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Improving Applied General Equilibrium Models of Trade Liberalization*

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ABSTRACT

Applied General Equilibrium (AGE) models are the dominant tool for the analysis of trade policy. Unfortunately, AGE models have historically performed poorly when used to predict the industry level impact of trade liberalization. In this paper, we show that much of this poor performance is due to the use of elasticities that are not suitable for capturing the impact of trade liberalizations. We develop a new methodology for estimating industry level trade elasticities based on finding the elasticities that yield AGE model predictions that best fit previous liberalizations, and show that these elasticities . We show how our methodology can flexibly be adapted to a wide range of model specifications, including the extensive margin from Kehoe et al. (2015) which further increases the predictive power of AGE models.

*The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

1. Introduction

Applied General Equilibrium (AGE) models featuring multiple industries, multiple regions, and input-output linkages across industries are the primary tool that policymakers employ when predicting the impact trade liberalization (or protectionism) will have on the industrial composition of an economy. For that reason, one would hope that AGE models yield predictions that are approximately correct, anticipating which industries will grow and which industries will decay as a result of the liberalization. Unfortunately, this has largely not been the case. In a string of papers, Kehoe (2005), Kehoe et al. (2015, henceforth KRR), and Kehoe et al. (2017, henceforth KPR), we show that AGE models have historically performed poorly.[1] In particular, AGE model predictions often have negative or zero correlation with what actually happens following liberalization, and that simple reduced form methods can perform better. Despite these negative results, our conclusion is not that AGE models should be abandoned, but rather that we must improve them, and in KPR, we suggest that the estimation of trade elasticities and the identification of trade costs are the two limiting aspects of AGE modeling most in need of improvement.

In this paper, we develop a new methodology for estimating industry-level trade elasticities for use in AGE models for predicting the impact of trade liberalization. Our methodology is based on finding the elasticities that yield AGE model predictions that best fit previous trade liberalizations. For example, to estimating the impact of the Korea-U.S. Free Trade Agreement (KORUS), we find the elasticities for the North American Free Trade Agreement that yield the highest weighted correlation between the predictions of our chosen AGE model and the industry-level changes in the data. This improves the predictive power of the AGE model significantly, from a weighted correlation of –0.31 using the elasticities from Caliendo & Parro (2015), to a weighted correlation of 0.34 using our NAFTA best-fit elasticities.

Our methodology has several strengths in addition to improving the predictive power of AGE models. First, when applied to the same trade liberalization we are trying to predict, it provides a theoretical maximum bound on the best we could have expected to perform. Second, our methodology is easily adaptable to a wide array of models, and can be used to estimate other parameters in addition to elasticities. This is important because different AGE models imply

[1] In all, we look at a number of AGE models and trade liberalizations, including one of the most prominent models built for NAFTA around the time of its implementation (Brown et al. (1995)), the most prominent recent model built for NAFTA well after its implementation (Caliendo & Parro (2015)), and the workhorse AGE model used by policymakers around the world (GTAP, see Hertel (2013)).

different optimal elasticities; whereas in practice, it is common to use the same set of elasticities (typically calibrated separately or taken from the literature) regardless of the features of the particular AGE model being used, for example if there are input-output linkages or not. Third, it is straightforward to change the best fit criteria used; in this paper we focus primarily on weighted correlations because simple to understand, consistent with earlier research, and unaffected by aggregate scaling that is constant across industries; however, depending on the goal of the AGE model, different fit criteria may be appropriate.

In order to highlight the flexibility of our approach, we construct an AGE model that features the product-level extensive margin featured in Kehoe & Ruhl (2013, henceforth KR). KR document that products that are initially traded in small, yet positive, amounts (henceforth least-traded products or LTPs) grow significantly more than other products following liberalization. Building on this insight, KRR and KPR demonstrate that a simple reduced form strategy based solely on the initial share of LTP within each industry significantly outperforms AGE models in predicting the industry-level impact of trade liberalization. We embed the LTP margin into an AGE model by treating LTPs as if they face amplified trade costs versus non-LTPs. This implies that industries with a higher share of LTPs will be more responsive to a given change in trade costs and effectively captures the margin from KRR and KPR. We employ our estimation methodology to simultaneously estimate industry-level trade elasticities and the degree to which LTPs are more-responsive than nonLTPs for each industry, and we show that this LTP-augmented AGE model outperforms both a standard AGE model and the reduced form methodology of KRR in out-of-sample predictions for the industry-level impact of past trade liberalizations.

