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Using the New Products Margin to Predict the Industry-Level Impact of Trade Reform*

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ABSTRACT

This paper develops a methodology for predicting the impact of trade liberalization on exports by industry (3-digit ISIC) based on the pre-liberalization distribution of exports by product (5-digit SITC). We evaluate the ability of our methodology to account for the industry-level variation in export growth by using our model to "predict" the growth in industry trade from the North American Free Trade Agreement (NAFTA). We show that our method performs significantly better than the applied general equilibrium models originally used for the policy evaluation of NAFTA. We find that the most important products in our analysis are not the ones with zero pre-liberalization trade, but those with positive, yet small amounts of pre-liberalization trade.

Keywords: Trade liberalization; Industry; Product
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1. Introduction

When policy makers debate trade liberalization, the worry is not over the aggregate increase in trade, but over the unequal impact of freer trade across industries: Which industries will expand and which will contract? When policy makers have turned to economic models for answers to these questions — most notably during the lead up to the North American Free Trade Agreement — they have been given industry-level forecasts (USITC, 1992) that were largely inaccurate (Kehoe, 2005). Can we improve our ability to forecast the industry-level impacts of trade policy?

In the last 20 years, several important advancements in trade theory have revolved around the idea that trade liberalization not only brings about trade in products already being traded, but trade in new kinds of products as well — what we call the extensive trade margin. Less work, however, has been done in incorporating these insights into models that can be used to predict the impacts of trade liberalization for use in policy analysis[1]. In this paper, we show that a very simple predictive model that incorporates the extensive trade margin performs quite well — beating several workhorse models — in accounting for the industry-level response of trade following the North American Free Trade Agreement (NAFTA).

Our methodology is based on the finding in Kehoe and Ruhl (2013) that products that were not traded or were traded very little before liberalization, what we call the *least traded products*, grow faster than the relatively heavily traded products following trade liberalization. Our model posits that industries — a collection of products — with relatively more of these least traded products will grow faster than industries with relatively fewer least traded products. Our model can be written as a linear function with two parameters, and we show how to find these two parameters using cross-sectional variation in trade data.

We evaluate our model by "forecasting" the industry-level effects of NAFTA using only data that would have been available in 1989 — several years before the implementation of NAFTA. We compare our forecasts with the actual growth in trade that occurred from 1989 to 2009 and find that the model does quite well: the weighted correlation between our forecasts and the data averages 0.39 across all six NAFTA country pairs. This result is even more striking when we compare our forecasts with those from general equilibrium models actually used to forecast the

[1] A notable exception is Yaylaci and Shikher (2014), which uses a model based on Eaton and Kortum (2002) to make predictions about the Korea-U.S. free trade agreement. We discuss their forecasts, and compare them to our own forecasts of the Korea U.S.-free trade agreement, in the appendix.

effects of NAFTA, whose weighted correlation with the data averages 0.00. We repeat this exercise using alternative measures of accuracy, and the conclusion remains the same. Our simple statistical model performs substantially better.

The failure of the general equilibrium models so often used in policy analysis is driven by the underlying structure that typically does not allow for an extensive margin. Models built from Armington (1969) assumptions about national product differentiation imply that countries already import all the available products from other countries. This leaves no role for products with little or no trade to have an impact on the model outcomes. Instead, the response to trade liberalization in these models is set by home bias parameters and elasticities of substitution between products.

In the workhorse heterogeneous agent trade models — variants of Eaton and Kortum (2002) and Melitz (2003) — the extensive trade margin is made up of goods that go from zero trade to positive trade following liberalization. In our model, a product with zero trade in the base year will not show up in the share of least traded products in an industry, so products with no trade in the base year do not factor into our predictions. What matters for our model are the products that are traded in small amounts before liberalization. This means that these workhorse trade models are not the theoretical analogue of our statistical model. Instead, a model like that in Arkolakis (2010), in which small firms react more to falling trade costs, is appropriate. Similar ideas can be found in Eaton et al. (2014) or Ruhl and Willis (2013), which focus on the growth of small firms growing larger in export markets.

In the following section, we describe our methodology and show how to estimate the parameters of the model using only pre-liberalization data. In section 3, we use the model to "forecast" the effects of NAFTA on industry-level exports, and we evaluate our forecasts using the observed changes in trade flows. In section 4, we compare our forecasts to those from general equilibrium models that were actually used to forecast NAFTA in the 1990s, and we show that our simple model outperforms the

2. A predictive model based on the extensive margin

In this section, we develop a methodology based on the insight from Kehoe and Ruhl (2013): much of the growth in trade following a trade liberalization occurs within the set of products that were previously not traded or were traded very little. We refer to growth in trade from products that were not previously traded or were traded very little as growth on the *extensive margin* or the *new products margin*. We refer to growth in trade from products that were previously traded in relatively large amounts as growth on the *intensive margin*. Our methodology, based on that of Kehoe and Ruhl (2013), allows the cutoff for what products we consider to be least traded to vary across country pairs in order to take into account the relative importance of each product for a country's trade.

We define a *product* to be a 5-digit SITC Rev. 2 code. We sort all of the products from lowest to highest by their average value of trade over the first three years in our sample. (We average over three years to minimize the measure's dependence on any particular year.) Starting with the products with the least trade in the first three years, we then sum the value of trade in the base year until we accumulate a set of products that accounts for 10 percent of total trade in the base year. If a product is in that set, we classify it as a *least traded product*. In the appendix, we show that our results are robust to using 5 percent or 20 percent of total trade as the cutoff instead of 10 percent. Within the set of least traded products are products from different industries, where an industry is a collection of products. Adapting a concordance developed by Muendler (2009), we map each of the 1,836 5-digit SITC products into one of 37 3-digit ISIC industries. In what follows, we use the industry classification system from Brown, Deardorff, and Stern (1995) to keep our results comparable to theirs. This classification system is a more aggregated version of the 3-digit ISIC.

Once we have mapped the products to industries, we can compute the share of trade in each industry that is accounted for by least traded products within the industry. How prevalent are these least traded products across industries? Consider the Canada-U.S. trade relationship before NAFTA, which we study in section 3 as way to evaluate our methodology. In table 4 we report the fraction of trade in an industry accounted for by the least traded products in 1989, the year before NAFTA was implemented. There are substantial differences across industries. For example, least traded products made up 77 percent of total textile exports from Canada to the United States in 1989, but only 1 percent of exports in the wood products industry.

How is the share of least traded products in an industry related to the growth in trade in that industry following liberalization? Kehoe and Ruhl (2013) show that growth in least traded products can be explosive after liberalization, so it follows that industries with more least traded products would be expected to grow faster after liberalization than industries with fewer least traded products. Our prediction is that industries with higher shares of least traded products will experience more growth than industries with lower shares of least traded products.

We formulate our model of trade growth by industry as a simple linear function of the share of exports accounted for by least traded products in that industry. Specifically, we predict that the growth between periods T_0 and T_1 in industry j will be

$$z_{ij}^k = (1 - s_{ij}^k)\alpha_i^k + s_{ij}^k(\alpha_i^k + \beta_i^k), \quad (1)$$

where z_{ij}^k is the growth in exports, $x_{ij,t}^k$, from country i to country k in industry j deflated by the growth in GDP, y_{it}, of the exporting country,

$$z_{ij}^k = 100\left(\frac{x_{ijT_1}^k / y_{iT_1}}{x_{ijT_0}^k / y_{iT_0}} - 1\right), \quad (2)$$

s_{ij}^k is the share of exports accounted for by least traded products in that industry, and α_i^k and β_i^k are constants. Here α_i^k is the average growth rate of non–least traded products, and β_i^k is the additional growth generated by least traded products.

Notice that as long as $\beta_i^k > 0$, all values of α_i^k and β_i^k give the same predictions for the relative ordering of growth across industries. This means that any series of predictions by industry of the form (1) generates the same correlation with a series of observations by industry if β_i^k is positive. Therefore, correlations offer a way of evaluating the general merit of our simple statistical model in a way that does not depend on its particular parameterization. If the correlation was low, that would indicate there is little hope for success regardless of the parameterization[2]. As we will show, however, our predictions perform much better in terms of correlation with observed changes than the general equilibrium models originally used to predict the effects of NAFTA. In the following sections, we lay out our methodology for parameterizing (1) and show that, as indicated by these correlations, our methodology does indeed deliver substantially improved industry-level predictions in the case of NAFTA.

[2] In addition to using correlation coefficients to evaluate the model, we consider other metrics in sections 3 and 4.

2.1 Parameterization

We need to choose values for α_i^k and β_i^k in order to use (1) to predict industry-level trade growth. Given our interest in industry-level outcomes, we develop a method to parameterize the model so that its aggregate predictions are consistent with the aggregate data. In particular, we require that α_i^k and β_i^k generate aggregate predictions that match the two features of the data described below.

First, the predicted total trade growth of our model must match the total trade growth predicted by the gravity equation. This condition is

$$\alpha_i^k + 0.1\beta_i^k = \hat{z}_i^k, \qquad (3)$$

where the left-hand side of (3) is our model's prediction of total trade growth (the 0.1 follows from the 10 percent threshold in the least traded products definition), and the right-hand side is the predicted trade growth from the gravity equation, which we specify below. The motivation for this restriction is straightforward: we would like our industry-level predictions to be consistent with an aggregate trade prediction, and the gravity equation is a simple and effective way to generate an aggregate trade prediction.

