Evaluating the Success of a CGE Model of the U.S.-Canada and North American Free Trade Agreements

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Abstract

In this paper I analyze the performance of the Michigan Model of Production and Trade in simulating the impact of trade liberalization under the North American Free Trade Agreement, reviewing the results of Brown, Deardorff, and Stern (1992). Because the NAFTA entered into force only part way through the phase-in of the U.S.-Canada FTA accord, I consider their joint impact on the pattern of relative trade flows. The methodology draws on the Fox (2000) analysis of the U.S.-Canada FTA. A substantial innovation in this paper is the reimplementation of the model using MPSGE/GAMS. Preliminary results suggest that the model performs best when simulating the impact on the already-substantial trade flows between U.S.-Canada and U.S.-Mexico. The expansion of certain sectors that had little pre-NAFTA trade highlights the difficulty of using a CES specification.

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Introduction

The North American Free Trade Agreement (NAFTA) has just celebrated its tenth anniversary, having entered into force January 1, 1994. The Canada-U.S. Free Trade Agreement, subsumed by the NAFTA, entered into force on January 1, 1989. Much ink was spilled in anticipation of the NAFTA, analyzing the potential ramifications of such an agreement. Since 1994, even more has been written about what has happened as a result of the agreement. One important question remains: How successful were we at anticipating what would happen? This question is not often asked, though knowing the answer could be of great assistance to policy analysts reflecting on the probable impact of future agreements.

This paper sets forth an implementation of one of the models used for both the U.S.-Canada FTA and the NAFTA and considers how well it performs at simulating the impact of liberalization among the three partner countries. Drusilla Brown, Alan Deardorff, and Robert Stern have employed the Michigan Model of Production and Trade to analyze these two agreements, as well as many others. Brown and Stern (1989) analyzed the U.S.-Canada FTA and concluded that both partner countries would enjoy increases in welfare (Canada's by 1.1 percent of GDP, that of the United States by 0.1 percent), while other countries would suffer a small decline. Brown, Deardorff, and Stern (1992) looked at the NAFTA and took as the starting point the state of the world before the establishment of either agreement. Given how both agreements are intertwined, this was a prudent approach, especially when one considers that only a portion of the U.S.-Canada FTA had entered into force by 1994. They suggest that a NAFTA encompassing tariffs and NTB reductions would yield results in line with those of the U.S.-Canada FTA study. U.S. welfare was expected to rise by 0.1 percent of GDP, while Canada would see an increase of 0.7 percent and Mexico a gain of 1.6 percent. Again, the rest of the world was expected to suffer a small decline in welfare, about $15 million.

Following the approach laid out in Kehoe, Polo, and Sancho (1994), Fox (2000) presents an approach to analyzing the success of the Brown and Stern model of the U.S.-Canada FTA, employing economic data that had been taken as exogenous in the original model and using it along with the known policy experiment of tariff removal to arrive at a simulation incorporating macroeconomic shocks to generate a simulation that can more reasonably be used to compare the model's performance against the observed economy. This paper performs the same kind of analysis, using the NAFTA model as its starting point and making appropriate macroeconomic adjustments to the policy change in order to assess the model's performance.

Model Implementation

This paper relies on a new implementation of the Michigan Model of Production and Trade that differs both from its original form as used in the work of Brown Deardorff, and Stern, as well as from its presentation in the earlier work by Fox. The model is written in MPSGE/GAMS, a flexible modeling framework for analyzing a wide range of economic models subject to a relatively modest number of specification constraints. For example, MPSGE requires that the model exhibit constant returns to scale. At first blush, this would appear to be problematic given the Michigan Model's use of Dixit-Stiglitz/Spence monopolistic competition in production. Following

Markusen and Rutherford (1995), however, this problem can be surmounted by creating an additional agent within the model to handle the disposal of economic rents that accrue when the model is out of equilibrium.

The model consists of 29 sectors, 23 of which are tradable, with four country/regions: the United States, Canada, Mexico, and an aggregate Other 31 region.[1] The Rest of World is represented through a reduced form supply and demand specification that maintains trade balance. Consumption demand is modeled as a two-stage process, with a representative agent in each country maintaining fixed budget shares for each sector in the first stage. Demand for particular varieties in the second stage follows the Dixit-Stiglitz/Spence specification.