It is important to note that our LTP-augmented AGE model performs superiorly precisely because of our estimation methodology. If our same model is calibrated using off-the-shelf estimates for trade elasticities and LTP-amplifiers, then our model actually performs worse than a standard AGE model. This example emphasizes one of the central conclusions of our paper: that researchers employing AGE models must use model consistent elasticities. In contrast to the prevailing paradigm of gravity-model based estimation techniques, our methodology makes this procedure straightforward, a feature which we hope will allow for greater innovation among AGE modelers.

2. An AGE model of LTPs

In this section we develop a multi-sector, multi-country, applied general equilibrium model. The key innovation in this model is the inclusion of two types of varieties of products: normal and inefficiently exported. We treat inefficiently exported varieties as "least traded products" (henceforth, LTP), and show how the bilateral, sector-specific trade elasticity in the model incorporates information on the LTP margin.

The household in country $i \in I$ derives utility from consuming c_i^s units of goods from sector $s \in S$, whose price is p_i^s. Her income is made of payments from market activities, w_i, plus rebated tariffs T_i. Namely, the problem she solves is

$$\max \sum_{s=1}^{S} a_i^s \log\left(c_i^s\right) \tag{1}$$

$$\text{s.t. } \sum_{s=1}^{S} p_i^s c_i^s = w_i L_i + T_i + D_i,$$

where a_i^s are the (country-specific) sector weights in the utility function and D_i is the trade balance. Let $Income_i = w_i L_i + T_i + D_i$, then

$$c_i^s = a_i^s \frac{Income_i}{p_i^s}. \tag{2}$$

Each industry produces y_i^s combining domestic and foreign production according to

$$y_i^s = \left(\sum_{j=1}^{J} \gamma_{ij}^s \left(y_{ij}^s\right)^{\frac{\sigma_s - 1}{\sigma_s}}\right)^{\frac{\sigma_s}{\sigma_s - 1}}, \tag{3}$$

where γ_{ij}^s is the sector weights for consumption in country i, originating from country j, in sector s, and σ_s is the elasticity. The producer of this bundle cost-minimizes expenses according to

$$\min \sum_{j=1}^{J} p_{ij}^s y_{ij}^s, \tag{4}$$

subject to equation (3). This problem has the following demand as solution

$$y_{ij}^s = y_i^s \left(\gamma_{ij}^s \frac{p_i^s}{p_{ij}^s}\right)^{\sigma_s}, \tag{5}$$

where

$$p_i^s = \left(\sum_{j=1}^{J} \left(\gamma_{ij}^s\right)^{\sigma_s} \left(p_{ij}^s\right)^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}} . \tag{6}$$

Exports from j to i in sector s are an Armginton aggregate of non-LTP with LTP products. The elasticity across these two types of goods is the same as the elasticity across countries. Namely, the aggregate is given by

$$y_{ij}^s = \left(\left(1-\nu_{ij}^s\right) \left(y_{ij}^{s,non}\right)^{\frac{\sigma_s-1}{\sigma_s}} + \nu_{ij}^s \left(y_{ij}^{s,LTP}\right)^{\frac{\sigma_s-1}{\sigma_s}} \right)^{\frac{\sigma_s}{\sigma_s-1}} , \tag{7}$$

where ν_{ij}^s is the non-LTP weight in country i's sector s goods from country j. The producer of this bundle cost-minimizes, which again implies the demand functions

$$y_{ij}^{s,non} = y_{ij}^s \left(\left(1-\nu_{ij}^s\right) \frac{p_{ij}^s}{p_{ij}^{s,non}} \right)^{\sigma_s} , \tag{8}$$

and

$$y_{ij}^{s,LTP} = y_{ij}^s \left(\nu_{ij}^s \frac{p_{ij}^s}{p_{ij}^{s,LTP}} \right)^{\sigma_s} , \tag{9}$$

where

$$p_{ij}^s = \left(\left(1-\nu_{ij}^s\right)^{\sigma_s} \left(p_{ij}^{s,non}\right)^{1-\sigma_s} + \left(\nu_{ij}^s\right)^{\sigma_s} \left(p_{ij}^{s,LTP}\right)^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}} , \tag{10}$$

Producers from country j of product $m = \{non, LTP\}$ operate the following production function

$$y_{ij}^{s,m} = \frac{1}{t_{ij}^{s,m}} \min\left\{ z_j^s \ell_{ij}^{s,m}, \frac{x_{ij}^{s_1,m}}{\alpha_j^{s_1}}, \ldots, \frac{x_{ij}^{s_k,m}}{\alpha_j^{s_k}}, \ldots, \frac{x_{ij}^{s_S,m}}{\alpha_j^{s_S}} \right\}, \tag{11}$$

where $x_{ij}^{s_k,m}$ is the quantity of composite intermediate inputs from sector k used in the production of sector s in country j for consumption in country i, and is the unit input requirement of inputs from sector k used in the production of sector s. Finally, $t_{ij}^{s,m}$ is equal to 1 if $m = non$ and it is greater if $m = LTP$. Later on we make this object a function of trade costs, so that the spike in LTP is larger than in non-LTP following a drop in trade costs.

