Comment by Timothy J. Kehoe

Drusilla Brown, in surveying the results of various applied general equilibrium studies of the potential impact of North American economic integration, provides more than a survey. She also analyzes the economic intuition behind the central results of each study and the differences among them. For estimating the impact of policy changes such as those involved in NAFTA, applied general equilibrium models have become the tool of choice; indeed this sort of model is virtually the only tool currently used to measure the global impact of NAFTA. Having worked on and off in applied general equilibrium modeling for the past twelve years, and having long been convinced of the superiority of this approach over obvious alternatives, such as large-scale macroeconomic models, I am pleased by these developments. Yet I think it essential to bear in mind that this sort of approach to policy analysis is still at a fairly early stage in its development.

As Brown stresses, it is important that these models do not become black boxes. Since there is still no widespread agreement on model structure, it is essential to relate the results that a model generates to the underlying assumptions on structure. Brown's paper is a major contribution in this direction. It is worth stressing, however, that a more complex model is not necessarily a better model. Ultimately, there is a need to choose among alternative model structures on the basis of how well they are able to match up with empirical evidence. In this respect, NAFTA will provide an ideal empirical test for the applied general equilibrium models used to analyze it. As Brown points out in her paper, these models must incorporate dynamic phenomena if they are to capture much of the actual impact of a change like NAFTA. They may also need to incorporate, even in simple ways, some stochastic phenomena, particularly to model the effect of NAFTA on investor confidence in Mexico.

Empirical Validation

Although much 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 gone into evaluating the performance of such models after such policy changes have actually taken place. Only by showing that a model can replicate

Table 9. Comparison of Spanish Model's Prediction with the Data
Percent change in relative price[a]

Sector	*Actual, 1985–86*	*Model*	*Adjusted model*
Food and nonalcoholic beverages	1.8	−2.3	1.7
Tobacco and alcoholic beverages	3.9	2.5	5.8
Clothing	2.1	5.6	6.6
Housing	−3.2	−2.2	−4.8
Household articles	0.1	2.2	2.9
Medical services	−0.7	−4.8	−4.2
Transportation	−4.0	2.6	−6.6
Recreation	−1.4	−1.3	0.1
Other services	2.9	1.1	2.8
Weighted correlation with 1985–86[b]	1.000	−0.079	0.936

Source: Timothy J. Kehoe, Clemente Polo, and Ferran Sancho, "An Evaluation of the Performance of an Applied General Equilibrium Model of the Spanish Economy," Working Paper 480 (Federal Reserve Bank of Minneapolis, 1991).
a. Change in sectoral price index deflated by appropriate aggregate price index.
b. Weighted correlation coefficients with actual changes 1985–86. The weights used, from top to bottom, are 0.2540, 0.0242, 0.0800, 0.1636, 0.0772, 0.0376, 0.01342, 0.0675, and 0.1617, respectively; these are the consumption shares in the model's benchmark year, which is 1980.

and, to some extent, predict the principal developments that occur in the economic system that it intends to represent can the effort put into a large-scale quantitative model be justified.

One approach to empirically validating a model is to investigate how well it tracks the impact of policy changes and exogenous shocks after these shocks have occurred.[22] Another approach is to compare predictions with actual outcomes. The problem with the second approach is that the actual data can be significantly affected by unforeseen exogenous shocks that occur concurrently with the foreseen policy change. Applied general equilibrium modelers of the Canadian-U.S. Free Trade Agreement complain, for example, that it is difficult to compare their predictions with the economic experience of the last several years because of the recession in both countries. Since applied general equilibrium models have very explicit structures, however, it should be possible to disentangle the impacts of different shocks and policy changes using the model.

Kehoe, Polo, and Sancho take a step in this direction.[23] They assess the performance of a model of the Spanish economy built in 1984–85 to analyze Spain's 1986 entry into the European Community. The first column of table 9 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 those 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 9, which correspond remarkably 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 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, and the adjusted model does somewhat worse. Overall, however, the exercise shows that this sort of model can well predict the changes in relative prices and resource allocation that result from a major policy change.

To be sure, the principal policy change that occurred in Spain in 1986 was a tax reform that converted most indirect taxes to a value-added tax, in accord with EC requirements. The process of trade liberalization began in 1986 and is captured in the model: unlike the modeling exercises evaluated by Brown, however, the work on Spain did not concentrate on trade issues. Consequently, the results from the Spanish model do not help us much to discriminate among the various model structures discussed in Brown's paper.

