Chapter 3:
Predicting the Effects of NAFTA: Now We Can Do It Better!

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In his presentation, Serge Shikher, international economist at the United States International Trade Commission, reviews the pre-NAFTA forecasts of the effects of NAFTA on trade and compares them to the actual post-NAFTA changes in trade. He then describes a new model of international trade, based on the Eaton and Kortum (2002) methodology. He uses this model to predict changes in post-NAFTA trade from the point of view of 1989. He compares the performance of the new trade model and pre-NAFTA models, and analyzes the differences in forecasts. Shikher's main conclusion is that the new model is able to predict the effects of NAFTA noticeably better than previous models.

Most of the pre-NAFTA forecasts were made using computable general equilibrium (CGE) models that relied on the Armington (1969) assumption to explain two-way trade between countries and home bias in consumption. The models were generally similar, with the type of competition in the goods market being the biggest difference. Their predictions anticipated little effect on trade, output, and employment in the United States, and moderate effects on trade, output, and employment in Mexico.

It turns out that the CGE models significantly underpredicted the effect of NAFTA on trade. In addition, the industry-level changes in bilateral trade that they forecast correlated poorly with the actual post-NAFTA changes.

1. New Model of Trade

Shikher proposes a new model for forecasting the effects of trade liberalizations. The model is based on the neoclassical assumptions of multiple industries, constant returns to scale, perfectly competitive markets, and several factors that are mobile across industries. Countries differ in their factor endowments. In all of these aspects, the model is similar to the currently available computable models of trade.

However, while other models use the Armington assumption to explain two-way trade between countries, this model relies on the Eaton-Kortum (EK) framework at the industry level. Within each industry, there is a continuum of goods produced with different productivities. Production of each good has constant

[11] The views in this article are solely the opinions of the author and should not be interpreted as reflecting the views of the U.S. International Trade Commission or any of its Commissioners.

returns to scale, and goods are priced at marginal cost. Since heterogeneous producers and perfect competition are the defining characteristics of this model, it will be referred to here as the HPPC model.

The use of the Eaton and Kortum (2002) framework instead of the Armington (1969) approach has several key implications. The goods are differentiated by their features, not by their country of origin. The home bias in consumption and cross-country price differentials are explained by trade costs rather than demand-side parameters. Productivity differences across countries and industries play a big role in determining the pattern of trade.

The model has 19 countries, eight manufacturing industries, and two factors of production: capital and labor. The trade cost takes the Samuelson's "iceberg" (ad valorem) form and is separated into policy-related trade costs and non-policy-related trade costs. The policy-related trade barriers (tariffs and tariff equivalents of nontariff barriers) are assumed to be imposed on the f.o.b. values of goods, which corresponds to the practice in the United States, Canada, and Mexico (for NAFTA countries).

Table 1. Pre-NAFTA Tariffs and Ad Valorem Equivalents of Nontariff Barriers (Percent)

Canada	12.06	25.60	21.44	3.46	9.49	7.78	16.65	6.50	11.84
Mexico	42.61	40.37	23.41	16.96	29.44	33.37	13.89	32.95	31.42
United States	13.21	16.45	5.10	1.29	7.76	7.94	3.04	7.42	8.78

Source: Nicita and Olarreaga (2007)

The model is parametrized using 1989 data. Total bilateral trade costs are estimated by applying the Eaton-Kortum approach at the industry level, which makes it possible to derive a gravity-like equation. The equation uses a trade cost function to relate the unobservable trade cost to the observable country-pair characteristics, such as physical distance, common border, common language, and membership in a free trade area. The average estimated transport cost (across country pairs and industries) is 2.27. To simulate NAFTA, total trade costs are reduced by the amount of pre-NAFTA tariffs and ad valorem equivalents of nontariff barriers, obtained from Nicita and Olarreaga (2007) and shown in table 1.

2. Evaluating the Predictions of the Model

The following analysis will compare the forecasts of the HPPC model with data from 1989 to 2008, as well as with the forecasts of the Brown-Deardorff-Stern (BDS) and Roland-Holst-Reinert-Shiells (RRS) models. Table 2 shows that the HPPC model accurately predicts the overall effect of NAFTA.

