The Effect of WTO on the Extensive and the Intensive Margins of Trade

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Abstract
We use 6-digit bilateral trade data to document the effect of WTO/GATT membership on the extensive and intensive product margins of trade. We construct gravity equations for the two product margins where the specifications of these gravity equations are motivated by a Melitz-Chaney model. The empirical results show that standard gravity variables provide good explanatory power for bilateral trade on both margins. Importantly, we show that the impact of the WTO is concentrated almost exclusively on the extensive product margin of trade, i.e. trade in goods that were not previously traded. In our preferred specification, WTO membership increases the extensive margin of exports by 25%. At the same time, WTO membership has a negative impact on the intensive margin. Our results suggest that WTO membership works as reducing the fixed rather than the variable costs of trade

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1. Introduction

Since its inception in 1948, the General Agreement on Tariffs and Trade (GATT) has formulated and implemented the rules of world trade. The biggest overhaul of trading rules took place in the 1980s through the Uruguay Round of talks, and eventually led to the creation of the World Trade Organization in 1995. The agenda of GATT/WTO has been to promote trade, reduce trade barriers through rounds of trade talks, and provide a venue for settling trade disputes.

However, its raison d'être as the promoter of world trade was cast in doubt by a seminal paper by Rose (2004a), who found a negligible impact of WTO membership on the volume of bilateral trade flows. That paper spawned multiple follow-up attempts to validate or overturn Rose's surprising result. For instance, Subramanian and Wei (2007) show that the impact of GATT/WTO depends on what the country does with its membership, with whom it negotiates, and which products the negotiation

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covers. Developing countries (e.g., India) enjoyed special exemptions in particular sectors (e.g., textiles) from the liberalization of trade; once these exceptions are accounted for, the WTO does promote trade. Tomz et al. (2007) argue that many countries are mistakenly classified as outside the GATT, even though they were de facto members with similar rights and obligations. They show that not counting such countries as GATT members systematically underestimates the effect of GATT on trade flows. Liu (2009) highlights the sample selection bias in the traditional gravity formulation: many country pairs exhibit zero trade, which the traditional formulation ignores by examining only strictly positive trade flows. Accounting for this, he finds a strong role for the WTO in initiating trade between non-trading countries—the so-called partner-level extensive margin of trade, as opposed to the partner-level intensive margin (increases in trade between partners that already trade with one another). Felbermayr and Kohler (2006) also emphasize the decomposition of the expansion of trade into partner-level extensive and intensive margins.[1] Helpman et al. (2008) argue that the puzzle is reconciled with an accurate theory-driven specification of the gravity equation. Using unidirectional trade data along with exporter and importer fixed effects reveals a statistically significant positive effect of WTO membership on trade volumes. Eicher and Henn (2011) argue the opposite—that accounting for multilateral trade resistance terms via time-varying exporter and importer fixed effects suffices to negate WTO trade effects.[2]

Even if we believe that the WTO raises trade volumes, there still remains the question whether the effect of the WTO is through the liberalization of trade policies. Once again, Rose (2004b) questions this by showing that few if any measures of trade policy significantly correlated with WTO membership, that trade liberalization lags WTO entry by many years, and that membership imposed few trade policy changes amongst many members, especially developing countries who remained closed to trade for years following GATT/WTO membership. In contrast, Bagwell and Staiger (2001) argue that GATT/WTO is not merely about tariff concessions and rules for tariff policies. Rather, "the central purpose of WTO rules is to create a negotiating forum where member governments can voluntarily exchange market access commitments, with the assurance that the property rights over negotiated market access commitments are secure against unilateral government infringement." In other words, GATT/WTO membership provides assurance of market access, that once foreign products enter a domestic market they will be accorded the same treatment as domestic markets and most importantly, governments will not take policy actions to undermine the promised market access. From this perspective, WTO

1. Throughout this paper, the terms "extensive margin" and "intensive margin", when used without a qualifier, refer to the product-level margins.

2. They question the hierarchical coding of trade preferences in Subramanian and Wei (2007) attributes all trade creation to preferential trading arrangements (PTA). That is, if a country-pair are members of both a PTA and members of the WTO, the PTA dummy takes the value 1 while the WTO dummy takes the value 0.

membership creates certainty about market access and is more akin to a reduction in the fixed costs of trade.

Our paper attempts to distinguish between these alternate roles of the WTO by examining the effect of WTO membership on the extensive and intensive margins of trade. In recent years, theoretical models of trade have emphasized firm-level productivity differences in trade patterns (the so-called new-new trade theory). These models arose out of empirical work showing striking firm-level differences in trading behavior. The data show that only a few firms export; among exporters, only a few firms export to more than a few countries; and most exporters only sell a small fraction of their output abroad. Moreover, exporting behavior is positively associated with productivity and size. (See Bernard and Jensen 1995, 1999, 2004; Clerides et al. 1998; Aw et al. 2000; Eaton et al. 2004.) Incorporating such firm-level heterogeneity into trade models leads first of all to a decomposition of trade expansion into an increase in export volume by firms that are already exporters (the firm-level intensive margin) and the entry of new firms into the export market (the firm-level extensive margin). When firms produce differentiated products, these firm-level margins translate into product-level margins. Second, multiple theoretical papers have then analyzed the consequences of trade liberalization, in terms of reduction of fixed and variable costs of trade, on these margins (Eaton and Kortum 2002; Melitz 2003; Bernard et al. 2003; Chaney 2008). By examining the effect of WTO membership on these margins, we are able to evaluate whether the WTO works via a reduction in fixed costs or variable costs of trade.