One way to evaluate these different modeling strategies would be to modify the Spanish model to incorporate 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 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.

In any case, 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 so is that of 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-good 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.[24]

Table 10. Growth Rates of GDP in Mexico and Spain, 1980–91
Real change in percent a year

	Mexico				*Spain*			
Year	*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: Instituto Nacional de Estadística, Geografía e Informática, Mexico; and Instituto Nacional de Estadística, Spain.

Intertemporal Factors

As Brown points out, and as I have stressed elsewhere,[25] the dynamic impact of NAFTA is likely to dwarf the static impact analyzed by most applied general equilibrium models. Perhaps the main impact of the entry into the EC on the Spanish economy, for example, has been a sharp increase in foreign investment closely related to increases in GDP and imports. From 1980 to 1985 investment in Spain actually fell by 1.0 percent per year (as shown in table 10). In contrast, since its entry into the EC in 1986, investment has grown by 10.0 percent a year on average. Similarly, GDP growth has increased from 1.4 percent average in 1980–85 to 4.1 percent in 1986–91, and import growth has increased from 1.3 percent to 14.2 percent. A similar pattern can be seen to emerge in Mexico with the "apertura," or openness policy, that began to take effect in 1988 and 1989.

NAFTA would 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. Interestingly, none of the models discussed by Brown deal explicitly with the issues involved. Robert McCleery mentions the pattern in the data in a footnote, but most of the relevant variables are assumed to be exogenous in his model.[26]

In many of the models, the most dramatic effects of NAFTA are those that result from increases in foreign investment in Mexico. Yet in all these models, even in the dynamic ones, this process is modeled as exogenous. A fully specified dynamic general equilibrium model is the ideal tool for analyzing capital flows. The essential question that such a model needs to address is: if the post-NAFTA capital stock in Mexico is large and the corresponding interest rate low, why is the pre-NAFTA capital stock small and the corresponding interest rate high? One possible answer is that a high interest rate in Mexico has been the result of relatively closed capital markets and of inefficient, oligopolistic financial intermediaries. There is indeed some evidence to support this view.[27] To follow this approach, one would model explicitly how NAFTA would result in more competition and lower prices in the financial intermediation market.

An alternative answer to the question why the pre-NAFTA interest rate in Mexico is higher than it is in the United States or Canada is that there is a risk premium on investing in Mexico because of fears of inflation or changes in government policies. To follow this approach, one would model how NAFTA would lock Mexico and its two northern neighbors into policies that would help guarantee economic stability in Mexico, which would lower the risk premium and, consequently, the interest rate. Modeling this satisfactorily would require including some stochastic features in the model: exactly what is it that potential investors, inside and outside Mexico, fear, and how does NAFTA lower the probability of this occurring?

There are, of course, other intertemporal factors that should be built into a complete analysis of the impact of NAFTA. One obvious factor is differences in the rates of population growth and in the demographic structures among the three countries. In Mexico, for example, because of a high rate of population growth, half the population is currently under the age of twenty, while in Canada and the United States the population is aging (see table 11). Modeling how the three countries will interact over time requires explicit modeling of borrowing, lending, and human capital accumulation decisions.

Table 11. Population by Age Group, 1990
Percent

Age	*Mexico*	*United States*
0–15	41.0	23.2
16–24	19.2	13.0
25–64	35.6	51.2
65 and over	4.2	12.6

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

Yet another intertemporal factor that should be built into a dynamic analysis of the impact of NAFTA is total factor productivity growth. Using simple econometric estimates based on cross-country data, I have calculated that openness in Mexico could lead to a 50 percent increase in total factor productivity in manufacturing in Mexico within twenty-five years, over and beyond other effects.[28] This work is still at a preliminary stage. The sizes of the numbers involved, compared with those in the studies analyzed by Brown, indicate that this is a fruitful direction for future research.

Comment by Robert Z. Lawrence

This is a very informative paper that does what it intended to do. Not only does Brown summarize the results of the various models, but she gives the reader some useful insights into why they differ. In particular, she makes clear the considerable degree to which fairly innocent modeling assumptions can affect results. Indeed, making assumptions that products are differentiated by country of destination or origin, or both, and that returns to scale are constant will reduce the size of the effects of NAFTA. Together these assumptions limit the degree to which countries specialize because of increased trade opportunities. This leads to results that suggest NAFTA has small effects on welfare, and, implicitly, on adjustment, even in the case of Mexico. As Brown notes, however, work following recent theoretical developments captures more realistic features, such as investment flows, imperfect competition, scale economies, product differentiation, endogenous growth, and uncertainty and indicates effects that are considerably larger.