We require an elasticity of aggregate trade growth with respect to tariffs. One approach would be to simply use the elasticities reported in the literature, a survey of which can be found in Head and Mayer (2013). This approach takes advantage of the econometric sophistication of modern gravity equation research, but does not allow us to control the samples from which the estimates arise. In particular, we demand that only pre-liberalization data are used in estimating our model. For our purposes, we specify a simpler gravity equation, but one that allows for the primary determinants found in the gravity literature,

$$\log\frac{x_i^k}{y_i} = \lambda_\tau \log\left(1+\tau_i^k\right) + \lambda_2 \log y_i + \lambda_3 \log y_k + \lambda_4 \log d_i^k + \lambda_{10} + \varepsilon_i^k, \qquad (4)$$

where x_i^k is exports from country i to country k, τ_i^k is the average tariff rate, y_i is GDP of the exporting country, y_k is GDP of the importing country, and d_i^k is the distance between countries.[3]

[3] Our gravity model is admittedly simple. We work with this specification because the data needed for our NAFTA exercise in the next section are severely limited by the tariff data. This restricts the number of observations, making it difficult to include, for example, country-level fixed effects to control for multilateral resistance. Despite these limitations, our model produces an estimated trade elasticity in the range of estimates given by Simonovska and Waugh (2014), who use a more state-of-the-art approach.

We also provide estimates where we include variables indicating whether the countries share a border, common language, or colonial relationship. With an estimate of λ_τ, we can predict the increase in trade corresponding to a decrease in tariffs from τ_i^k to $\tau_i^{k\prime}$ as

$$\hat{z}_i^k = \exp\left(-\lambda_\tau \left[\log(1+\tau_i^k) - \log(1+\tau_i^{k\prime})\right] - 1\right) \times 100 . \qquad (5)$$

Our gravity equation only takes into account tariff reductions when predicting changes in trade. Trade liberalizations, however, often include not just reductions in bilateral tariffs, but reductions in non-tariff trade barriers as well. Measuring these nontariff barriers is a difficult task that is outside the scope of this study. See Baier and Bergstrand (2007) and Head and Mayer (2013) for discussions about measuring the impact of free trade agreements using binary variables.

Our second restriction requires that the model's predicted aggregate growth in least traded products, as a share of total trade growth, be consistent with the cross-country evidence. This restriction can be written as

$$\frac{\alpha_i^k + \beta_i^k}{\alpha_i^k + 0.1\beta_i^k} = \gamma , \qquad (6)$$

where γ is the cross-country average of the ratio of the growth in trade of least traded products to overall growth in trade. Following Kehoe and Ruhl (2013), γ is estimated from

$$\Delta_t x_i^k = \gamma \Delta_t \tilde{x}_i^k + \varepsilon_i^k , \qquad (7)$$

where x_i^k is total exports from i to k, $\tilde{x}_i^k$ is exports of least traded products, and Δ_t is the 10-year growth rate operator. This equation is estimated using data on as many bilateral pairs as possible, but using a time period (to compute growth rates) that ends before our period of interest, T_0.

In (3) and (6), the left-hand side quantities are predictions of our model, and the right-hand side quantities are independent data moments. Given values of γ and $\hat{z}_i^k$, we solve the system of equation defined by (3) and (6) for α_i^k and β_i^k. We are then ready to use (1) to make predictions about industry-specific growth rates.

3. Evaluating the methodology: NAFTA

In this section, we evaluate the predictive power of our methodology by using it to “predict” the impact of NAFTA. We select 1989 as our base year and we use 2009 as our endpoint, since that is the year of full implementation of NAFTA. Our results are robust to selecting 2007 as our endpoint in order to avoid entangling the effects of NAFTA with the effects of the 2008–2009 recession and the fall in trade that accompanied it.

To parameterize the NAFTA model, we follow the procedure laid out in section 2.1, and we restrict our estimation to use only data that would have been available in 1989. We estimate the gravity equation in (4) using 1989 data (results reported in table 1) and find $\lambda_\tau = -2.76$. This value is somewhat lower than the range of trade elasticities reported in the gravity literature, as surveyed in Head and Mayer (2013). This discrepancy appears to be largely due to our use of earlier data. If we reestimate the gravity equation using 2005 data, we estimate a trade elasticity very much in line with the carefully constructed estimates of Simonovska and Waugh (2014). We use (7) to estimate γ using 1978–1987 data and find that $\gamma = 3.65$, which is nearly identical to the estimate in Kehoe and Ruhl (2013), which uses 1995–2005 data. Table 2 reports the average initial tariffs, the predicted aggregate changes in trade based on our gravity model, and the estimated α_i^k and β_i^k that we use with equation (1) to make our NAFTA predictions for the United States, Canada, and Mexico. Tariffs for Mexican imports are unavailable for 1989, so we use Mexican tariffs in 1991 as the initial tariff levels.

The predictions for the NAFTA country pairs are reported in tables 4–6. For each country pair we report, by industry: the observed growth rate from the data, 1989–2009; the least traded products’ share of trade in 1989; and the predictions from our least traded products model (LTP). In what follows, we evaluate our predictions against both the observed export growth rates and the predictions from general equilibrium models used to forecast NAFTA export growth.

3.1 Evaluating the parameterization methodology

We have estimated $\left(\alpha_i^k, \beta_i^k\right)$ for the NAFTA countries following the procedure in section 2.1, which uses only data that were available in 1989. Using the growth in trade that actually occurred following NAFTA, we can find the best possible coefficients given our statistical model’s form and compare them with our estimates. These optimal coefficients are the solution to

$$\tilde{\alpha}_i^k, \tilde{\beta}_i^k = \arg\min \sum_{j=1}^{38} \omega_{ij}^k \left(\alpha_i^k + \beta_i^k s_{ij}^k - z_{ij}^{k,data} \right)^2, \qquad (8)$$

where ω_{ij}^k is industry j's share of total exports from country i to k in 1989 and s_{ij}^k is the share of least traded products in each industry. The observed industry-level growth rate is $z_{ij}^{k,data}$. The optimal coefficients are reported in table 2. Take, for example, trade between Canada and the United States: setting $\alpha_{usa}^{can} = -34.54$ and $\beta_{usa}^{can} = 175.84$ would have been the best possible linear prediction based on the least traded products data for U.S. exports to Canada, indicating that between 1989 and 2009, exports in the least traded set grew by 141.3 ($= -34.54 + 175.84$) percent more than U.S. GDP, whereas other exports grew 34.54 percent less than U.S. GDP.

In table 2, we compare the optimal coefficients with our estimated coefficients that we used to make our NAFTA predictions. Overall, we find a correlation of 0.65 for $\tilde{\alpha}_i^k$ and α_i^k and a correlation of 0.63 for $\tilde{\beta}_i^k$ and β_i^k. These differences indicate that, while there remains room for improvement, our methodology for estimating α_i^k and β_i^k performs well.

3.2 Controlling for tariff size

A potential concern is that larger growth rates for least traded products may be driven by larger decreases in tariffs. As evident in table 3, the least traded products are indeed subject to larger initial tariffs, and larger declines in tariffs, when compared with non–least traded products.[4] Also clear from the table is that our assumption that a free trade agreement means the complete elimination of tariffs is a good approximation of NAFTA. To investigate whether accounting for tariffs eliminates the finding that least traded products grow faster following trade liberalization, we estimate a modified version of (8) that incorporates tariff data,

$$\tilde{\alpha}_i^k, \tilde{\beta}_i^k = \arg\min \sum_j \omega_{ij}^k \left(\alpha_i^k + \beta_i^k s_{ij}^k + \zeta_i^k \tau_{ij}^k - z_{ij}^{k\,data} \right)^2, \qquad (9)$$

where τ_{ij}^k is the average tariff rate in 1989.

The resulting estimates for $\tilde{\alpha}_i^k$ and $\tilde{\beta}_i^k$ are reported in table 3 and show that accounting for tariffs does not have a significant impact on the degree to which least traded products grow more

[4] We use 1991 tariff data for Mexican imports because tariff data are not available in 1989. We exclude the code 02242 (Dry Milk) for Canadian exports to Mexico as an outlier, because it experiences a tariff rate increase from 1.05 to 1.37, which upwardly skews the average tariff rate for non–least traded products.

than non–least traded products. The only exception is for Mexican exports to the United States, where our estimate of $\tilde{\beta}_i^k$ falls significantly when estimated using industry-level data. The correlation between the coefficients estimated in (8) and the coefficients that control for initial tariff rates is −0.53 for $\tilde{\alpha}_i^k$ and 0.62 for $\tilde{\beta}_i^k$. This indicates that while tariffs may explain much of the average growth in trade across all products, differences in tariffs do not appear to be responsible for the higher growth rates of least traded products.

There is room for future research to investigate other ways in which the new products margin may interact with other traditional determinants of trade flows. For example, it may be that least traded products exhibit more growth when an exporter exhibits a revealed comparative advantage in those products.