The Leontieff structure of the production function implies that

$$z_j^s \ell_{ij}^{s,m} = \frac{x_{ij}^{s_1,m}}{\alpha_j^{s_1}} = \ldots = \frac{x_{ij}^{s_k,m}}{\alpha_j^{s_k}} = \ldots = \frac{x_{ij}^{s_S,m}}{\alpha_j^{s_S}}, \tag{12}$$

which means that

$$x_{ij}^{s_k,m} = \alpha_j^{s_k} z_j^s \ell_{ij}^{s,m}. \tag{13}$$

Consumers in country i pay tariffs equal to τ_{ij}^s, which implies that firm's profit maximization problem is given by

$$\max \frac{p_{ij}^{s,m} y_{ij}^{s,m}}{\tau_{ij}^s} - w_j \ell_{ij}^{s,m} - \sum_{k=1}^{S} p_j^k x_{ij}^{s_k,m} \;, \tag{14}$$

which implies that equilibrium prices are given by

$$p_{ij}^{s,m} = \tau_{ij}^s t_{ij}^{s,m} \left(\frac{w_j}{z_{ij}^s} + \sum_{k=1}^{S} p_j^k \alpha_j^{s_k} \right), \tag{15}$$

which implies that $p_{ij}^{s,LTP} = t_{ij}^{s,LTP} p_{ij}^{s,non}$. The tariffs paid in country i are collected by the government and rebated back to consumers. In particular, the expression for the rebate is given by

$$T_i = \sum_{s=1}^{S} \sum_{j=1}^{J} \sum_{m=1}^{M} \left(\tau_{ij}^s - 1 \right) p_{ij}^{s,m} y_{ij}^{s,m} \;. \tag{16}$$

For country i, the trade deficit is given by

$$D_i = \sum_{s=1}^{S} \left(\sum_{j=1}^{J} \frac{p_{ij}^s y_{ij}^s}{\tau_{ij}^s} - \sum_{j=1}^{J} \frac{p_{ji}^s y_{ji}^s}{\tau_{ji}^s} \right). \tag{17}$$

Finally, labor markets clear

$$L_j = \sum_{s=1}^{S} \sum_{i=1}^{J} \left(\ell_{ij}^{s,non} + \ell_{ij}^{s,LTP} \right), \tag{18}$$

and good markets clear too

$$x_j^k = \sum_{s=1}^{S} \sum_{i=1}^{J} \left(x_{ij}^{s_k,non} + x_{ij}^{s_k,LTP} \right), \tag{19}$$

with

$$y_j^k = x_j^k + c_j^k \;. \tag{20}$$

3. Data and Calibration of Standard Model Parameters

In this section we explain our calibration exercise. Here we provide a quick summary and then move on to explain the exercise in great detail. We use data on trade flows (including self-trade), tariffs, Input-output flows, and the share of LTP for each trade flows. Then, we use, from outside the model, information on the elasticity parameters, such as σ_s and θ_s. We normalize wages and productivities to one, and calibrate trade deficits, tariff revenues, labor endowments and labor used in the production of each good. After that, we calibrate output for LTP and non-LTP producers, prices for LTP and non-LTP, and the LTP shares in each sector. With this information we move on to compute sectoral prices and outputs, as well as each home bias parameter. Again, with this information we can retrieve sectoral prices, sectoral output, input-output share parameters, consumption and intermediate inputs at sectoral level, and, finally, the utility shares for each sector.

From our data, we have expenditures, $p_{ij}^s y_{ij}^s$, which means that to calculate the share of least traded products we simply divide expenditures according to

$$LTP_{ij}^s = \frac{p_{ij}^{s.LTP} y_{ij}^{s,LTP}}{p_{ij}^s y_{ij}^s}, \tag{21}$$

and the data also contains information on tariffs, τ_{ij}^s. Note also that $p_{ij}^s y_{ij}^s$ is expenditures from the consumer side, which include tariffs. Therefore, if our trade flows do not include tariffs, we need to add them in to get expenditures. Moreover, we assume $t_{ij}^{s,LTP} = \left(\tau_{ij}^s\right)^{\theta_s - 1}$.