In our paper, we set up a simple Melitz/Chaney model which predicts how the extensive and intensive margins are affected by reduction in variable and fixed costs of trade. Next, we use COMTRADE HS-6 data to decompose the total volume of trade into the extensive and intensive product margin and examine how membership in the GATT/WTO influences these two margins of trade. We do this decomposition, while accounting for the zeros in the bilateral trade matrices (zero trade between partners) which leads to a sample selection bias and a heterogeneity bias as emphasized by Helpman et al. (2008).

We begin, in Section 2, by taking a first look at the data and decompose the evolution of the volume of world trade into changes in the extensive product margin (the rise in trade in new products) and changes in the intensive product margin (rise in trade volume of goods that were traded at the beginning of the sample period). In Section 3, we perform two decompositions of the traditional gravity equation into an extensive and intensive product margin. The first one simply decomposes the volume of bilateral exports into the number of products multiplied by average export per product (see Hillberry and Hummels 2008; Bernard et al. 2007). The second follows the methodology of Feenstra and Kee (2008). The Feenstra-Kee extensive margin of exports for a country pair measures the fraction of goods sold by the exporter in the destination but weights each product by its importance in world exports to this destination, averaged over time. The Feenstra-Kee intensive margin is the market share of the exporter in the importer's total spending on the products the exporter sells there. The volume of bilateral exports equals the product of the two margins as a fraction of

total imports in the destination country. Section 4 details the data sources and describes the other independent variables commonly used in the gravity equation specification.

In Section 5, across gravity-based specifications for these margins, we show that the effect of WTO membership is mainly along the extensive product margin. In the most demanding specification (with time-varying importer and exporter fixed effects and country-pair effects) we find that the WTO raises the extensive margin by 25%. In contrast, regardless of the specification, WTO has a negative impact on the intensive margin of exports, reducing the intensive margin by 7%. This suggests that WTO membership works through an introduction of the fixed costs of trade rather than variable costs. We also find that the gravity specification is a good fit for explaining variations in the two margins, accounting for more than 75% of the variation in the margins in the most demanding specification.

Our paper makes three contributions. First, it shows that the effect of WTO membership is mainly on the extensive margin and that it reduces the intensive margin. Broda et al. (2006) show that the extensive margin and the rise in imports of new varieties is responsible for important increases in productivity growth. The WTO, by facilitating such trade, has potentially large welfare effects. Second, our empirical results allows us to understand how well the theoretical predictions of the various new-new trade models are borne out in data that spans close to 100% of world trade. Finally, our decomposition allows us to evaluate how well the traditional gravity specification holds up in the data for the extensive and intensive margins.

2. A First Look at the Data

2.1. Evolution of Trade

We start with some descriptive evidence by plotting the evolution of world trade over time and then decomposing the volume of trade into extensive and intensive margins, similar to the decomposition in Helpman et al. (2008). Helpman et al. (2008) show the decomposition for the extensive partner margin (the rise of trade between new partners) rather than the extensive product margin (the rise of trade in new products). To ensure that we have sufficient coverage over time and across countries, we use data from the World Trade Flows Database (Feenstra et al. 2005). This database contains information on bilateral exports for more than 150 countries over the period 1962–1999. The data are based on the 4-digit Standard International Trade Classification, revision 2, with 790 4-digit categories and accounts for 98 percent of all world trade.[3] While these data are available only at a higher level of aggregation (compared to more recent data from UNCTAD), they are available over a longer time frame, which helps in the identification of trends in these series. We use these data mainly for graphical depictions of the evolution of the extensive and intensive margins, over time.

3. Some trade gets classified at the 3-digit level but cannot be classified at the 4-digit level. We drop such trade. However, assigning it to fictitious sub-categories does not qualitatively affect our results.

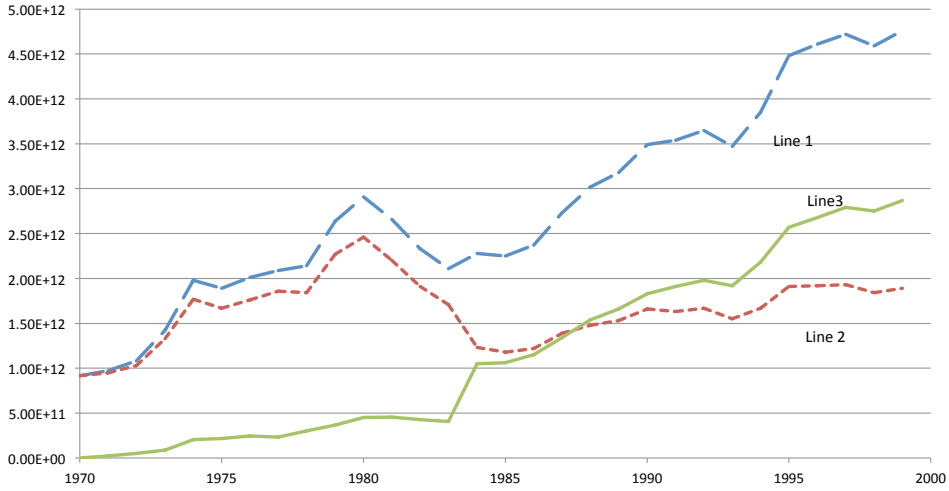

FIGURE 1. Intensive and extensive product margins from 1970 to 1999 for countries pairs that already traded in 1970. Line 1 (blue) shows total real exports. This is then divided between exports in sectors in which pairs already traded in 1970 (line 2, orange) and amounts in new sectors (line 3, green).