4. Predictions of NAFTA models

In the previous section, we compared our results with the best possible linear forecasting model. In this section, we compare our results with those from general equilibrium models that were used to forecast the effects of NAFTA. To develop a baseline for judging our predictions for NAFTA, we follow Fox (1999) and Kehoe (2005) and evaluate the performance of one of the most prominent of the models built to analyze NAFTA, the Brown-Deardorff-Stern (BDS) model (Brown 1992, 1994; Brown, Deardorff, and Stern, 1992, 1995; Brown and Stern, 1989). In this section, we compare the predictions made by the BDS model and our forecasting model with the observed growth in trade following NAFTA. In the appendix, we perform similar comparisons for two alternative models of NAFTA.

4.1 The BDS model and the data

The BDS model made predictions at the industry level, where each of their 23 industries is defined as an aggregate of ISIC 3-digit industries: this is the classification we adopted in section 3, in order to make our model comparable with the BDS model. We compute the percentage growth in exports for each industry deflated by GDP growth in accordance with (2). We report the industry-level export growth rates from the data and the predictions of the BDS model in tables 4–6.

We use two criteria to compare the predictions of the BDS model with the data: the weighted correlation coefficient between the model predictions and the data, where the weights are the 1989 trade volumes, and the estimated coefficients a_i^k and b_i^k from the regression

$$\min_{a_i^k, b_i^k} \sum_{j=1}^{23} \omega_{ij}^k \left(a_i^k + b_i^k z_{ij}^{k,model} - z_{ij}^{k,data} \right)^2, \tag{10}$$

where, again, j indexes the industry. The deviation of the coefficient b_i^k from 1 indicates how poorly the model does in predicting the signs and the absolute magnitudes of the changes in the data. In particular, b_i^k tells us whether the differences across industries are underpredicted $(b_i^k > 1)$, overpredicted ($0 < b_i^k < 1$), or predicted in the wrong direction ($b_i^k < 0$).

We report the estimated coefficients from (10) for the NAFTA pairs at the bottom of tables 4–6. Take, for example, exports from Canada to the United States, which we report in table 4. The BDS model does a poor job of predicting Canadian exports to the United States: the weighted correlation between the model's predictions and the data is negative (−0.28), and the coefficients from (10) that come closest to the data involve multiplying all of the predicted growth rates by −3.33 and adding 21.82.

4.2 The BDS model and our predictions

Using the methodology laid out in section 2.1, we form our predictions for the NAFTA countries and report our results in tables 4–6 alongside the results from the BDS model. We find that our predictions based on the initial fraction of least traded products considerably outperform the BDS model for each country pair. Returning to the example of Canadian exports to the United States (see table 4), we see that our predictions perform better, with a weighted correlation of 0.39, and the linear function of the prediction that comes closest to the data involving multiplying all of the predicted growth rates by 3.53 and subtracting 50.21. That our predictions significantly outperform the predictions in BDS for Canadian exports to the United States can be seen in figures 1 and 2, which plot the regression lines resulting from (10), where the size of each data point corresponds to that industry's weight.

Table 7 summarizes our findings and reports the corresponding statistics for all six of the bilateral North American country pairs. Notice that the BDS model had almost no predictive power for the impact of NAFTA by industry. When we estimate (10) pooling the data for all six pairs, the coefficient b put on the predictions of the BDS model is 0.17, and when we allow b to differ by country pair, the weighted average is −0.94 compared with 2.72 and 3.53 for our predictions.

Table 8 compares the overall accuracy of our predictions with the accuracy of the BDS predictions. In this table we compare the average absolute percentage difference between the predictions and the actual growth over 1989–2009:

$$\chi_i^k = \frac{1}{23}\sum_{j=1}^{23}\left\|\frac{z_{ij}^k - \hat{z}_{ij}^k}{\hat{z}_{ij}^k}\right\|. \qquad (11)$$

Our predictions significantly outperform the BDS predictions — by an order of magnitude in most cases. We also compare the accuracy of "predictions" based on the optimal coefficients from (8). Although these are not true predictions since they make use of ex-post data, they establish an upper bound of how useful predictions of the form (1) can be. We see that the best fit estimates perform very well, especially for bilateral trade involving Mexico. This suggests that there are large potential gains in accuracy from an improved methodology for estimating α_i^k and β_i^k.

It is worth stressing that this failure of the BDS model is not specific to this particular model. We focus on the BDS model because it is a widely used and well-documented model built to analyze the impact of NAFTA, and it has predictions for all directions of bilateral trade between Mexico, Canada, and the United States. Kehoe (2005) argues that two other models that were very prominent in policy discussions of NAFTA, the Cox-Harris model of Canada (Cox, 1994, 1995; Cox and Harris 1985, 1992a, 1992b) and the Sobarzo model of Mexico (Sobarzo, 1992a, 1992b, 1994, 1995), also perform poorly in this sort of exercise. In the appendix, we show that we achieve similar results with the Sobarzo model and the Cox-Harris model as well. It is also important to note that the sorts of models used to analyze NAFTA are still being employed to analyze trade policies around the world, so understanding the limitations of this class of models remains important. See, for example, Brown, Kiyota, and Stern (2005), Ciuriak and Chen (2007), DeRosa and Gilbert (2004), Francois, Rivera, and Rojas-Romagosa (2008), Lips and Rieder (2005), U.S. International Trade Commission (2004), as well as Kiyota and Stern (2007). In the appendix, we show how our model's predictions compare to Kiyota and Stern (2007), which forecasts the effects of the Korea-U.S. free trade agreement — a liberalization that is currently underway. Our predictions are substantially different than theirs, but we cannot, however, perform an ex-post analysis of the models until sometime in the future.

Why do these models have difficulty explaining industry trade patterns after liberalization? As Kehoe (2005) explains, the models used to predict the impact of NAFTA could not pick up increases in exports on the extensive margin, or new products margin, because of the assumptions made in these models. In particular, the sorts of Armington aggregators and Dixit-Stiglitz utility functions used in these models, along with no fixed costs of exporting, allowed only increases on the intensive margin.

4.3 Discussion of Results

To get some idea of what drives our results, we examine an industry where the simple least traded products exercise does better than the BDS model: Canadian exports of chemicals to the United States, which grew 99.6 percent while the BDS model predicted −3.1 percent. The disaggregated data for this industry show that the chemicals industry is made up of 318 5-digit SITC categories. Of the 318 categories, 296 are least traded Canadian exports. Compared with Canadian GDP, the least traded chemicals increased by 187 percent, whereas the other non–least traded chemicals increased by only 47 percent. The growth in least traded products is far from uniform: for example, exports of code 51571 (Sulphonamides) increased by 3,424 percent more than Canadian GDP, 58241 (Polyamides in primary forms) increased by 4 percent, and 58241 (Chlorine) decreased by 28 percent compared with Canadian GDP.

Products that report zero trade in 1989 are classified as least traded products, and if they report positive trade in 2009, that trade is counted toward the growth rate for least traded products. Notice, however, that the number of zero-traded products has no influence on our shares s_i of least traded products in each industry in 1989. In the appendix we show that our results are unchanged even when we completely ignore growth from products that report zero trade in 1989. This means that the essential products in terms of generating any predictive power from our exercise are not products reporting zero trade, but products that are positively traded, although with very small amounts of trade. Arkolakis (2010) shows that the importance of products with small, nonzero trade to overall trade growth can be explained by marketing costs and the number of consumers that purchase a product. This additional margin for growth is diminishing for products with large amounts of trade and causes products with small yet positive trade to experience higher levels of growth.

5. Conclusions

This paper provides a methodology for predicting changes in bilateral trade at the industry level following a trade liberalization. We evaluate our methodology in the context of NAFTA and show that our methodology — which exclusively focuses on least traded products — would have yielded better predictions than the general equilibrium models employed at the time. Our results suggest that researchers should include the new products margin in any analysis of the impact of trade reform. We hope this finding will spur the development of models that are consistent with the expansion of trade on the new products margin so that we can improve our ability to predict the effects of trade reforms and so that we can perform counterfactual analyses of alternative reforms.

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Table 1: Gravity equation estimates

Variable	**1989**	**1989**	**2005**	**2005**
Initial tariffs	−2.755	−2.085	−3.511	−3.371
	(0.454)	(0.617)	(0.411)	(0.440)
Exporter GDP	1.191	1.112	1.252	1.215
	(0.026)	(0.032)	(0.011)	(0.014)
Importer GDP	0.743	0.690	0.986	0.994
	(0.040)	(0.048)	(0.013)	(0.015)
Distance	−1.135	−0.987	−1.520	−1.312
	(0.098)	(0.105)	(0.034)	(0.036)
Exporter GDP per capita		0.260		0.093
		(0.049)		(0.020)
Importer GDP per capita		0.100		−0.032
		(0.078)		(0.023)
Border		1.108		1.208
		(0.382)		(0.168)
Common language		0.820		0.988
		(0.162)		(0.065)
Colonial relationship		−0.517		0.638
		(0.270)		(0.143)
Constant	6.173	3.164	4.413	2.177
	(1.101)	(1.271)	(0.334)	(0.383)
Observations	1,280	1,280	9,833	9,833
R-squared	0.641	0.660	0.640	0.651

Notes: Standard errors are reported in parentheses. Bilateral aggregate trade data from UN Comtrade. *Initial tariff* is the effectively applied average tariff rates obtained from the TRAINS (Trade Analysis and Information System) database accessed through WITS (World Integrated Trade Solution). All other gravity variables are from the CEPII Gravity Dataset from Head, Mayer, and Ries (2010) and Head and Mayer (2013). *Common language* is equal to one if a common language is spoken by at least 9 percent of the population. *Colonial relationship* is equal to one if a colonial relationship has ever existed. Sample includes all countries with data for all variables in the given year.