Table 2. Actual vs. Predicted Percent Changes in NAFTA Trade

Measure	Predicted HPPC	Actual 1989–2008

NAFTA trade relative to the total trade of the NAFTA countries	25.9	24.8
NAFTA trade relative to the total income of the NAFTA countries	62.2	66.5

Note: NAFTA trade is the sum of all bilateral trade flows between the NAFTA countries. The total trade of the NAFTA countries is the sum of their exports and imports. The total income of the NAFTA countries is the sum of their GDPs.
Sources: Author's calculations.

Table 3 gives a more detailed look at the changes in trade of the NAFTA countries. It shows the actual and predicted percentage changes in the total exports and imports of Canada, Mexico, and the United States, relative to their respective GDPs.

Table 3. Actual vs. Predicted Percentage Changes in Total Exports and Imports

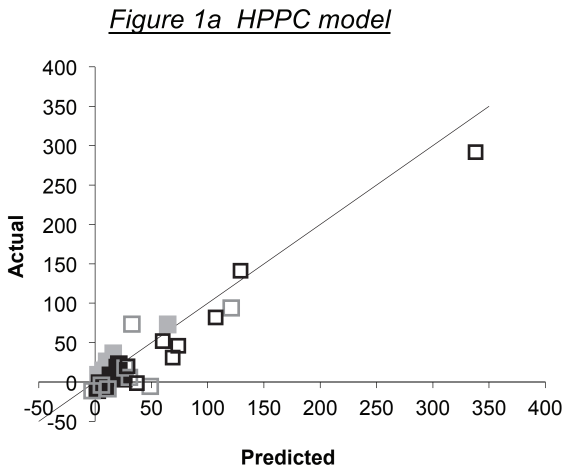
	Actual	Predicted			
Variable	1989–2008	RRS (CRS)	RRS (IRS)	BDS	HPPC
Canadian exports	66.7	17.1	26.0	4.3	45.4
Canadian imports	58.2	10.5	12.3	4.2	37.1
Mexican exports	120.3	11.1	14.0	50.8	130.4
Mexican imports	64.2	12.4	13.9	34.0	58.3
U.S. exports	39.2	6.0	7.8	2.9	24.0
U.S. imports	46.2	7.7	10.1	2.3	17.5
Correlation with data		0.4	0.3	0.9	1.0

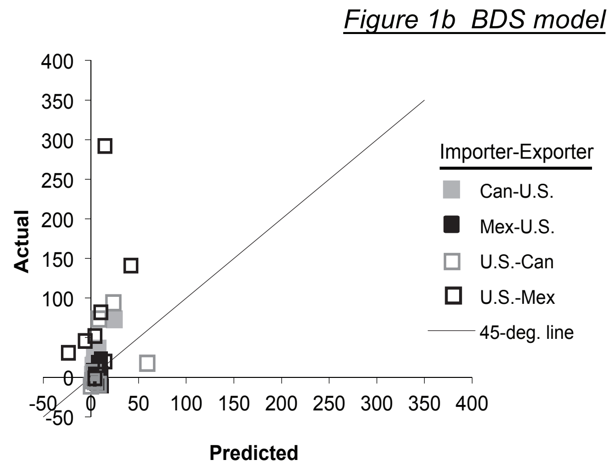
Note: Exports and imports are measured relative to GDP. The model of Ronald-Holst, Reinert, and Shiells (RRS) has two versions: one with constant returns to scale (CRS) and another with increasing returns to scale (IRS). The Brown-Deardorff-Stern (BDS) model has increasing returns to scale. The model with heterogeneous producers (HPPC) described in this paper has constant returns to scale.
Sources: Author's calculations; Roland-Holst, Reinert, and Shiells (1994); Brown, Deardorff, and Stern (1992).

The changes predicted by the RRS and BDS models are many times smaller than the actual changes. The RRS model, whether with constant or increasing returns to scale, performs the worst in terms of correlation with data. The BDS model performs better, but its predicted changes in Canadian and Mexican exports and imports are smaller than the actual changes by an order of magnitude. The HPPC model performs the best: its predicted changes are the closest to the actual.

Figure 1 plots the actual vs. predicted percentage changes in the industry import shares for the U.S.-Canada and U.S.-Mexico trade, which together constitute about 99 percent of NAFTA trade. The share of country i in industry j imports of country n is X_{nij} / IM_{nj} , where IM_{nj} are the total imports of industry j goods in country n. The BDS model is chosen because it seems to be the better-performing of the three previous NAFTA simulations and because of the availability of the detailed simulation results.