Line 1 on Figure 1 shows the aggregate real volume of exports of the set of country pairs that had positive exports prior to 1970. Line 2 shows the evolution of trade volume between these country pairs in sectors where there was positive trade prior to 1970. We can think of this as the intensive margin of trade. The difference (plotted as line 3) shows the evolution of trade in sectors where there was zero trade at the beginning of the period within the set of countries that traded with each other prior to 1970.[4] Line 3 captures the evolution of the extensive margin of trade. Figure 1 strongly suggests that from the 1980s onwards, trade in sectors that these countries already had positive trade in 1970 remains relatively flat. At the same time, the growth in the overall trade volume is closely mirrored by the expansion of trade in new products. In fact, more than half of trade increase is in goods that were not traded in 1970. This at least suggests, that the extensive margin of trade has been relatively a much more significant contributor to the expansion in trade volumes rather than the intensive margin.[5]

4. In order to ensure that our results are not driven by the choice of initial year, we used the union of partners and sectors that had strictly positive trade at any time between 1962 and 1970.

5. The World Trade Flows Database has a significant discontinuity in 1984 where there was a change in the product classification system. This is responsible for the sharp increase around 1984 shown by the extensive margin (line 3) in Figure 1. Even when we confine the sample period to 1984–1999, the importance of the extensive margin stands out.

3. Extensive and Intensive Margins of Exports

Our basic measure of extensive and intensive margin corresponds exactly to the specification in a simplified Melitz/Chaney monopolistic competition model with firm-heterogeneity in productivity. This model, which we briefly outline in Appendix A, is used to construct the gravity equation for the two margins of trade. Trade volume reflects an extensive margin (number of sectors/goods traded) and an intensive one (volume of trade per product/sector). As shown in the Appendix, a decrease in either the fixed or variable bilateral costs of trade, leads to entry of new exporters raising the extensive margin of trade. Reduction in variable trade barriers has two effects on the exports per firm (our definition of intensive margin). First, it raises the exports of existing exporters, which raises average export per firm. Second, by permitting entry of new small exporters, it reduces the average export per firm. The net effect is ambiguous. These two effects cancel out when productivities are Pareto distributed so that variable trade costs do not affect the average export per product. Reduction in fixed costs does not affect exports of existing firms but reduces average export per firm by bringing in new small exporters so that there is a positive relationship between fixed costs of trade and the intensive margin.

Our main measure of the bilateral extensive margin is simply a count of the number of products exported from country o to country d at time t. The bilateral intensive margin is defined as the exports per product. This permits a natural and easily interpretable decomposition of the overall volume of bilateral exports $X_{ni}(t)$ to destination n from exporter i at time t as

$$X_{od,t} = N_{od,t} * \overline{x}_{od,t}$$

the product of the extensive $\left(N_{od,t}\right)$ and the intensive margins $\left(\overline{x}_{od,t}\right)$. Since the gravity specification is always implemented in terms of the natural log of trade volumes, the sum of the logged margins will equal the log of the aggregate bilateral exports. Moreover, the sum of the estimated coefficients for the two margins of any independent variable will equal the coefficient on that variable in a standard gravity specification, with total bilateral exports as the dependent variable. In our dataset, the extensive margin in terms of number of products, is the highest between US and Canada, with the US exporting 4930 products to Canada in the year 1994. For this country-pair–year, we observe positive exports in 98% of all 5017 HS-6 product categories. We also observe that 70% of all bilateral exports span less than 100 categories amongst all country pairs that exhibit strictly positive exports. However, once we take into account that 40% of all country pairs exhibit zero exports, we find that 90% of all bilateral exports are in less than 100 categories amongst all country pairs in the world. In terms of the intensive margin, we observe the highest intensive margins for oil exporters such as Angola, Iran, Iraq, Libya and Saudi Arabia.

Following Hummels and Klenow (2005); Feenstra and Kee (2008), we construct an alternate measure of extensive and intensive margin of exports.[6] The measure is very similar to the simple count and export per product measure except that these are weighted measures with weights constructed on the basis of a consistent comparison country. Following Feenstra and Kee (2008) we shall use the worldwide exports from all countries to the destination as the comparison, denoting the world as W. Furthermore, we use constant weights. In destination d we take the union of all products sold in any year, and average real export sales of each product over years. Define the set $J_{dW} = \cup_{o,t} J_{od,t}$ where $J_{od,t}$ is the set of products exported by o to d in year t.Define $\overline{X}_{Wd}(j)$ as the average value of exports from the world (summed over all exporting countries and averaged across years) of product j to d from the world.