We normalize $w_j = 1$ and $z_j^s = 1$. Then, we calibrate the trade balance directly from equation (17), initial tariff revenues from equation (16), and income as

$$Income_i = \sum_{s=1}^{S} \sum_{i=1}^{J} p_{ij}^s y_{ij}^s - \sum_{s=1}^{S} p_i^s x_i^s . \tag{22}$$

Then we can calibrate the aggregate labor supply from the budget constraint as

$$L_i = \frac{Income_i - T_i - D_i}{w_i}. \tag{23}$$

Note that value added is given by

$$VA_{ij}^s = \frac{p_{ij}^{s,non} y_{ij}^{s,non} + p_{ij}^{s,LTP} y_{ij}^{s,LTP}}{\tau_{ij}^s} - \sum_{k=1}^{S} \alpha_j^{s_k} p_j^k y_{ij}^{s,non} - t_{ij}^{s,m} \sum_{k=1}^{S} \alpha_j^{s_k} p_j^k y_{ij}^{s,LTP}, \tag{24}$$

and then use this to compute

$$\ell_{ij}^{s,LTP} = \frac{LTP_{ij}^s VA_{ij}^s}{w_j}, \tag{25}$$

and

$$\ell_{ij}^{s,non} = \frac{(1-LTP_{ij}^{s})VA_{ij}^{s}}{w_j}, \tag{26}$$

and using the production function, we get that $y_{ij}^{s,m} = z_{ij}^{s}\ell_{ij}^{s,m}\left(t_{ij}^{s,m}\right)^{-1}$. From combining LTP and non-LTP goods we can calibrate the LTP biases (the exact computation of σ_s is the central part of the next section)

$$\nu_{ij}^{s} = \frac{p_{ij}^{s,LTP}\left(y_{ij}^{s,LTP}\right)^{\frac{1}{\sigma_s}}}{p_{ij}^{s,non}\left(y_{ij}^{s,non}\right)^{\frac{1}{\sigma_s}} + p_{ij}^{s,LTP}\left(y_{ij}^{s,LTP}\right)^{\frac{1}{\sigma_s}}}, \tag{27}$$

and retrieve the prices for the aggregate good using equation (10), where

$$p_{ij}^{s.LTP} = \frac{LTP_{ij}^{s}}{y_{ij}^{s,LTP}} p_{ij}^{s} y_{ij}^{s}, \tag{28}$$

We can then use this information in equation (10) to get p_{ij}^{s}. In turn, we can make use of data on expenditure per sector to get output using

$$y_{ij}^{s} = \frac{p_{ij}^{s} y_{ij}^{s}}{p_{ij}^{s}}, \tag{29}$$

and use these values to to calibrate country shares

$$\gamma_{ij}^{s} = \frac{p_{ij}^{s}\left(y_{ij}^{s}\right)^{\frac{1}{\sigma_s}}}{\sum_{k=1}^{S} p_{ik}^{s}\left(y_{ik}^{s}\right)^{\frac{1}{\sigma_s}}}, \tag{30}$$

Lastly we calibrate sector shares as

$$a_{i}^{s} = \frac{p_{i}^{s} c_{i}^{s}}{Income_i}, \tag{31}$$

We can use our prices and gammas to get the price index for each sector from equation (3) along with our previous $y_{ij}^{s,non}$ and $y_{ij}^{s,LTP}$ to derive the expression

$$\alpha_{j}^{s_k} y_{ij}^{s,non} = \frac{p_{ij}^{k} x_{ij}^{s_k,non}}{p_{j}^{k}}, \tag{32}$$

$$\frac{\alpha_{j}^{s_k} y_{ij}^{s,LTP}}{t_{ij}^{s,LTP}} = \frac{p_{ij}^{k} x_{ij}^{s_k,LTP}}{p_{j}^{k}}, \tag{33}$$

And adding them together we get

$$\alpha_j^{s_k}\left(\frac{y_{ij}^{s,LTP}}{t_{ij}^{s,LTP}}+y_{ij}^{s,non}\right)=\frac{p_{ij}^k x_{ij}^{s_k}}{p_j^k}, \tag{34}$$