Table 2: Estimated and optimal coefficients, NAFTA

Exporter	Importer	Initial tariff	Predicted growth	Estimated α	Estimated β	Optimal $\tilde{\alpha}$	Optimal $\tilde{\beta}$
CAN	MEX	13.85	42.96	30.31	126.54	254.23	4468.37
CAN	USA	4.26	12.18	8.59	35.88	–20.42	185.24
MEX	CAN	7.27	21.33	15.05	62.83	115.16	286.39
MEX	USA	5.62	16.26	11.47	47.89	51.52	77.54
USA	CAN	7.81	23.02	16.24	67.81	–34.54	175.84
USA	MEX	13.70	42.44	29.94	125.01	62.31	265.44
Correlation with estimated coefficients						0.65	0.63

Growth in trade is measured as the change in trade deflated by the GDP growth rate. The estimated coefficients are the solution to (3) and (6). The optimal coefficients are the solution to (8).

Table 3: Tariff rates by product type, NAFTA

		Average tariff rates (percent)				Optimal coefficients	
		Least traded products		Non-least traded products		Conditional on initial tariffs	
Exporter	Importer	1989	2009	1989	2009	$\tilde{\alpha}$	$\tilde{\beta}$
CAN	MEX	13.22	0.00	6.29	0.00	−306.08	3890.50
CAN	USA	2.62	0.05	0.78	0.02	23.57	273.88
MEX	CAN	6.20	0.09	4.17	0.00	101.94	354.89
MEX	USA	4.73	0.01	4.11	0.00	36.71	3.86
USA	CAN	6.30	0.65	5.57	0.18	−32.78	111.59
USA	MEX	12.99	0.21	11.80	0.16	61.61	241.03
Correlation with estimated coefficients						−0.53	0.62

The optimal coefficients conditional on initial tariff rates are the solution to (9). The correlation with estimated coefficients uses the estimated coefficients given in table 2. These optimal coefficients are computed using 3-digit ISIC codes as industries instead of the industry classification from Brown, Deardorff, and Stern (1995) that is used elsewhere in the paper. We do this because WITS provides tariff data directly at the 3-digit ISIC level.

Table 4: Changes in Canada-U.S. sectoral trade

Industry	Canada to United States Data	Canada to United States BDS	Canada to United States Least traded share	Canada to United States LTP	United States to Canada Data	United States to Canada BDS	United States to Canada Least traded share	United States to Canada LTP
Agriculture	12.5	3.4	0.26	17.8	−6.4	5.1	0.19	28.8
Mining and quarrying	237.6	0.4	0.05	10.4	51.3	1.0	0.16	26.8
Food	101.2	8.9	0.24	17.0	124.1	12.7	0.25	33.3
Textiles	42.4	15.3	0.77	36.0	−35.9	44.0	0.52	51.8
Clothing	50.2	45.3	0.59	29.6	−3.0	56.7	1.00	84.1
Leather products	−67.7	11.3	1.00	44.5	−64.0	7.9	0.61	57.5
Footwear	−49.9	28.3	1.00	44.5	−67.2	45.7	0.34	39.6
Wood products	−54.5	0.1	0.01	9.0	−30.6	6.7	0.07	20.7
Furniture and fixtures	−46.6	12.5	0.00	8.6	22.5	35.6	0.00	16.2
Paper products	−65.9	−1.8	0.04	10.1	13.7	18.9	0.15	26.1
Printing and publishing	0.7	−1.6	0.12	12.9	−19.6	3.9	0.05	19.6
Rubber products	45.8	9.5	0.10	12.0	30.2	19.1	0.05	19.9
Chemicals	99.6	−3.1	0.38	22.1	50.2	21.8	0.24	32.8
Petroleum products	−79.8	0.5	0.07	11.2	−43.1	0.8	0.13	25.3
Glass products	−45.7	30.4	0.40	22.9	−20.0	4.4	0.23	31.6
Nonmetal minerals	−0.4	1.2	0.38	22.4	−1.9	11.9	0.59	56.1
Iron and steel	−12.7	12.9	0.36	21.5	53.5	11.6	0.28	35.2
Nonferrous metals	−20.9	18.5	0.07	11.0	−20.8	−6.7	0.11	23.6
Metal products	17.7	15.2	0.20	15.7	−5.3	18.2	0.16	27.0
Nonelectrical machinery	−8.4	3.3	0.21	16.0	−38.9	9.9	0.08	21.5
Electrical machinery	−16.4	14.5	0.15	13.9	−42.6	14.9	0.05	19.7
Transportation equip.	−44.3	10.7	0.01	8.8	−37.8	−4.6	0.01	16.6
Misc. manufactures	56.1	−2.1	0.45	24.8	−19.2	11.5	0.15	26.6
Weighted correlation with data		−0.28		0.30		0.39		0.54
Regression coefficient *a*		21.82		−64.78		–26.62		−76.65
Regression coefficient *b*		−3.33		5.16		1.34		2.59
BDS-LTP weighted correlation				−0.11				0.70

The column *Data* reports the growth rates of industry exports deflated by the exporter's GDP growth rate, 1989−2009. The column *BDS* reports the predictions from Brown, Deardorff, and Stern (1995). The column *Least traded share* reports the share of industry exports accounted for by least traded products in 1989. The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10).

Table 5: Changes in Canada-Mexico sectoral trade

Industry	Canada to Mexico				Mexico to Canada			
	Data	BDS	Least traded share	LTP	Data	BDS	Least traded share	LTP
Agriculture	410.8	3.1	0.04	34.9	105.5	−4.1	0.11	22.0
Mining and quarrying	6.9	−0.3	0.03	33.8	77.8	27.3	0.03	16.8
Food	181.2	2.2	0.02	33.0	175.3	10.8	0.22	28.9
Textiles	656.4	−0.9	0.49	92.2	−39.2	21.6	0.29	33.1
Clothing	3553.9	1.3	1.00	156.8	703.5	19.2	1.00	77.9
Leather products	165.1	1.4	1.00	156.8	71.5	36.2	1.00	77.9
Footwear	23.6	3.7	1.00	156.8	−41.2	38.6	0.15	24.5
Wood products	16636.0	4.7	0.97	153.4	419.1	15.0	1.00	77.9
Furniture and fixtures	12913.0	2.7	1.00	156.8	1402.1	36.2	0.01	15.9
Paper products	214.7	−4.3	0.04	34.9	46.1	32.9	0.14	24.0
Printing and publishing	1887.8	−2.0	1.00	156.8	2412.5	15.0	1.00	77.9
Rubber products	3185.0	−1.0	0.23	59.6	1416.2	−6.7	1.00	77.9
Chemicals	1249.4	−7.8	0.25	61.5	272.7	36.0	0.91	72.5
Petroleum products	489.2	−8.5	1.00	156.8	-	-	-	-
Glass products	519.7	−2.2	1.00	156.8	−13.0	13.3	0.10	21.2
Nonmetal minerals	1497.6	−1.8	1.00	156.8	143.8	5.7	0.45	43.2
Iron and steel	190.2	−15.0	0.02	33.1	52.3	19.4	1.00	77.9
Nonferrous metals	442.0	−64.7	0.07	39.4	−50.9	138.1	0.07	19.7
Metal products	2843.9	−10.0	0.73	122.6	276.9	41.9	0.45	43.3
Nonelectrical machinery	1360.5	−8.9	0.19	55.0	124.0	17.3	0.05	18.1
Electrical machinery	2293.0	−26.2	0.23	59.7	263.7	137.3	0.08	20.1
Transportation equip.	6352.2	−4.4	0.27	64.2	119.3	3.3	0.00	15.3
Misc. manufactures	409.9	−12.1	0.18	53.0	523.4	61.1	0.55	49.4
Weighted correlation with data		−0.10		0.55		0.06		0.33
Regression coefficient *a*		645.29		−815.91		135.79		46.57
Regression coefficient *b*		−7.94		35.31		0.16		4.56
BDS-LTP weighted correlation				−0.12				0.02

The column *Data* reports the growth rates of industry exports deflated by the exporter's GDP growth rate, 1989−2009. The column *BDS* reports the predictions from Brown, Deardorff, and Stern (1995). The column *Least traded share* reports the share of industry exports accounted for by least traded products in 1989. The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10).