We construct the extensive margin of exports from county o to county d as

$$EM_{od,t} = \frac{\sum_{j \in J_{od,t}} \overline{X}_{Wd}(j)}{\sum_{j \in J_{Wd}} \overline{X}_{Wd}(j)}, \tag{1}$$

Thus, this is a measure of the count of products in which country o exports to d in year t, but it weights each product by its importance in average world exports to d. Notice that with constant weights, for each country-pair the measure of the bilateral extensive margin changes over time only due to changes in the set of goods sold by o in the destination d, $J_{od,t}$. The denominator is importer-specific and constant across exporting countries and time.

The intensive margin of exports from county o to d is

$$IM_{od,t} = \frac{\sum_{j \in J_{od,t}} X_{od,t}(j)}{\sum_{j \in J_{od,t}} \overline{X}_{Wd}(j)}, \tag{2}$$

where $X_{od,t}(j)$ is the value of exports from country o to country d of good j at time t. The intensive margin equals o's nominal exports relative to W's average exports in those categories in which o exports to d at time $t(J_{od,t})$. Thus, it measures the overall market share country o has within the set of categories in which it exports to d.[7] Note

6. Feenstra (1994) and Feenstra and Kee (2004) provide microfoundations for the construction of these indices. These papers develop a methodology for measuring the impact of new varieties on productivity. It uses a constant elasticity of substitution (CES) specification that identifies the gains from variety by keeping track of only two factors: the elasticity of substitution among different varieties of a good and shifts in expenditure shares among new, remaining, and disappearing goods. The main intuition is that increasing the number of varieties does not increase productivity much if new varieties are close substitutes to existing varieties or if the share of new varieties is small relative to existing ones. Broda and Weinstein (2006) use this methodology as well and apply it to all U.S. imports. They find that increased import variety contributes to a 1.2% per year fall in the "true" import price index.

7. Hummels and Klenow (2005) calculate the two margins between country pairs relative to the rest of the world rather than to the world as a whole, as we do. We feel that the two margins are more easily interpreted in terms of market shares if we use the world as a whole. Second, for a small subset of country pairs, the intensive margin may be negative. This would happen, for example, if a single country accounts for all exports to a destination country of the only product that is exported to it.

that the product of the two margins is

$$EM_{od,t} * IM_{od,t} = \frac{\sum_{j \in J_{od,t}} X_{od,t}(j)}{\sum_{j \in J_{Wd}} \overline{X}_{Wd}(j)} = \frac{X_{od,t}}{\overline{X}_d},$$

which equals total bilateral exports from i to n in year t as a fraction of country $n's$ average imports. This implies that adding the coefficients on the extensive and intensive margins will yield the traditional gravity coefficients once we include importer country fixed effects which would then exactly capture the term $\overline{X}_d$.

The correlation between the count measure and the Feenstra–Kee extensive margin measure equals 0.86 and correlation between exports per product measure and the Feenstra–Kee intensive margin measure equals 0.49. Both measures of extensive margins are highly skewed. For instance, in the year 2006 (the last year for which data are available), we have data on 19,935 country pairs that had strictly positive bilateral trade flows. In 31% of these country pairs, we observe exactly one product being exported, whereas in only 7% of the sample, the exporting country exported more than 1000 products to at least one trading partner. Similarly $EM_{od} < 0.05$, for 52% of the country pairs whereas only 12% of country pairs exhibit $EM_{od} > 0.5$.

4. Independent Variables

Market Access. To capture market access and the ability to circumvent artificial trade barriers, we use three measures of preferential market access: multilateral, bilateral, and unilateral. Trade liberalization under GATT/WTO is on a Most Favored Nation basis, whereby trade concessions granted to one member should be available to all members. Therefore, multilateral market access, the main focus of our paper, is captured by a dummy variable which takes the value 1 if both trading partners are members of the GATT/WTO and 0 otherwise. We also code a dummy that takes the value 1 if neither country in a country-pair is a member of the WTO, with exactly one WTO member in a country-pair as the omitted category. Data on dates of accession to the GATT/WTO are from the WTO website. Our data covers the period 1988–2006 and we find that 91 countries were already GATT/WTO members by 1988. 53 additional countries joined the WTO during the time period of our study (see Table A.1 in Appendix A for this list), whereas 45 countries remained outside the multilateral trading system up until 2006. This, in our view, provides sufficient variation in membership as well as changes in WTO membership over time.

Since the early days of GATT, there have been two major ways in which the non-discriminatory aspect has been violated. First, GATT permits exemptions to the MFN principle for regional or bilateral preferential trade arrangements that reduce local barriers to trade. Members in free trade areas and customs unions obtain privileged access to each other's markets that do not have to be granted to non-members. Such bilateral preferential trade arrangements are captured by a dummy variable which takes the value 1 if both trading partners are members in a preferential trade arrangement (PTA). Data on PTAs are also from the WTO website. PTAs account for

3% of our sample and 1634 of the 24,261 country pairs were part of a PTA for at least one year of the sample. The second major exemption to the multilateral principle is the Generalized System of Preferences (GSP). This is a scheme of trade preferences granted on a non-reciprocal basis by developed countries to developing countries. It is a unilateral tariff preference which facilitates developing country access to markets of rich countries. We follow Eicher and Henn (2011) and code a dummy variable as 1 if the importing county j grants a GSP to exporter j at time t.[8] GSP data are from Andrew Rose's website. 71 importing countries granted unilateral preferential access to at least one exporting country, whereas 124 exporters were beneficiaries under the GSP exception.