Producers in most sectors follow the Dixit-Stiglitz/Spence model of symmetric monopolistic competition, where each producer faces a fixed cost of production and exercises some market power that allows it to charge some markup over fixed cost. In equilibrium, the revenue from markups just covers the fixed cost of production. As the price received by the producer rises, more firms are drawn into production such that each individual firm's profits fall to the point where they again just cover fixed costs. Conversely, as price received falls, firms withdraw from production, attenuating the price drop and returning the market to equilibrium. Several sectors[2] are characterized by perfect competition. These product markets are modeled following Cobb-Douglas, while

[1] The Other 31 aggregate region is composed of Australia; Austria; Belgium-Luxembourg; Denmark; Federal Republic of Germany; Finland; France; Ireland; Italy; Japan; the Netherlands; New Zealand; Norway; Sweden; Switzerland; the United Kingdom; Argentina; Brazil; Chile; Colombia; Greece; Hong Kong; India; Israel; Portugal; Singapore; South Korea; Spain; Taiwan; Turkey; and Venezuela.
[2] The sectors modeled as perfectly competitive are Agriculture, Forestry, and Fishing; Leather Products; Wood Products; Construction; and Commercial, Social and Personal Services.

consumers differentiate goods by country of origin (the Armington assumption) rather than by firm.

Data

Data are drawn from a number of sources to establish the 1988 benchmark for the model, the state of the economy in the comparison period of 2000, and to calculate the magnitude of the macroeconomic shocks applied to the model to represent changes to the economy that are exogenous to the model framework.

The benchmark data set is more fully described in Fox (2000). Briefly, the input-output tables are drawn from the original Michigan Model. The U.S. table is constructed from the 1977 benchmark table, the Canadian table from 1976, and the Mexican IO table from 1980. The tables are then rebalanced to reflect the sectoral gross output, exports, and imports prevailing in the base year, 1988. Trade flows are drawn from Statistics Canada's trade database documented in Feenstra et al. (1997). Gross output by sector is provided by the OECD.

The macroeconomic shocks are drawn from a number of sources. Changes to the capital stock are constructed using OECD data on capital investment, while changes in the quantity of labor are proxied by changes in the work force drawn from the OECD. Balance of trade changes are drawn from the IMF International Financial Statistics.

Data describing the state of the world in the comparison year, 2000, come from many of the same sources. Trade, however, is drawn from the UN COMTRADE database through the World Bank WITS system. Output and employment both come from the same OECD sources.

Testing

In order to answer the question of whether a model performs well or not, some kind of measure of fit must be employed to permit comparison of different policy scenarios. Fox (2000) provides a full discussion of the two measures employed in this paper. What follows is an abbreviated explanation.

The first measure, *r*, was proposed by Kehoe et al. (1995) and adopted by Fox (2000). This is the weighted correlation and can be expressed as follows:

$$r = \frac{\Sigma_i w_i^2 y_i \hat{y}_i}{\sqrt{\Sigma_i w_i^2 y_i^2 \Sigma_i w_i^2 \hat{y}_i^2}}$$

The parameter w_i is the weight for sector *i*. The observed percentage change of the variable in question is y_i, while $\hat{y}_i$ represents the simulated percentage change in the same variable.

Fox (2000) proposes a second measure, similar to the R^2 statistic used in Kehoe et al. In order to test model performance, the following regression is performed using the observed percentage change as the dependent variable and the simulation result as the independent variable:

$$y_i \sqrt{w_i} = \beta_1 \hat{y}_i \sqrt{w_i} + \varepsilon_i \sqrt{w_i}$$

This is a weighted regression with no intercept, generating two principal indicators to measure the fit of the simulation. The first is the coefficient β_1, which reports the ability of the simulation to simulate the magnitude of the observed outcome. When $\beta_1 > 1$, the magnitude of the simulated $\hat{y}_i$ is too small, while if $\beta_1 < 1$, then the simulated values are too large. The second indicator is the adjusted R^2 of the regression equation.

Experiment

As a first step, we perform the experiment of applying the policy of full tariff removal in the model and comparing the results to the observed changes in real trade flows between the partner countries in 2000. The summary of the measures of fit is shown in Table 1, in the column labeled “Full Tariff”. Sectoral simulation results for trade are given in Tables 3-7. The weighted correlation, *r*, indicates a positive correlation in every case, although the correlation between Canada’s simulated and actual percentage changes in imports from Mexico are only weakly positive, with r=0.100. Turning to the regression test results, the adjusted R^2 ranges from essentially zero for the same Canada-Mexico trade flow to a high of 0.713 for Mexico’s imports from the United States. The magnitude coefficient β_1 is greater than 1 in every case, meaning that the model under-predicts the magnitude of changes in trade flows. Given that no adjustment has yet been made to capital stock or labor supply, this should come as little surprise.

