussed here. Suppose that Mexico is able to increase its growth rate of output per worker by an additional 1.43 percent per year by taking advantage of both specialization and increased imports of specialized intermediate and capital goods. After thirty years, its level of output per worker would be more than 50 percent higher than it would otherwise have been. By way of comparison, if Mexico's output per worker had been 50 percent higher in 1988 than it actually was, then Mexico's output per worker would be about the same as Spain's.[36] My earlier calculations suggested that Mexico could increase its output per worker by about 66 percent by increasing its capital per worker until the rate of return on capital is equal to that in the United States. Admittedly, these calculations are very crude, but they suggest that increased openness has a significant impact on growth through dynamic increasing returns. Furthermore, the dynamic benefits of increased openness dwarf the static benefits found by more conventional applied general equilibrium models.

Obviously, this is an area that requires more research, and even a crude disaggregated dynamic general equilibrium model of North American economic integration would make a substantial contribution. More empirical work also needs to be done. Notice, for example, that the Grubel-Lloyd indices reported earlier fail to capture the observation that Korea is fairly closed in final goods markets but open to imports of intermediate and capital goods.

My analysis therefore suggests that Mexico has more to gain from free trade than either Canada or the United States. Both of the latter countries are already fairly open economies, and the United States is big enough to exploit its dynamic scale economies. Mexico, however, has a smaller internal market. To follow an export-led growth strategy, it must look to the United States, as the trade statistics in Figure 1.3 indicate.

Notes

I would like to thank Karine Moe at the University of Minnesota and Patricia Bravo at the Secretaría de Comercio y Fomento Industrial for their help in gathering the data.

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31. See Stokey, "Learning by Doing and the Introduction of New Goods," and Young, "Learning by Doing."

32. See P. Aghion and P. Howitt, "A Model of Growth Through Creative Destruction," manuscript, Massachusetts Institute of Technology, 1989; G.M. Grossman and E. Helpman, "Product Development and International Trade," *Journal of Political Economy* 97 (1989):1261–1283; and L. Rivera-Batiz and P.M. Romer, "International Trade with Endogenous Technological Change," manuscript, University of Chicago, 1989.

33. Backus, Kehoe, and Kehoe, "In Search of Scale Effects."

34. R. Levine and D. Renelt, "A Sensitivity Analysis of Cross-Country Growth Regressions," manuscript, World Bank, 1990.

35. See H. Grubel and P.J. Lloyd, *Intra-Industry Trade* (London: Macmillan, 1975).

36. Data for this comparison are from Summers and Heston, "The Penn World Table (Mark 5)."

Technical Appendix

Differences in Output per Worker and Interest Rates

To illustrate the point that differences in capital-labor ratios cannot explain the differences in output per worker that are observed between the United States and Mexico, we can perform calculations similar to those of Lucas (1990). Suppose that each of the two countries has the same production function:

$$Y_j = \gamma N_j^{(1-\alpha)} K_j^{\alpha}$$

where Y_j = GDP
N_j = size of work force
K_j = capital
γ and α = parameters
j = country identification (us = United States and mex = Mexico)

In per capita terms, where $y_j = Y_j/N_j$ and $k_j = K_j/N_j$, this becomes $y_j = \gamma k_j^{\alpha}$. The net return on capital r_j is

$$r_j = \alpha \gamma k_j^{(\alpha-1)} - \delta$$

where δ is the depreciation rate. In 1988, according to Summers and Heston (1991), real GDP per worker was $14,581 in Mexico and $37,608 in the United States. Suppose that $\alpha = 0.3$, which is roughly the capital share of income in the United States. Then, to explain this difference in output per worker, we need capital per worker to be larger than that in Mexico by a factor of 23.5,

$$\frac{k_{us}}{k_{mex}} = \left(\frac{y_{us}}{y_{mex}}\right)^{1/\alpha} = \left(\frac{37{,}608}{14{,}581}\right)^{1/0.3} = 23.5$$

Suppose that $\delta = 0.05$ and $r_{us} = 0.05$, which are roughly the numbers obtained from calibration. Then, the net real interest rate in Mexico should be 17.2 times that in the United States,

$$r_{mex} = (r_{us} + \delta)\left(\frac{k_{us}}{k_{mex}}\right)^{1-\alpha} - \delta = 0.10(23.5)^{0.7} - 0.05 = 0.86$$

At least two objections can be raised to the above calculations. First, a comparison based on per capita GDP in U.S. dollars using the exchange rate to convert pesos into dollars would suggest that y_{us}/y_{mex} is much larger, about 7.9. Second, calibrating the capital share parameter using Mexican GDP data would yield a larger value, about 0.5. These two objections work in opposite directions, however, and the calculations can be defended as being in a sensible middle ground: Income comparisons based on exchange rate conversions neglect purchasing-power parity differentials, much of what is classified as net business income in Mexico is actually returned to labor, per capita comparisons rather than per worker comparisons neglect demographic differences, and so on.

