Terms of Trade and Global Efficiency Effects of Free Trade Agreements, 1990-2002 *†

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Abstract

This paper infers the terms of trade effects of Free Trade Agreements (FTAs) implemented in the 1990s. We estimate large FTA effects on bilateral trade volume in 2 digit manufacturing goods from 1990-2002, using panel data gravity methods to resolve two way causality. The terms of trade changes implied by these volume effects are deduced for 40 countries plus a rest-of-the-world aggregate using an endowments general equilibrium model. Some countries gain over 5% of real manufacturing income, some lose less than 0.3%. Global efficiency of manufactures trade rises 0.9% based on a distance function measure of iceberg melting.

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Introduction

The proliferation of Free Trade Agreements (FTAs) in the 1990's alarmed many trade policy analysts and popular observers. Trade diverted from non-partners harms their terms of trade. Losses to non-partners could even outweigh the gains to partners, reducing the efficiency of the world trading system. This paper estimates the effects of trade agreements implemented in the 1990s on manufacturing real incomes using the gravity model. Large inferred volume effects of FTAs are attributed to non-tariff cost reductions, since they exceed reasonable attribution to tariff changes. Terms of trade changes inclusive of such effects measure national gains. For the world as a whole, global efficiency is equal to the change in how much of the iceberg melts, a natural interpretation in the gravity context. The results are reassuring: FTAs delivered benefits while negligibly harming outsiders. Some countries gain over 5%, a few lose less than 0.3% and global efficiency rises 0.9%.

Theory gives prominence to the terms of trade effects of trade agreements and simulation models provide numerical measures of terms of trade changes due to tariff changes induced by particular FTAs. In contrast, there is little empirical evidence on the effect of trade agreements on the terms of trade, because terms of trade are notoriously hard to measure and causation faces difficult inference problems.[1] Our empirical approach is to estimate the volume effects of the FTAs implemented in the 90s using the gravity model with panel data methods to deal with two way causality, and then use the estimated volume effects to simulate the terms of trade implications of a hypothetical FTA

[1]Feenstra (2004, pp. 197-99) reviews the literature. Studies using prices directly are quite limited in scope due to the difficulties in assembling comparable price data across a wide range of countries as well as inferring the effect of FTAs on prices. Chang and Winters (2002) address both problems using export unit values at the 6 digit Harmonized System level for Brazil. See their footnote 5, pp. 891-2, for discussion of the severe limitations. They treat prices as set by a foreign and domestic firm in a duopoly pricing game that avoids general equilibrium considerations. Clausing (2001) uses a partial equilibrium model disaggregated by sector that links import volume changes to tariff changes for Canada, and does not go on to link them to price changes. Romalis (2007) simulates the equilibrium price changes induced by the Canada-US Free Trade Agreement (CUSFTA) and the North American Free Trade Agreement (NAFTA) tariff changes using detailed demand elasticities estimated with a "difference in differences based estimation technique to identify demand elasticities that focuses on where each of the NAFTA partners sources its imports of almost 5,000 6-digit Harmonized System (HS-6) commodities and comparing this to the source of European Union (EU) imports of the same commodities. The technique enables identification of NAFTAs effects on trade volumes even when countries' production costs shift." Caliendo and Parro (2015) calculate what proportion of NAFTA members trade changes can be accounted for by the tariff changes using the Eaton-Kortum (2002) version of the gravity model.

implementation in 1990.

Our estimation methods extend an empirical gravity literature on the trade volume effects of FTAs. Notable studies include Frankel (1997), Magee (2003) and Baier and Bergstrand (2002, 2004, 2007). Early findings on the effects of FTAs and trading blocs on bilateral trade flows were mixed,[2] but recent developments deal effectively with two way causality and show that trading blocs and FTAs have large direct effects on aggregate bilateral trade between member countries relative to non-member countries. Baier and Bergstrand (2007) find that, on average, a FTA induces approximately a 100% increase in bilateral trade between member relative to non-member countries within ten years from their inception. Volume changes like these, larger than explicable by tariff changes, are plausible because FTAs typically induce unobservable actions that effectively reduce trade costs. Various regulatory policy barriers typically fall between FTA partners[3] while the enhanced security of bilateral trade induces relationship-specific investment in trade with partner counter-parties.

We infer the volume effects of FTAs implemented between 1990 and 2002 for 40 separate countries and an aggregate region consisting of 24 additional nations (none of which entered FTAs). The inference is drawn from estimated gravity equations at the 2 digit ISIC level in manufacturing, a disaggregation that contrasts with the aggregate trade focus of much of the empirical gravity literature. We find large volume effects comparable to the aggregate estimates of Baier and Bergstrand (2007) but varying across sectors. We further extend the original specification of Baier and Bergstrand (2007) to allow for differential FTA effects depending on whether an agreement was formed between countries with low most-favored-nation (MFN) tariffs or between countries with high MFN tariffs. We find that FTA effects are much stronger for country pairs with high MFN tariffs.

[2]For example, Bergstrand (1985) found insignificant European Community (EC) effects on bilateral member's trade and Frankel et al (1995) supported his findings. Frankel (1997) found significant Mercosur effects on trade flows but even negative EC effects on trade in certain years. Frankel (1997) also provides a summary of coefficient estimates of the FTA effects from different studies. Ghosh and Yamarik (2004) perform extreme-bounds analysis to support the claim that the FTA effects on trade flows are fragile and unstable.

[3]For example, Canadian support for the CUSFTA was based primarily on its provision for bi-national review of US antidumping procedures, a benefit not measurable by reduction of already low tariffs.

We then calculate the terms of trade changes implied by hypothetically implementing all the FTAs of the 90s in the 1990 base year. Our simulation approach belongs to the family of recent small scale computable general equilibrium models based on structural gravity. See the survey by Costinot and Rodriguez-Clare (2014). In contrast to papers based on the Eaton-Kortum (2002) extension of the Ricardian model (Caliendo and Parro, 2015, and Ossa, 2014), we use an endowments model of manufacturing sectors[4] extending the Anderson and van Wincoop (2003) one good model (used also by Egger et al., 2011). The Ricardian approach imposes infinite elasticity of transformation between tradable goods sectors while the endowments approach imposes zero elasticity. Either simplification avoids the complexity of data, specification and parameter estimation requirements of large scale computable general equilibrium models.[5] The two approaches share a common gravity structure of trade flows with its robust fit to data. In contrast to the simulation literature using tariff changes (e.g., the NAFTA studies of Romalis, 2007, and Caliendo and Parro, 2015), our approach focuses on volume changes induced by FTA effects that include more than tariffs while treating the entire set of FTAs and countries simultaneously.

Equilibrium sellers' prices are calculated from market clearance equations for each national variety in each sector. Intermediate input demand is given by a two level Cobb-Douglas/CES system. Sectoral CES demand systems are consistent with a gravity model for each sector while the upper level Cobb-Douglas aggregator is a common simplification in the literature referenced in the preceding paragraph. Supply is assumed fixed in each sector and country, a simplification that implies the results are (quasi-) general equilibrium measures of impact effects. A technical appendix explains how manufacturing demand and supply endowments are related to other sectors by embedment in national GDP functions with more sectors.

[4]Non-manufacturing is suppressed because our methods require internationally comparable sales and expenditure data that is only available for manufacturing.

[5]An alternative 'intermediate' model with finite substitution within manufacturing or for substitution between manufacturing and non-manufacturing could shift calculated terms of trade effects in either direction due to offsetting effects. On the one hand, standard implications of maximizing behavior with substitution imply that for given price changes, our estimates are lower bounds of the real income gains from FTAs due to terms of trade effects. On the other hand, substitution presumptively reduces the size of price changes. These opposing effects may even cancel out.

National gains are measured by the terms of trade. The numerator is a fixed weight sellers' price index of the equilibrium sellers prices. The denominator is a Cobb-Douglas/CES buyers' price index of equilibrium buyers' prices, where buyers' prices equal sellers' prices times trade cost factors modeled as iceberg costs. (This definition of the terms of trade as the ratio of sellers' price index to buyers' price index differs slightly from the standard one because it includes internal trade in both numerator and denominator. Ours is the relevant concept in the gravity model.)

The results show that the 1990's FTAs significantly increased real manufacturing income of most economies in the world. 8 out of the 40 countries had terms of trade gains greater than 5% and 3 of those countries enjoyed gains greater than 9%, including Mexico with gains of close to 15%.[6] Losses were smaller than -0.3% and confined to countries that did not enter into FTAs: Australia, China, Korea and Japan (and the rest of the world aggregate), and Iceland.

The national gains measure in the benchmark case does not allow for rents in the trade costs. The no rents assumption avoids measuring and modeling many unobservable rents on inward and outward trade and their division between buyers and sellers. Terms of trade effects are one component of the full national gains. Our main conclusions are robust to the alternative extreme assumption that the only rents are tariffs and all tariff revenue is fully rebated locally. National gains on balance remain for almost all partners.[7] Some big gains remain (e.g. Poland) and some other big gains are considerably reduced (e.g., Mexico). This robustness is because tariff revenue changes are a very small part of the income changes because tariffs are generally low.

The global efficiency effect of FTAs is naturally quantified as the change in how much of the iceberg melts due to FTAs. The basis is an application of the distance function (Deaton, 1979; itself an application of Debreu's coefficient of resource utilization, 1951) to the gravity model. It provides intuitive and consistent aggregation of gains across

[6] A counter-factual experiment reveals that large benefit to Mexico is mostly due to NAFTA. Most of Mexico's gains disappear if NAFTA is switched off, while without NAFTA the US and Canada still gain due to the Canada-US agreement.

[7] We only find three cases, Morocco, Ireland, and Tunisia, where revenue losses can potentially outweigh terms of trade gains. The explanation is a combination of relatively small manufacturing base, large tariffs, and potentially missing terms of trade gains that presumably accrue in other industries.

countries and sectors, a feature that seems useful for many trade policy applications. In our FTA case, global efficiency rises in each manufacturing sector (ranging from 0.42% for Paper to 2.1% for Textiles) with an overall efficiency gain of 0.9%.

Global efficiency is also equal to the utilitarian aggregator of national real income changes measure by terms of trade changes. Its positive sum contrasts with the usual zero-sum implication of terms of trade effects in simple trade policy theory. The non-zero sum property of the global efficiency measure arises for two reasons. Directly, less of the iceberg melts in bilateral shipments between FTA partners due to a reduction in border frictions. Indirectly, general equilibrium forces change inward and outward multilateral resistance for each country, respectively changing the denominator and the numerator of the terms of trade. In principle, the indirect effect could be negative and could even outweigh the first effect. For the 1990s implementations of FTAs the net effect is positive. (Rents are omitted from global efficiency because they are transfers with the zero sum property.)

Section 1 presents the theoretical foundation. Section 2 discusses the estimation of the gravity equation and the trade volume effect of FTAs. Section 3 presents the terms of trade and global efficiency effects of switching on the FTAs of the 1990's in the base year 1990. Section 4 concludes with some suggestions for further research.

1 Theoretical Foundation

Manufacturing trade is the focus of this paper, taking country/sector endowments within manufacturing as given. A technical appendix details how manufacturing fits into a much larger world economy under the endowment restriction.

Let p_{ij}^k denote the price of origin i goods in class k delivered to region j buyers. p_i^{*k} denotes the factory-gate price at i. Equilibrium arbitrage implies $p_{ij}^k = p_i^{*k} t_{ij}^k$, where $t_{ij}^k \geq 1$ denotes the 'trade cost' factor on shipment of goods in class k from i to j.[8] Effectively it is as if goods melt away in distribution so that 1 unit shipped becomes $1/t_{ij}^k < 1$ units on arrival.

[8] 'Cost' in quotes denotes that taste differences (home bias) could play a role.

Cost minimizing buyers of inputs using the globally common CES technology have expenditure on goods of class k shipped from origin i to destination j given by:

$$X_{ij}^k = (\beta_i^k p_i^{*k} t_{ij}^k / P_j^k)^{1-\sigma_k} E_j^k. \tag{1}$$

Here, E_j^k is country j's expenditure on goods of class k while in the CES share expression preceding it σ_k is the elasticity of substitution for goods' class k,[9] β_i^k is a CES share parameter, and $P_j^k = [\sum_i (\beta_i^k p_i^{*k} t_{ij}^k)^{1-\sigma_k}]^{1/(1-\sigma_k)}$ is a CES price index.

On the supply side an endowment q_i^k at the origin is valued at the factory gate price p_i^{*k}. The value of shipments at end user prices for country i and goods class k is equal to $p_i^{*k} q_i^k = Y_i^k$, where the iceberg trade cost metaphor implies that some of q_i^k melts en route to the buyers who must pay the full production plus distribution cost.

Market clearance for goods in each class and origin implies

$$Y_i^k = \sum_j (\beta_i^k p_i^{*k})^{1-\sigma_k} (t_{ij}^k / P_j^k)^{1-\sigma_k} E_j^k, \qquad \forall i, k. \tag{2}$$

Define $Y^k \equiv \sum_i^N Y_i^k$ where N is the number of countries and divide (2) by Y^k to obtain:

$$(\beta_i^k p_i^{*k} \Pi_i^k)^{1-\sigma_k} = Y_i^k / Y^k, \tag{3}$$

where $(\Pi_i^k)^{1-\sigma_k} \equiv \sum_j (t_{ij}^k / P_j^k)^{1-\sigma_k} E_j^k / Y^k$. In the structural gravity representation of the model of Section 1.2, Π_i^k and P_j^k are inward and outward multilateral resistance respectively, usefully interpreted as sellers' and buyers' incidence of all trade costs.

1.1 Calculating the Effects of Free Trade Agreements

The hypothetical FTA terms of trade require computing the general equilibrium solution for market clearing factory gate prices. The specification includes the budget constraint requirements and a normalization. It is convenient to solve the market clearance system

[9] Estimates from the trade literature suggest that the elasticity of substitution varies across countries. See Broda et al. (2006). In our analysis however, we do not allow the elasticity to vary across countries.

in world share form. The world supply shares in the endowments economy are given by

$$\frac{Y_i^k}{Y^k} = \frac{p_i^{*k} q_i^k}{\sum_i^N p_i^{*k} q_i^k}, \forall i, k. \tag{4}$$

The world demand shares are given by

$$\frac{E_j^k}{Y^k} = \frac{\phi_j \sum_k^K p_j^{*k} q_j^k}{\sum_j \phi_j \sum_k p_j^{*k} q_j^k}, \forall j, k; \tag{5}$$

where K is the number of sectors.

The demand share on the right hand side of (5) uses the assumption of identical Cobb-Douglas technology at the upper level to set country j's share of world spending on goods of class k as the ratio of j's spending on all goods to world spending on all goods, canceling the common parameter α_k in numerator and denominator. $\phi_j > 0$ is the ratio of total expenditure to income for manufacturing as a whole in country j.[10]

There are NK p^*s that change from their initial value equal to 1 when the t's change. They are solved from the market clearance equations

$$\frac{p_i^{*k} q_i^k}{\sum_i p_i^{*k} q_i^k} = \sum_j (\beta_i^k p_i^{*k} t_{ij}^k / P_j^k)^{1-\sigma_k} \frac{\sum_k \phi_j p_j^{*k} q_j^k}{\sum_{j,k} \phi_j p_j^{*k} q_j^k}, \forall i, k; \tag{6}$$

where

$$(P_j^k)^{1-\sigma_k} = \sum_i (\beta_i^k p_i^{*k} t_{ij}^k)^{1-\sigma_k}, \forall j, k \tag{7}$$

and (5) is utilized to replace E_j^k / Y^k on the right of the right hand side of (6). There are NK equations in (6) and another NK in (7), the latter being solved recursively with the solution $\{p_i^{*k}\}$ obtained by substituting the right hand side of (7) into (6).

The computation requires values for the sectoral technology distribution parameters $(\beta_i^k)^{1-\sigma_k}, \forall i, k$. They are calibrated from the base year ($p_i^{*k} = 1, \ \forall i, k$) market clearance equations (6). Since only $N - 1$ of the equations are independent for each sector, the

[10] $\phi_j \neq 1$ allows for nationally varying manufacturing trade imbalance. If all goods were included in K and total trade was balanced, $\phi_j = 1, \forall j$. ϕ_j is assumed to be constant, rationalized under the assumption that manufactured inputs are a constant share of GDP and that non-manufactured goods are affected by FTAs in proportion to their effect on manufactures. Variation in ϕ's is not an important concern in practice based on sensitivity experiments. Our results are not sensitive to setting $\phi_j = 1, \forall j$.

natural normalization $\sum_i (\beta_i^k)^{1-\sigma_k} = 1, \ \forall k$ is imposed on the calibration of the β_i^k's is without consequence for comparative static simulation, because in (6) the numerator and denominator terms in $\beta_i^k p_i^{*k} t_{ij}^k / P_j^k$ are each scaled by the normalization, canceling their effect on the solution of the model. (This follows because $(P_j^k)^{1-\sigma_k} = \sum_i (\beta_i^k p_i^{*k} t_{ij}^k)^{1-\sigma_k}$ by the CES price index definition.)