Table 6: Changes in Mexico-U.S. sectoral trade

Industry	Mexico to United States: Data	BDS	Least traded share	LTP	United States to Mexico: Data	BDS	Least traded share	LTP
Agriculture	−20.1	2.5	0.07	14.8	46.6	7.9	0.10	41.9
Mining and quarrying	27.0	26.9	0.01	12.0	86.2	0.5	0.18	52.0
Food	119.5	7.5	0.27	24.6	129.5	13.0	0.17	51.4
Textiles	89.6	11.8	0.72	45.9	125.7	18.6	0.43	84.0
Clothing	449.4	18.6	0.42	31.4	63.9	50.3	0.24	60.0
Leather products	−66.8	11.7	0.53	36.9	58.4	15.5	0.67	113.8
Footwear	−62.1	4.6	0.03	12.9	−58.5	35.4	0.10	42.3
Wood products	−74.8	−2.7	0.12	17.0	−21.6	7.0	0.09	41.2
Furniture and fixtures	64.9	7.6	0.00	11.5	6.6	18.6	0.00	29.9
Paper products	−61.0	13.9	0.23	22.7	29.4	−3.9	0.07	38.2
Printing and publishing	212.3	3.9	1.00	59.4	194.9	−1.1	0.13	46.0
Rubber products	147.1	−5.3	0.43	32.2	165.9	12.8	0.06	37.0
Chemicals	27.9	17.0	0.59	39.6	208.2	−8.4	0.23	58.2
Petroleum products	−98.0	34.1	0.12	17.0	−71.6	−7.4	0.06	37.5
Glass products	12.1	32.3	0.16	19.3	53.8	42.3	0.39	78.1
Nonmetal minerals	−19.5	3.7	0.26	24.1	57.8	0.8	0.57	100.7
Iron and steel	18.5	30.8	0.28	24.7	84.0	−2.8	0.24	60.4
Nonferrous metals	53.8	156.5	0.12	17.3	104.6	−55.1	0.12	44.7
Metal products	80.4	26.8	0.30	25.8	84.7	5.4	0.14	47.1
Nonelectrical machinery	171.3	18.5	0.14	18.3	102.8	−2.9	0.09	41.3
Electrical machinery	46.5	178.0	0.02	12.4	59.5	−10.9	0.01	31.0
Transportation equip.	127.0	6.2	0.02	12.6	79.3	9.9	0.02	32.5
Misc. manufactures	92.8	43.2	0.24	23.0	96.6	−9.4	0.13	46.1
Weighted correlation with data		−0.13		0.17		−0.06		0.47
Regression coefficient *a*		66.64		32.95		88.47		-1.26
Regression coefficient *b*		−0.11		1.62		−0.24		2.12
BDS-LTP weighted correlation				−0.32				0.21

The column *Data* reports the growth rates of industry exports deflated by the exporter's GDP growth rate, 1989−2009. The column *BDS* reports the predictions from Brown, Deardorff, and Stern (1995). The column *Least traded share* reports the share of industry exports accounted for by least traded products in 1989. The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10).

Table 7: Measures of model fit, NAFTA

Exporter	Importer	BDS model predictions			LTP model predictions		
		Correlation with data	*a*	*b*	Correlation with data	*a*	*b*
CAN	MEX	−0.10	645.29	−7.94	0.55	−815.91	35.31
CAN	USA	−0.28	21.82	−3.33	0.30	−64.78	5.16
MEX	CAN	0.06	135.79	0.16	0.33	46.57	4.56
MEX	USA	−0.13	66.64	−0.11	0.17	32.95	1.62
USA	CAN	0.39	−26.62	1.34	0.54	−76.65	2.59
USA	MEX	−0.06	88.47	−0.24	0.47	−1.26	2.12
Weighted average		−0.00	19.83	−0.94	0.39	−50.21	3.53
Pooled regression		0.06	10.53	0.17	0.24	−41.41	2.72

The regression coefficients a and b are the solution to (10). The weighted average uses the 1989 bilateral total trade values as weights for each country-pair. The pooled regression is the results of the regression with the data for all six country-pairs pooled together.

Table 8: Mean absolute percentage difference between predictions and data, NAFTA

Exporter	Importer	Predictions		LTP model with optimal coefficients
		BDS	LTP	
CAN	MEX	14929.4	1251.4	46.9
CAN	USA	8417.9	604.2	382.5
MEX	CAN	1517.5	709.3	52.4
MEX	USA	567.4	370.5	74.5
USA	CAN	617.7	273.2	156.3
USA	MEX	1734.5	128.0	33.7
Weighted average		3942.2	395.8	223.6

The mean absolute percentage change is defined in (11). The weighted average uses the 1989 bilateral total trade values as weights for each country-pair.

Figure 1: Predicted and actual growth rates, BDS model

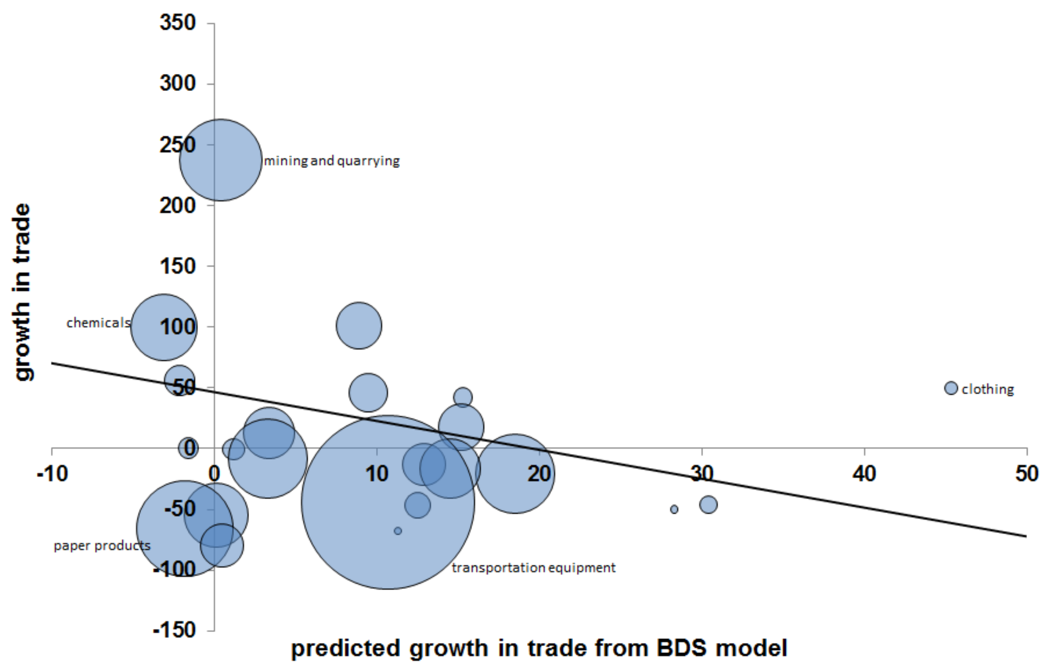
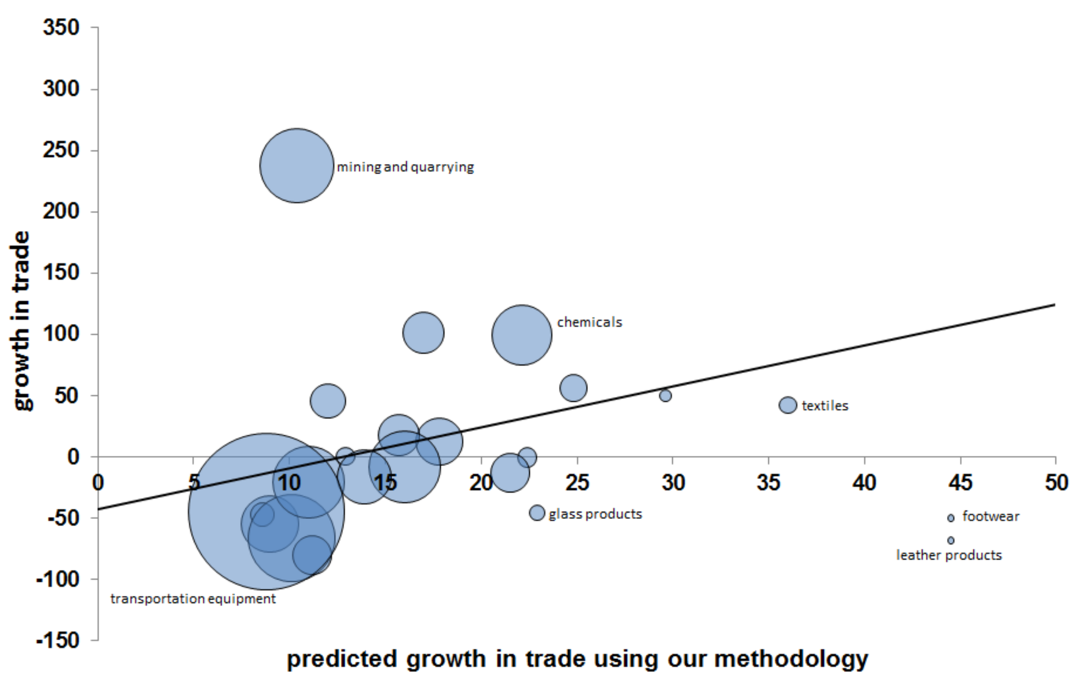


Figure 2: Predicted and actual growth rates, LTP model



Online Appendix to:
Using the New Products Margin to Predict the Industry-Level Impact of Trade Reform
Kehoe, Rossbach, and Ruhl
December 2014

Appendix A. Robustness checks

In this section we offer several robustness checks for our results with respect to NAFTA.