I do not wish to criticize the overall CGE modeling framework. The

great virtue of models is that they usually rest on solid theoretical grounds and are thus far more credible than the ad hoc polemical calculations that often characterize advocacy pieces in trade research. Since Brown has done such a good job of showing what these models capture, in my comments I discuss what they leave out.

A spurious criticism sometimes lodged against these models is that they typically assume full employment. In many policy discussions the question arises about the impact of policy on net job loss. I have heard it argued that models which assume full employment cannot capture employment effects. However, they are able to indicate the sectoral reallocation of labor induced by NAFTA and thus, implicitly, the extent of employment adjustment. By contrast, the more Keynesian models that assume permanent and variable unemployment are not well suited for analyzing the medium-term effects of trade policy.

What is NAFTA? In the models summarized by Brown it is a policy that would remove the tariff and nontariff barriers in North America. But in several respects, I believe this characterization is inadequate and tends to understate NAFTA's impact both on North America and the rest of the world. Admittedly, some features of NAFTA are difficult to quantify, but they could actually be more significant than those that have been quantified in the models. I feel they should not be overlooked in appraising the merits of an agreement.

The first relates to the issue of policy credibility. Implicitly all policies in the models are assumed to be credible and permanent. However, particularly so far as Mexico is concerned (and to some degree so far as the United States is concerned) without NAFTA these policies would be less credible. President Salinas could have unilaterally reduced tariffs and investment barriers in Mexico—indeed he did to a large extent—but he would not have had the effects of NAFTA in convincing foreign and domestic investors that his policies were likely to persist. Some have tried to embody this effect by lowering risk premiums on aggregate investment, but I think doing so fails to capture the major effects on sourcing decisions that multinational corporations are likely to undertake when changes are credibly permanent. I would argue that the elasticity parameters of adjustment are likely to be considerably larger when changes are credible.

A second issue is that NAFTA is about much more than the simple removal of border barriers. As seen in the deliberations over NAFTA, when a poor country lowers its border barriers it raises concerns not simply about competition between workers of different wages but also about the effects of different institutional practices and legal regimes. These relate

to rules for intellectual property, pollution, worker safety, and so on. The result is that to allow free trade, the governments have to agree to a much greater degree of integration than is reflected simply by the removal of border barriers. In many cases, this will again lead to much greater responses than the models estimate. As a result of NAFTA, for example, Mexico has introduced a new regime for the protection of intellectual property rights. Mexico has also radically transformed its sectoral industrial policies in automobiles and informatics and technology transfer. Mexico will also be importing U.S. rules and standards, a change that will eventually mean much easier and less costly access for products and capital flows on both sides of the border. In some cases, however, tougher standards could raise costs, and some Mexican industries could find expansion more difficult than the models estimate.

A third feature of NAFTA of particular concern to U.S. consumers and producers in third countries relates to the definition of rules of origin. In textiles, automobiles, and semiconductors, U.S. producers see NAFTA as an opportunity to increase domestic protection and to gain an advantage, particularly against Asian competitors. Tough, protectionist rules of origin could well take away what the lowering of tariffs and nontariff barriers seem to provide. Trade diversion from third countries could be more significant than the estimates that ignore the effect of such rules.

A fourth aspect, which is missing from the models but was central to the U.S.-Canadian trade negotiations, concerns the administration of trade and investment rules. Indeed a major reason for the Canadian-U.S. Free Trade Agreement was the Canadian fear of the arbitrary and protectionist administration of U.S. trade laws. Likewise the United States sought easier access for investment in Canada. To be sure, the goals were not fully achieved, but nonetheless their impact could potentially be greater than the removal of tariffs worth a few percentage points.

A fifth aspect relates to the geographic incidence of the effects. This issue demands considerable more work and detail in the models. Nonetheless, as Paul Krugman has pointed out, NAFTA is likely to have a dramatic effect on the geographic development of Mexico—in particular, in alleviating some of the centripetal forces that the inward-looking strategies of the past set up around Mexico City and in redistributing growth toward the north of the country. Likewise in the United States, NAFTA's effects appear small in relation to the U.S. economy but could be large in certain regions and communities. These locational aspects deserve more attention.