A normalization of prices is required to solve (6)-(7) in simulations because the system is homogeneous of degree zero in the vector of factory gate prices. A natural normalization holds world real resources constant:

$$\sum_{i,k} p_i^{*k} q_i^k = \sum_{i,k} p_i^{*k0} q_i^k = \sum_k Y^{k0}. \tag{8}$$

By choice of units $p_i^{*k0} = 1$.

In (6)-(7), due to separability and homotheticity, only 2NK-K equations are linearly independent, so (8) must apply in each sector in equilibrium: $\sum_i q_i^k = \sum_i p_i^{*k} q_i^k, \forall k$. To see this, let $\mathbf{p}^{1k} \equiv \{p_i^{*k}\}$, denote the vector of equilibrium factory gate prices in sector k in some particular equilibrium with the new t's. At this equilibrium $\mathbf{p}^{1k}$, a scalar shift λ^k in $\mathbf{p}^k$ raises the P_j^k's equiproportionately. Then for the block of equations for sector k within (6), conditional on the initial equilibrium value of $\sum_k p_j^{*k} q_j^k / \sum_{i,k} p_i^{*k} q_i^k = \lambda^k \sum_k p_i^{1k} q_j^k / \sum_{i,k} q_i^k$ under the normalization (8), the equation block continues to hold. Consistency with normalization (8) requires $\lambda^k = 1, \forall k$.

The change in the sellers' equilibrium incidence due the trade cost changes drives the change in factory gate prices due to equation (9). Solving (3) for p_i^{*k} using $Y_i^k = p_i^{*k} q_i^k$:

$$p_i^{*k} = (Y^k / q_i^k)^{1/\sigma_k} (\beta_i^k \Pi_i^k)^{(1-\sigma_k)/\sigma_k}. \tag{9}$$

Y^k is constant due to the normalization. The remaining terms on the right hand side of (9) are the supply shifter q_i^k, the demand shifter β_i^k and sellers' incidence Π_i^k. In full general equilibrium the sellers' incidence Π_i^k is a function of the sellers' price p_i^{*k} through the seller's share Y_i^k / Y^k. But Π_i^k carries the general equilibrium complexity into a separable partial equilibrium market module that determines the sellers' price for each

origin and sector. As for national terms of trade changes, buyers' price index changes in each sector are equal to buyers' incidence changes while sellers' price changes decrease in sellers' incidence changes with elasticity $1/\sigma_k - 1$ all else equal, due to (9).

1.2 Structural Gravity Representation

The standard structural gravity representation of the model provides a useful interpretation and decomposition of the terms of trade and global efficiency changes reported in Sections 1.3-1.4, complementing its use in inference of trade costs including the effects of FTAs.

The representation uses (3) to substitute for $\beta_i^k p_i^{*k}$ in (1), the market clearance equation and the CES price index. Then:

$$X_{ij}^k = \frac{E_j^k Y_i^k}{Y^k} \left(\frac{t_{ij}^k}{P_j^k \Pi_i^k} \right)^{1-\sigma_k} \tag{10}$$

$$(\Pi_i^k)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}^k}{P_j^k} \right)^{1-\sigma_k} \frac{E_j^k}{Y^k} \tag{11}$$

$$(P_j^k)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}^k}{\Pi_i^k} \right)^{1-\sigma_k} \frac{Y_i^k}{Y^k}. \tag{12}$$

(10)-(12) is the structural gravity model. Π_i^k denotes outward multilateral resistance (OMR), while P_j^k denotes inward multilateral resistance (IMR).

For analyzing the effect of FTAs (and other comparative static shifts) on the terms of trade, multilateral resistance is a window into the black box of the general equilibrium model. Outward multilateral resistance is the average sellers' incidence. It is as if each country i shipped its product k to a single world market facing supply side incidence of trade costs of Π_i^k. (3) is interpreted as the market clearance condition for a hypothetical world market where a single representative buyer purchases variety i in class k at price $p_i^{*k}\Pi_i^k$.[11] Note that multilateral resistance is an index of all bilateral trade costs, incorporating discrimination imposed by policy (MFN vs. discriminatory tariffs) and by geography. Inward multilateral resistance in (12) is a CES index of bilateral buyers' inci-

[11]The CES cost index for this hypothetical user in the world market is equal to 1 because this is implied by summing (3) over i.

dences t_{ij}^k/Π_i^k, using the interpretation of Π_i^k as the sellers incidence and recognizing that t_{ij}^k/Π_i^k is the incidence falling on the buyer. It is as if each country j bought its vector of class k goods from a single world market facing buyers' incidence of P_j^k.

The terms of trade of each country is the ratio of sellers' prices to buyers' price indexes. The sellers' prices are inversely related to sellers' incidence due to (3), a relationship embedded in general equilibrium in Section 1.1. The buyers' price indexes are Cobb-Douglas aggregates of sectoral CES aggregates, in turn equal to the corresponding inward multilateral resistances for each sector and country. The global efficiency deflator is the theoretically consistent global index of national buyers' incidence of trade costs. Sellers' incidence plays no direct role in the global efficiency measure because the related sellers' price changes are transfers satisfying the zero sum property for the world economy.

Equations (10)-(12) also link the general equilibrium measures of gains to the intuitive notions of trade creation and trade diversion. In the context of structural gravity, trade creation (diversion) is defined as an increase (decrease) in bilateral trade. The cause of the change can be direct (switching on an FTA between i and j raises X_{ij} all else equal) or indirect (switching on an FTA between i and j lowers P_j and thus lowers X_{kj} for k not a member of the FTA, all else equal). The full general equilibrium induces further shifts but the 'all else equal' intuition remains useful in discussing results below. More broadly, these definitions are useful because Arkolakis et al. (ACR, 2012) show that the complement to the sum of bilateral trade shares (the home good share) is a sufficient statistic for gains from trade in a wide class of gravity models.

1.3 National Gains Measures

National gains are the changes in manufacturing real income. National manufacturing income is $\sum_k p_i^{*k} q_i^k$. Buyers in i face price indexes P_i^k for goods class k. The user price index for all goods is $C_i = \exp(\sum_k \alpha_k \ln P_i^k)$. Then real manufacturing income is

$$R_i = \sum_k p_i^{*k} q_i^k / C_i = T_i \sum_k q_i^k,$$

i's real product $\sum_k q_i^k$ (under normalization (8)) times i's terms of trade T_i given by

$$T_i = \frac{\sum_k p_i^{*k} q_i^k / \sum_k q_i^k}{C_i}. \tag{13}$$

T_i is the ratio of the Laspeyres price index of exportable goods to the 'true' cost index of importable goods. It differs from the standard definition of the terms of trade because it includes goods produced and sold at home in both numerator and denominator. The variation of (13) from the standard terms of trade definition is natural in the present context where trade frictions affect all shipments including intra-national ones. (13) retains the intuition of the usual terms of trade definition for rates of change calculations and is locally equivalent.[12] Measure (13) is equivalent to the welfare measure proposed by Arkolakis et al. (2012) for a broad class of gravity models.[13]

The effect on real manufacturing income in country i from a switch from No FTA (denoted with superscript 0) to FTA (denoted with superscript F) can be evaluated by computing the proportional real income change with the ratio R_i^F/R_i^0, equal to the proportionate change in the terms of trade T_i^F/T_i^0. T_i^F/T_i^0 should be interpreted as the terms of trade effects component of the welfare change due to FTAs. The local change in welfare due to tariff changes (for example see Feenstra, 2004, p. 215) comprises a terms of trade effect, a tariff marginal deadweight loss effect and a marginal rent effect. We avoid attempting to calculate the marginal deadweight loss effects that embody tariff and rent changes, many of which are invisible. If all trade costs and their changes are 'real', iceberg melting really decreases, then our benchmark treatment could be interpreted as

[12]To see this, note that by Shephard's Lemma, $\partial \ln C_i / \partial \ln p_h^{*k} = X_{hi}^k / E_i$. Let δ_{hi} denote the Kronecker delta. Then the elasticity of the terms of trade with respect to p_h^{*k} is $\partial \ln T_i / \partial \ln p_i^{*k} = \delta_{hi} p_i^{*k} q_i^k / \sum_k q_i^k - X_{hi}^k / E_i \; \forall h, i, k$. Let $\hat{x}$ denote the percentage change in variable x. At the initial prices and with expenditure equal to income, using market clearance and the preceding formula, the percentage change in real income is given by $\sum_{k,j \neq i} \hat{p}_i^{*k} X_{ij}^k / Y_i - \sum_{k,h \neq i} \hat{p}_h^{*k} X_{hi}^k / Y_i$. Divide and multiply by total exports, equal to total imports, denoted X_i and factor out X_i/Y_i. The percentage change in real income is X_i/Y_i times a conventional measure of the terms of trade percentage change, the export-weighted average of i's sellers price percentage changes minus the import-weighted average of all other sellers' price percentage changes. For discrete changes, a conventional terms of trade measure may use the Tornqvist approximation, while (13) is exact given its specification.

[13]Their extension to the multi-sector case uses the same nested Cobb-Douglas/CES structure and their restriction on profits obtains due to perfect competition. Their restriction on the relationship between sectoral income and sectoral sales obtains in our model (see their footnote 25 on page 114) with the inessential difference that sectoral income in the Ricardian version is the sectoral wage bill rather than the value of the sectoral endowment.

a welfare change. Sensitivity to the no rent treatment is checked below with a first order approximation of the change in tariff revenues induced by FTAs, to be compared to the terms of trade effects.

The terms of trade act on the full GDP in proportion to manufacturing's share of GDP. Details are in the technical appendix.

1.4 World Efficiency Measure

The effect of FTAs on the world efficiency of trade is measured by the change in iceberg melting, consistently aggregated in a natural application of Deaton's (1979) distance function. The world efficiency measure is also equivalent to the utilitarian aggregator of national real income changes due to changes in (13). Rents play no role, being transfers that cancel in their effect on world efficiency.

The endowment of world resources is the vector $\mathbf{q} = \{q_i^k\} = \{\mathbf{q}^k\}$ where $\mathbf{q}^k$ is the world endowment vector in sector k. Destination j's share of the endowment $\mathbf{q}^k$ actually consumed in the equilibrium distribution is reduced by sectoral deflators P_j^k that melt down j's share of the endowment (effectively, as if the buyers ship their 'world' market purchases to their destinations). The desired distance function measure is a consistent aggregator (across destinations and sectors) of the P_j^k deflators, a uniform deflator applied to the endowment vector $\mathbf{q}$. The uniform deflator is derived here by its equivalence to a world real income measure.

The utilitarian real income measure for the world is given by

$$\sum_i T_i \sum_k q_i^k = \bar{T} \sum_{i,k} q_i^k. \tag{14}$$

$\bar{T}$ on the right hand side is interpreted as the average efficiency of utilization of the world endowment. Effectively, world consumption is is $\bar{T}\mathbf{q}$, a scalar reduction of the endowment vector due to iceberg melting. $\bar{T}$ is related to trade costs through inward multilateral resistances.

$\bar{T}$'s structure is revealed by considering local rates of change (denoted by hats) in T_i

and $\bar{T}$ induced by changes in the trade cost set $\{t_{ij}^k\}$.

$$\widehat{T}_i = \sum_k \frac{q_i^k}{\sum_k q_i^k} \hat{p}_i^{*k} - \sum_k \alpha_k \widehat{P}_i^k \qquad \& \qquad \widehat{\bar{T}} = \sum_i \frac{\sum_k q_i^k}{\sum_{i,k} q_i^k} \widehat{T}_i.$$

Under the standard normalization of the producer price vector (used in this paper and the family of models contained in ACR's framework), the change in $\bar{T}$ using the expressions above reduces to

$$\widehat{\bar{T}} = -\sum_i \frac{\sum_k q_i^k}{\sum_{i,k} q_i^k} \alpha_k \widehat{P}_i^k.$$

The right hand side of the preceding equation is a consistent aggregator of the national buyers' incidences $\widehat{P}_j^k$.[14]

In discrete closed form, $\bar{T}$ is given by

$$\bar{T} = \exp \sum_{i,k} w_{i,k} \ln(1/P_i^k) \tag{15}$$

where $w_{i,k} = \alpha_k q_i^k / \sum_{i,k} q_i^k$. Discrete change between two situations such as the initial trade cost 0 and the FTA trade cost F is evaluated by $\bar{T}^F/\bar{T}^0$:

$$\frac{\bar{T}^F}{\bar{T}^0} = \exp \left[\sum_{i,k} w_{i,k} (\ln P_i^{k0} - \ln P_i^{kF}) \right] \tag{16}$$

The right hand side of (16) provides a decomposition of the sources of efficiency change. Results below decompose the global efficiency change into sectoral aggregates across countries.[15]

[14] Sellers' incidence does not appear on the right-hand side because, given the equilibrium prices $\{p_i^{*k}\}$, the sellers' shares given by (3) must sum to 1, hence $\sum_i (Y_i^k/Y^k)\widehat{\Pi}_i^k = 0$. This formalizes the intuition that sellers' price changes are effectively transfers summing to zero effect in the world economy.

[15] The *level* of $\bar{T}$ that measures the total fraction of the iceberg that melts in any situation is meaningless in practice because gravity equations cannot measure the absolute level of trade costs, only relative trade costs inferred from the distortion of trade relative to its frictionless benchmark. Relative global efficiency (16) is in contrast conceptually and practically useful.

2 Empirical Implementation and Analysis

2.1 Econometric Specification

The standard procedure to infer FTA effects on bilateral trade flows accounts for the presence of free trade agreements with a fixed effect, interpreted as part of the unobservable trade costs t_{ij}^k. The trade cost power transform in the structural gravity equation (10) is modeled as:

$$t_{ij}^{k\,1-\sigma} = \exp[\beta_1^k FTA_{ij} + \beta_2^k \ln DIST_{ij} + \beta_3^k BRDR_{ij} + \beta_4^k LANG_{ij} + \beta_5^k CLNY_{ij} + \beta_6^k SMCTRY_{ij}]. \tag{17}$$

Here, FTA_{ij} is an indicator variable for a free trade agreement between trading partners i and j. $\ln DIST_{ij}$ is the logarithm of bilateral distance. $BRDR_{ij}$, $LANG_{ij}$ and $CLNY_{ij}$ capture the presence of contiguous borders, common language and colonial ties, respectively. Finally, $SMCTRY_{ij}$ is a dummy variable equal to 1 when $i = j$ and zero elsewhere, which captures the effect of crossing the international border by shifting up internal trade, all else equal.

The econometric specification of gravity is completed by substituting (17) for the power transform of t_{ij} into (10) and then expanding the gravity equation with an error term. To obtain econometrically sound estimates of the parameters of interest we must meet the following challenges: heteroskedasticity in trade flows data; presence of zero trade flows; endogeneity of free trade agreements; and, unobservable multilateral resistance terms.

To utilize the information carried by the zero trade flows and, more important, to account for heteroskedasticity in trade flows data, we resort to the Poisson pseudo-maximum-likelihood (PPML) estimator advocated by Santos Silva and Tenreyro (2006) who argue that the standard log-linear OLS approach results in inconsistent coefficient estimates.[16] Time-varying, directional (source and destination), country-specific dummies control for the multilateral resistances along with the sales (Y_i^k) and expenditure

[16] Helpman et al. (2008) propose an alternative approach to zero trade flows. Exporter firms' entry into a foreign market requires a fixed cost that becomes sunk. They develop a formal model of selection, where exporters must absorb some fixed costs to enter a market. Selection is identified using religion as an exogenous variable that enters selection but is excluded from determination of the volume of trade. Besedes and Prusa (2006a,b) give evidence that highly disaggregated bilateral US trade flickers on and off, contra-indicating the hysteresis expected if sunk fixed costs are important.

(E_j^k) variables in (10).[17] To account for FTA endogeneity, we use the panel data estimation techniques described in Wooldridge (2002) and first applied to study the partial equilibrium effects of FTAs by Baier and Bergstrand (2007).[18]

Thus we use the PPML technique[19] to estimate:

$$\begin{aligned} X_{ij,t}^k &= \exp[\beta_0^k + \beta_1^k FTA_{ij,t} + \beta_2^k FTA_{ij,t-1} + \beta_3^k FTA_{ij,t-2} + \beta_4^k FTA\_LOW\_MFN_{ij,t}^k + \\ &\quad + \beta_5^k FTA\_HIGH\_MFN_{ij,t}^k + \eta_{i,t}^k + \theta_{j,t}^k + \gamma_{ij}^k] + \epsilon_{ij,t}^k \end{aligned} \tag{18}$$

across country pairs and time for each class of commodities k. Here, X_{ij}^k is bilateral trade (in levels) in class k between partners i and j at time t.[20] $\eta_{i,t}^k$ denotes the time-varying source-country dummies, which control for the (log of) outward multilateral resistances and total shipments. $\theta_{j,t}^k$ encompasses the time varying destination country dummy variables that account for the (log of) inward multilateral resistances and total expenditure. γ_{ij}^k captures the country-pair fixed effects used to address FTA endogeneity, where we impose a common internal trade fixed effect γ_{ii}^k for each sector across the regions.