A.1 Other models of NAFTA

As shown in Kehoe (2005), the poor predictions of the BDS model are not unique, and other applied general equilibrium models predicting the effects of NAFTA performed in a similarly poor fashion. To show that our results extend beyond just the BDS model of NAFTA, we examine the Sobarzo model of Mexico (Sobarzo, 1992a, 1992b, 1994, 1995) and the Cox-Harris model of Canada (Cox, 1994, 1995; Cox and Harris 1985, 1992a, 1992b).

The Cox-Harris model predicted the changes in exports and imports between Canada and the World for 14 different industries. Since a concordance from the ISIC classification to the Cox-Harris industries is not provided in the original paper, we adapt the one provided in Kehoe (2005). We use imports and exports from Canada to the World, both as reported by Canada, from Comtrade as our base data and follow the same methodology as we used for evaluating the BDS model. Since the Cox-Harris predictions are for total imports and exports for Canada, we follow the same procedure as we did for the Kiyota and Stern (2007) predictions for Korea, using the World as a trading partner. In our results shown in table A1, we see that the results are similar to what we found when evaluating the BDS model. We report our predictions instead of the share of least traded products, since the two are no longer perfectly correlated. The Cox-Harris model had very little predictive power for both imports and exports, whereas using the share of least traded products in each industry performed significantly better at matching the relative changes in industry trade, achieving a weighted correlation of the data of 0.18 for exports and 0.33 for imports compared with the weighted correlations of 0.06 and 0.04, respectively, for the Cox-Harris model.

The Sobarzo model predicted the changes in imports and exports between Mexico and North America for 21 different industries, where North America is considered to be Canada and the United States. Since Sobarzo does not provide a concordance between ISIC and its industries, we adapt the concordance given in Kehoe (2005). We use the same base 5-digit SITC data as we did for the BDS exercise, constructing the share of least traded products for imports and exports between Mexico and the United States and Mexico and Canada separately. We then predict the increase in trade by industry separately for Mexico-U.S. and Mexico-Canada before combining the predictions to generate overall predictions for growth in imports and exports between Mexico and North America. After that we again follow the same methodology as we did for the BDS exercise, and we find that the Sobarzo model does poorly in predicting both imports and exports between North America and Mexico. As summarized in table A2, the weighted correlation between the Sobarzo model's predictions and the data is negative (−0.12) for imports from North America to Mexico, whereas the correlation between the share of least traded products in an industry and the industry's growth is much higher (0.47). For exports to North America from Mexico, the correlation between the predictions and the data is much better (0.43) and in fact does better than using the share of least traded products (0.05). The poor performance of the least traded exercise seems to stem from considering the predictions for Mexico with Canada and the United States jointly rather than Mexico-Canada and Mexico-U.S. separately. In particular, in table 18 we see that when we consider them separately, the weighted correlation between our predictions and the data is 0.33 for Mexican exports to Canada and 0.17 for Mexican exports to the United States. When the predictions are computed separately and then aggregated together, however, the weighted correlation drops to 0.05 (see table A2). How the aggregation of individual countries into regions affects the predictions from our least traded exercise is something that merits further study.

A.2 Alternative thresholds

One might be concerned that our results depend on our choice to define the set of least traded products using a cutoff of 10 percent of total trade, which may appear somewhat arbitrary. Table A3 reports our optimal coefficients and correlation with the data while using a cutoff of 5 percent or 20 percent of total trade when defining least traded products. Under all cutoffs, the correlation between observed changes in the data and the share of least traded products in each industry remains high relative to competing models. The optimal coefficients change slightly to adjust for the fact that least traded products account for a different share of total trade, however, the correlation between the optimal coefficients under the various cutoffs is very high, ranging from

0.91 to approximately 1.00. This indicates that our results are largely robust to plausible alternative cutoffs and that the exact cutoff does not play a large role as long as it is not too small and not too large. These findings parallel those of Kehoe and Ruhl (2013), which show that the new products margin operates largely the same even with alternative cutoffs for defining the set of least traded products. Therefore, we choose a cutoff of 10 percent because we think this cutoff performs well in capturing the new products margin and is the simplest and most straightforward to understand and remember.

A.3 Ignoring non-traded products

As mentioned in the paper, the number of zero traded products has no influence on our shares of least traded products in each industry in 1989. This means that the our extensive margin is not the typical extensive margin of products that are previously not traded at all, but rather products with very small amounts of trade. To highlight this fact, we recompute the optimal coefficients and correlations between observed growth in the data and the share of least traded products and completely ignore growth in products that initially reported zero trade. Table A4 reports the results of this exercise and shows that our results are largely unchanged. This lends further support to our claim that the essential products in terms of generating any predictive power from our exercise are not products reporting zero trade, but products that are positively traded, although with very small amounts of trade.

A.4 Prices and quantities

Although our exercises look at changes in the value of trade, our results are primarily driven by changes in quantities rather than changes in prices. To show this, we examine all products for which we have quantity data and decompose the changes in real value into changes in price and changes in quantity, where real value is taken to be the reported level of trade converted to the exporting country's national currency and then deflated by the exporting country's producer price index. We then compute a weighted average of this decomposition, using the initial trade value as each product's weight. To reduce the effect of outliers, we do not include products in the top and bottom fifth percentile of products in terms of the percentage of growth accounted for by changes in quantity. These results are shown in table A5, where we see that on average, 86.9 percent of all changes in value are due to changes in quantities. When more than 100 percent of the change is due to changes in quantities, this indicates that prices decreased while the total value of trade increased or vice versa.

Appendix B. Predictions for U.S.-Korea FTA

In this section we use our model to make predictions about a trade liberalization that is currently under way, the U.S.-Korea free trade agreement (KORUS). The United States and Korea signed a free trade agreement, KORUS, in 2007, which was enacted in 2012. To make our predictions for the effects of KORUS, we follow the methodology laid out in section 2. We take the base year to be 2005. To parameterize the model, we need an elasticity of total trade to tariffs and the cross-country coefficient relating aggregate trade growth to newly traded products growth. We reestimate the gravity equation in (4), this time using data from 2005. Columns 3 and 4 of table B1 report the estimates. The value for γ comes from table 2 in Kehoe and Ruhl (2013). They estimate that γ is 3.59 using data on 1,913 bilateral country pairs covering 1995–2005.

For simplicity, we assume that KORUS reduces tariffs to zero. Table B1 reports our results from equations (3) and (6). We predict that total growth in bilateral trade will be 43.57 percent for U.S. exports to Korea and 14.14 percent for Korean exports to the United States. The difference in predicted trade growth is the result of initial tariffs that are significantly higher on U.S. exports to Korea than they are on Korean exports to the United States. For our industry-level predictions using (1), we set $\alpha_{kor}^{usa} = 9.06$ and $\beta_{kor}^{usa} = 50.78$ for Korean exports to the United States and $\alpha_{usa}^{kor} = 27.92$ and $\beta_{usa}^{kor} = 156.46$ for Korean imports from the United States. In table B2 we report the fraction of least traded products by industry for Korean exports to the United States and U.S. exports to Korea. Again, we see significant variation in this share, ranging from 0.01 to 1.00.

B.1 Our KORUS predictions

Table B2 reports our predictions for each industry (a list of each 3-digit ISIC industry code and its description is given in table B3). Our predictions vary widely across industries: for Korean exports to the United States, our predictions range from an increase of 10.1 percent in exports of furniture and fixture (ISIC code 332) to an increase of 50.8 percent in exports of industries that are completely made of up least traded products, such as pottery and glass products (ISIC codes

361 and 362). For U.S. exports to Korea, our predictions are substantially higher, ranging from an increase of 31.0 percent for paper products (ISIC code 341) to 156.5 percent for industries such as apparel and footwear (ISIC codes 322 and 324).

B.2 Predictions from other models

We first compare our predictions with the predictions from two alternative models. First, we compare predictions with those from Kiyota and Stern (2007), which are based on the methodology and assumptions of the Brown-Deardorf-Stern model discussed in section 4. Then we compare our results with those from Yaylaci and Shikher (2014), which are based on the Ricardian framework of Eaton and Kortum (2002).

Kiyota and Stern (2007) predict the changes in total imports and exports for 14 industries, as well as two service industries that we ignore, for Korea and the United States following liberalization. To make our results comparable to theirs, we aggregate the ISIC industries into their industries and compute the share of least traded products in each of those industries. Kiyota and Stern do not provide an exact concordance between the ISIC codes and their industries, so we develop one. Kiyota and Stern focus on trade flows between Korea and the World and the United States and the World, whereas our methodology predicts bilateral trade flows. To make our predictions comparable to theirs, we assume that exports from the United States to the World, excluding Korea, grow by the factor α and similarly for exports from Korea to the World, excluding the United States. This assumption allows us to keep our predictions of the form (1) using U.S.-Korea data. We use these data on trade flows to identify the set of least traded products. Mechanically, we multiply α by the fraction of trade accounted for by the United States for Korea, and by Korea for the United States. For example, for predicting Korean exports to the World, we set α to 2.27 $(=(15.55)(0.146))$ since Korean exports to the United States account for 14.6 percent of Korean exports to the World in 2005. Tables B4 and B5 compare our results with those of Kiyota and Stern. As we see, there are significant differences in the predictions between the two methods, especially for U.S. exports: our predictions have correlations with theirs that range from –0.23 for U.S. exports to 0.82 Korean exports.