And then summing over i and rearranging gives sector shares as

$$\alpha_j^{s_k}=\frac{p_{ij}^k x_{ij}^{s_k}}{p_j^k}\frac{1}{\sum_{i=1}^{S}\frac{y_{ij}^{s,LTP}}{t_{ij}^{s,LTP}}+y_{ij}^{s,non}}. \tag{35}$$

4. Estimating Elasticities with Best Fit

We now discuss our methodology for estimating industry-level trade elasticities by finding the best fit elasticities for a previous liberalization. We adopt as our fit criterion the weighted correlation between changes in industry-level trade flow volumes in the data and those generated by our chosen AGE model. This fit criterion is the same as in KRR and KPR and has the benefit of being straightforward to calculate and understand, and is unaffected by scaling that is common across industries, for example if industry level trade flows are normalized by GDP. It is straightforward, however, to implement our methodology using alternative or even multiple fit criteria.

Given some base period t and final period t', let $\Delta\left(X_{ij}^s\right)_{t,t'}\equiv\left(\frac{X_{ij,t'}^s}{Y_{j,t'}}\right)/\left(\frac{X_{ij,t}^s}{Y_{j,t}}\right)$ be the change in in the data of exports, $X_{ij,t}^s=\frac{p_{ij,t}^s y_{ij,t}^s}{\tau_{ij,t}^s}$, from j to i in industry s, deflated by exporter GDP, $Y_{j,t}=\sum_s\sum_i p_{ji,t}^s y_{ji,t}^s$. Likewise, let $\Delta\left(\hat{X}_{ij}^s\right)_{t,t'}\equiv\left(\frac{\hat{X}_{ij,t'}^s}{\hat{X}_{j,t'}}\right)/\left(\frac{X_{ij,t}^s}{X_{j,t}}\right)$ be the change in industry-level trade flows divided by exporter GDP in our AGE model for a given policy experiment, $\Omega_t\to\Omega_{t'}$, where Ω_t is the set of exogenous parameters subject to change.[2] For example, if the

[2] Because our calibration strategy fits the data exactly in the base period, the denominator, $\left(\frac{X_{ij,t}^s}{X_{j,t}}\right)$ or base period exports deflated by exporter GDP, is the same across both $\Delta\left(X_{ij}^s\right)_{t,t'}$ and $\Delta\left(\hat{X}_{ij}^s\right)_{t,t'}$.

only parameters that change between t and t' in the model are the set of bilateral industry-level tariffs then $\Omega_t = \{\tau_{ij,t}^s\}$, however, policy experiments can include changes in other exogenous parameters, such as industry-level expenditure shares or productivities, as well. For changes in exports from country j to country i, we use as weights each industry's share of exports weighted across the base and final period,

$$\omega_{ij} = \frac{X_{ij,t}^s + X_{ij,t'}^s}{\sum_s \left(X_{ij,t}^s + X_{ij,t'}^s\right)},$$

and compute the weighted correlation between the predicted changes in the AGE model and the changes in the data for, $\rho\left(\Delta\left(X_{ij}^s\right)_{t,t'}, \Delta\left(\hat{X}_{ij}^s\right)_{t,t'}, \omega_{ij}\right)$.[3]

Formally, in order to find the best-fit elasticities, we solve the following problem,

$$\{\sigma_1,\ldots,\sigma_K\} = \arg\max \rho\left(\Delta\left(X_{ij}^s\right)_{t,t'}, \Delta\left(\hat{X}_{ij}^s\right)_{t,t'}, \omega_{ij}\right).$$

Unfortunately, there is no analytical expression for the solution to this problem, and the frequent occurrence of local optima make many traditional numerical approaches, for example Newton's method, unsuitable. Instead, we employ a genetic algorithm to solve this problem, which is a heuristic approach to global optimization. Our genetic algorithm works by creating an initial population of guesses for $\{\sigma_1,\ldots,\sigma_K\}$. For each set of elasticities, we calibrate our AGE model (recall in section 3, the calibrated parameters depend on our elasticities), perform our policy experiment, $\Omega_t \to \Omega_{t'}$, and to evaluate the performance of our AGE model according to our best fit criterion, the weighted correlation between changes in the model with changes in the data. After doing this, the genetic algorithm randomly selects sets of elasticities such that the probability of selection is higher for those sets that yield a higher weighted correlation with the data. After selecting these sets as parents, the algorithm generates a new population of elasticity sets by pairing

[3] Given a vector of weights, ω, the weighted correlation between two vectors x and y is given by $\rho(x,y,\omega) = \frac{cov(x,y,\omega)}{cov(x,x,\omega)cov(x,y,\omega)}$ where $cov(x,y,\omega) = \sum_i \omega_i \left(x_i - \bar{x}(\omega)\right)\left(y_i - \bar{y}(\omega)\right)$ where ω_i is the ith element of ω and $\bar{x}(\omega) = \sum_i \omega_i x_i$ is the weighted mean of x.

parent sets and altering them through mixing the sets, or crossover, and mutation, where elements are changed randomly. The process continues iteratively until the algorithm converges, whereby the set of elasticities yielding the highest value for the best fit criterion does not change after several iterations.