Due to perfect collinearity one of the bilateral fixed effects need to be dropped. We choose to drop the fixed effect for internal trade in each sector γ_{ii}^k. In effect, this implies

[17] Anderson and van Wincoop (2003) use custom programming to account for the multilateral resistances in a static setting. Hummels (1999) and Feenstra (2004) advocate the directional, country-specific fixed effects approach. To estimate the effects of the Canadian Agreement on Internal Trade (AIT), Anderson and Yotov (2010a) use panel data with time-varying, directional (source and destination), country-specific fixed effects. Olivero and Yotov (2012) formalize their econometric treatment of the MR terms in a dynamic gravity setting.

[18] The issue of FTA endogeneity is not new to the trade literature (see Trefler 1993, for example). However, primarily due to the lack of reliable instruments, standard instrumental variable (IV) treatments of endogeneity in cross-sectional settings have not been successful in addressing the problem. See for example Magee (2003) and Baier and Bergstrand (2002, 2004). Baier and Bergstrand (2007) summarize the findings from these studies as "at best mixed evidence of isolating the effect of FTAs on trade flows," and propose the pair fixed effects treatment employed here. Egger et al. (2011) offer a recent IV treatment of the endogeneity of trade agreements in a cross section setting.

[19] Consistency of the PPML estimator arises from the large sample structure of the gravity model. If N is the number of regions and τ is the number of periods, the number of fixed effects grows at rate $2N\tau+N^2$ while the number of observations grows at rate $N^2\tau >> 2N\tau+N^2$ as τ grows. As a robustness check, we also estimate and report OLS estimates.

[20] In a static setting, (10) implies that income and expenditure elasticities of bilateral trade flows are unitary and, therefore, size-adjusted trade is the natural dependent variable. Bringing output and expenditures on the left-hand side has the additional advantage of controlling for endogeneity of these variables. Using aggregate data however, Frankel (1997) shows that the bias due to GDP endogeneity is insignificant. In addition, Olivero and Yotov (2012) show that income and expenditure elasticities are not necessarily equal to one in a dynamic setting, such as the one that we employ here to account for FTA endogeneity. Thus, in addition to accounting for the unobserved multilateral resistances, the fixed effects in our estimations will also absorb country-specific output and expenditures.

that all internal trade costs are set to one and all international fixed effects $\gamma_{ij}^k, j \neq i$ are estimated relative to γ_{ii}^k, where the latter corresponds to the $SMCTRY$ indicator from specification (17). Finally, $\epsilon_{ij,t}^k$ is an exogenous Poisson error term.[21]

$FTA_{ij,t}$ is an indicator variable that takes a value of one if at time t countries i and j are members of the same free trade agreement. Following Baier and Bergstrand (2007), we allow for gradual phasing-in of the free trade agreement effects by including FTA lags, $FTA_{ij,t-1}$ and $FTA_{ij,t-2}$, in specification (18). From an economic perspective, the intuition for the phasing-in effects is that private agents in the trading partners gradually adjust to the new economic conditions under a recently implemented FTA. From an econometric perspective, allowing for phasing-in adds a time dimension (in addition to the commodity, country, and seller and buyer dimensions) to the data sets of terms of trade (welfare) effects that we construct in the next section.

We extend the original specification of Baier and Bergstrand (2007) to allow for differential FTA effects depending on whether an agreement was formed between countries with low most-favored-nation (MFN) tariffs or between countries with high MFN tariffs.[22] The intuition is that FTAs should have stronger effects for pairs with high MFN tariffs. To capture such differences we construct $FTA\_LOW\_MFN_{ij,t}^k$, which takes a value of one if both FTA members have MFN tariffs bellow the median for the corresponding sample of all FTA pairs in class k at time t, and $FTA\_HIGH\_MFN_{ij,t}^k$, which takes a value of one if both FTA members have MFN tariffs above the median for the sample of all FTA pairs in class k at time t.

Finally, as noted by Cheng and Wall (2005), "Fixed-effects estimations are sometimes criticized when applied to data pooled over consecutive years on the grounds that dependent and independent variables cannot fully adjust in a single year's time." (p.8). To avoid this critique, we use only the years 1990, 1994, 1998, and 2002, which is comparable to the 5 year intervals in Baier and Bergstrand (2007) and to the 3-year intervals in Tre-

[21] Exogeneity of the error term is reasonable in this specification due to the rich structure of fixed effects, where the pair fixed effects in our regressions control for all possible (observable and unobservable) time-invariant trade costs components, while the directional, time-varying country-specific fixed effects account for any time-varying country-specific characteristics (e.g. trade costs, size variables, etc.) on the importer and on the exporter side.

[22] We thank Robert Staiger for this useful suggestion.

fler (1993). This implies that $FTA_{ij,t-1}$ and $FTA_{ij,t-2}$ in specification (18) are four-year and eight-year lags, respectively.

To calculate terms of trade effects, estimated t_{ij}'s with and without FTA effects are required. Ideally, we would estimate all pair fixed effects γ_{ij}^k from specification (18) and use those to construct a complete set of bilateral trade costs as:

$$\begin{aligned}\left(\widehat{t_{ij}}\right)^{1-\sigma} &= \exp[\hat{\beta}_1^k FTA_{ij,t} + \hat{\beta}_2^k FTA_{ij,t-1} + \hat{\beta}_3^k FTA_{ij,t-2} + \hat{\beta}_4^k FTA\_LOW\_MFN_{ij,t}^k + \\ &\quad + \beta_5^k FTA\_HIGH\_MFN_{ij,t}^k + \hat{\gamma}_{ij}^k].\end{aligned}$$

Unfortunately, some pairs of countries in our sample did not trade at all during the period of investigation so not all bilateral fixed effects are identified in (18). To complete the set of pair fixed effects estimates γ_{ij}^k's (and ultimately a complete set of bilateral trade costs t_{ij}'s), we propose a two-step procedure. The missing estimates of the pair fixed effects from (18) are replaced with predicted values (projections) from a second-stage regression of the estimates of γ_{ij}^k on the set of standard gravity variables:

$$\begin{aligned}\exp\left(\hat{\gamma}_{ij}^k\right) &= \exp[\gamma_1^k \ln DIST_{ij} + \gamma_2^k BRDR_{ij} + \gamma_3^k LANG_{ij} + \gamma_4^k CLNY_{ij} \\ &\quad + \gamma_5^k OLD\_FTA] + \varepsilon_{ij,t}^k, \qquad (19)\end{aligned}$$

where OLD_FTA is an indicator that takes a value of one for FTAs that entered into force before the period of investigation, and all other variables are defined in (17).[23]

The full matrix of bilateral trade costs is needed for our general equilibrium analysis. Our two-step procedure implies that the trade costs corresponding to the fixed effects that cannot be identified from (18) will be replaced with estimates from (19) and then used to solve the GE multilateral resistance system.

Egger et al. (2011) propose an alternative treatment, where the bilateral links for the pairs for which the γ_{ij}^k's cannot be identified because of zero trade flows are eliminated

[23]Following the existing literature, our treatment of the error term is once again as stochastic. Recent literature, e.g. Egger and Nigai (2015) and Agnosteva et al. (2014), studies the relationships between the pair fixed effect and the gravity variables treatment of trade costs in gravity equations. These studies suggest that the error in (19) may actually carry some systematic information about trade costs. This serves as a motivation for using directly the estimates of the pair fixed effects from equation (18) as a measure bilateral trade costs in our analysis.

with an indicator variable in the multilateral resistance system. Researchers should employ the methods from Egger et al. (2011) when they are confident that the zero trade flows in their sample are indeed true zeros. Our procedures should be used when the pair fixed effects cannot be identified due to missing data. We experimented with both approaches and obtained almost identical results, which is due to the fact that our sample allowed us to identify almost all pair fixed effects for each sector.[24] We report results based on the proposed two-step procedure to construct a complete set of bilateral trade costs. Estimates from (19) and actual data on the gravity variables are used to complete the set of the estimates of the bilateral fixed effects $\hat{\gamma}_{ij}^k$ and to construct a complete set of power transforms of bilateral trade costs in the absence of FTAs:

$$\left(\widehat{t}_{ij}^{NOFTA}\right)^{1-\sigma} = \exp[\hat{\gamma}_{ij}^k]. \tag{20}$$

The set of bilateral trade costs including FTA effects is constructed from (18) and (20):

$$\begin{aligned}\left(\widehat{t}_{ij}^{FTA}\right)^{1-\sigma} &= \left(\widehat{t}_{ij}^{NOFTA}\right)^{1-\sigma} \times \exp[\hat{\beta}_1^k FTA_{ij,t} + \hat{\beta}_2^k FTA_{ij,t-1} + \hat{\beta}_3^k FTA_{ij,t-2} + \\ &\quad + \beta_4^k FTA\_LOW\_MFN_{ij,t}^k + \beta_5^k FTA\_HIGH\_MFN_{ij,t}^k]. \end{aligned} \tag{21}$$

In the following sections, we translate the difference in the partial equilibrium trade costs with and without FTAs into general equilibrium effects on producer prices, consumer prices, and terms of trade.

2.2 Data Description

Our study covers the period 1990-2002 for a total of 41 trading partners including 40 separate countries and a rest of the world (ROW) aggregate, consisting of 24 additional nations.[25] None of the countries included in ROW are part of any FTAs with countries

[24]The number of pair fixed effects that we could not identify varied from 4 in sectors 31 (Food) and 35 (Chemicals) to 23 (out of 820, i.e. 2.8%) in sector 34 (Paper).

[25]The 40 countries are Argentina, Australia, Austria, Bulgaria, Belgium-Luxembourg, Bolivia, Brazil, Canada, Switzerland, Chile, China, Colombia, Costa Rica, Germany, Denmark, Ecuador, Spain, Finland, France, United Kingdom, Greece, Hungary, Ireland, Iceland, Israel, Italy, Japan, Korea, Rep., Mexico, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Sweden, Tunisia, Turkey, Uruguay, United States. The rest of the world includes Cameroon, Cyprus, Egypt Arab Rep., Hong Kong, Indonesia, India, Iran Islamic Rep., Jordan, Kenya, Kuwait, Sri Lanka, Macao, Malta, Myanmar, Malawi, Malaysia, Niger, Nepal, Philippines, Senegal, Singapore, Trinidad and Tobago, Tanzania, South Africa.

in the main sample during the period of investigation.[26] There are four nations however (Australia, China, Japan, and South Korea), that are treated separately, even though they did not enter any FTA between 1990 and 2002. We use these countries (outsiders), along with the aggregate ROW region, to gauge FTA effects on non-members. The commodities covered include manufacturing production classified according to the United Nations' 2-digit International Standard Industrial Classification (ISIC) Revision 2.[27]

To estimate gravity and to calculate the indexes of interest, we use industry-level data on bilateral trade flows and output, and we construct expenditures, subject to our structural model, for each trading partner and each commodity class, all measured in thousands of current US dollars for the corresponding year.[28] In addition, we use data on bilateral distances, contiguous borders, colonial ties, common language, elasticity of substitution, tariffs, and the presence of regional free trade agreements.

Summary statistics for the main estimation variables for the first and the last year in the sample as well as data sources and description of the variables employed in our estimations and analysis are presented in the Data Appendix accompanying this manuscript. Here, we just describe the data sources that we use to construct the main explanatory variables that account for the FTA effects. Most of the data on the presence of FTAs are from the FTA dataset constructed by Baier and Bergstrand (2007), which we update with data on some additional agreements and years from the World Trade Organization

[26]The ROW aggregation is to ease estimation by limiting the very large number of fixed effects.

[27]The nine 2-digit ISIC manufacturing categories are (short labels, used for convenience throughout the paper, are reported in parentheses): 31. Food, Beverages, and Tobacco Products (Food); 32. Textile, Apparel, and Leather Products (Textile); 33. Wood and Wood Products (Wood); 34. Paper and Paper Products (Paper); 35. Chemicals, Petroleum, Coal, Rubber, and Plastic Products (Chemicals); 36. Other Non-metallic Products (Minerals); 37. Basic Metal Industries (Metals); 38. Fabricated Metal Products, Machinery, Equipment (Machinery); 39. Other manufacturing. Inspection of the output data at the 3-digit and 4-digit ISIC level of aggregation reveals that many countries report Equipment production, and especially Scientific Equipment production, under the category Other Manufacturing. Therefore, to avoid inconsistencies, we combine the last two 2-digit categories into one, which we label Machinery.

[28]Baldwin and Taglioni (2006) discuss in length the implications of inappropriate deflation of nominal trade values, which they call "the bronze-medal mistake" in gravity estimations. Their most preferred econometric specification is one with un-deflated trade values, bilateral fixed effects, and time-varying country dummies, which, in addition to accounting for the multilateral resistances in a dynamic setting, will "also eliminate any problems arising from the incorrect deflation of trade." The structural interpretation of the time-varying, country-specific, directional fixed effects (FEs) in our setting is a combination of the multilateral resistance terms and the trading partners output and expenditures. It is easy to see how the FEs would also absorb any deflator indexes, exchange rates, etc. Thus, the real- and nominal-trade estimates should be identical.

(WTO) web site. Following Baier and Bergstrand (2007), we only consider full FTAs and customs unions. Table 1 lists the trade agreements in our sample in chronological order.

In order to construct the FTA variables that allow for heterogeneous FTA effects between country pairs with high MFN tariffs and country pairs with low MFN tariffs we use MFN tariff data from two sources. In particular, we combine the United Nations Conference on Trade and Development (UNCTAD) Trade Analysis and Information System (TRAINS) and the World Trade Organization (WTO) Integrated Data Base (IDB), which is available for the years after 1995. After combining the MFN tariff data, we ended up with 53%, 93%, and 93% non-missing MFN tariffs for 1994, 1998 and 2002, respectively. To increase the number of non-missing observations, we interpolated the tariff data. As a result, we ended up with 94%, 98%, and 96% non-missing MFN tariffs for 1994, 1998 and 2002, respectively. Then, we extrapolated the data by taking the values from the closest 3 non-missing years to increase the number of non-missing MFN tariffs to 97%, 99%, and 97% non-missing MFN tariffs for 1994, 1998 and 2002, respectively. Finally, we used the average world tariff for each sector to obtain a complete set of MFN tariffs for each of the countries and years in our sample.

2.3 Gravity Estimation Results

Discussion of results begins with the FTA estimates, presented in order of increasing complexity of the FTA modeling. Panel A of Table 2 reports sectoral OLS estimates.[29] All FTA estimates in panel A are positive, sizable in magnitude, and only three (those for Wood, for Chemicals, and for Machinery) are not statistically significant. The sectoral estimates are smaller then the average aggregate OLS estimate of 0.76 from Baier and Bergstrand (2007). Possible explanations for these differences include: (i) The different time and country coverage between our sample and the sample in Baier and Bergstrand (2007); (ii) The fact that we use sectoral manufacturing data while Baier and Bergstrand employ aggregate data; and (iii) The different sets of fixed effects employed in the two studies. Specifically, while Baier and Bergstrand (2007) employ exporter, importer, and

[29] All estimates in Table 2 are obtained with country-pair dummies and time-varying, directional (importer and exporter) fixed effects.

time fixed effects, we include a richer set of exporter-time and importer-time fixed effects, which are motivated by the structural gravity theory. Overall, we view our sectoral OLS estimates as comparable and complementary to the estimates from Baier and Bergstrand (2007).

The PPML estimator yields the results reported in panel B of Table 2. Most PPML numbers are different from the corresponding OLS estimates. One possible explanation for these differences is the inclusion of zero trade flows, which change the reference group that is used to identify the FTA effects. Intuitively, one would expect that the PPML estimates will be larger when the zero trade flows are added to the reference group in the estimating sample. We see that this is indeed the case for most sectors. However, there are some industries, such as Paper, where the PPML FTA estimate loses statistical significance and becomes smaller than the corresponding OLS number. Another possible explanation is the heteroskedasticity bias proposed by Santos Silva and Tenreyro (2006). Given the relatively small number of zeros in our sample, we are inclined to attribute the differences between the OLS and the PPML estimates of the FTA effects to the heteroskedasticity bias. In terms of magnitude, the sectoral PPML numbers are, on average, closer to the aggregate estimates from Baier and Bergstrand (2007).