As a second experiment, I include shocks to each region’s capital stock and labor supply, and I take into account the observed change in the balance of trade in order to account for capital flows among the regions. The shocks applied are listed in Table 2.

Next I combine experiments one and two into a third experiment, removing trade barriers and applying shocks to the capital stock, labor supply, and capital flow/balance of trade in the four countries/regions. A summary of the measures of fit is found in Table 1 in the column entitled “Full Tariff + K,L,BT”. Using the weighted correlation as the standard, applying the macroeconomic shocks does not appear to improve model performance. Compared to the application of tariff reduction only, *r* falls in four of the six cases. Turning to the regression results, it is immediately apparent that the model is performing much better with respect to magnitude of changes, yielding measure of β_1 that are closer to 1, though in most cases much too high. In general, they fall by about half, although the geometric mean remains about 4. The adjusted R^2 improves in four out of six cases, the two exceptions being Mexico's imports from the United States and Canada.

Conclusion

This paper considers the performance of the Michigan Model of Production and Trade in analyzing the potential impact of the North American Free Trade Agreement on trade flows between the partner countries. Initial results suggest that while the model does a reasonable job of capturing the general pattern of trade, it fails to simulate the magnitude of trade, especially in cases where observed trade growth was substantial. This argues for a careful consideration of the elasticities employed in the model.

Table 1: Summary of Goodness of Fit Measures

Variable	Simulation: Full Tariff	Simulation: Full Tariff + K,L,BT
United States		
Pct. Change in Imports from Canada		
Weighted *r*	0.526	0.501
β_1	1.397	1.126
s.e.	(0.256)	(0.199)
R^2	0.556	0.574
Pct. Change in Imports from Mexico		
Weighted *r*	0.278	0.194
β_1	14.136	9.442
s.e.	(4.852)	(3.521)
R^2	0.246	0.212
Canada		
Pct. Change in Imports from the United States		
Weighted *r*	0.305	0.291
β_1	1.383	0.984
s.e.	(0.520)	(0.356)
R^2	0.209	0.224
Pct. Change in Imports from Mexico		
Weighted *r*	0.080	0.067
β_1	7.835	6.392
s.e.	(7.455)	(5.224)
R^2	0.005	0.021
Mexico		
Pct. Change in Imports from the United States		
Weighted *r*	0.105	0.266
β_1	3.308	3.412
s.e.	(0.614)	(0.553)
R^2	0.569	0.617
Pct. Change in Imports from Canada		
Weighted *r*	0.394	0.482
β_1	6.088	6.111
s.e.	(1.368)	(1.250)
R^2	0.461	0.510

Table 2: Macroeconomic Shocks Applied to Model

Region	Capital stock (pct.)	Labor supply (pct.)	Capital flow (billions of 1988 dollars)
United States	45.1	18.7	+29.55
Canada	35.9	17.8	-3.07
Mexico	53.8	39.9	+3.03
Other 31	45.1 (est.)	20.0 (est.)	-29.59

Table 3: U.S. Imports from Canada

		Simulation		Observed		Tariff
	Sector	Full tariff	FT + K,L,BT*	88-00 %Chg.	1988 Base	1988
g1	Agriculture, forestry, and fishing	17.8	68.2	129.3	1439.8	1.6
g310	Food, beverages, and tobacco	130.6	162.7	139.2	2812.9	3.8
g321	Textiles	215.4	263.9	344.7	383.0	7.2
g322	Wearing apparel	771.9	958.3	402.1	337.4	18.4
g323	Leather products	185.4	155.5	-6.7	43.2	2.5
g324	Footwear	290.5	373.9	30.1	52.2	9.0
g331	Wood products	47.8	33.6	139.4	4079.5	0.2
g332	Furniture and fixtures	118.3	150.8	378.3	974.4	4.6
g341	Paper and paper products	43.1	59.3	31.3	8942.3	0.0
g342	Printing and publishing	43.2	62.8	127.5	478.8	0.3
g35A	Chemicals	53.4	74.0	132.3	4247.5	0.6
g35B	Petroleum and related products	35.9	52.0	137.7	1502.9	0.4
g355	Rubber products	93.7	117.1	296.6	479.0	8.4
g36A	Nonmetallic mineral products	44.4	61.1	81.3	555.4	0.3
g362	Glass and glass products	99.0	112.0	110.9	284.4	6.9
g371	Iron and steel	75.7	91.2	43.4	1972.9	4.4
g372	Nonferrous metals	36.2	48.7	59.9	4874.6	0.5
g381	Metal products	83.2	98.4	174.9	1604.6	4.0
g382	Nonelectrical machinery	41.3	49.0	110.2	6380.2	2.2
g383	Electrical machinery	94.1	112.1	256.4	5087.4	4.5
g384	Transport equipment	29.7	43.9	83.4	29663.4	0.0
g38A	Miscellaneous Manufacturing	41.2	54.7	270.5	1842.4	0.9
g2	Mining and quarrying	18.9	35.5	180.1	4421.5	0.0