Figure 1. Actual vs. Predicted Percentage Changes in Import Shares by Industry





Note: Each observation is a share of country *i* in country *n*'s imports of industry *j*. The correlation between the predicted and actual changes is 0.95 for the HPPC and 0.31 for the BDS model.
Sources: Author's calculations and Brown, Deardorff, and Stern (1992).

It can be seen from these figures that the predictions of the HPPC model are generally close to the actual values, while the BDS model tends to significantly underpredict trade changes. The HPPC model is also better able to explain the variation of changes in trade across industries: the correlation of its predictions with data is 0.95, while for the BDS model it is 0.31.

Table 4 shows the correlations between the actual and predicted changes in import shares for each pair of countries. It also shows the estimated intercepts and slopes for the regressions of actual on predicted changes. Ideally, we would like the intercept to be zero and the slope, one. The correlation is a measure of how much of the variation in the data is explained by the model.

Table 4. Relationships Between Atual and Predicted Changes

		HPPC model			BDS model		
Importer	Exporter	Correlation	Intercept*	Slope	Correlation	Intercept*	Slope
Canada	Mexico	-0.15	423.10	-1.31	0.41	111.09	23.89
Canada	U.S.	0.91	5.71	1.04	0.95	5.54	2.88
Mexico	Canada	-0.57	-185.64	-12.53	-0.14	93.82	-0.81
Mexico	U.S.	0.72	-9.46	1.00	0.10	2.54	0.31
U.S.	Canada	0.77	-7.59	0.81	0.28	12.26	0.58
U.S.	Mexico	0.98	-15.70	0.93	0.44	65.84	2.23

*Note: R^2 for these regressions is correlation.
Source: Author's calculations.

The table shows, for example, that on average the HPPC's estimates of changes in Mexican import shares in the United States have to be multiplied by 0.93 and the product reduced by 15.70 percentage points to match the actual changes in those import shares. By comparison, the BDS model's predicted changes have to be multiplied by 2.23 and the product increased by 65.84 percentage points to match the actual changes. The correlation between the actual and predicted changes is 0.98 for the HPPC model and 0.44 for the BDS model.

3. Analysis of the Results

The HPPC and Armington models use similar equations to predict changes in trade after liberalization. The role of Armington elasticity, which is key to determining the magnitude of trade change after liberalization, is played by the technology dispersion parameter in the Eaton-Kortum framework. The HPPC model sets the technology dispersion parameter equal to 8.28 while the BDS model sets the Armington elasticity at around 3. Holding everything else equal, using elasticity of 8.28 instead of 3 should result in about 2.76 times greater predicted change in trade flows. To check the effects of this difference in parameter values on NAFTA forecasts, Shikher sets the technology dispersion parameter equal to 3 and re-simulates the effects of NAFTA. The results are shown in table 5. The columns present various measures of the relationship between the actual and predicted changes in industry-level import shares (excluding Canada-Mexico trade).

Table 5. Relationships Between Predicted and Actual Changes In Industry-Level Import Shares (excluding Canada-Mexico trade)

	HPPC				BDS			
	Correl.	Intercept	Slope	Av(abs)*	Correl.	Intercept	Slope	Av(abs)*
Original	0.95	-4.6	0.87	42.8	0.31	21.23	1.33	10.4
θ = σ =3	0.87	-13.6	4.75	9.9				
θ = σ = 3 and c.i.f. barriers	0.93	-16.5	2.2	22.8				
All of the above and BDS tariffs	0.88	-17.1	2.61	19.2				
All of the above and NTBs	0.74	-0.52	2.82	7.8	0.44	13.8	1.1	9.6

Note: Av(abs) is the average absolute percent change in import shares. Its value in the data is 35.9 percent. θ is the technology dispersion parameter, σ is the Armington elasticity. NTBs = nontariff barriers.
Source: Author's calculations.

The first line of the table shows the results for the original model configurations and parameter values. The second line shows that setting technology dispersion parameter $\theta = 3$ results in much smaller predicted changes in trade. The overall magnitudes of the forecasted changes in trade in this case are similar to those of the BDS model, but the correlation between the predicted and actual changes is much higher at 0.87 (vs. 0.32 for the BDS model). The third row assumes that tariffs are imposed on c.i.f. values, as in the BDS model. The fourth row uses BDS data on pre-NAFTA tariffs. The fifth row uses BDS data on tariffs and nontariff barriers. The correlation between the predicted and actual changes for the 30 trade flows falls to 0.74, as shown on the last line of table 5. This is not as good as using HPPC's own parameter values (0.95), but still substantially better than the BDS's result of 0.44.