Gravity Variables. We use traditional gravity variables—such as geographic distance, contiguity, colonial links, and linguistic similarities—to capture factors that facilitate or impede trade. Geographic distance is measured as the logarithm of the distance (in kilometers) between the two most populous cities. Contiguity is a dummy variable that takes the value 1 if the country pair shares a common border. Linguistic similarity is captured using two variables: one is a dummy that equals one if the country pair shares a common official language; the other takes the value one if a common language is spoken by at least 9% of the population. Colonial links are measured using two variables, one that measures whether a country pair were ever in a colonial relationship (one country was the colonizer and the other colonized or vice versa) and one that captures the fact if a country pair had a common colonizer (for instance, Singapore and Malaysia). Our final measure of links between countries is a dummy that takes the value one if a country pair in the past had been part of the same country (example, Georgia and Russia). Data on these variables are obtained from the CEPII bilateral distance database (www.cepii.fr).

Table A.2 in Appendix A presents the summary statistics for measures of extensive and intensive margins as well as for other variables used in this paper. When all independent variables are included, our sample size has 231,501 country-pair–year observations covering 24,594 country-pairs comprised of 190 exporters and 168 importers over the period 1988–2006.

4.1. Empirical Specification

Our benchmark specification of the gravity equation is of the following form:

$$\log X_{od,t} = \beta^{both} WTO^{both}_{od,t} + \beta^{none} WTO^{none}_{od,t} + Z_{od,t}\gamma + \chi_{o,t} + \mu_{d,t} + e_{od,t} \quad (3)$$

where $WTO^{both}_{od,t} = 1$ if both origin and destination are WTO members and 0 otherwise; $WTO^{none}_{od,t} = 1$ if both origin and destination are outside the WTO and 0 otherwise; $Z_{od,t}$ is a vector of traditional gravity variables including dummies for

8. GSP resulted in a substantial increase in developing country exports. For empirical evidence, see Baldwin and Murray (1977), Romalis (2003), and Rose (2004a).

PTA and GSP; $\chi_{o,t}$ are exporter-year dummies and $\mu_{d,t}$ are importer-year dummies.[9] Using such time-varying exporter and importer dummies dramatically reduces the scope for omitted variables, mis-measurement and even potential endogeneity in WTO membership. These dummies will not only capture global shifts in the patterns of world trade, but also changes in exports and imports of each country, some of which may be attributable to WTO membership.[10] At the same time, any changes in the HS-6 classification will also be subsumed in these dummies. Finally, in a subset of specifications, we also add time-invariant country-pair dummies to account for all variation that is time-invariant but specific to bilateral pairs. Overall, the use of panel-data with both country-year and country-pair dummies allows us to account for selection of countries and country-pairs into WTO and PTA membership as emphasized by Baier and Bergstrand (2007).

From the definitions of the two sets of extensive and intensive margins we can decompose overall bilateral trade as

$$\log X_{od,t} = \log N_{od,t} + \log \overline{x}_{od,t} \tag{4}$$

to estimate gravity equations for the count and export per product measures, and as

$$\log X_{od,t} = \log EM_{od,t} + \log IM_{od,t} + \log \overline{X}_d \tag{5}$$

for the Feenstra-Kee margins. In the second decomposition, the last term $\log \overline{X}_d$ will be absorbed in $\mu_{d,t}$, the time-varying importer dummies.

We also examine whether the effect of the WTO is increasing, decreasing, or roughly constant over time. We do so in two ways: First, we estimate the gravity models for the two models year-by-year, with exporter and importer dummies. While the year-by-year specification does not account for selection into WTO (see Baier and Bergstrand 2007 who make a case for using panel data to account for endogeneity of PTA membership,) it is a more general specification allowing us to estimate year-specific coefficients for every independent variable. Second, we use pooled data but allow the coefficient on the WTO to be year-specific by interacting $WTO^{both}_{od,t}$ and $WTO^{none}_{od,t}$ with year dummies.

Recent papers by Evenett and Venables (2002), Anderson and van Wincoop (2004), Haveman and Hummels (2004), and Helpman et al. (2008) all highlight the prevalence of zero bilateral trade flows. This is a potential concern for our

9. Exporter and importer size are also subsumed within these country-year dummies.

10. In gravity model estimations, particular care has to be exercised in capturing the impact of the price indices, often addressed as multilateral trade resistance terms (Anderson and van Wincoop 2004; Baldwin and Taglioni 2006). The multilateral trade resistance terms reflect both the openness of the importing nation to all goods and the openness of the world to the exporter's goods (not simply the openness of a pair of exporter and importer). Trade between any pair of countries depends on their bilateral trade costs (including here transport and border costs) *relative* to average trade costs with all trade partners (measured by the multilateral trade resistance terms). Omission of these multilateral trade resistance terms biases estimates of the trade costs toward zero. The country-year dummies will capture these multilateral trade resistance terms.

estimates since the dataset which we use to calculate the various margins reports only positive levels of trade. For the aggregate bilateral trade data over the period 1988–2006, 37% of all possible bilateral trade flows show a zero value. For these country pairs, the extensive margin is clearly equal to zero but taking log of the extensive margin automatically drops these observations. Helpman et al. (2008) argue that this introduces two forms of bias: one is the standard sample selection bias and the second is a heterogeneity bias that arises from acknowledging that firms are heterogeneous and self-select into exporting. To examine whether this introduces a bias in our estimates, we follow Helpman et al. (2008) to correct for both types of bias.