Phasing-in of FTA effects is allowed for in results reported in panel C of Table 2. First, FTAs again have positive and economically and statistically significant impact on bilateral trade flows between member countries. Second, there is evidence for phasing-in and persistence of the FTA effects over time. Some sectors (e.g. Minerals) have a decrease in the FTA estimates over time. In contrast, the FTA effects are quite persistent for some categories (e.g. Chemicals and Machinery), and even increase a bit for others (e.g. Metals). Third, the estimates from row '$LAG2\_FTA$' indicate that the FTA effects for most of the sectors are still strong nine years after their entry into force, which is in contrast with the aggregate findings from Baier and Berstrand (2007) that the FTA effects should fade away in about ten years after their implementation.[30] We see that

[30]The fact that twice lagged FTA is statistically significant in some cases casts doubt on the assumption of strict FTA exogeneity. To test for feedback effects from trade changes to FTA changes, we introduce leads of the FTA dummy in (18). Sensitivity checks reveal the following: (i) the future FTA dummy is significant only for one category Textiles. However, this estimate is only marginally significant and it

this result changes in our next specification.

Our main FTA estimates are presented in panel D of Table 2. These add to the estimator reported in Panel C an allowance for differential FTA effects depending on whether an agreement was formed between countries with low MFN tariffs (FTA_LOW_MFN) or between countries with high MFN tariffs (FTA_HIGH_MFN). The intuition is that FTAs should have stronger effects for pairs with high initial MFN tariffs. By construction, the estimates on the new covariates FTA_LOW_MFN and FTA_HIGH_MFN should be interpreted as deviations from the average FTA effect. Four results stand out. First, the estimates on the FTA_HIGH_MFN are always larger than the corresponding estimates on FTA_LOW_MFN. Second, more important, all estimates (with the exception of Food) on FTA_LOW_MFN are negative and all but one of them (the estimate for Machinery) are statistically significant. This result suggests that the FTA effects for pairs with low MFN tariffs are indeed smaller as compared to the average FTA effects. Third, seven of the eight FTA_HIGH_MFN estimates are positive and four of them are statistically significant, suggesting that the FTA effects for pairs with high MFN tariffs are larger as compared to the average FTA effects. Fourth, there is stronger evidence for phasing-in of the FTA effects, as all estimates on $LAG2\_FTA$ are now smaller as compared to the corresponding contemporaneous FTA estimates, and three of the estimates on the second lag FTA effects are not statistically significant. Overall, the estimates from panel D offer evidence for heterogeneous FTA effects and point to potential gains from more research in that direction. We leave this for future work.[31]

The second-stage gravity estimates of equation (19) are presented in Table 3. Without going into details, note that all estimates of the effects of bilateral distance on bilateral trade flows are negative and statistically significant at any conventional level. The

is negative. All other *lead* estimates are not significant; and, (ii) none of the current and lagged FTA estimates change significantly when the leads are introduced. In combination, (i) and (ii) suggest that our panel treatment has been successful in accounting for FTA endogeneity.

[31] We also attempted to capture heterogeneous FTA effects by distinguishing between *deep vs. shallow* FTAs. Based on information from the WTO's PTA database, where PTAs are split into four groups: Free Trade Agreements, Customs Unions, Economic Integration Agreements (EIAs), and Partial Scope Agreement (PSAs), we classify an FTA or a CU as *deep* if it is also an EIA, and it is classified as *shallow* otherwise. We use '*'s to mark the *shallow* agreements in Table 1. In a complementary sensitivity analysis we did not document any stronger effects for the deeper agreements in our sample.

variability of the estimates across commodities reflects the influence of value/weight on transportation costs. Common borders facilitate trade. With one exception, namely Chemicals, the estimates of the coefficients on BRDR are large and positive, and five of the seven positive estimates are statistically significant.

The estimated coefficient on LANG is positive and statistically significant for only three of the eight product categories, in contrast to previous findings on aggregated trade. A possible explanation for this result is that over the past quarter-century, manufactures trade has grown between North and South, enhanced by the vertical disintegration of manufacturing, both weakening the influence of common language relative to its effect on aggregate trade found in previous studies. Notably, one of the significant estimates on LANG is for Paper, which can be explained with the fact that this category includes 'Printing and Publishing Products' whose consumption requires knowledge of a specific language. We also obtain a negative and marginally significant estimate of the effect of language for Wood.

The role of colonial ties in explaining bilateral trade flows in our analysis is low relative to earlier studies on aggregate data. Only two (for Food and for Metals) of the eight CLNY estimates are positive and statistically significant and we obtain a strong negative effect of colonial relationships for Machinery. This is consistent with the estimates from Anderson and Yotov (2010b) who also find weak evidence for the effects of colonial ties using more disaggregated data. Finally, we obtain large, positive, and statistically significant estimates for the effects of FTAs that entered into force before the period of investigation for seven of the eight sectors in our sample. The exception, with a negative and significant estimate is Wood. The OLD_FTA estimates are larger as compared to the FTA estimates from Table 2. Two possible explanations are (i) that these estimates capture the total (long-run) FTA effects, and (ii) that these effects are mostly driven by the heavily integrated economies in Europe.

Overall, we find the results from Tables 2 and 3 convincing. Aggregate estimations with similar properties have been interpreted as strong evidence in support of gravity theory and used to construct aggregate bilateral trade costs. Similarly, the set of standard

gravity covariates and the commodity level estimates derived here can be used to construct a reasonable proxy for the missing values of the bilateral fixed effects and trade costs following our procedures from Section 2.1.

3 Real Income Effects of FTAs

The terms of trade and global efficiency effects of the FTAs that entered into force between 1990 and 2002 are calculated applying the theory of Section 1 and the inferred trade costs of Section 2. Sellers' and buyers' price effects in each country are reported and combined into the change in the terms of trade. Global efficiency measures are reported. Finally, we analyze the counterfactual experiments of switching off NAFTA and of eliminating all FTAs for Mexico.

3.1 Terms of Trade Effects

Most of the indexes reported here are at the country- and commodity-level and are consistently aggregated from country-commodity pair numbers. The latter are available by request.

To gauge the significance of the indexes, we construct confidence intervals by bootstrapping the original FTA estimates. We first generate 500 sets of bootstrapped estimates of the FTA variables from equation (18). Then, we use each set of the FTA estimates to calculate 500 corresponding sets of each of the indexes of interest. Then, we calculate 95% centered bootstrap confidence intervals for each index:

$$\left[2\widehat{IND} - \widehat{IND}^{B}_{(487)}; 2\widehat{IND} - \widehat{IND}^{B}_{(13)}\right],$$

where: $\widehat{IND}$ can be any index of interest obtained with the original estimates; and $\widehat{IND}^{B}_{(13)}$ and $\widehat{IND}^{B}_{(487)}$ are, respectively, the $13th$ and the $487th$ indexes from the ranked (from bottom to top) bootstrap sample $\left(\widehat{IND}^{B}_{(1)}, \widehat{IND}^{B}_{(2)}, ..., \widehat{IND}^{B}_{(500)}\right)$.[32]

[32]In the results, a few of the main estimates fall outside of the bootstrapped confidence intervals. The proportion of such discordant cases is small, and even smaller for the cumulative FTA results. The cumulative results are more reliable due to a lack of sharp identification of the lag structure. Discordant cases arise for several reasons that do not vitiate our approach. First, to obtain our main GE indexes we combine bootstrapped estimates from different sectors. Thus, it is possible that large FTA estimates in

FTA Effects on Sellers. We use factory-gate prices, p^*'s, to measure FTA effects on sellers, obtained by solving for market clearing prices in (5) subject to normalization (8). Substituting in (5) for the CES price index yields:

$$\frac{p_i^{*k}q_i^k}{\sum_i p_i^{*k}q_i^k} = \sum_j \frac{(\beta_i^k p_i^{*k} t_{ij}^k)^{1-\sigma_k}}{\sum_i (\beta_i^k p_i^{*k} t_{ij}^k)^{1-\sigma_k}} \frac{\sum_k \phi_j p_j^{*k} q_j^k}{\sum_{j,k} \phi_j p_j^{*k} q_j^k}, \forall i,k. \tag{22}$$

(22) consists of NK-K independent equations and, as discussed earlier, the restrictions of separability together with the normalization imply K additional restrictions on the sectoral price vectors $1 = \sum_{i,} p_i^{*k} \frac{q_i^k}{\sum_i q_i^k}, \forall k$, interpreted as maintaining world 'real' resource use in each sector k.

We need data on the elasticity of substitution for each goods' class, σ_k, and on the CES share parameters for each country-commodity combination, β_i^k. Data on the elasticity of substitution are from Broda et al (2006),[33] while we calibrate the CES share parameters $\{(\beta_i^k)^{1-\sigma_k}\}$[34] using system (22) evaluated at the initial prices where by units choice all p^*'s for 1990 are equal to one:

$$\frac{q_i^k}{\sum_i q_i^k} = \sum_j \frac{(\beta_i^k t_{ij}^k)^{1-\sigma_k}}{\sum_i (\beta_i^k t_{ij}^k)^{1-\sigma_k}} \frac{\sum_k \phi_j q_j^k}{\sum_{j,k} \phi_j q_j^k}, \forall i,k. \tag{23}$$

The numbers for each of the other three years in our sample (1994, 1998 and 2002) take into account the presence and phasing-in of all free trade agreements that entered into force between 1990 and 2002. We use sectoral output shares as weights to obtain country-level estimates of the factory-gate prices. The numbers in columns 1-3 of Table 4 are percentage changes in producer prices calculated using the phased-in FTAs for the three years shown. These sellers' price changes reflect FTA general equilibrium incidence

one sector are combined with small FTA estimates in another sector, which push in opposite direction for the total effects. Second, we use bootstrapped estimates of five FTA variables (FTA, LAG_FTA, LAG2_FTA, FTA_LT, and FTA_HT)) at the same time. Thus, for example, it is possible that large estimates of the current effects of FTAs are combined with small estimates of the lagged FTA effects. Third, we construct GE indexes based on the simultaneous effects of all FTAs at the same time. Thus, it is possible that the effect of an FTA on member countries is offset and outweighed by the effects of FTAs among other countries. Fourth, we are solving a highly nonlinear GE system.

[33] See the Data Appendix for description and further details on these numbers.

[34] We impose the natural normalization $\sum_i (\beta_i^k)^{1-\sigma_k} = 1, \ \forall k$.

on the sellers in each country.[35] In our analysis, we concentrate on the indexes for 2002, which capture the total FTA effects over the whole period of investigation.

There is wide variability in the FTA effects on sellers. Close to half of the world's sellers suffer losses, while the rest enjoy gains. The gains for the winners might be at the expense of the losers. According to our estimates the two biggest losers, in terms of decrease in producer prices are Ecuador (3.2%) and Chile (1.7%). The next group, with losses around 0.6%-0.7% includes regions that did not enter any FTAs during the 90's (Korea, China, Japan and ROW) as well as Iceland and Greece. Trade diversion explains why losers lose. Interestingly, the next group of countries where sellers suffer from FTAs' are developed nations, including countries from Europe (e.g. Switzerland, Italy, UK, France). Germany and the United States are the two countries where producers lose the least. We attribute the negative effects for the European countries to trade diversion due to the accession of new countries. The explanation for the effects on US sellers is probably trade diversion due to NAFTA, even though US also entered other FTAs during the period of investigation. Sellers in other developed nations suffered minor losses too. The losses for the developed countries are more pronounced in sectors such as Textile, Apparel, and Leather Products (Textile) and Basic Metal Industries (Metals).

The biggest winners from the integration of the 90's are sellers from relatively small European and American economies that signed FTAs with large trading partners. From the European economies, Poland, Romania and Hungary are leaders with seller gains of 5.3%, 3.9% and 3.0%, respectively. Membership to the Central European Free Trade Agreement (CEFTA), the European Free Trade Association (EFTA) and, consequently, to the European Union (EU) should explain the strong positive effects in these nations. The large gains for these countries may come at the expense of other EU members. This is supported by the small losses for the sellers in the larger European economies.

Of the American economies, Mexican sellers are the biggest winners with 6.3% increase in their factory-gate prices followed by Canada with an increase of a bit more than 4%. Combined with the fact that US is among the countries with FTA seller losses, this result

[35] We demonstrate the importance of the general equilibrium forces in our model in Section 3.3.

suggests that NAFTA and the Canada-US agreement, which enters our sample with its phasing-in effects, have benefitted Mexican and Canadian sellers disproportionately, and maybe, at the expense of sellers in US. The counterfactual exercise of switching off NAFTA (described in Section 3.4) shows that NAFTA is the main reason for the gains to Mexican sellers, despite a series of bilateral FTAs as well as agreements between Mexico and most of the other Latin American economies. Finally, we see that Tunisia and Morocco are also in the upper tail of the sellers gains distribution with 3.6% and 3.3%, respectively. The explanation is that these countries signed FTAs with the European Union.

FTA Effects on Buyers. FTA effects on buyers in the world are reported in columns 4-6 of Table 4. Country-level indexes are obtained by aggregating the country-commodity numbers with sectoral-level expenditure shares used as weights. The numbers in each column are percentage changes in the inward multilateral resistances for the base year calculated with and without FTAs. Column '%Δ02' captures the total effects over the period 1990-2002 because the 2002 bilateral trade costs (used in the construction of the 2002 IMRs) account for the cumulative, direct FTA impact.

Without exception, buyers in the world benefitted from the integration of the 90's with benefits increasing over time. FTAs have lead to decrease in consumers prices everywhere. Importantly, even buyers in nations that did not enter any free trade agreement during the period of investigation enjoy lower prices.[36] All five such regions in our sample (Australia, China, Japan, South Korea and ROW) register small IMR decreases. It should also be noted that, despite being small, the price decrease for the outsiders in our sample are not the smallest in the sample.

The variability of the FTA effects on buyers across countries is wide but mostly intuitive. The biggest FTA winners are relatively small countries that are geographically close to their major markets. Thus, some of the largest FTA gains are for some small

[36]By definition, the IMR values in principle are comparable to price indexes, and in particular their variation across countries might be expected to reflect variation in buyer (or user) price indexes. The IMR's have more variation than CPI's, and we expect that they only loosely track variations in buyer price indexes. A possible explanation is that the inward incidence of trade costs probably falls on intermediate goods users in a way that does not show up in measured prices. In addition, by construction, the IMRs capture the home bias in preferences that cannot show up in prices.

European economies including Hungary, Poland, and Bulgaria. A partial explanation is that the latter group were heavily involved in integration during the period of investigation. All these nations are founding members of the Central European Free Trade Agreement in 1993. Subsequently each of them signed an agreement with the European Free Trade Association, and then, most important, with the European Union. Romania follows a similar integration pattern and also registers significant buyer gains.

Buyers in many of the Latin American countries are in the upper tail of the FTA gains' distribution too. Mexico, Ecuador, Bolivia, and Chile are the leaders with buyer gains between 8.3% and 3.3%. Uruguay follows closely with 2.8% gains. Argentina also enjoys buyer gains of more than 1%. All these nations are members of the Latin American Free Trade Agreement (LAFTA), since 1993. In addition, most of these countries are (founding) members of Mercosur and have FTAs with each other. Finally, NAFTA and series of bilateral FTAs between Mexico and other countries may contribute to the positive effects for this particular country.[37] Buyers in most of the developed economies enjoy moderate FTA gains. This is in accordance with the standard prediction based on 2 country models of smaller gains from freer trade for the larger trading partner.

Finally, we discuss three interesting examples. Morocco did not enter any FTAs until 2000. Yet this country enjoyed IMR reductions in 1994 and in 1998. The gains increased dramatically in 2002 following Morocco's FTA with the European Union in 2000. A possible reason is positive spill-over effects: sellers in nations that entered FTAs enjoy efficiency gains in distribution that are passed on to all their trading partners, including the ones with whom they have no FTAs. Consumer prices in Tunisia follow a similar pattern. This country enjoyed very little gains in 1994, however, we see that once Tunisia signed the FTA with the European Union in 1998, consumer prices fell significantly. Finally, we note that the only country in our sample where buyers suffered higher prices in 1994 and in 1998 is Colombia. The explanation is that this country

[37]When interpreting our results, the reader should remember that the equilibrium welfare effects in each country are generated in response to the impact of all FTAs in our sample. While it is probably true that the strongest FTA effect on Mexico comes from NAFTA, the model allows for any other FTA to also influence the welfare of Mexican buyers and sellers, even if Mexico is not part of the FTA at all. This is why we observe welfare effects for the countries that did not participate in any free trade agreement initiated between 1990 and 2002.

was mostly left out of the intensive integration efforts in Latin America in the early 90s. Several FTAs in the mid-90s resulted in positive (but very small) gains for this country in the late 90s and overall over the whole period of investigation.

Terms of Trade Indexes. Buyer and seller price index changes for each country and year combine in the terms of trade (ToT) changes:

$$\frac{T_i^F - T_i^0}{(T_i^F + T_i^0)/2} * 100, \forall i$$

where T_i^t is defined by (13) evaluated at FTA ($t = F$) and initial ($t = 0$) prices. T_i decomposes into the seller price and buyer price multiplicative components reported separately and multiplicatively combined in the last three columns of Table 4. The mid-point percentage change formula ensures that the buyers' and sellers' price changes sum to the ToT change.