5. Trade Liberalizations and Predictive Performance

For an illustrative example, we will lay out our procedure for finding the best fit elasticities for NAFTA. We select 1989 as our base year because the United States and Canada signed a bilateral free trade agreement in 1988, and we wish to avoid trying disentangling the effect of this trade liberalization with that of NAFTA.[4] We select as our final year 2007, since only 50 percent of initial tariffs were abolished immediately when NAFTA took effect, with the rest set to phase tariffs out over 15 years (1994–2009), however most tariffs were eliminated within 10 years and we want to avoid the impact of the global recession on trade flows.

Following KRR and KPR, we judge the predictive performance of a model by computing the correlation between predicted and actual changes after the liberalization. We look at two different sets of correlations: the internal-validation and the external-validation elasticities. For the internal-validation, given that we estimate our elasticities to NAFTA, we compute the correlation between predicted and actual changes in each bilateral trade relationship.

Table 1: Correlations between model and data, internal validity

Importer	Exporter	Base model	Without LTP	Caliendo-Parro
USA	CAN	0.63	0.35	0.03
USA	MEX	0.92	0.83	0.60
MEX	USA	0.79	0.48	0.19
MEX	CAN	0.69	0.53	0.36
CAN	USA	0.51	0.09	-0.20
CAN	MEX	0.72	0.59	0.54
Simple average		0.71	0.48	0.25

[4] Ideally we would be able to select a year prior to 1988 as our base year, however, as we show in KR, the adoption of the Harmonized System in 1989 lead to a structural break in the trade data which makes combining pre- and post-Harmonized System (HS) data impossible, even when products are classified according to the Standard International Trade Classification (SITC).

Table 1 documents the success of our methodology, decomposing the gains between the model with LTP and also performing the exercise on a model without LTP. For comparison, we also present the performance of the well-known model by Caliendo and Parro in the last row.

The results are clear, on average, our base model can account for 71% of the variability in the data, whereas the standard CP model can only account for 25% (note that in this exercise we re-do their calibration exercise to give that model the best shot at predicting changes—in KPR we took their values as given and the predictive power was 0%). Part of our success arises from performing the calibration using "model-consistent elasticities." By that we mean that the model is using elasticities that are computed i) on a policy experiment that resembles our object of interest (a trade liberalization) and ii) using the model that is to be used in the policy experiment. The other part of our success arises from introducing the LTP margin. Without it, the model would already improve in 23% from CP. The model gives an extra 23% by introducing the LTP margin, because sectors react differently in different countries, depending on how many of their products are traded only in very little amounts before the liberalization.

Next we show how our exercise works when we do external validation. To this end, we look at two trade liberalizations, USA-KOR and MEX-JPN. We choose these two exercises because they both have a rich and a poor country, like in our exercise USA and MEX. We present the results in Table 2.

Table 2: Correlations between model and data, external validity

Importer	Exporter	Base model	Without LTP	Caliendo-Parro
USA	KOR	0.97	0.34	-0.32
KOR	USA	0.75	0.33	-0.31
MEX	JPN	0.59	0.26	-0.02
JPN	MEX	0.71	0.18	-0.42
Simple average		0.76	0.28	-0.27

The results are here even more striking that before. While, if one uses "off the shelf" elasticities from the Caliendo-Parro model, one gets negative correlations throughout, which average at -0.27, by using our methodology the correlation is an impressive 76%. Again, part of this success already arises from using the "model-consistent elasticities" from the NAFTA liberalization, which gives a 28%, and the remaining 48% comes from introducing the LTP margin.

6. Conclusion

In this paper we demonstrate that Applied General Equilibrium models can be used to make accurate predictions regarding the impact of a trade reform. The key insight from our paper is that model-consistent elasticities, computed from previous liberalizations make the model generate changes in the industry composition that positively correlate with the changes that actually occur after a trade reform. Moreover, we also show that when the model is extended to incorporate the least-traded products margin, model predictions are even better.

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