5. Results

The results from estimating gravity-specifications for the count measure of extensive margin and the export per product measure of intensive margin of exports, based on the decomposition shown in equation 4, are reported in Tables 1. Columns 1 and 2 in Table 1 use only time-varying exporter and importer fixed effects, while columns 3 and 4 add country-pair fixed effects. With country-pair effects, all time-invariant regressors are absorbed in these fixed effects. All standard errors are adjusted for clustering on country pairs.

In column 1 of Table 1, we see that the extensive margin of exports is significantly higher when both countries are WTO members. The estimated coefficient on the Both in WTO dummy in column 1 implies that if both countries in a country pair are members of the WTO, then this boosts the extensive margin of exports by 63.5%. Column 2 shows that WTO membership significantly reduces the intensive margin of exports by about 22.5%. Adding the two coefficients we see that WTO increases bilateral exports by approximately 26.7%. Adding country-pair fixed effects in columns 3 and 4, which accounts for all pair-specific time invariant characteristics, leads to a similar finding - WTO membership increases the extensive margin while reducing the intensive margin. The corresponding magnitude of the effects, fall since we are identifying WTO effects using within-variation over time. When both members in a country-pair become WTO members they experience an increase in the extensive margin by 25% and a reduction in the intensive margin by 6.3%. These results suggest that WTO membership acts more like a reduction in the fixed costs of trade—by reducing fixed costs it increases the number of products exported from origin to destination and by bringing in new smaller exporters reduces the intensive margin of exports.

In columns 3 and 4, the estimated coefficients for bilateral PTAs imply that country pairs who are members of a bilateral PTA tend to exhibit lower extensive margins and higher intensive margins, with an overall positive impact on bilateral exports. Columns 1 and 2, finds a positive role for the Generalized System of Preferences—market access granted by rich countries to poor countries—is instrumental in raising both margins, compared to countries that lack such market access. However, once use country-pair effects, columns 3 and 4 show that GSP has an on only the extensive

TABLE 1. Gravity specification for the extensive and intensive margins.

	(1)	(2)	(3)	(4)
	extensive margin (count)	intensive margin (exports per product)	extensive margin (count)	intensive margin (exports per product)
Both in GATT/WTO	0.492***	-0.255**	0.223***	-0.065**
	(0.092)	(0.104)	(0.015)	(0.027)
None in GATT/WTO	-0.134	0.319***	-0.040	-0.048
	(0.098)	(0.111)	(0.034)	(0.050)
Preferential trading arrangement	-0.147***	0.048	-0.004	0.297***
	(0.031)	(0.031)	(0.017)	(0.025)
GSP	0.329***	0.260***	0.078**	0.144
	(0.025)	(0.038)	(0.040)	(0.093)
Distance	-0.963***	-0.517***		
	(0.012)	(0.013)		
Contiguity	0.312***	0.065		
	(0.076)	(0.053)		
Common official language	0.428***	-0.019		
	(0.036)	(0.046)		
Common language spoken by at least 9% of population	0.116***	0.079*		
	(0.035)	(0.046)		
Colonial relationship	0.683***	0.402***		
	(0.065)	(0.059)		
Common colonizer	0.551***	0.445***		
	(0.030)	(0.039)		
Same country	0.508***	0.146*		
	(0.104)	(0.076)		
Observations	231501	231501	231501	231501
Number of pairs	24594	24594	24594	24594
R-squared	0.84	0.53	0.95	0.77
Joint significance test	33.74***	27.90***	20.77***	5.37***
Year effects	Yes	Yes	Yes	Yes
Country-year effects	Yes	No	Yes	Yes
Pair effects	No	Yes	Yes	Yes

Standard errors (in parentheses) are adjusted for clustering on country pairs.
*Significant at 10%; **significant at 5%; ***significant at 1%.
All columns include a constant (not shown).

margin. This is in contrast to Rose (2004a) who shows that the Generalized System of Preferences plays a stronger role in trade flows. We find a far stronger effect of the WTO on trade flows.

Next, the traditional gravity variables have significant explanatory power for the two margins. Distance reduces both the extensive and intensive margin of exports, which is consistent with the role of distance as capturing variable trading costs. Countries that border each other exhibit higher extensive margin, but has no effect on the intensive margin. Linguistic similarity mainly impacts the extensive margin while colonial links positively influence both export margins. Finally, if a country pair was part of the same country, then these past ties tend to increase both the extensive and intensive margin of exports. Overall, the traditional gravity variables affect the

extensive margin of exports in much the same as it has been shown to affect bilateral trade flows.

5.1. Year-Specific Estimates of WTO Membership

In Table 3 we show how the effect of WTO membership on the two margins has evolved over time. We first estimate gravity-specifications for the extensive and intensive margins year-by-year, where every specification included a set of dummies for exporters and another for importers, as well as all pair-specific gravity variables shown in Table 2. Once again, such a specification should also account fully for the multilateral trade resistance terms.[11] Columns 1 and 2 in Table 3 report only the coefficient and significance of the dummy variable "Both in WTO". We see that for 15 years of our sample, WTO membership has a positive effect on the extensive margin of exports. It has a negative or insignificant influence on the intensive margins of exports. Columns 3 and 4 use pooled data but estimate year-specific coefficients for the WTO dummies (both in WTO and neither in WTO) by interacting $WTO^{both}_{od,t}$ and $WTO^{none}_{od,t}$ with year dummies. We obtain coefficient estimates nearly identical in sign, magnitude and significance as compared to columns 1 and 2 with WTO membership again exhibiting a strong positive effect on the extensive margin of exports.