Our findings suggest that the integration of the 90's benefitted FTA members while hurting outsiders by an amount too small to be noticeable. As to losers, there are only six regions whose terms of trade worsen during the the 90's. These include the five regions that did not enter any FTA during the period of investigation along with Iceland. Even though buyers in these regions enjoyed small FTA gains, integration in the rest of the world had a stronger negative impact on sellers. Importantly, the net ToT losses that we document are very small (less than 0.3%). As to winners, all countries (except for Iceland) that entered FTAs during the 90's enjoy real income (ToT) gains. This suggests that (i) the direct FTA effects among trading partners dominates the indirect FTA effect from ongoing regional integration in the rest of the world, and (ii) the losses for the sellers in larger FTA members are dominated by buyer gains at the national level. Differences among the winners are large. The nations with the largest ToT improvements during the 90s include small countries that entered FTAs with large partners in close proximity: Mexico and Uruguay (due to NAFTA and intense integration in Latin America), Canada (due to integration with Mexico and US), Poland and Hungary (due to EU and integration within Central and eastern Europe) and Tunisia and Morocco (due to FTAs with EU). In contrast, large nations benefit less from FTAs. Almost all developed economies are

ordered in the lower tail of the distribution of ToT increases. (Austria is an exception with total gains of 5.44%, which fall mostly on the buyer side.) Nevertheless, even the large FTA members enjoy some gains. For example, even though US sellers suffered losses (probably due to NAFTA) their buyers gain more.

3.2 Global Efficiency Effects

Global efficiency estimates are reported in Table 5. The first eight rows of the table report global sectoral indexes and the last row presents the global efficiency measure for world manufacturing in each year. Columns (1)-(3) of Table 5 depict the trajectory of efficiency gains, where column '%Δ2002' presents the total efficiency changes caused by FTAs during the whole period of investigation. Consistent with the phasing-in FTA estimates from Table 2, the efficiency gains from FTAs increase over time for each sector in the sample.

Column '%Δ2002' shows that all sectors enjoy statistically significant efficiency gains while there is wide variability across industries. The largest effect is for Textiles, with an efficiency gain of 2.1%. Machinery also register a large gain of close to 1%. Metals and Chemicals follow with gains of more than 0.5%. The sectors with smallest efficiency gains are Paper, Food, and Minerals. The sectoral level efficiency change measures combine to a global efficiency change of 0.88%, driven by the large combined share of Textiles, Machinery, and Metals in world manufacturing in Table 5.

3.3 Sensitivity Experiments

Two simplifications in our basic approach seem most problematic, the no rent assumption and the no substitution (endowment economy) assumption in production. This section provides perspective on the sensitivity of our results to these simplifications.

Assume temporarily that all rents are tariffs and that all tariff revenue is fully rebated to the representative agent. We calculate the change in tariff revenue induced by switching on all FTAs in the base year while keeping the base year trade values (using equation scaled up to include all relevant FTAs and modified to allow for initially discriminatory

tariffs where applicable).[38] This compares to the change in manufacturing real income attributable to the FTAs, $R_j \Delta T/T$. The ratio of the former to the latter is reported in the last column of Table 4. In most cases the ratio is smaller than one and in more than two-thirds of the cases it is less that 0.5. This suggests that the gains from FTAs outweigh the losses in terms of forgone tariff revenues. For example, our indexes indicate that in the case of Mexico, the average yearly losses from tariff revenues were about 39% of the average yearly gains from the FTAs that this country entered during the period of investigation.[39]

The loss in tariff revenues exceeds the ToT gains in only three cases and only slightly: Morocco (with an index of 1.12), Ireland (1.07), and for Tunisia (1.03). The explanation in the case of Ireland is a relatively small manufacturing base combined with relatively high tariffs (about 9% in 1990) and a small ToT effect. The explanation in the cases of Tunisia and Morocco is a combination of a small manufacturing base, very high initial tariffs (about 30% in each country), and potentially missing terms of trade gains that presumably accrue to agriculture and other natural resource industries and over time.

The conclusions to be drawn are: (i) national gains remain for almost all partners, (ii) some big gains remain (e.g. Poland and Canada), (iii) some other big gains are considerably reduced (e.g. Mexico and Brazil) due to high MFN tariffs in imports from major trading partners, and (iii) in the only instances of a loss, Ireland, Morocco and Tunisia, gains outside of manufacturing appear likely to overturn the result. In addition,

[38]Four data sources were used to construct bilateral tariffs, needed to calculate tariff revenues. We combined the United Nations Conference on Trade and Development (UNCTAD) Trade Analysis and Information System (TRAINS), the CEPII TradeProd database (This dataset is based on Jon Haveman's UTBC database and CEPII's Market Access Map, MAcMap, database), the World Trade Organization (WTO) Integrated Data Base (IDB), which is available for the years after 1995, and the World Bank's *Trade, Production and Protection* (TPP) Database, which is based on TRAINS but the authors extend on it by collecting data from national statistical documents and web sites (See Nicita and Olarreaga, 2006). TradeProd tariffs are the base, to which we add bilateral tariffs from TRAINS and IDB. It turns out that bilateral tariff data at the sectoral level needed were available for only about half of countries and commodities in our sample. In the first column of Table 4, we use '*'s to mark the countries for which bilateral tariff data were not available. To substitute for the missing bilateral values, we use average MFN tariffs from TRAINS and IDB.

[39]According our data, in 1990, the value of Mexican manufacturing output was about 60 billion dollars, Mexican manufacturing tariffs on imports from all potential FTA partners that realized during the 90s were about 15%, and the total imports from these partners amounted to about 23 billion dollars. Combined with our estimate of about 14% average ToT gains, these numbers suggest average gains of about 8.4 billion dollars and average losses of about 3.3 billion dollars, resulting in an approximate index of 39%.

we expect the effects of the FTA between Morocco and the EU, which was signed in 2000 to eventually outweigh the costs in terms of lost revenues by a significant margin.

Perspective on sensitivity to the no substitutes in supply assumption of our approach is provided by comparing the benchmark with some partial equilibrium variants. (General equilibrium variants require full general equilibrium alternative models that are beyond this study.) The issue is sensitivity of the results to variation of the total shipments values, the Y_is, and to a lesser extent the total expenditures, the E_js. (In the endowments model the endogenous sales shares move only due to changes in factory gate prices to sellers, whereas in a finite elasticity of supply model they would move due to changes in endowments. The expenditures on each goods class change in our model due to substitution effects between goods classes, but total expenditure changes are equal to total sales of all goods, hence reflect sellers' factory gate price changes only.)

We compare four scenarios ordered by increasing general equilibrium complexity. The comparison demonstrates the significance of the general equilibrium linkages (through endogenous output and expenditure) in our analysis. In each case, we use system (6)-(7) subject to the normalizations described above to obtain the factory-gate prices and consumer prices that are combined into terms of trade changes.

The results are reported in Table 6 for the total effects over the whole period only. The estimates for factory-gate prices in column (3), the inward multilateral resistances in column (7), and the terms of trade effects in column (11) are our main estimates from Table 4 and are reported to ease comparison. Using terminology from Head and Mayer (2014) the main results are labeled General Equilibrium Trade Impact (GETI).

Alternative scenarios begin by quantifying the partial equilibrium impact (PEI) of FTAs. In this scenario, by construction, factory gate prices do not respond to FTAs and the effects on buyers at each period t are obtained as $(P^k_{j,t})^{1-\sigma_k} = \sum_i (\beta^k_{i,t} t^k_{ij,t})^{1-\sigma_k}, \ \ \forall j,k$.[40] Our IMR and ToT results are presented in columns (4) and (8) of Table 6, respectively. We do not report effects on factory-gate prices because those are zero by construction.

[40] A nice feature of this expression is that it offers a structural foundation for aggregating bilateral trade costs and their changes for a given country. For example, there are countries in our sample that entered multiple FTAs in a given year, and we can aggregate these effects consistently using the estimates of the share parameters β.

Turning to the effects on buyers from column (4), we see that, as expected, buyers in all countries that entered FTAs enjoy lower prices. These effects are stronger for small countries that entered FTAs with large partners in close proximity, e.g. Mexico, Poland, Tunisia. Buyers in the five outsiders in our sample do not experience any price change because they did not enter any FTAs during the period of investigation. Finally, the ToT effects on the partial equilibrium scenario (see column 8) are driven exclusively by the effects on buyers.

The second scenario allows both seller prices and buyer prices (IMRs) to respond to FTAs, but sales and expenditures are given. Using terminology from Head and Mayer (2014) this scenario is Modular Trade Impact (MTI). Results are presented in columns (1), (5), and (9). First, from column (1), we see that sellers in about half of the countries in our sample gain, while sellers in the outside countries and some other (mostly developed) nations incur small losses. These findings are qualitatively identical to the main (GETI) effects on sellers from column (3). Quantitative differences between the PEI and the GETI scenarios are small in absolute value but sometimes (meaninglessly) large in percentage terms. On average, the PEI effects on sellers, especially for those who gain, are larger in absolute value compared to the GETI effects on sellers. Thus the full general equilibrium forces in the main analysis (by allowing output and expenditure to respond to FTAs) operate in the opposite direction of the forces that affect producers in the MTI scenario. This relationship is still present but not as pronounced on the consumer side. Comparison between the MTI estimates from column (5) and the GETI estimates from column (7) reveals smaller differences for consumers. Finally, comparison between columns (5) and (4) suggests that the modular trade impact of FTAs on consumers can be quite strong compared to the partial equilibrium effects (see Poland, Romania, and Chile for example).

The third scenario is a Hybrid between MTI and GETI, labeled HTI. Here, expenditure remains fixed but the value of sales changes via changes in producer prices. Columns (2), (6), and (10) report the results. Comparison between the HTI and the MTI findings on the seller side reveal that allowing for endogenous sales mitigates the MTI effects (both gains and losses) on sellers. However, allowing for endogenous expenditure, i.e. moving

from HTI (column 2) to GETI (column 3), results in sizable changes in seller prices. Moving from HTI to GETI leads to (i) larger gains for sellers in member countries who win; (ii) mixed effects on the losses for sellers in member countries who lose; and (iii) larger losses for sellers in the outsiders. Turning to buyers, comparison between the HTI and MTI findings from columns (6) and (5), respectively, suggests that, on average, allowing for endogenous sales benefits buyers in member countries but hurts buyers in outsiders. Allowing for endogenous expenditure, i.e. moving from HTI (column 6) to GETI (column 7) results in higher buyer prices in member countries (i.e. a smaller decrease in prices due to FTAs) and lower buyer prices in outside countries.

3.4 Counterfactual FTA Experiments

Our approach is usefully applied to isolate the effects of NAFTA, and also the impact of all FTAs signed by a Mexico.[41] The choice of NAFTA and Mexico, respectively, for counterfactual experiments seems natural as both have been objects of interest for an extensive literature.[42] First, we estimate a hypothetical set of multilateral resistances, factory-gate prices and corresponding FTA ToT effects as if there is no NAFTA (but all other FTAs are still in place). Then, we shut down the rest of the Mexican free trade agreements and we estimate the effects from globalization happening elsewhere in the world.

Table 7 presents our findings for the changes in the total welfare (ToT) effects. The numbers in Column 1 of the table are the indexes from column (9) of Table 4, capturing total welfare effects from all FTAs that entered into force during the period of investigation. Column 2 reports welfare effects without NAFTA. The estimates reveal that NAFTA benefits significantly all members, but most of all Mexico. Killing NAFTA causes a big fall in the ToT gains for Mexico: NAFTA accounts for more than 88% of

[41] These FTAs include LAFTA/LAIA (1993) and series of bilateral agreements between Mexico and other partners including Bolivia (1995), Costa Rica (1995), Colombia (1995) (As part of the Group of Three. The third country, Venezuela, is not in the sample), the EU (2000), and Israel (2000).

[42] Our framework can be applied to study series of other interesting counterfactual experiments including global free trade, switch on FTAs for all bilaterals $i \neq j$, or a 1% fall in trade barriers for all bilaterals $i \neq j$. Another area where our methods can lead to potentially very important contributions is in providing much needed empirical evidence on whether regionalism is a stumbling block or a stepping stone toward global free trade. See the concluding section for more applications.

the gains from all Mexican FTAs. Canada and the US benefit from NAFTA too. The gains for Canada from NAFTA amount to about 5%, while the real income gains for the Unites States of about 0.3% are significantly smaller. These results are in accordance with findings from a series of computationally intensive CGE models.[43]

Our counterfactual simulations indicate that without NAFTA both Canada and US will still benefit from the presence of FTAs. It turns out however, that the net gains for these countries are due to the Canada-US FTA, and once we simulate its removal together with NAFTA,[44] both Canada and the US register losses from the integration taking place in the rest of the world, even though both countries entered other FTAs during the period of investigation.

The removal of NAFTA has small impact on other countries.[45] According to our estimates, most non-NAFTA members would enjoy small gains if NAFTA were not there. The natural explanation is trade diversion toward the large US market, which no longer is served 'freely' by Mexico and Canada. Some outside nations suffer slightly from the removal of NAFTA.

The final experiment shuts down all FTAs implemented by Mexico in the 1990s. The results are reported in column 3 of Table 7: (i) Mexico has the largest welfare loss. Total FTA welfare effects for Mexico turn negative: the country suffers a 0.18% decrease in its terms of trade and manufacturing real GDP due to the FTAs happening elsewhere in the world. (ii) All other Latin American countries also experience welfare losses due to the removal of the FTA relations that they have with Mexico.[46] Most of the Latin American countries, however, still enjoy positive FTA welfare effects, probably due to the strong FTA connections among themselves. Costa Rica is the only exception with negative terms of trade changes. (iii) The effect on the European economies is very

[43]Our estimate of the welfare gains for Mexico from NAFTA are in the upper tail of the range of corresponding CGE indexes. The majority of these numbers are in the 5%-6% range, but some studies predict 11% welfare gains by the year 2000 (see McLeery, 1992) and even 14% by 2003 (see Klein and Salvatore, 1995). Part of the higher gains from our study are due to the longer post-NAFTA period of investigation. See Brown et al. (1992a) for a concise summary of the findings from leading CGE models regarding the welfare implications of NAFTA.

[44]This analysis is available by request.

[45]The small effects on the rest of the world accord with the conclusions from Brown et al. (1992b).

[46]Note that some of those countries would have benefitted from the removal of NAFTA, prrobably due to trade diversion.

small and mixed. Some economies in Europe (e.g. Belgium-Luxembourg) suffer small welfare losses. Thus, the direct effects of the removing the Mexico-EU FTA dominate the indirect (trade diversion) effects from the removal of the rest of the Mexican FTAs (but NAFTA). The opposite is true for other European economies (e.g. Hungary) that enjoy small benefits. Finally, (iv) both Canada and US would benefit a bit if all other FTAs for Mexico were not there. Trade diversion is a natural explanation.

4 Conclusion

The numbers presented in this paper portray a regional integration process in the 1990's that increased global efficiency in each manufacturing sector, provided many integrating partners with substantial gains and inflicted small losses on a few countries that did not enter FTAs.

The methods developed here should be useful for other purposes. For example, as in Ossa (2014), multi-dimensional (country, commodity, and time) simulated comparative statics of trade policy can be examined for patterns suggested by commercial policy theory. As another example, the effect of hypothetical FTAs and their sequencing can be calculated to look for stumbling blocks vs. building blocks to wider MFN liberalization. Finally, terms of trade externalities also arise from policies other than FTAs or other trade policies. Future hypothetical comparative statics can evaluate domestic policy changes that affect internal trade costs relative to international ones (e.g. infrastructure investments), affect supplier costs and volume or buyer costs and volume (e.g. carbon emissions controls) within our framework.

Our global efficiency of distribution measure $\bar{T}$ has potential future application in understanding and measuring globalization. $\bar{T}$ measures globalization from technology, policy or shifts in location of production and consumption. Globalization measured in this way is familiar because its logic is the same as Total Factor Productivity. Equation (15) is the basis for a full country-sector decomposition of the sources of globalization.