*Shading in cell indicates fit worsens with macro shock.

Table 4: U.S. Imports from Mexico

		Simulation		Observed		Tariff
		Full	FT +	88-00	1988	
	Sector	tariff	K,L,BT*	%Chg.	Base	1988
g1	Agriculture, forestry, and fishing	21.1	94.3	101.3	1461.6	4.0
g310	Food, beverages, and tobacco	105.3	133.9	140.8	1055.8	2.6
g321	Textiles	107.4	139.3	667.9	180.4	2.8
g322	Wearing apparel	193.9	256.7	6571.2	115.6	6.2
g323	Leather products	214.8	254.4	132.1	37.6	4.8
g324	Footwear	132.7	182.4	475.1	54.2	3.5
g331	Wood products	42.8	61.6	152.9	132.6	1.3
g332	Furniture and fixtures	60.0	83.8	3206.6	107.9	1.4
g341	Paper and paper products	83.2	104.0	81.5	246.6	2.5
g342	Printing and publishing	41.8	61.2	674.8	20.1	0.2
g35A	Chemicals	62.7	84.6	124.0	743.4	1.2
g35B	Petroleum and related products	37.2	53.5	124.2	320.1	0.1
g355	Rubber products	42.8	60.0	491.3	70.9	0.1
g36A	Nonmetallic mineral products	54.8	72.7	146.0	226.4	1.0
g362	Glass and glass products	102.7	116.0	295.8	200.0	5.9
g371	Iron and steel	57.8	71.7	250.7	353.9	1.6
g372	Nonferrous metals	51.9	65.8	66.2	663.5	1.6
g381	Metal products	53.8	66.6	774.3	255.6	2.2
g382	Nonelectrical machinery	24.3	31.1	356.2	1524.7	0.9
g383	Electrical machinery	56.9	71.4	5560.6	697.2	2.3
g384	Transport equipment	49.0	65.4	1083.6	1981.1	1.4
g38A	Miscellaneous Manufacturing	45.4	59.4	1530.6	378.6	1.2
g2	Mining and quarrying	20.1	36.9	201.7	3636.5	0.1

*Shading in cell indicates fit worsens with macro shock.

Table 5: Canadian Imports from United States

	Sector	Simulation Full tariff	Simulation FT + K,L,BT*	Observed 88-00 %Chg.	Observed 1988 Base	Tariff 1988
g1	Agriculture, forestry, and fishing	124.4	106.9	61.8	1703.7	2.2
g310	Food, beverages, and tobacco	125.1	171.8	189.2	1533.0	5.4
g321	Textiles	246.4	423.1	162.4	946.9	16.9
g322	Wearing apparel	911.2	1188.4	313.7	122.7	23.7
g323	Leather products	26.8	127.0	-45.1	99.2	4.0
g324	Footwear	708.5	902.3	18.9	42.1	21.5
g331	Wood products	15.0	50.6	133.9	689.9	2.5
g332	Furniture and fixtures	226.9	290.2	289.5	629.2	14.3
g341	Paper and paper products	85.2	161.9	200.0	1228.7	6.6
g342	Printing and publishing	49.8	51.0	91.9	949.4	1.1
g35A	Chemicals	70.1	134.6	235.8	4023.4	7.9
g35B	Petroleum and related products	19.2	47.6	108.2	526.1	0.5
g355	Rubber products	128.2	179.9	182.4	763.4	8.9
g36A	Nonmetallic mineral products	52.3	86.8	36.1	447.1	4.4
g362	Glass and glass products	104.5	105.0	216.0	423.2	7.7
g371	Iron and steel	45.7	92.7	-24.8	809.0	7.4
g372	Nonferrous metals	19.1	56.2	55.4	1901.1	3.3
g381	Metal products	105.9	140.1	85.4	1518.2	8.6
g382	Nonelectrical machinery	31.0	43.6	-44.7	10317.5	4.6
g383	Electrical machinery	56.0	74.7	135.9	9599.7	7.5
g384	Transport equipment	3.4	31.5	-0.5	21553.8	0.0
g38A	Miscellaneous Manufacturing	58.2	83.7	786.5	3721.5	5.0
g2	Mining and quarrying	14.3	45.8	111.5	1857.0	0.0