If we accept that other factors besides differences in capital-labor ratios must be crucial in explaining differences in output per worker, we must accept that Mexico and the United States have different production technologies. One possibility is that the constant terms differ:

$$Y_j = \gamma_j N_j^{(1-\alpha)} K_j^{\alpha}$$

This difference could be explained by differences in infrastructure, level of education of the work force, and so on. Using this production function, we can estimate the impact of policies that would result in an inflow of capital into Mexico that lower the net real interest from 28 percent to 5 percent per year.

We first estimate the change in the capital-labor ratio:

$$k_{mex} = [\alpha \gamma_{mex}/(r_{mex} + \delta)]^{1/(1-\alpha)}$$

$$\frac{k'_{mex}}{k_{mex}} = \left(\frac{r_{mex} + \delta}{r'_{mex} + \delta}\right)^{1/(1-\alpha)} = \left(\frac{0.28 + 0.05}{0.05 + 0.05}\right)^{1/0.7} = 5.5$$

Plugging this change into the production function, we can estimate the increase in output per worker that would result from this capital inflow:

$$\frac{y'_{mex}}{y_{mex}} = \left(\frac{k'_{mex}}{k_{mex}}\right) = 1.67$$

which implies that output per worker would increase to about $24,300 per year.

Openness to Trade and Productivity Growth

Consider a relationship of the form

$$g(\bar{y}^j) = \alpha + \beta_1 \log \bar{Y}^j + \beta_2 \log \sum_{i=1}^{I} (\bar{X}_i^j/\bar{Y}^j)^2 + \beta_3 \log \overline{GL}^j$$
$$+ \beta_4 \log y^j + \beta_5 \, PRIM^j + \epsilon^j$$

where $g(\bar{y}^j)$ = average yearly growth of manufacturing output per worker in percent form from 1970 to 1985

$\bar{Y}^j$ = 1970 manufacturing output

$\sum_{i=1}^{I} (\bar{X}_i^j/\bar{Y}^j)^2$ = specialization index for exports at the three-digit SITC level

$\overline{GL}^j$ = 1970 Grubel-Lloyd index of intraindustry trade

y^j = 1970 per capita income

$PRIM^j$ = 1970 primary school enrollment

A bar above the variable indicates that the variable deals with the manufacturing sector only; the specialization index and the Grubel-Lloyd index, for example, are computed for manufacturing industries only.

The Grubel-Lloyd (1975) index for country j is

$$GL^j = \frac{\sum_{i=1}^{I} (X_i^j + M_i^j - |X_i^j - M_i^j|)}{X^j + M^j}$$

where X_i^j = exports of industry

M_i^j = imports of industry

X^j = total exports

M^j = total imports

Backus, Kehoe, and Kehoe (1991) find a strong positive relation between the Grubel-Lloyd index for all products at the three-digit SITC level and growth in GDP per capita for a large sample of countries. They also find a strong positive relationship between the Grubel-Lloyd index for manufactured products and growth in manufacturing output per worker. Trade in category 711, nonelectrical machinery, might consist of imports of steam engines (7113) and exports of domestically produced jet engines (7114). Simultaneous imports and exports of these goods provide the country with both and lead to more efficient production.

I include total manufacturing output and the specialization index to account for the impact of specialization in production of final goods. One motivation for using export data is that specialization is most important in the export sector. Another motivation is purely practical: The trade data permit a more detailed breakdown of commodities. Furthermore, the export specialization index can be thought of as a proxy for the total production specialization index: If exports are proportional to outputs, then

$$\overline{X}_i^j = \epsilon \overline{Y}_i^j$$

and

$$\sum_{i=1}^{I} (\overline{X}_i^j/\overline{Y}^j)^2 = \epsilon^2 \sum_{i=1}^{I} (\overline{Y}_i^j/\overline{Y}^j)^2$$

and the two indices are proportional. The Grubel-Lloyd index is included, as I have explained, because it captures, in a loose way, the ability of a country to trade in finely differentiated products, which my theory implies is important for growth. I include initial per capita income and the primary enrollment rate partly because they are widely used by other researchers in this area, such as Barro (1991), and partly because they may be relevant to my theory: The inclusion of per capita income allows for less-developed countries, which are playing catch-up in order to face different technological constraints. The inclusion of the enrollment rate allows for differences in countries' ability to profit from learning by doing because of differences in levels of basic education.

A regression of this relationship yields

$$g(\overline{y}^j) = \underset{(5.686)}{2.602} + \underset{(0.259)}{0.743} \log \overline{Y}^j + \underset{(0.113)}{0.309} \log \sum_{i=1}^{I} (\overline{X}_i^j/\overline{Y}^j)^2$$

$$+ \underset{(0.410)}{0.890} \log \overline{GL}^j - \underset{(0.799)}{0.172} \log y^j + \underset{(2.271)}{2.421}\, PRIM^j$$

$$NOBS = 49 \qquad R^2 = 0.479$$

(The numbers in parentheses are heteroskedasticity-consistent standard errors.) Notice that in this regression, the coefficients all have the expected signs and that the first three variables—total manufacturing output, the specialization index, and the Grubel-Lloyd index—are all statistically significant.