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Table 1: Free Trade Agreements

European Union, or EU (1958): Belgium–Luxembourg, France, Italy, Germany, Netherlands, Denmark (1973), Ireland (1973), United Kingdom (1973), Greece (1981), Portugal (1986), Spain (1986), Iceland (1994) Austria (1995), Finland (1995), Sweden (1995)
European Free Trade Association, or EFTA (1960): Austria (until 1995), Denmark (until 1973), Iceland (1970), Finland (1986–1995), Norway, Portugal (until 1986), Sweden (until 1995), Switzerland, United Kingdom (until 1973)
Latin American Free Trade Agreement/Latin American Integration Agreement, or LAFTA/LAIA (1993–): Argentina, Bolivia, Brazil, Chile, Ecuador, Mexico, Uruguay
EU–EFTA Agreement/European Economic Area (1973/1994)
*US–Israel (1985)
*US–Canada (1989)
*EFTA–Israel (1993)
Central Europe Free Trade Agreement, or CEFTA (1993): Hungary, Poland, Romania (1997), Bulgaria (1998)
EFTA–Turkey (1992)
EFTA–Bulgaria (1993)
EFTA–Hungary (1993)
EFTA–Poland (1993)
EFTA–Romania (1993)
Andean Community (1993): Bolivia, Colombia, Ecuador
EU–Hungary (1994)
EU–Poland (1994)
North American Free Trade Agreement, or NAFTA (1994): Canada, Mexico, United States
*Bolivia–Mexico (1995)
Costa Rica–Mexico (1995)
EU–Bulgaria (1995)
EU–Romania (1995)
Colombia–Mexico (1995). As part of the Group of Three. The third country, Venezuela, is not in the sample.
Mercosur (1991): Argentina, Brazil, Uruguay (formed in 1991 FTA in 1995)
Mercosur–Chile (1996)
Mercosur–Bolivia (1996)
EU–Turkey (1996)
Canada–Chile (1997)
*Canada–Israel (1997)
*Hungary–Turkey (1998)
*Hungary–Israel (1998)
*Israel–Turkey (1998)
*Romania–Turkey (1998)
*Poland–Israel (1998)
*EU–Tunisia (1998)
*Mexico–Chile (1999)
*EU–Israel Agreement (2000)
EU–Mexico (2000)
*EU–Morocco (2000)
*EFTA–Morocco (2000)
*Poland–Turkey (2000)
*Mexico–Israel (2000)
Chile–Costa Rica (2002)

Notes: This table lists, in chronological order, all free trade agreements used in the estimations. Only agreements involving the countries in our sample are included. FTAs that entered into force before 1990 are used, when appropriate, to construct the lagged variables of the FTA dummy variable. The latter is constructed from FTAs that entered into force after 1990. '*'s mark the *shallow* agreements, as defined in the text.

Table 2: Partial FTA Effects on Trade Flows

	Food	Textile	Wood	Paper	Chemicals	Minerals	Metals	Machinery
A. OLS Estimates								
FTA	0.295	0.374	0.136	0.396	0.113	0.239	0.411	0.128
	(0.078)**	(0.079)**	(0.104)	(0.112)**	(0.074)	(0.078)**	(0.112)**	(0.092)
N	6330	6358	5818	5882	6346	5953	5760	6402
R^2	0.912	0.930	0.906	0.921	0.933	0.927	0.876	0.947
B. PPML Estimates								
FTA	0.604	0.747	0.153	0.143	0.405	0.386	0.467	0.328
	(0.083)**	(0.167)**	(0.096)	(0.085)+	(0.096)**	(0.118)**	(0.081)**	(0.067)**
N	6691	6642	6561	6532	6700	6628	6502	6659
C. PPML Estimates, Phasing-in								
FTA	0.444	0.657	0.033	0.099	0.252	0.212	0.291	0.257
	(0.086)**	(0.148)**	(0.098)	(0.096)	(0.073)**	(0.126)+	(0.058)**	(0.060)**
LAG_FTA	0.205	0.230	0.221	0.074	0.226	0.288	0.299	0.171
	(0.035)**	(0.147)	(0.105)*	(0.080)	(0.052)**	(0.070)**	(0.066)**	(0.057)**
LAG2_FTA	0.289	0.483	0.043	0.191	0.290	0.109	0.319	0.252
	(0.044)**	(0.106)**	(0.046)	(0.050)**	(0.046)**	(0.050)*	(0.069)**	(0.152)+
N	6691	6642	6561	6532	6700	6628	6502	6659
D. FTAs and MFN Tariffs								
FTA	0.315	0.910	0.437	0.407	0.474	0.510	0.484	0.338
	(0.077)**	(0.127)**	(0.072)**	(0.070)**	(0.056)**	(0.160)**	(0.083)**	(0.080)**
LAG_FTA	0.205	0.208	0.216	0.069	0.182	0.250	0.256	0.167
	(0.042)**	(0.139)	(0.097)*	(0.061)	(0.052)**	(0.071)**	(0.061)**	(0.056)**
LAG2_FTA	0.310	0.443	-0.077	0.117	0.260	0.084	0.297	0.246
	(0.044)**	(0.107)**	(0.052)	(0.046)*	(0.045)**	(0.067)	(0.070)**	(0.153)
FTA_LT	0.264	-0.631	-0.698	-0.589	-0.514	-0.515	-0.435	-0.158
	(0.116)*	(0.158)**	(0.130)**	(0.105)**	(0.065)**	(0.154)**	(0.077)**	(0.108)
FTA_HT	0.397	0.511	0.042	0.507	0.197	0.109	-0.029	0.305
	(0.089)**	(0.132)**	(0.187)	(0.143)**	(0.136)	(0.058)+	(0.145)	(0.259)
N	6691	6642	6561	6532	6700	6628	6502	6659

Notes: Huber-Eicker-White robust standard errors, clustered by country pair, are reported in parentheses. + $p < 0.10$, * $p < .05$, ** $p < .01$. The years in the data are 1990, 1994, 1998, and 2002. All estimations are performed with bilateral dummies and directional (source and destination) time-varying fixed effects as defined in equation (18). Fixed effects estimates, including the constant, are omitted for brevity. Panel A reports OLS FTA estimates. Panel B reports PPML estimates with a single FTA variable. Panel C allows for phasing-in FTA effects. Here, L.FTA and L2.FTA are the first and the second four-year lags, respectively. Panel D reports our main estimates, which allow for differential effects of FTAs between countries with *high* and with *low* MFN tariffs, respectively.

Table 3: Second-stage Gravity Estimates, PPML

	(1) Food	(2) Textile	(3) Wood	(4) Paper	(5) Chemicals	(6) Minerals	(7) Metals	(8) Machinery
LN_DIST	-0.794	-0.423	-0.483	-0.716	-0.399	-0.799	-0.621	-0.429
	(0.015)**	(0.032)**	(0.041)**	(0.015)**	(0.063)**	(0.012)**	(0.049)**	(0.025)**
CONTIG	0.524	0.326	0.651	1.037	-1.458	1.051	1.370	1.149
	(0.342)	(0.351)	(0.233)**	(0.196)**	(0.464)**	(0.165)**	(0.409)**	(0.419)**
LANG	-0.208	-0.253	-0.525	0.487	0.372	-0.117	0.863	1.845
	(0.327)	(0.248)	(0.299)+	(0.218)*	(0.483)	(0.199)	(0.494)+	(0.398)**
CLNY	1.006	-0.164	0.054	0.001	-0.712	0.329	1.739	-1.717
	(0.404)*	(0.356)	(0.520)	(0.361)	(0.504)	(0.285)	(0.686)*	(0.657)**
FTA_OLD	1.563	1.897	-0.832	0.419	5.004	0.851	2.052	1.140
	(0.191)**	(0.378)**	(0.280)**	(0.184)*	(0.795)**	(0.136)**	(0.340)**	(0.409)**
N	1632	1626	1606	1594	1632	1616	1596	1630

Notes: This table reports estimates from a second-stage estimating equation (19), where the country-pair fixed effects from the first stage specification (18) are regressed on the standard set of gravity variables. Robust standard errors are reported in parentheses. + $p < 0.10$, * $p < .05$, ** $p < .01$. See text for further details.

Table 4: FTA Effects by Country, 1990-2002

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	Factory-gate Prices			IMR's			ToT Effects			$\Delta TR/\Delta R$
	%Δ94	%Δ98	%Δ02	%Δ94	%Δ98	%Δ02	%Δ94	%Δ98	%Δ02	
Argentina*	.24	.45	.51	-.49	-.71	-1.13	.73	1.16	1.64	.08
	[.07;.32]	[.29;.6]	[.42;.9]	[-.8;-.15]	[-1.06;-.37]	[-1.65;-.71]	[.39;.97]	[.83;1.47]	[1.41;2.29]	
Australia*	-.13	-.24	-.37	-.09	-.18	-.28	-.04	-.06	-.09	0
	[-.17;-.12]	[-.3;-.21]	[-.51;-.34]	[-.12;-.08]	[-.22;-.13]	[-.39;-.22]	[-.05;-.03]	[-.09;-.06]	[-.13;-.09]	
Austria	-.16	.6	1.92	-.27	-1.7	-3.52	.11	2.29	5.44	.74
	[-.23;-.14]	[-.11;1.22]	[1.1;2.81]	[-.33;-.21]	[-2.45;-.96]	[-4.99;-2.71]	[.02;.15]	[.87;3.66]	[3.85;7.78]	
Blgm-Lxmbrg	-.1	-.15	-.21	-.19	-.34	-.6	.09	.19	.38	.49
	[-.13;-.04]	[-.18;-.1]	[-.3;-.19]	[-.25;-.19]	[-.43;-.31]	[-.81;-.54]	[.09;.18]	[.18;.29]	[.3;.56]	
Bolivia*	-.1	-.01	.04	-1.59	-2.61	-4.47	1.49	2.6	4.51	.46
	[-.35;.06]	[-.17;.16]	[-.1;.41]	[-1.9;-1.28]	[-3.18;-2.15]	[-5.96;-4.41]	[1.17;1.75]	[2.17;3.19]	[4.48;6.16]	
Brazil	-.01	-.05	-.1	-.1	-.25	-.37	.1	.2	.27	.65
	[-.17;.06]	[-.26;.05]	[-.42;.03]	[-.22;-.06]	[-.41;-.17]	[-.7;-.31]	[.03;.13]	[.12;.24]	[.22;.38]	
Bulgaria*	-.15	.71	1.02	-.64	-2.21	-3.1	.49	2.92	4.11	.26
	[-.34;-.04]	[.15;1.14]	[.53;1.58]	[-.88;-.43]	[-2.92;-1.6]	[-4.01;-2.46]	[.35;.57]	[2.45;3.32]	[3.75;4.84]	
Canada*	1.71	2.68	4.04	-1.84	-2.78	-4.41	3.55	5.45	8.44	.07
	[.84;2.37]	[1.71;3.53]	[2.73;5.9]	[-2.53;-.99]	[-3.69;-1.82]	[-6.76;-3.25]	[1.94;4.91]	[3.55;7.23]	[6.09;12.58]	
Chile*	-.77	-1.16	-1.67	-1.28	-2.33	-3.27	.51	1.17	1.6	.26
	[-.99;-.61]	[-1.48;-1.07]	[-2.4;-1.73]	[-1.52;-1.06]	[-2.8;-2.15]	[-4.39;-3.43]	[.38;.6]	[.97;1.41]	[1.49;2.13]	
China*	-.22	-.4	-.61	-.14	-.26	-.41	-.08	-.13	-.2	0
	[-.29;-.21]	[-.51;-.37]	[-.85;-.57]	[-.19;-.13]	[-.34;-.21]	[-.58;-.33]	[-.11;-.08]	[-.17;-.13]	[-.28;-.2]	
Colombia*	.08	.25	.24	.06	.04	-.01	.02	.22	.25	.28
	[-.01;.11]	[.15;.3]	[.09;.31]	[0;.1]	[-.05;.1]	[-.12;.07]	[-.03;.04]	[.13;.26]	[.15;.29]	
Costa Rica*	-.16	0	-.25	-.01	-.2	-.38	-.15	.21	.13	1
	[-.23;-.14]	[-.17;.09]	[-.41;-.22]	[-.06;.02]	[-.3;-.13]	[-.47;-.33]	[-.18;-.14]	[.07;.28]	[.01;.15]	
Denmark	-.14	-.17	-.13	-.21	-.51	-.97	.07	.34	.83	.64
	[-.18;-.12]	[-.26;-.13]	[-.26;-.06]	[-.29;-.22]	[-.63;-.45]	[-1.28;-.94]	[.07;.11]	[.23;.47]	[.78;1.11]	
Ecuador*	-1.73	-2.37	-3.15	-2.35	-3.33	-4.66	.63	.96	1.51	.35
	[-2.05;-1.56]	[-2.8;-2.25]	[-4.21;-3.3]	[-2.73;-2.05]	[-3.86;-3.14]	[-6.05;-4.9]	[.29;.87]	[.6;1.28]	[1.17;2.13]	
Finland	.49	.55	1.4	-.47	-1.3	-2.37	.96	1.84	3.76	.33
	[.52;.89]	[.21;1.04]	[.79;2.28]	[-.78;-.35]	[-1.87;-.99]	[-3.58;-1.7]	[.93;1.66]	[1.41;2.77]	[2.78;5.68]	
France	-.07	-.12	-.23	-.23	-.36	-.57	.16	.24	.34	.37
	[-.1;.03]	[-.14;-.06]	[-.3;-.2]	[-.31;-.23]	[-.47;-.33]	[-.78;-.52]	[.15;.32]	[.22;.37]	[.31;.5]	
Germany	-.08	-.06	-.08	-.2	-.41	-.71	.12	.34	.62	.35
	[-.12;-.01]	[-.1;-.01]	[-.15;-.05]	[-.26;-.2]	[-.5;-.37]	[-.94;-.65]	[.12;.21]	[.32;.45]	[.56;.84]	
Greece	-.21	-.39	-.66	-.21	-.49	-.9	0	.1	.24	.81
	[-.27;-.2]	[-.46;-.35]	[-.86;-.66]	[-.28;-.2]	[-.59;-.4]	[-1.18;-.78]	[-.03;.03]	[.03;.16]	[.07;.36]	
Hungary*	.41	1.54	3.02	-.93	-3.05	-4.44	1.35	4.59	7.46	.35
	[-.04;.76]	[1.26;2.06]	[3.06;4.5]	[-1.72;-.02]	[-4.12;-2]	[-6.62;-3.25]	[.51;1.85]	[3.86;5.63]	[7.24;10.37]	
Iceland*	-.22	-.42	-.69	-.28	-.41	-.67	.06	-.02	-.02	1
	[-.28;-.2]	[-.52;-.39]	[-.89;-.66]	[-.36;-.26]	[-.54;-.34]	[-.89;-.61]	[.03;.11]	[-.08;.06]	[-.1;.09]	
Ireland	-.15	-.2	-.3	-.15	-.22	-.4	0	.02	.11	1.07
	[-.19;-.13]	[-.26;-.18]	[-.43;-.28]	[-.19;-.14]	[-.29;-.19]	[-.55;-.37]	[-.01;.02]	[-.01;.04]	[.07;.15]	
Israel*	.54	.47	.81	-.46	-.64	-1.82	.99	1.11	2.63	.69
	[.63;1.05]	[.54;.98]	[.74;1.44]	[-.7;-.26]	[-.99;-.37]	[-2.46;-1.47]	[1.07;1.55]	[1.05;1.8]	[2.31;3.8]	