*Shading in cell indicates fit worsens with macro shock.

Table 5: Canadian Imports from Mexico

		Simulation		Observed		Tariff
	Sector	Full tariff	FT + K,L,BT*	88-00 %Chg.	1988 Base	1988
g1	Agriculture, forestry, and fishing	21.8	64.5	405.7	28.7	1.8
g310	Food, beverages, and tobacco	125.1	171.8	53.4	60.2	5.4
g321	Textiles	73.7	162.2	184.8	26.5	9.1
g322	Wearing apparel	634.0	835.3	3786.3	3.1	19.8
g323	Leather products	397.9	758.7	713.1	0.2	16.8
g324	Footwear	777.6	988.0	535.3	1.5	22.5
g331	Wood products	114.9	192.8	743.4	0.4	8.3
g332	Furniture and fixtures	207.4	267.0	12607.0	2.5	13.6
g341	Paper and paper products	151.3	255.2	580.4	3.5	9.9
g342	Printing and publishing	96.8	98.5	7299.5	0.0	3.9
g35A	Chemicals	78.2	145.7	567.3	10.7	8.4
g35B	Petroleum and related products	14.6	41.8	3131.3	1.5	0.0
g355	Rubber products	12.8	38.4	7149.0	0.3	0.0
g36A	Nonmetallic mineral products	18.4	45.1	520.2	3.0	1.8
g362	Glass and glass products	58.3	58.7	468.2	10.0	4.2
g371	Iron and steel	-11.4	17.2	230.8	25.1	0.0
g372	Nonferrous metals	-13.9	12.9	1256.4	1.0	0.0
g381	Metal products	136.2	175.4	2118.3	5.4	10.1
g382	Nonelectrical machinery	-4.0	5.2	144.8	223.5	1.4
g383	Electrical machinery	22.1	36.7	3631.5	74.4	4.9
g384	Transport equipment	13.1	43.8	15948.3	13.1	0.9
g38A	Miscellaneous Manufacturing	115.6	150.3	3243.0	7.5	8.3
g2	Mining and quarrying	9.9	40.1	127.6	101.9	0.0

*Shading in cell indicates fit worsens with macro shock.

Table 6: Mexican Imports from United States

	Sector	Simulation: Full tariff	Simulation: FT + K,L,BT*	Observed: 88-00 %Chg.	Observed: 1988 Base	Tariff 1988
g1	Agriculture, forestry, and fishing	256.7	157.3	136.1	1527.8	2.0
g310	Food, beverages, and tobacco	366.3	377.8	269.3	911.5	9.3
g321	Textiles	381.5	434.3	2556.7	171.5	11.6
g322	Wearing apparel	385.4	430.4	915.1	283.0	19.8
g323	Leather products	252.1	285.0	1371.8	46.4	12.3
g324	Footwear	746.6	817.6	38.4	48.7	19.7
g331	Wood products	56.1	66.6	599.0	78.7	13.6
g332	Furniture and fixtures	234.7	257.9	1403.8	126.4	14.7
g341	Paper and paper products	72.0	89.3	389.6	673.5	3.0
g342	Printing and publishing	212.7	238.2	1863.0	46.7	8.2
g35A	Chemicals	149.2	175.3	430.1	1786.5	7.1
g35B	Petroleum and related products	105.4	114.2	776.2	329.4	3.4
g355	Rubber products	307.9	293.0	1795.7	109.5	12.3
g36A	Nonmetallic mineral products	413.2	446.7	564.5	68.1	14.6
g362	Glass and glass products	428.1	444.2	1902.5	38.5	15.1
g371	Iron and steel	89.6	111.7	404.4	450.8	7.5
g372	Nonferrous metals	110.5	135.4	485.2	344.6	7.9
g381	Metal products	178.7	191.7	2380.0	318.9	9.6
g382	Nonelectrical machinery	52.7	53.6	673.2	1779.2	12.7
g383	Electrical machinery	132.7	144.6	842.7	3968.3	14.2
g384	Transport equipment	266.9	300.6	1381.2	905.4	13.7
g38A	Miscellaneous Manufacturing	237.6	247.5	1258.8	849.2	14.0
g2	Mining and quarrying	103.9	45.4	141.8	191.5	3.7

*Shading in cell indicates fit worsens with macro shock.