Interestingly, the magnitude of effect of the WTO on the extensive margin is the greatest just prior to date of transition from the GATT to the WTO (1995). Subramanian and Wei (2007) present data showing that countries that joined prior to 1995 undertook fewer obligations to bind tariffs in the industrial sector, and bound tariffs at much higher levels in the industrial sector and in the agricultural sector as compared to those that joined after the 1995 transition from GATT to WTO. Since these countries did not have to undertake significant trade liberalization, WTO membership for them may be analogous to a reduction in the fixed costs of trade. Only for countries that joined after 1995 WTO membership entailed significant tariff concessions. For these countries, WTO membership seems more like a reduction in the variable costs of trade. In this case, prior to 1995 we should observe WTO membership as having a positive impact on the extensive margin and a negative impact on the intensive margin. In contrast, post Uruguay-round the WTO may work via reduction in variable trade barriers, increasing the extensive margin but with an ambiguous or zero impact on the intensive margin. The results in Table 3 are somewhat consistent with such an expectation. First, we see a positive impact of WTO on the extensive margin for all years. Second, we observe a zero impact post-1995 on the intensive margin and a negative impact on the intensive margin in 1992 and 1994.

11. Note that Baier and Bergstrand (2007) argue that such cross-section estimates may fail to account for endogeneity and recommend the use of panel data.

TABLE 2. Year-specific effect of WTO on extensive and intensive margins.

Year	Coefficient on WTO: Year by Year		Coefficient on WTO: Pooled Data	
	extensive margin (count)	intensive margin (exports per product)	extensive margin (count)	intensive margin (exports per product)
1989	0.211	0.291	-0.024	0.297
1990	0.384	-0.219	0.197	-0.396
1991	1.125*	-0.421	0.920	-0.493
1992	0.986***	-1.281***	0.973***	-1.248***
1993	0.494**	-0.449	0.507**	-0.405
1994	0.911**	-0.867**	0.943***	-0.790**
1995	0.817***	-0.060	0.819***	-0.042
1996	0.334***	-0.279	0.341***	-0.258
1997	0.525***	-0.197	0.516***	-0.182
1998	0.479***	-0.346*	0.467***	-0.329
1999	0.308**	0.006	0.302**	0.006
2000	0.114	-0.238	0.114	-0.244
2001	0.878***	-0.366	0.885***	-0.361
2002	0.764***	-0.356	0.768***	-0.385
2003	0.732***	-0.263	0.738***	-0.261
2004	0.521**	-0.335	0.522**	-0.310
2005	0.385**	0.061	0.390**	0.093
2006	0.507**	-0.342	0.493**	-0.345

Standard errors (not shown) are adjusted for clustering on country pairs.

*Significant at 10%; **significant at 5%; ***significant at 1%.

The coefficient reported above is for the "Both in WTO" dummy. Each regression includes all controls. For the year by year estimate, we include exporter and importer dummies in each year; for pooled data we interact WTO membership dummies (both in WTO; none in WTO) with year dummies and include county-year fixed effects.

5.2. Heterogeneity and Selection Bias

A recent paper by Helpman et al. (2008) (HMR) criticizes the traditional gravity model on the grounds that it includes only those observations where we see strictly positive bilateral trade flows. Helpman et al. (2008) argue that excluding these zeroes, when we take the log of the dependent variable, creates a sample selection bias from dropping zeros and a heterogeneity bias from omitting variables (unobserved trade costs) that account for firms' self-selection into exports. The first induces a downward bias in the estimates of trade costs (country pairs with large observed trade barriers that trade with each other are likely to have low unobserved trade barriers). Since trade barriers also affect the proportion of firms that select into exports, failure to account for this, confounds the effects of trade barriers on trade with their effects on the proportion of exporting firms, inducing an upward bias in the estimated coefficient. Consistent estimation of (3) requires controls for both the selection of firms into export markets, and the selection of country pairs into a trading relationship. We adopt the two-step HMR methodology and estimate the following probit equation year by year

$$\rho_{od} = \Phi\left(\beta^{both} WTO_{od}^{both} + \beta^{none} WTO_{od,t}^{none} + Z_{od}\gamma + \chi_o + \mu_d\right) \tag{6}$$

where ρ_{od} is the probability of positive exports from o to d, $\Phi(\cdot)$ is the cdf of the unit-normal distribution, χ_o and μ_d are exporter and importer fixed effects. Next for each year t,we use the probit equation to predict two values: one is that of a latent variable z_{od} that determines self-selection into exports as $\widehat{z}^*_{od} = \Phi^{-1}(\rho_{od})$ and the second

$$\widehat{\eta}^*_{od} = \varphi\left(\frac{\widehat{\overline{z}}^*_{od}}{\Phi(\widehat{z}^*_{od})}\right),$$

which is the inverse Mills ratio.[12] In the second-step, HMR claim that a transformation of gravity equation (3) that will give consistent estimates is