Continued

Table 4 – continued from previous page

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	Factory-gate Prices			IMR's			ToT Effects			$\Delta TR/\Delta R$
	%Δ94	%Δ98	%Δ02	%Δ94	%Δ98	%Δ02	%Δ94	%Δ98	%Δ02	
Italy	-.11	-.17	-.29	-.21	-.36	-.6	.1	.18	.31	.46
	[-.15;-.05]	[-.2;-.14]	[-.39;-.28]	[-.29;-.21]	[-.46;-.32]	[-.82;-.55]	[.09;.2]	[.17;.27]	[.24;.45]	
Japan	-.23	-.38	-.59	-.19	-.32	-.51	-.04	-.06	-.09	0
	[-.33;-.17]	[-.53;-.28]	[-.92;-.43]	[-.26;-.14]	[-.44;-.23]	[-.77;-.37]	[-.06;-.02]	[-.09;-.04]	[-.15;-.05]	
Mexico*	2.6	4.05	6.25	-3.64	-5.24	-8.34	6.24	9.29	14.57	.38
	[1.7;3.29]	[3.24;5.01]	[5.64;8.65]	[-4.68;-2.56]	[-6.62;-4.05]	[-11.46;-7.01]	[4.35;7.75]	[7.29;11.61]	[12.75;19.91]	
Morocco*	-.28	-.5	3.33	-.06	-.14	-3.87	-.22	-.35	7.2	1.12
	[-.41;-.29]	[-.65;-.52]	[2.37;4.15]	[-.12;.01]	[-.2;-.09]	[-5.07;-2.49]	[-.36;-.25]	[-.5;-.39]	[5.53;8.61]	
Netherlands	-.1	-.11	-.18	-.21	-.35	-.61	.11	.24	.43	.6
	[-.13;-.05]	[-.14;-.07]	[-.26;-.16]	[-.28;-.2]	[-.45;-.32]	[-.83;-.56]	[.12;.18]	[.23;.32]	[.39;.58]	
Norway*	-.07	-.22	-.38	-.32	-.38	-.45	.25	.17	.07	.3
	[-.11;-.01]	[-.27;-.14]	[-.49;-.34]	[-.44;-.32]	[-.57;-.32]	[-.7;-.46]	[.24;.41]	[.09;.4]	[.07;.26]	
Poland*	1.05	3.45	5.28	-1.82	-2.84	-4.32	2.87	6.28	9.6	.17
	[.6;1.38]	[3.1;4.02]	[5.23;6.99]	[-2.66;-.97]	[-3.85;-1.78]	[-6.58;-3.1]	[1.83;3.65]	[5.06;7.6]	[8.62;13.17]	
Portugal	1.73	1.59	1.42	-2.71	-2.8	-2.99	4.43	4.39	4.41	.03
	[1.71;3.44]	[1.63;3.24]	[1.45;2.95]	[-4.88;-2.75]	[-4.97;-2.79]	[-5.27;-2.97]	[4.84;7.97]	[4.81;7.86]	[4.81;7.88]	
ROW	-.21	-.39	-.58	-.1	-.18	-.28	-.11	-.21	-.3	0
	[-.28;-.2]	[-.49;-.36]	[-.82;-.53]	[-.13;-.09]	[-.24;-.14]	[-.4;-.22]	[-.16;-.12]	[-.26;-.2]	[-.42;-.29]	
Romania*	.25	2.89	3.86	-.21	-.44	-.81	.46	3.33	4.67	.2
	[.08;.34]	[2.3;3.48]	[3.49;4.65]	[-.39;-.04]	[-1.21;.34]	[-1.72;.22]	[.33;.53]	[2.6;3.89]	[3.94;5.69]	
S. Korea	-.24	-.41	-.62	-.13	-.25	-.39	-.1	-.16	-.24	0
	[-.32;-.21]	[-.53;-.35]	[-.89;-.54]	[-.18;-.11]	[-.32;-.19]	[-.55;-.31]	[-.14;-.09]	[-.21;-.15]	[-.34;-.23]	
Spain	.75	.69	.59	-1.58	-1.67	-1.87	2.33	2.36	2.45	.04
	[.57;1.51]	[.54;1.42]	[.44;1.25]	[-3.01;-1.31]	[-3.11;-1.38]	[-3.42;-1.55]	[1.99;4.37]	[2;4.38]	[2.08;4.5]	
Sweden	-.09	0	.87	-.37	-1.55	-3.17	.28	1.56	4.04	.4
	[-.15;-.03]	[-.6;.43]	[.13;1.54]	[-.52;-.37]	[-2.12;-1.07]	[-4.39;-2.59]	[.29;.42]	[.58;2.46]	[2.82;5.83]	
Switzerland*	.01	-.16	-.36	-.35	-.33	-.48	.37	.17	.12	.52
	[-.01;.1]	[-.22;-.06]	[-.46;-.3]	[-.45;-.37]	[-.48;-.31]	[-.72;-.5]	[.39;.51]	[.14;.4]	[.16;.32]	
Tunisia	-.31	2.92	3.63	-.09	-4	-5.92	-.21	6.92	9.55	1.03
	[-.42;-.3]	[1.96;4.01]	[2.71;4.71]	[-.14;-.03]	[-5.41;-2.43]	[-7.61;-4.25]	[-.32;-.24]	[5.28;8.48]	[7.83;11.49]	
Turkey*	.04	.11	.94	-.06	-1.45	-2.02	.1	1.57	2.97	.32
	[-.12;.13]	[-.41;.5]	[.55;1.52]	[-.17;.08]	[-2.09;-.83]	[-3.11;-1.09]	[-.04;.14]	[.93;2.09]	[2.18;4.05]	
UK	-.12	-.18	-.29	-.18	-.31	-.53	.07	.13	.24	.57
	[-.16;-.06]	[-.22;-.13]	[-.4;-.25]	[-.25;-.18]	[-.4;-.28]	[-.72;-.49]	[.06;.15]	[.13;.2]	[.22;.34]	
USA	.01	-.02	-.06	-.25	-.41	-.62	.26	.38	.56	.16
	[-.06;.04]	[-.08;0]	[-.09;-.01]	[-.31;-.22]	[-.5;-.35]	[-.81;-.53]	[.18;.33]	[.29;.47]	[.48;.77]	
Uruguay*	.86	2.4	2.99	-.77	-1.78	-2.8	1.63	4.18	5.79	.12
	[.53;1.05]	[2.03;2.88]	[2.83;4.27]	[-1.1;-.42]	[-2.39;-1.21]	[-3.89;-2.19]	[1.14;1.94]	[3.4;5.08]	[5.42;7.86]	

Notes:This table reports percentage changes in factory-gate prices, inward multilateral resistances and ToT indexes for each country and year in our sample. Country-level factory-gate prices are constructed as weighted averages across all country-commodity indexes with output shares used as weights. IMR's are aggregated from the country-commodity numbers with expenditure shares used as weights. ToT's are calculated as the difference between the corresponding effects on sellers (the factory-gate prices) and buyers (IMR's). 95% bootstrapped confidence intervals are reported in square brackets. The last column reports the ratio of potential tariff revenue losses to output gains due to FTAs. See text for further details.

Table 5: Global Efficiency Indexes, 1990-2002

	(1)	(2)	(3)
Sector Name	%Δ1994	%Δ1998	%Δ2002
Food	.114	.225	.359
	[.12;.16]	[.22;.3]	[.34;.55]
Textile	.746	1.38	2.092
	[.86;1.14]	[1.42;1.9]	[2.04;3.12]
Wood	.294	.377	.437
	[.03;.36]	[.02;.58]	[-.71;.71]
Paper	.298	.276	.42
	[.18;.41]	[.15;.4]	[.2;.72]
Chemicals	.278	.41	.685
	[.27;.37]	[.38;.56]	[.65;1.06]
Minerals	.108	.216	.336
	[.04;.11]	[.11;.26]	[.07;.46]
Metals	.21	.431	.757
	[.19;.29]	[.37;.55]	[.61;1.1]
Machinery	.377	.631	.982
	[.25;.57]	[.4;.91]	[.56;1.6]
Mnfctrng	.337	.558	.876
	[.26;.48]	[.41;.77]	[.63;1.34]

Notes:This table reports global efficiency measures for each sector and aggregate manufacturing numbers obtained from the country-commodity IMR's. 95% bootstrapped confidence intervals are reported in square brackets. See text for procedures used to obtain the efficiency indexes and the bootstrapped confidence intervals accompanying them.

Table 6: Modular vs. Full General Equilibrium Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Country	Factory-gate Prices			IMR's				ToT Effects			
	MTI	HTI	GETI	PEI	MTI	HTI	GETI	PEI	MTI	HTI	GETI
Argentina	.54	.41	.51	-1.45	-1.19	-1.23	-1.13	1.45	1.72	1.63	1.64
	[.43;.95]	[.34;.72]	[.42;.9]	[-2.09;-1.11]	[-1.73;-.8]	[-1.77;-.84]	[-1.65;-.71]	[1.11;2.09]	[1.52;2.39]	[1.39;2.27]	[1.41;2.29]
Australia	-.34	-.22	-.37	0	-.3	-.17	-.28	0	-.05	-.05	-.09
	[-.47;-.31]	[-.3;-.2]	[-.51;-.34]	[0;0]	[-.43;-.24]	[-.23;-.12]	[-.39;-.22]	[0;0]	[-.08;-.01]	[-.09;-.04]	[-.13;-.09]
Austria	2.17	1.68	1.92	-3.83	-3.6	-3.69	-3.52	3.83	5.76	5.37	5.44
	[1.24;3.14]	[.93;2.46]	[1.1;2.81]	[-5.44;-3]	[-5.16;-2.76]	[-5.24;-2.85]	[-4.99;-2.71]	[3;5.44]	[4.06;8.24]	[3.81;7.68]	[3.85;7.78]
Blgm-Lxmbrg	-.27	-.22	-.21	-.69	-.63	-.62	-.6	.69	.36	.4	.38
	[-.38;-.24]	[-.31;-.21]	[-.3;-.19]	[-.96;-.59]	[-.87;-.58]	[-.85;-.55]	[-.81;-.54]	[.59;.96]	[.29;.54]	[.32;.58]	[.3;.56]
Bolivia	.13	.03	.04	-4.74	-4.44	-4.5	-4.47	4.74	4.57	4.53	4.51
	[-.04;.52]	[-.06;.32]	[-.1;.41]	[-6.37;-4.65]	[-5.97;-4.4]	[-6.02;-4.45]	[-5.96;-4.41]	[4.65;6.37]	[4.56;6.24]	[4.49;6.17]	[4.48;6.16]
Brazil	-.18	-.1	-.1	-.43	-.42	-.38	-.37	.43	.23	.28	.27
	[-.54;-.05]	[-.34;-.02]	[-.42;.03]	[-.61;-.43]	[-.77;-.37]	[-.65;-.36]	[-.7;-.31]	[.43;.61]	[.18;.35]	[.24;.39]	[.22;.38]
Bulgaria	1.13	.75	1.02	-3.44	-3.36	-3.33	-3.1	3.44	4.48	4.08	4.11
	[.67;1.7]	[.4;1.16]	[.53;1.58]	[-4.19;-3.02]	[-4.27;-2.74]	[-4.2;-2.75]	[-4.01;-2.46]	[3.02;4.19]	[4.14;5.29]	[3.72;4.81]	[3.75;4.84]
Canada	4.56	3.51	4.04	-5.84	-4.37	-4.78	-4.41	5.84	8.93	8.28	8.44
	[3.21;6.62]	[2.4;5.15]	[2.73;5.9]	[-8.63;-4.7]	[-6.78;-2.96]	[-7.27;-3.44]	[-6.76;-3.25]	[4.7;8.63]	[6.34;13.32]	[5.95;12.37]	[6.09;12.58]
Chile	-2.13	-1.42	-1.67	-2.42	-3.62	-3.14	-3.27	2.42	1.49	1.71	1.6
	[-3.02;-2.22]	[-2.04;-1.49]	[-2.4;-1.73]	[-3.31;-2.39]	[-4.88;-3.83]	[-4.22;-3.28]	[-4.39;-3.43]	[2.39;3.31]	[1.38;2.01]	[1.62;2.29]	[1.49;2.13]
China	-.63	-.4	-.61	0	-.4	-.24	-.41	0	-.23	-.16	-.2
	[-.86;-.6]	[-.55;-.37]	[-.85;-.57]	[0;0]	[-.59;-.34]	[-.34;-.18]	[-.58;-.33]	[0;0]	[-.31;-.21]	[-.22;-.16]	[-.28;-.2]
Colombia	.19	.16	.24	-.27	-.06	-.07	-.01	.27	.25	.23	.25
	[.03;.23]	[.07;.2]	[.09;.31]	[-.35;-.21]	[-.18;-.02]	[-.14;-.01]	[-.12;.07]	[.21;.35]	[.16;.3]	[.14;.27]	[.15;.29]
Costa Rica	-.48	-.36	-.25	-.4	-.53	-.46	-.38	.4	.05	.1	.13
	[-.66;-.44]	[-.51;-.35]	[-.41;-.22]	[-.47;-.35]	[-.67;-.5]	[-.57;-.42]	[-.47;-.33]	[.35;.47]	[-.04;.09]	[0;.11]	[.01;.15]
Denmark	-.17	-.1	-.13	-1.06	-1	-.98	-.97	1.06	.84	.88	.83
	[-.31;-.08]	[-.2;-.05]	[-.26;-.06]	[-1.45;-1.05]	[-1.34;-.94]	[-1.3;-.94]	[-1.28;-.94]	[1.05;1.45]	[.78;1.11]	[.83;1.16]	[.78;1.11]
Ecuador	-3.72	-2.5	-3.15	-3.42	-5	-4.38	-4.66	3.42	1.27	1.89	1.51
	[-4.89;-3.9]	[-3.35;-2.63]	[-4.21;-3.3]	[-4.54;-3.46]	[-6.47;-5.24]	[-5.7;-4.57]	[-6.05;-4.9]	[3.46;4.54]	[.91;1.89]	[1.61;2.56]	[1.17;2.13]
Finland	1.68	1.2	1.4	-3.11	-2.21	-2.49	-2.37	3.11	3.89	3.69	3.76
	[1.01;2.7]	[.68;1.96]	[.79;2.28]	[-4.5;-2.48]	[-3.44;-1.48]	[-3.74;-1.75]	[-3.58;-1.7]	[2.48;4.5]	[2.84;5.93]	[2.72;5.57]	[2.78;5.68]
France	-.27	-.23	-.23	-.6	-.59	-.58	-.57	.6	.32	.35	.34
	[-.36;-.23]	[-.3;-.2]	[-.3;-.2]	[-.85;-.56]	[-.83;-.55]	[-.8;-.54]	[-.78;-.52]	[.56;.85]	[.3;.49]	[.32;.52]	[.31;.5]
Germany	-.14	-.12	-.08	-.95	-.72	-.74	-.71	.95	.58	.62	.62
	[-.23;-.11]	[-.18;-.11]	[-.15;-.05]	[-1.29;-.85]	[-.98;-.67]	[-.99;-.68]	[-.94;-.65]	[.85;1.29]	[.54;.79]	[.57;.83]	[.56;.84]
Greece	-.71	-.58	-.66	-.83	-.94	-.9	-.9	.83	.22	.31	.24
	[-.93;-.71]	[-.77;-.58]	[-.86;-.66]	[-1.1;-.7]	[-1.25;-.82]	[-1.18;-.78]	[-1.18;-.78]	[.7;1.1]	[.06;.36]	[.15;.45]	[.07;.36]
Hungary	3.59	2.56	3.02	-5.96	-4.29	-4.73	-4.44	5.96	7.88	7.29	7.46
	[3.7;5.29]	[2.63;3.85]	[3.06;4.5]	[-8.47;-5.21]	[-6.43;-3.07]	[-6.95;-3.65]	[-6.62;-3.25]	[5.21;8.47]	[7.75;10.94]	[7.06;10.17]	[7.24;10.37]
Iceland	-.86	-.58	-.69	-.52	-.77	-.65	-.67	.52	-.1	.07	-.02
	[-1.11;-.82]	[-.74;-.56]	[-.89;-.66]	[-.75;-.5]	[-1.03;-.72]	[-.87;-.61]	[-.89;-.61]	[.5;.75]	[-.2;.04]	[0;.19]	[-.1;.09]
Ireland	-.37	-.24	-.3	-.21	-.47	-.37	-.4	.21	.09	.13	.11
	[-.54;-.36]	[-.34;-.22]	[-.43;-.28]	[-.3;-.2]	[-.65;-.43]	[-.5;-.33]	[-.55;-.37]	[.2;.3]	[.05;.14]	[.1;.18]	[.07;.15]
Israel	.86	.67	.81	-2.12	-1.89	-1.92	-1.82	2.12	2.75	2.59	2.63
	[.8;1.56]	[.61;1.19]	[.74;1.44]	[-2.95;-1.84]	[-2.56;-1.52]	[-2.61;-1.57]	[-2.46;-1.47]	[1.84;2.95]	[2.43;3.97]	[2.26;3.72]	[2.31;3.8]