The final consideration, which I am particularly concerned about and

which could in principle be modeled but has not been, concerns the impact of the real exchange rate and its dynamics. There is a consensus that the most important effects of NAFTA are on capital flows. This implies that if NAFTA is successful, there will be an adjustment in the North American capital stock that could be associated with large shifts in the real exchange rate. Yet the CGE models examine only the comparative static long-run effects and fail to track the effects of this stock adjustment. Over the long run, Mexico, as a debtor country, will probably have to run larger trade surpluses (or smaller deficits), and thus the real value of the peso will have to be weaker than it would otherwise be. However, the transition path is more complex. In the short run, to effect the capital transfer to Mexico, the real exchange rate of the peso would have to rise and of course Mexico would have to sustain a larger trade deficit. These effects imply that, in the short run, the Mexican adjustment to NAFTA is more difficult and larger than implied in the CGE models, since the traded-goods sector will be hit by a strong currency as well as liberalization. On the other hand, the inflationary adjustment in Mexico may be eased. For the United States, the process is the mirror image. The dollar will be weaker, the trade surplus with Mexico larger, and thus the impact on adversely affected sectors smaller than the CGE models suggest. Indeed, in anticipation of NAFTA there has been a larger Mexican trade deficit, a larger U.S. trade surplus with Mexico, and a stronger peso. This sort of adjustment is not beyond the capacity of modelers to perform, and I believe just such an analysis should be undertaken as a guide to policy.

Notes

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3. Roy G. Boyd, Kerry Krutilla, and Joseph A. McKinney, "The Impact of Tariff Liberalization between the United States and Mexico: A General Equilibrium Analysis," Ohio University, Economics Department, February 1992.

4. David Roland-Holst, Kenneth A. Reinert, and Clinton R. Shiells, "North American Trade Liberalization and the Role of Nontariff Barriers," Mills College, April 1992.

5. Carlos Bachrach and Lorris Mizrahi, "The Economic Impact of a Free Trade Agreement between the United States and Mexico: A CGE Analysis," KPMG Peat Marwick, Washington, February 1992.

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7. Irene Trela and John Whalley, "Bilateral Trade Liberalization in Quota Restricted Items: U.S. and Mexico in Textiles and Steel," University of Western Ontario, Department of Economics, May 1991.

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9. Bob Hamilton and John Whalley, "Optimal Tariff Calculations in Alternative Trade Models and Some Possible Implications for Current World Trading Arrangements," *Journal of International Economics*, vol. 15 (November 1983), pp. 323–48; John B. Shoven and John Whalley, "Applied General Equilibrium Models of Taxation and International Trade," *Journal of Economic Literature*, vol. 22 (September 1984), pp. 1007-51; and Drusilla K. Brown, "Tariffs, the Terms of Trade, and National Product Differentiation," *Journal of Policy Modeling*, vol. 9 (Autumn 1987), pp. 503–26.

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11. Richard Harris, "Market Structure and Trade Liberalization: A General Equilibrium Assessment," *American Economic Review*, vol. 74 (December 1984), pp. 1016–32.

12. David Cox and Richard G. Harris, "North American Free Trade and Its Implications for Canada: Results from a CGE Model of North American Trade," *World Economy*, vol. 15 (January 1992), pp. 31–44. Horacio E. Sobarzo, "A General Equilibrium Analysis of the Gains from Trade for the Mexican Economy of a North American Free Trade Agreement," El Colegio de México, Centro de Estudios Económicos, December 1991; and Drusilla K. Brown, Alan V. Deardorff, and Robert M. Stern, "A North American Free Trade Agreement: Analytical Issues and a Computational Assessment," *World Economy*, vol. 15 (January 1992), pp. 11–30.

13. H. Eastman and S. Stykolt, "A Model for the Study of Protected Oligopolies," *Economic Journal*, vol. 70 (June 1960), pp. 336–47.

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19. Robert K. McCleery, "An Intertemporal, Linked, Macroeconomic CGE Model of the United States and Mexico, Focusing on Demographic Change and Factor Flows," Economic Development and Policy, East-West Center, Honolulu, February 1992.

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23. Timothy J. Kehoe, Clemente Polo, and Ferran Sancho, "An Evaluation of the Performance of an Applied General Equilibrium Model of the Spanish Economy." Working Paper 840 (Federal Reserve Bank of Minneapolis, 1991).

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25. Kehoe, "Modeling the Dynamic Impact."

26. McCleery, "An Intertemporal, Linked, Macroeconomic CGE Model."

27. See for example, Garber and Weisbrod, "Opening the Financial Services Market in Mexico," Brown University, 1991.

28. Kehoe, "Modeling the Dynamic Impact."