Table 5 shows that of all parameter values, the BDS model's treatment of nontariff barriers contributes the most to the poor quality of its forecasts (it explains more than 3/4 of the change in the correlation gap). More recent estimates of nontariff barriers, used by the HPPC model, produce better results. The rest of the difference in the performance of the HPPC and BDS models must be explained by the values of other parameters, such as the input-output shares. Unfortunately, the values of these parameters are not published by the authors of the BDS model. Therefore, a comparison of their values in the BDS and HPPC models is not possible.

In summary, NAFTA is a natural experiment that is useful for evaluating models of trade. Unfortunately, the pre-NAFTA forecasts using computable general equilibrium models did not do a good job forecasting the effects of NAFTA. The results described in this paper show that if a CGE model based on the Eaton-Kortum methodology (such as the one described in this study) had existed when NAFTA was being deliberated, it would have much more accurately forecast the changes in industry-level trade flows following NAFTA. In addition, newly available methods of creating ad valorem equivalents of nontariff barriers also significantly improve the quality of trade forecasts.

References

Anderson, J. E., and E. van Wincoop. 2003. "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review* 93(1).

Armington, P. S. 1969. "A Theory of Demand for Products Distinguished by Place of Production." *IMF Staff Papers* 16(1): 159–78.

Brown, D.K., A.V. Deardorff, and R.M. Stern. 1992. "A North American Free Trade Agreement: Analytical Issues and a Computational Assessment." *The World Economy* 15(1): 15–29.

Eaton, J., and S. Kortum. 2002. "Technology, Geography, and Trade." *Econometrica* 70(5): 1741–79.

Kehoe, T.J. 2005. "An Evaluation of the Performance of Applied General Equilibrium Models of the Impact of NAFTA." In *Frontiers in Applied General Equilibrium Modeling,* edited by T. J. Kehoe, T. N. Srinivasan and J. Whalley. Cambridge, UK: Cambridge University Press.

Krueger, A.O. 1999. "Trade Creation and Trade Diversion under NAFTA." NBER Working Paper No. 7429.

Nicita, A., and M. Olarreaga. 2007. "Trade, Production and Protection Database 1976–2004." *World Bank Economic Review* (forthcoming).

Roland-Holst, D., K.A. Reinert, and C.R. Shiells. 1994. "A General Equilibrium Analysis of North American Economic Integration." In *Modeling Trade Policy: Applied General Equilibrium Assessments* *of North American Free Trade*, edited by J.F. Francois and C.R. Shiells. Cambridge, UK: Cambridge University Press.

Romalis, J. 2007. "NAFTA's and CUSFTA's Impact on International Trade." *Review of Economics and Statistics* 89(3): 416–35.

Ruhl, K. 2008. "The International Elasticity Puzzle." Manuscript, University of Texas.

Shiells, C.R., and R.C. Shelburne. 1992. "Industrial Effects of a Free Trade Agreement between Mexico and the USA." In *Economy-Wide Modeling of the Economic Implications of a FTA with Mexico and a NAFTA with Canada and Mexico*. Washington, DC: USITC.

Shikher, S. 2004. "An Improved Measure of Industry Value Added and Factor Shares: Description of a New Dataset of the U.S. and Brazilian Manufacturing Industries." Manuscript, Suffolk University.

Shikher, S. 2012. "Predicting the Effects of NAFTA: Now We Can Do It Better." *Journal of International and Global Economic Studies* 5(2):32-59.

Sobarzo, H. E. 1992. "A General Equilibrium Analysis of the Gains from Trade for the Mexican Economy of a North American Free Trade Agreement." In *Economy-Wide Modeling of the Economic Implications of a FTA with Mexico and a NAFTA with Canada and Mexico*. Washington, DC: USITC.

U.S. International Trade Commission (USITC). 1992. *Economy-Wide Modeling of the Economic Implications of a FTA with Mexico and a NAFTA with Canada and Mexico*. USITC Publication No. 2508. Washington, DC: USITC.