Continued

Table 6 – continued from previous page

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Country	Factory-gate Prices			IMR's				ToT Effects			
	MTI	HTI	GETI	PEI	MTI	HTI	GETI	PEI	MTI	HTI	GETI
Italy	-.36	-.3	-.29	-.61	-.65	-.62	-.6	.61	.3	.32	.31
	[-.48;-.34]	[-.39;-.29]	[-.39;-.28]	[-.86;-.54]	[-.91;-.61]	[-.85;-.57]	[-.82;-.55]	[.54;.86]	[.25;.46]	[.26;.47]	[.24;.45]
Japan	-.57	-.36	-.59	0	-.48	-.28	-.51	0	-.09	-.08	-.09
	[-.88;-.43]	[-.56;-.25]	[-.92;-.43]	[0;0]	[-.74;-.39]	[-.42;-.19]	[-.77;-.37]	[0;0]	[-.15;-.04]	[-.14;-.05]	[-.15;-.05]
Mexico	7.15	5.57	6.25	-9.97	-8.34	-8.7	-8.34	9.97	15.47	14.26	14.57
	[6.56;9.92]	[5.07;7.75]	[5.64;8.65]	[-13.55;-8.73]	[-11.53;-6.84]	[-11.97;-7.26]	[-11.46;-7.01]	[8.73;13.55]	[13.59;21.18]	[12.44;19.52]	[12.75;19.91]
Morocco	3.66	2.79	3.33	-4.43	-4.15	-4.18	-3.87	4.43	7.81	6.97	7.2
	[2.55;4.58]	[1.95;3.49]	[2.37;4.15]	[-5.59;-3.06]	[-5.4;-2.82]	[-5.37;-2.83]	[-5.07;-2.49]	[3.06;5.59]	[6.07;9.35]	[5.3;8.35]	[5.53;8.61]
Netherlands	-.22	-.16	-.18	-.68	-.63	-.63	-.61	.68	.41	.46	.43
	[-.32;-.21]	[-.24;-.15]	[-.26;-.16]	[-.94;-.64]	[-.87;-.58]	[-.85;-.58]	[-.83;-.56]	[.64;.94]	[.36;.56]	[.42;.63]	[.39;.58]
Norway	-.51	-.35	-.38	-.51	-.52	-.45	-.45	.51	.01	.1	.07
	[-.66;-.46]	[-.44;-.31]	[-.49;-.34]	[-.82;-.54]	[-.79;-.53]	[-.69;-.46]	[-.7;-.46]	[.54;.82]	[0;.21]	[.1;.3]	[.07;.26]
Poland	6.17	4.56	5.28	-6.49	-4.2	-4.79	-4.32	6.49	10.36	9.34	9.6
	[6.2;8.21]	[4.54;6.1]	[5.23;6.99]	[-9.27;-5.46]	[-6.42;-2.93]	[-7.12;-3.63]	[-6.58;-3.1]	[5.46;9.27]	[9.41;14.17]	[8.34;12.86]	[8.62;13.17]
Portugal	1.53	1.17	1.42	-3.14	-3.17	-3.16	-2.99	3.14	4.7	4.33	4.41
	[1.56;3.16]	[1.21;2.45]	[1.45;2.95]	[-5.58;-3.08]	[-5.61;-3.22]	[-5.57;-3.18]	[-5.27;-2.97]	[3.08;5.58]	[5.12;8.41]	[4.74;7.72]	[4.81;7.88]
ROW	-.59	-.44	-.58	0	-.3	-.18	-.28	0	-.29	-.26	-.3
	[-.82;-.55]	[-.62;-.41]	[-.82;-.53]	[0;0]	[-.45;-.25]	[-.27;-.14]	[-.4;-.22]	[0;0]	[-.38;-.27]	[-.35;-.24]	[-.42;-.29]
Romania	4.53	3.04	3.86	-2.94	-.72	-1.44	-.81	2.94	5.25	4.48	4.67
	[4.18;5.42]	[2.75;3.69]	[3.49;4.65]	[-3.79;-2.18]	[-1.58;.24]	[-2.28;-.5]	[-1.72;.22]	[2.18;3.79]	[4.52;6.36]	[3.72;5.48]	[3.94;5.69]
S. Korea	-.66	-.46	-.62	0	-.4	-.25	-.39	0	-.26	-.21	-.24
	[-.93;-.59]	[-.66;-.4]	[-.89;-.54]	[0;0]	[-.58;-.33]	[-.36;-.19]	[-.55;-.31]	[0;0]	[-.35;-.25]	[-.3;-.2]	[-.34;-.23]
Spain	.65	.45	.59	-2.2	-1.87	-1.97	-1.87	2.2	2.52	2.41	2.45
	[.53;1.4]	[.32;.98]	[.44;1.25]	[-3.95;-1.96]	[-3.47;-1.52]	[-3.59;-1.64]	[-3.42;-1.55]	[1.96;3.95]	[2.16;4.62]	[2.05;4.42]	[2.08;4.5]
Sweden	.9	.77	.87	-3.33	-3.27	-3.25	-3.17	3.33	4.17	4.01	4.04
	[.05;1.64]	[.1;1.36]	[.13;1.54]	[-4.63;-2.72]	[-4.54;-2.68]	[-4.5;-2.64]	[-4.39;-2.59]	[2.72;4.63]	[2.83;6.09]	[2.81;5.79]	[2.82;5.83]
Switzerland	-.47	-.36	-.36	-.42	-.56	-.49	-.48	.42	.09	.13	.12
	[-.6;-.39]	[-.46;-.31]	[-.46;-.3]	[-.64;-.44]	[-.84;-.58]	[-.74;-.52]	[-.72;-.5]	[.44;.64]	[.13;.31]	[.17;.33]	[.16;.32]
Tunisia	3.88	2.91	3.63	-6.17	-6.4	-6.32	-5.92	6.17	10.28	9.23	9.55
	[2.93;5.05]	[2.17;3.78]	[2.71;4.71]	[-7.79;-4.62]	[-8.14;-4.67]	[-8.01;-4.63]	[-7.61;-4.25]	[4.62;7.79]	[8.47;12.41]	[7.48;11.12]	[7.83;11.49]
Turkey	.98	.69	.94	-2.37	-2.19	-2.2	-2.02	2.37	3.16	2.89	2.97
	[.57;1.63]	[.39;1.14]	[.55;1.52]	[-3.45;-1.53]	[-3.3;-1.2]	[-3.29;-1.28]	[-3.11;-1.09]	[1.53;3.45]	[2.39;4.32]	[2.1;3.95]	[2.18;4.05]
UK	-.33	-.26	-.29	-.47	-.56	-.51	-.53	.47	.23	.26	.24
	[-.45;-.28]	[-.36;-.23]	[-.4;-.25]	[-.67;-.44]	[-.78;-.52]	[-.7;-.47]	[-.72;-.49]	[.44;.67]	[.22;.34]	[.24;.36]	[.22;.34]
USA	-.13	-.15	-.06	-.87	-.66	-.7	-.62	.87	.53	.55	.56
	[-.19;-.09]	[-.21;-.11]	[-.09;-.01]	[-1.25;-.64]	[-.89;-.59]	[-.95;-.59]	[-.81;-.53]	[.64;1.25]	[.48;.74]	[.48;.75]	[.48;.77]
Uruguay	3.35	2.64	2.99	-4.28	-2.72	-3.02	-2.8	4.28	6.06	5.66	5.79
	[3.2;4.76]	[2.52;3.79]	[2.83;4.27]	[-5.85;-3.77]	[-3.8;-2.13]	[-4.16;-2.42]	[-3.89;-2.19]	[3.77;5.85]	[5.75;8.24]	[5.28;7.68]	[5.42;7.86]

Notes: This table compares the effects of FTAs from four scenarios. Columns labeled GETI reproduce our main results from Table 4, which capture the General Equilibrium Impact of FTAs. Columns labeled PEI estimate the Partial Equilibrium Impact of FTAs. Columns labeled MTI estimate the Modular Trade Impact of FTAs, where output and expenditure are exogenous. Results in columns labeled HTI are hybrid between the MTI and the GETI estimates. HTI results are obtained with endogenous output and exogenous expenditure. 95% bootstrapped confidence intervals are reported in square brackets. See text for further details.

Table 7: Counterfactual FTA Experiments

	(1)	(2)	(3)
Country	All FTAs	No NAFTA	No FTAs Mexico
Argentina	1.64	1.73	1.55
	[1.41;2.29]	[1.54;2.41]	[1.35;2.18]
Australia	-.09	-.07	-.06
	[-.13;-.09]	[-.1;-.07]	[-.08;-.05]
Austria	5.44	5.46	5.47
	[3.85;7.78]	[3.89;7.8]	[3.9;7.82]
Blgm-Lxmbrg	.38	.41	.4
	[.3;.56]	[.34;.59]	[.34;.6]
Bolivia	4.51	4.62	4.39
	[4.48;6.16]	[4.61;6.32]	[4.37;6.03]
Brazil	.27	.34	.26
	[.22;.38]	[.3;.47]	[.24;.37]
Bulgaria	4.11	4.12	4.13
	[3.75;4.84]	[3.79;4.86]	[3.81;4.87]
Canada	8.44	3.66	3.68
	[6.09;12.58]	[1.81;5.44]	[1.83;5.47]
Chile	1.6	1.69	1.46
	[1.49;2.13]	[1.57;2.25]	[1.37;1.98]
China	-.2	-.15	-.13
	[-.28;-.2]	[-.21;-.15]	[-.18;-.13]
Colombia	.25	.4	.13
	[.15;.29]	[.33;.5]	[.11;.19]
Costa Rica	.13	.29	-.12
	[.01;.15]	[.22;.35]	[-.18;-.1]
Denmark	.83	.83	.84
	[.78;1.11]	[.77;1.11]	[.79;1.14]
Ecuador	1.51	1.58	1.38
	[1.17;2.13]	[1.25;2.21]	[1.05;1.98]
Finland	3.76	3.77	3.78
	[2.78;5.68]	[2.79;5.68]	[2.81;5.7]
France	.34	.36	.36
	[.31;.5]	[.34;.53]	[.35;.55]
Germany	.62	.65	.65
	[.56;.84]	[.59;.88]	[.6;.89]
Greece	.24	.26	.26
	[.07;.36]	[.13;.37]	[.14;.39]
Hungary	7.46	7.46	7.48
	[7.24;10.37]	[7.27;10.36]	[7.29;10.4]
Iceland	-.02	-.02	-.01
	[-.1;.09]	[-.07;.07]	[-.05;.1]
Ireland	.11	.12	.12
	[.07;.15]	[.09;.15]	[.1;.17]
Israel	2.63	2.67	2.68
	[2.31;3.8]	[2.35;3.83]	[2.37;3.85]
Italy	.31	.35	.35
	[.24;.45]	[.3;.5]	[.31;.52]
Japan	-.09	-.06	-.05
	[-.15;-.05]	[-.1;-.03]	[-.09;-.01]
Mexico	14.57	1.66	-.18
	[12.75;19.91]	[1.36;2.13]	[-.27;-.1]
Morocco	7.2	7.22	7.21
	[5.53;8.61]	[5.53;8.63]	[5.54;8.63]
Netherlands	.43	.43	.45

Continued

Table 7 – continued from previous page

	(1)	(2)	(3)
Country	All FTAs	No NAFTA	No FTAs Mexico
	[.39;.58]	[.4;.59]	[.41;.61]
Norway	.07	.07	.09
	[.07;.26]	[.07;.26]	[.09;.28]
Poland	9.6	9.61	9.62
	[8.62;13.17]	[8.65;13.17]	[8.67;13.2]
Portugal	4.41	4.44	4.45
	[4.81;7.88]	[4.86;7.92]	[4.86;7.93]
ROW	-.3	-.23	-.21
	[-.42;-.29]	[-.33;-.22]	[-.29;-.19]
Romania	4.67	4.69	4.71
	[3.94;5.69]	[3.97;5.71]	[3.98;5.74]
S. Korea	-.24	-.16	-.13
	[-.34;-.23]	[-.23;-.14]	[-.19;-.11]
Spain	2.45	2.47	2.45
	[2.08;4.5]	[2.12;4.52]	[2.1;4.51]
Sweden	4.04	4.07	4.07
	[2.82;5.83]	[2.86;5.87]	[2.86;5.89]
Switzerland	.12	.15	.14
	[.16;.32]	[.2;.36]	[.19;.37]
Tunisia	9.55	9.62	9.63
	[7.83;11.49]	[7.92;11.53]	[7.96;11.58]
Turkey	2.97	3	3.01
	[2.18;4.05]	[2.22;4.08]	[2.24;4.11]
UK	.24	.27	.28
	[.22;.34]	[.26;.38]	[.26;.4]
USA	.56	.17	.19
	[.48;.77]	[.1;.24]	[.13;.27]
Uruguay	5.79	5.95	5.57
	[5.42;7.86]	[5.63;8.08]	[5.21;7.59]

Notes:The indexes in this table are aggregate country-level ToT effects. The numbers in column 1 account for the presence of all FTAs. The numbers in column 2 are constructed as if there was no NAFTA. The indexes in the third column are calculated as if Mexico was not involved in any FTA during the 90s. 95% bootstrapped confidence intervals are reported in square brackets. See text for further details.

5 Technical Appendix: Embedment

Manufactures are intermediate goods produced and used in a convex technology. The maximum value GDP function is given by $g(\pi, \mathbf{p}, C, v)$ for a generic country, where π denotes the tradable goods price vector for non-manufactures, v denotes the primary factor vector, $\mathbf{p}$ denotes the marginal cost vector for producing another unit of each manufactured good and C denotes the input buyers' price index of manufactured goods. National production of manufactures is frozen at the vector $\mathbf{q}$. The GDP of the unconstrained part of the economy subject to the quantity constraint is $\widetilde{g}(\pi, \mathbf{q}, C, v) \equiv \min_{\mathbf{p}} g(\pi, \mathbf{p}, C, v) - \mathbf{pq}$.[47] Then GDP is equal to

$$g^*(\pi, \mathbf{q}, C, v; \mathbf{p}^*) = \mathbf{p}^*\mathbf{q} + \widetilde{g}(\pi, \mathbf{q}, C, v) \tag{24}$$

where the market sellers price vector $\mathbf{p}^*$ is used to value manufacturing output, $\mathbf{p}^* \neq \mathbf{p} = -\widetilde{g}_{\mathbf{q}}$. By construction, $g^*_{\mathbf{p}^*} = \mathbf{q}$, hence changes in sellers' prices alter GDP by $\mathbf{q}d\mathbf{p}^*$.

A change in buyers' prices alters GDP by $-g^*_C dC$. The change in GDP due to FTA-induced price changes is given by $\mathbf{q}d\mathbf{p}^* - g^*_C dC$ the local change in real manufacturing income. In percentage terms this is the initial manufacturing income times the percentage change in terms of trade. Our application extends to discrete changes but the intuition is the same.

A closure assumption relates aggregate manufactures input expenditure $-g^*_C C$ to sales $\mathbf{p}^*\mathbf{q}$ as a constant ratio that can differ by country. This assumption avoids a full general equilibrium treatment, and is valid if (i) manufactures inputs are a constant proportion of GDP, and (ii) the non-manufactures portion of GDP rises in proportion to the manufactures portion of GDP under FTA implementation.[48]

Potential bias in our terms of trade measures due to the fixed supply assumption is ambiguous. On the one hand, the value of a marginal change in the quantity constraint is $\mathbf{p}^* + \widetilde{g}_{\mathbf{q}} = \mathbf{p}^* - \mathbf{p}$, the market sellers' price vector minus the marginal cost vector. The constant quantity assumption of our approach omits the value of quantity changes $(\mathbf{p}^* - \mathbf{p})d\mathbf{q} \geq 0$ where the sign follows from maximization. On the other hand, the implied changes in production will increase supply where $p_i^{*k} - p_i^k > 0$ and hence tend to lower the market equilibrium p_i^{*k}. The net effect of suppressing substitution in supply between the manufacturing sectors and between manufacturing and non-manufacturing is ambiguous on this reasoning.

The closure assumption suggests a further potential bias due to an omitted multiplier effect of intermediate goods linkages between manufacturing and non-manufacturing output. A fall in input prices could lower non-manufacturing prices that serve as inputs to manufactures. Caliendo and Parro's NAFTA exercise argues that intermediate linkages raise trade and welfare estimates by some 40%.[49] Our results do not appear to be sensitive to the closure assumption, as explained below.

g^* is specialized in the application to yield 2 stage Cobb-Douglas/CES manufactures input demand, applying Shephard's Lemma. Within each sector the input demand for

[47] Quantity constrained GDP and expenditure functions are analyzed in Anderson and Neary (1992).

[48] The second part of the assumption is that $\widetilde{g}_\pi \pi$ rises proportionately to $\mathbf{p}^*\mathbf{q}$. The first part of the assumption is that $-g^*_C C/g^*$ is constant. Since g^* is homogeneous of degree 1 in $\pi, C, \mathbf{p}^*$, the ratio $g^*_C C/\mathbf{p}^*\mathbf{q}$ is constant.

[49] The difficulties facing more elaborate CGE studies prominently include very inaccurate information on the actual end users of imported intermediate goods based on a distribution of imports in proportion to the distribution of domestic shipments across sectors.

manufactures is spread across national varieties, derived (using Shephard's Lemma) from a Constant Elasticity of Substitution (CES) cost function for sector k. The aggregate input quantity index is $-g_C^*$, a Cobb-Douglas aggregate of CES sectoral aggregates.

Terms of trade changes affect GDP as follows. Differentiate GDP given by equation (24) with respect to the manufacturing prices, suppress the country subscript to reduce notational clutter, and apply Hotelling's and Shephard's Lemmas. The proportional rate of change of GDP is

$$\hat{g}* = \frac{\sum_k Y^k}{g^*}[\sum_k w^k \hat{p}^{*k} - \sum_k \omega^k \hat{P}^k] + \frac{\sum_k (E^k - Y^k)}{g^*} \sum_k \omega^k \hat{P}^k,$$

where $w^k = Y^k / \sum_k Y^k$ and $\omega^k = E^k / \sum_k E^k$. The square bracket term on the right hand side is the percentage change in the terms of trade. It is multiplied by the importance of manufacturing in GDP, a scaling factor held constant for each country. The second term on the right is equal to zero under balanced trade. While this is not generally true for any subset of sectors, the normal convention is to impose it when all sectors are included, so we suppress this term in our treatment. Equation (13) follows by integrating the square bracket under the restrictions of fixed q's and the Cobb-Douglas cost function C with input expenditure shares parameterized as $\alpha_k = \omega^k$.