Yaylaci and Shikher (2014) predict the changes in bilateral trade for 15 manufacturing industries between the United States and Korea following liberalization. Yaylaci and Shikher lack predictions for the agricultural industry, so we exclude it from our predictions after classifying products as least traded. Table B6 compares our predictions with the predictions of Yaylaci and Shikher. Again, there are significant differences between them, with a correlation of 0.43 between our predictions and those of Yaylaci and Shikher for Korean exports to the United States and a correlation of 0.19 for U.S. exports to Korea. The largest difference is for Korean exports to the United States: we predict the paper industry will experience the most growth, whereas Yaylaci and Shikher predict it will experience the least growth of all industries. There are similarities as well: Yaylaci and Shikher predict, for example, that for Korean exports to the United States, food will exhibit the most growth, whereas we predict it will exhibit the second highest growth. Similarly, we predict textiles will exhibit the most growth in U.S. exports to Korea, and Yaylaci and Shiker predict it will exhibit the second highest growth.

Table A1
Changes in Canadian trade relative to Canadian GDP (percent):
Observed changes vs. Cox-Harris predictions and least traded products based predictions

	exports to World			imports from World		
Industry	**Data**	**Cox-Harris**	**LTP**	**Data**	**Cox-Harris**	**LTP**
Agriculture	39.1	−4.1	5.8	−7.6	7.2	19.0
Chem. & misc. man.	70.9	28.1	14.5	29.7	10.4	21.0
Fishing	−30.9	−5.4	5.9	8.3	9.5	17.2
Food, bev., and tobacco	95.5	18.6	10.9	52.0	3.8	16.4
Forestry	−24.8	−11.5	11.7	−14.8	7.1	24.0
Machinery and appl.	11.7	57.1	12.2	−23.9	13.3	14.1
Mining	117.0	−7.0	5.9	65.4	4.0	9.0
Nonmetallic minerals	20.9	31.8	22.3	−15.8	7.3	27.4
Refineries	−67.8	−2.7	10.0	−77.1	1.5	10.7
Rubber and plastics	107.3	24.5	15.4	27.1	13.8	14.5
Steel and metal products	6.6	19.5	10.3	8.5	10.0	18.3
Textiles and leather	18.4	108.8	26.1	−20.1	18.2	14.1
Transportation equip.	−37.5	3.5	8.5	−34.6	3.0	13.4
Wood and paper	−58.5	7.3	6.6	−8.1	7.2	17.9
weighted correlation with data		0.06	0.18		0.04	0.33
regression coefficient *a*		2.00	−25.40		−10.57	−55.51
regression coefficient *b*		0.16	3.24		0.24	3.07
CH-LTP weighted correlation			0.81			0.22

The column *Data* reports the growth rates of industry exports deflated by the exporter's GDP growth rate, 1989−2009. *Cox-Harris* reports the predictions from Cox (1995), which are based on the methodology of Cox and Harris (1985). The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10). Fraction least traded is for U.S.-Korea trade, not total trade with the world.

Table A2
Changes in Mexican trade relative to Mexican GDP (percent):
Observed changes versus Sobarzo predictions and least traded products based predictions

	exports to North America			**imports from North America**		
Industry	**Data**	**Sobarzo**	**LTP**	**Data**	**Sobarzo**	**LTP**
Agriculture	−15.3	−11.1	15.1	61.0	3.4	41.6
Beverages	161.8	5.2	12.1	189.0	−1.8	70.0
Chemicals	34.1	−4.4	40.4	218.5	−2.7	58.2
Electrical machinery	54.7	1.0	12.7	66.3	9.6	31.1
Food	100.8	−6.9	31.4	128.8	−5.0	49.2
Iron and steel	19.6	−4.9	26.4	92.0	17.7	58.3
Leather	−64.6	12.4	37.5	60.0	−0.4	114.1
Metal products	86.2	−4.4	26.3	94.8	9.5	47.4
Mining	27.7	−17.0	12.1	79.4	13.2	50.4
Nonelectrical machinery	166.5	−7.4	18.2	115.8	20.7	41.4
Nonferrous metals	36.8	−9.8	17.7	113.9	9.8	44.6
Nonmetallic min. prod.	−16.0	−6.2	24.5	64.3	10.9	100.9
Other manufactures	88.4	−4.5	22.9	96.7	4.2	49.4
Paper	−35.9	−7.9	25.8	49.7	−4.7	38.8
Petroleum	−98.0	−19.5	17.0	−71.2	−6.8	37.6
Rubber	158.9	12.8	32.6	178.2	−0.1	37.1
Textiles	69.5	1.9	43.9	131.3	−1.2	84.0
Tobacco	−61.3	2.8	59.4	575.5	−11.6	155.0
Transportation equip.	126.1	−5.0	12.9	97.7	11.2	32.6
Wearing apparel	197.2	30.0	23.3	29.2	4.5	54.7
Wood	30.8	−8.5	13.6	2.9	11.7	36.5
Weighted correlation with data		0.43	0.05		−0.12	0.47
Regression coefficient *a*		81.13	56.62		104.22	6.41
Regression coefficient *b*		3.06	0.43		−0.77	2.17
Sobarzo-LTP weighted correlation			0.20			−0.32

The column *Data* reports the growth rates of industry exports deflated by the exporter's GDP growth rate, 1989−2009. *Sobarzo* reports the predictions from Sobarzo (1995). The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10). Fraction least traded is for U.S.-Korea trade, not total trade with the world.

Table A3
Correlations and optimal coefficients with alternative cutoffs

Exporter	Importer	5% LTP Cutoff			20% LTP Cutoff		
		correlation with data	$\tilde{\alpha}$	$\tilde{\beta}$	correlation with data	$\tilde{\alpha}$	$\tilde{\beta}$
CAN	MEX	0.36	474.86	4524.16	0.48	200.78	2501.44
CAN	USA	0.30	−18.83	338.66	0.33	−26.22	121.57
MEX	CAN	0.32	122.13	433.39	0.21	117.31	132.43
MEX	USA	0.08	55.96	66.28	0.10	53.37	29.50
USA	CAN	0.52	−30.64	273.64	0.61	−41.69	123.66
USA	MEX	0.45	62.46	527.87	0.56	51.58	186.33
Weighted average		0.37	−2.74	311.31	0.42	−11.65	122.31
Pooled regression		0.23	−2.21	300.51	0.26	−11.03	119.23
Correlation with 10% estimates			0.91	1.00		0.99	1.00

The optimal coefficients are the solution to (8). These coefficients are calculated using alternative cutoffs for defining the share of least traded products and compared correlation to the coefficients in the paper with the original 10 percent cutoff definition by computing the correlation between them. The weighted average uses the 1989 bilateral total trade values as weights for each country-pair. The pooled regression is the results of the regression with the data for all six country-pairs pooled together.

Table A4
Correlations and optimal coefficients with zeros ignored

Exporter	Importer	Original			Ignoring Zeros		
		correlation with data	$\tilde{\alpha}$	$\tilde{\beta}$	correlation with data	$\tilde{\alpha}$	$\tilde{\beta}$
CAN	MEX	0.36	254.23	4468.37	0.61	165.14	3719.32
CAN	USA	0.30	–20.42	185.24	0.28	−20.09	175.52
MEX	CAN	0.32	115.16	286.39	0.25	107.86	210.37
MEX	USA	0.08	51.52	77.54	0.05	52.64	20.16
USA	CAN	0.52	–34.54	175.84	0.54	−34.63	176.08
USA	MEX	0.45	62.31	265.44	0.41	63.31	227.14
Weighted average		0.37	−5.74	185.67	0.36	−5.59	168.58
Pooled regression		0.24	−5.30	181.18	0.24	−4.95	162.14
Correlation with original optimal coefficients						0.97	1.00

The optimal coefficients are the solution to (8). The column *Original* corresponds to the coefficients reported in the main paper in table 2. The column *Ignoring Zeros* reports the optimal coefficients when growth in products that are originally not traded at all is ignored. The weighted average uses the 1989 bilateral total trade values as weights for each country-pair. The pooled regression is the results of the regression with the data for all six country-pairs pooled together.

Table A5
Changes in North American trade deflated by exporter's PPI:
Growth decomposed into changes in quantities and changes in prices (percent)

			average share of total growth	
exporter	**importer**	**period**	***P***	***Q***
Canada	Mexico	89–09	−9.1	109.1
Canada	United States	89–09	32.3	67.7
Mexico	Canada	89–09	24.4	75.6
Mexico	United States	89–09	8.9	91.1
United States	Canada	89–09	−3.2	103.2
United States	Mexico	89–09	−1.3	101.3
weighted average			13.1	86.9
pooled			16.2	83.8

This table decomposes growth in exports into changes in prices, column *P*, and changes in quantities, column *Q*. These are the weighted averages across products for which both quantity and price data are available, where the weight for each product is its trade value in 1989 and varies by country-pair.

Table B1: Estimated coefficients, U.S.-Korea trade

Exporter	Importer	Initial tariff	Predicted growth	Estimated α	Estimated β
United States	Korea	10.85	43.57	31.03	125.43
Korea	United States	3.84	14.14	10.07	40.72

Growth in trade is measured as the change in trade deflated by the GDP growth rate. The estimated coefficients are the solution to (3) and (6). The optimal coefficients are the solution to (8).