Table 7: Mexican Imports from Canada

	Sector	Simulation Full tariff	Simulation FT + K,L,BT*	Observed 88-00 %Chg.	Observed 1988 Base	Tariff 1988
g1	Agriculture, forestry, and fishing	126.3	113.0	247.2	98.7	1.1
g310	Food, beverages, and tobacco	124.6	130.1	435.8	49.4	1.6
g321	Textiles	385.8	439.1	4094.6	1.8	11.7
g322	Wearing apparel	369.5	412.9	5748.3	0.4	19.4
g323	Leather products	257.1	199.3	2241.8	0.3	8.8
g324	Footwear	718.7	787.4	250.3	0.0	19.3
g331	Wood products	119.2	94.9	10492.3	0.3	15.0
g332	Furniture and fixtures	220.4	242.6	6476.0	0.4	14.2
g341	Paper and paper products	70.4	87.4	178.4	40.0	2.9
g342	Printing and publishing	161.9	183.3	10040.4	0.2	6.3
g35A	Chemicals	219.6	253.1	629.7	27.6	9.8
g35B	Petroleum and related products	399.2	420.4	5126.2	0.2	13.0
g355	Rubber products	202.7	191.7	7808.9	0.8	9.0
g36A	Nonmetallic mineral products	417.7	451.5	1803.2	0.5	14.7
g362	Glass and glass products	681.4	705.2	2554.7	0.4	19.7
g371	Iron and steel	33.6	49.2	193.6	39.0	3.8
g372	Nonferrous metals	48.5	66.1	1222.6	10.3	4.2
g381	Metal products	147.3	158.9	2611.8	4.7	8.3
g382	Nonelectrical machinery	44.7	45.6	1091.0	37.4	12.1
g383	Electrical machinery	126.6	138.3	2506.4	21.6	13.9
g384	Transport equipment	188.5	215.0	1602.2	49.6	11.0
g38A	Miscellaneous Manufacturing	180.3	188.6	2199.1	6.0	11.9
g2	Mining and quarrying	102.0	44.0	10.8	52.7	3.6

*Shading in cell indicates fit worsens with macro shock.

References

Brown, Drusilla K., and Robert M. Stern, "Computable General Equilibrium Estimates of the Gains from U.S.-Canadian Trade Liberalisation," in David Greenaway, Thomas Hyclak, and Robert J. Thornton, eds., Economic Aspects of Regional Trading Arrangements, Hertfordshire, England: Harvester Wheatsheaf, 1989, pp. 69–108.

_____, Alan V. Deardorff, and Robert M. Stern, "A North American Free Trade Agreement: Analytical Issues and Computational Assessment," *The World Economy*, January 1992, *15*, 11-29.

Feenstra, Robert C., Robert E. Lipsey, and Harry P. Bowen, "World Trade Flows, 1970-1992, with Production and Tariff Data," *NBER*, January 1997. Working Paper No. 5910.

Fox, Alan Keith, "Evaluating the Success of a CGE Model of the U.S.-Canada Free Trade Agreement." PhD dissertation, University of Michigan 2000.

Hillberry, Russell H., Michael A. Anderson, Edward J. Balistreri, and Alan K. Fox, "Taste Parameters as Model Residuals: Assessing the 'Fit' of an Armington Trade Model," working paper, available at http://www-personal.umich.edu/~alanfox.

Kehoe, Timothy J., Clemente Polo, and Ferran Sancho, "An Evaluation of the Performance of an Applied General Equilibrium Model of the Spanish Economy," *Economic Theory*, June 1995, *6*, 115-41.

Markusen, James, and Thomas F. Rutherford, "General Equilibrium Modeling with MPSGE: Some Examples for Self-Study," Department of Economics, University of Colorado 1995. Available at http://debreu.colorado.edu/markusen/markusen.htm.