Table B2: Predicted growth in Korea-U.S. trade relative to exporter's GDP (percent)

Korea to United States						United States to Korea					
ISIC code	**LTP**	**Least traded share**	**ISIC code**	**LTP**	**Least traded share**	**ISIC code**	**LTP**	**Least traded share**	**ISIC code**	**LTP**	**Least traded share**
111	50.8	1.00	**342**	29.1	0.47	**111**	37.9	0.05	**342**	50.9	0.16
113	50.8	1.00	**351**	24.0	0.34	**113**	35.9	0.04	**351**	53.4	0.18
121	50.8	1.00	**352**	28.9	0.46	**121**	35.1	0.03	**352**	47.1	0.13
122	50.8	1.00	**353**	13.4	0.08	**122**	50.1	0.15	**353**	35.3	0.03
130	50.8	1.00	**354**	50.8	1.00	**130**	53.3	0.18	**354**	156.5	1.00
210	-	-	**355**	14.2	0.10	**210**	31.0	0.00	**355**	102.4	0.57
220	50.8	1.00	**356**	12.3	0.05	**220**	33.3	0.02	**356**	34.7	0.03
230	50.8	1.00	**361**	50.8	1.00	**230**	38.5	0.06	**361**	40.0	0.07
290	50.8	1.00	**362**	50.8	1.00	**290**	76.0	0.36	**362**	89.5	0.47
311*	33.5	0.58	**369**	15.1	0.12	**311***	53.8	0.18	**369**	106.6	0.60
313	50.8	1.00	**371**	14.4	0.11	**313**	84.8	0.43	**371**	106.2	0.60
314	10.1	0.00	**372**	26.9	0.41	**314**	156.5	1.00	**372**	43.7	0.10
321	28.7	0.46	**381**	26.7	0.41	**321**	115.1	0.67	**381**	51.0	0.16
322	23.0	0.32	**382**	13.2	0.08	**322**	156.5	1.00	**382**	42.8	0.09
323	50.8	1.00	**383**	10.9	0.02	**323**	55.3	0.19	**383**	35.6	0.04
324	50.8	1.00	**384**	10.4	0.01	**324**	156.5	1.00	**384**	34.8	0.03
331	50.8	1.00	**385**	30.1	0.49	**331**	57.4	0.21	**385**	37.7	0.05
332	14.3	0.10	**390**	24.0	0.34	**332**	71.5	0.32	**390**	63.6	0.26
341	50.8	1.00				**341**	40.0	0.07			

The column *Least traded share* reports the share of industry exports accounted for by least traded products in 2005. The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10).

*311 is the single Major Group 311–312.

Table B3: ISIC industry codes and descriptions

ISIC code	Industry name
111	Agriculture and livestock production
113	Hunting, trapping and game propagation
121	Forestry
122	Logging
130	Fishing
210	Coal mining
220	Crude petroleum and natural gas production
230	Metal ore mining
290	Other mining
311–312*	Food manufacturing
313	Beverage industries
314	Tobacco manufactures
321	Manufacture of textiles
322	Manufacture of wearing apparel, except footwear
323	Manufacture of leather and products of leather, leather substitutes and fur
324	Manufacture of footwear
331	Manufacture of wood and wood and cork products, except furniture
332	Manufacture of furniture and fixtures, except primarily of metal
341	Manufacture of paper and paper products
342	Printing, publishing and allied industries
351	Manufacture of industrial chemicals
352	Manufacture of other chemical products
353	Petroleum refineries
354	Manufacture of miscellaneous products of petroleum and coal
355	Manufacture of rubber products
356	Manufacture of plastic products not elsewhere classified
361	Manufacture of pottery, china and earthenware
362	Manufacture of glass and glass products
369	Manufacture of other non-metallic mineral products
371	Iron and steel basic industries
372	Non-ferrous metal basic industries
381	Manufacture of fabricated metal products
382	Manufacture of machinery except electrical
383	Manufacture of electrical machinery apparatus, appliances and supplies
384	Manufacture of transport equipment
385	Manufacture of professional and scientific equipment
390	Other manufacturing industries

*311–312 is considered by the United Nations to be one Major Group (3-digit code) within the Division (2-digit code) 31, Manufacture of Food, Beverages and Tobacco, within the Major Division (1-digit code) 3, Manufacturing. It has eleven Groups (4-digit codes).

Table B4: Predicted growth in Korean trade, Kiyota-Stern model

Industry	Korean exports to World			Korean imports from World		
	Kiyota-Stern	LTP	Least traded share	Kiyota-Stern	LTP	Least traded share
Agriculture	−0.6	5.8	1.00	10.6	11.4	0.05
Chemicals	1.0	1.9	0.25	3.5	9.5	0.15
Food, bev., and tobacco	6.9	4.3	0.50	7.6	9.5	0.19
Leather and footwear	7.7	2.5	1.00	0.6	3.0	0.34
Machinery and equip.	−0.2	1.8	0.04	1.8	6.6	0.06
Metal products	0.4	2.1	0.24	1.7	3.7	0.18
Mining	−1.8	5.3	1.00	1.0	0.3	0.08
Misc. manufactures	5.3	1.9	0.27	4.2	8.1	0.08
Natural resources	0.6	2.5	1.00	1.3	5.1	0.16
Nonmetallic min. prod.	0.2	4.2	0.47	3.4	8.4	0.46
Textiles	8.6	2.6	0.44	3.6	5.4	0.67
Transportation equip.	2.7	2.1	0.01	2.1	10.3	0.03
Wearing apparel	27.7	10.5	0.33	−6.0	2.6	1.00
Wood products	0.2	3.5	0.39	2.0	8.1	0.11
KS-LTP weighted correlation			**0.82**			**0.63**

The column *Kiyota-Stern* reports the predictions from Kiyota and Stern (2007). The column *Least traded share* reports the share of industry exports accounted for by least traded products in 2005. The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10). Fraction least traded is for U.S.-Korea trade, not total trade with the world.

Table B5: Predicted growth in United States, Kiyota-Stern model

Industry	U.S. exports to World			U.S. imports from World		
	Kiyota-Stern	LTP	Least traded share	Kiyota-Stern	LTP	Least traded share
Agriculture	4.4	1.4	0.07	0.2	0.1	1.00
Chemicals	0.4	1.6	0.15	0.0	0.4	0.26
Food, bev., and tobacco	2.0	1.8	0.19	0.1	0.2	0.56
Leather and footwear	0.4	2.2	0.23	−0.1	0.1	1.00
Machinery and equip.	0.3	1.5	0.05	0.0	0.6	0.04
Metal products	0.3	1.6	0.24	0.0	0.4	0.22
Mining	0.1	0.6	0.15	0.0	0.0	1.00
Misc. manufactures	0.5	1.4	0.08	0.0	0.3	0.40
Natural resources	0.4	4.1	0.15	0.0	0.3	1.00
Nonmetallic min. prod.	0.6	3.0	0.71	0.0	0.3	0.27
Textiles	−0.1	1.4	0.64	−0.4	1.0	0.46
Transportation equip.	0.0	0.7	0.02	−0.1	0.5	0.01
Wearing apparel	−0.1	1.7	0.70	−0.5	0.4	0.32
Wood products	0.1	1.2	0.23	0.0	0.2	0.58
KS-LTP weighted correlation			**0.22**			**−0.23**

The column *Kiyota-Stern* reports the predictions from Kiyota and Stern (2007). The column *Least traded share* reports the share of industry exports accounted for by least traded products in 2005. The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10). Fraction least traded is for U.S.-Korea trade, not total trade with the world.

Table B6: Predicted growth in Korean trade

Industry	Korea to United States			United States to Korea		
	Yaylaci-Shikher	**LTP**	**Least traded share**	**Yaylaci-Shikher**	**LTP**	**Least traded share**
Chemicals	28.2	24.7	0.36	30.3	51.4	0.16
Electrical machinery	15.5	10.9	0.02	41.0	35.6	0.04
Food	70.1	33.0	0.56	422.3	55.0	0.19
Other machinery	8.9	13.2	0.08	31.9	42.8	0.09
Medical	9.9	30.1	0.49	45.0	37.7	0.05
Metals	9.3	15.5	0.13	17.0	56.5	0.20
Nonmetals	20.5	21.2	0.27	38.7	89.1	0.46
Other	11.8	24.0	0.34	28.5	63.6	0.26
Paper	1.4	37.6	0.68	5.5	42.1	0.09
Petroleum	2.2	15.1	0.12	7.2	35.3	0.03
Metal products	14.2	26.7	0.41	33.8	51.0	0.16
Rubber	19.8	13.7	0.09	48.0	52.7	0.17
Textile	56.3	26.0	0.39	63.5	112.8	0.65
Transportation equip.	23.3	10.4	0.01	33.9	34.8	0.03
Wood	7.9	18.4	0.21	21.1	62.0	0.25
KS-LTP weighted correlation			**0.43**			**0.19**

The column *Yaylaci-Shikher* reports the predictions from Yaylaci and Shikher (2014). The column *Least traded share* reports the share of industry exports accounted for by least traded products in 2005. The column *LTP* reports the predictions from the least traded products model in (1). The regression coefficients a and b are the solution to (10).