$$\begin{aligned}\log X_{od,t} = {} & \beta^{both} WTO^{both}_{od,t} + \beta^{none} WTO^{none}_{od,t} + Z_{od,t}\gamma \\ & + \chi_{o,t} + \mu_{d,t} + \beta_{e,\eta}\widehat{\eta}^*_{od,t} + \widehat{\overline{z}}^*_{od,t} + \widehat{\overline{z}}^{*2}_{od,t} + \widehat{\overline{z}}^{*3}_{od,t} + e_{od,t},\end{aligned}$$

where $\widehat{\overline{z}}^*_{od,t} = \widehat{z}^*_{od} + \widehat{\eta}^*_{od}$ for each year t. The polynomial in $\widehat{\overline{z}}^*_{od,t}$ is an approximation of an arbitrary increasing function of the latent variable $z_{od,t}$, which in turn controls for firm-level heterogeneity and $\widehat{\eta}^*_{od,t}$ is Heckman correction for sample selection bias, again estimated year by year.

Helpman et al. (2008) suggests that trade barriers that affect fixed costs of exporting but do not affect variable trade costs are valid exclusion restrictions and should affect only the probability of trade in equation (6). However, finding a valid exclusion restriction for the extensive margin is non-trivial since both fixed and variable costs affect the extensive margin. Therefore, we present results for the margins with and without an exclusion restriction. For the exclusion restrictions we follow HMR and use their common religion index.[13] The common religion index for a country pair (o, d) at time t is constructed as

$$\sum\left(\text{proportion of religion}^k_{ot}\right) * \left(\text{proportion of religion}^k_{dt}\right),$$

where k is an index for a particular religion.[14]In the absence of an exclusion restriction, we rely on the assumption of normality of the residuals. To estimate (6) we use the IMF's Direction of Trade Statistics Database to code zero vs. positive exports between country-pairs. We confirm that exports from o to d are indeed zero by cross-checking with the COMTRADE and the World Trade Flows Database (Feenstra et al. 2005)

12. HMR show that z_{od} is the ratio of the export profits of the most efficient firm to the common fixed export cost for exporters from o to d, is a latent variable and selection of firms into export markets is a monotonic function of this variable.

13. HMR also use the fixed cost of starting a firm from the Doing Business database. However, data on these are available only from 2004 onwards. Therefore, we use only the common religion index as the exclusion restriction.

14. The set of religions we use are more comprehensive than that of Helpman et al. (2008). These include Bahais, Buddhist, Chinese Universist, Christianity, Confucian, Ethnoreligionist, Hinduism, Jainism, Judaism, Islam, Shinto, Sikhism, Taoists and Zoroastrian. The data are from Association of Religion Data Archives.

TABLE 3. Correction for sample selection bias and heterogeneity bias.

	(1)	(2)	(3)	(4)	(5)	(6)
	extensive margin (count)	intensive margin (exports per product)	extensive margin (count)	intensive margin (exports per product)	extensive margin (count)	intensive margin (exports per product)
Both in GATT/WTO	0.257***	-0.336***	0.251***	-0.342***	0.155***	-0.072***
	(0.096)	(0.125)	(0.095)	(0.125)	(0.015)	(0.028)
None in GATT/WTO	0.007	0.280**	0.004	0.279**	-0.006	-0.040
	(0.101)	(0.131)	(0.101)	(0.131)	(0.034)	(0.051)
Preferential trading arrangement	-0.159***	-0.114***	-0.179***	-0.132***	-0.029	0.247***
	(0.035)	(0.041)	(0.035)	(0.041)	(0.018)	(0.028)
GSP	-0.385***	-0.138***	-0.407***	-0.157***	-0.035	0.049
	(0.037)	(0.052)	(0.037)	(0.052)	(0.039)	(0.098)
Distance	-0.477***	-0.115***	-0.453***	-0.094**		
	(0.034)	(0.036)	(0.033)	(0.037)		
Contiguity	0.615***	0.121**	0.624***	0.129**		
	(0.063)	(0.057)	(0.063)	(0.057)		
Common official language	0.164***	-0.261***	0.154***	-0.270***		
	(0.039)	(0.052)	(0.039)	(0.051)		
Common language spoken by at least 9% of population	0.083**	0.075	0.080**	0.073		
	(0.035)	(0.049)	(0.035)	(0.049)		
Colonial relationship	0.618***	0.418***	0.615***	0.417***		
	(0.071)	(0.071)	(0.071)	(0.071)		
Common colonizer	0.323***	0.287***	0.308***	0.274***		
	(0.031)	(0.043)	(0.031)	(0.043)		
Same country	0.013	-0.079	-0.004	-0.093		
	(0.095)	(0.077)	(0.095)	(0.078)		
$\hat{\eta}^*$	0.274***	-0.300***	0.242***	-0.327***	0.067**	-0.222***
	(0.053)	(0.064)	(0.053)	(0.064)	(0.030)	(0.054)
$\hat{z}^*$	1.512***	1.346***	1.550***	1.384***	0.534***	0.022
	(0.068)	(0.083)	(0.067)	(0.084)	(0.036)	(0.062)
$\hat{z}^{*2}$	-0.092***	-0.193***	-0.093***	-0.195***	-0.066***	0.006
	(0.012)	(0.016)	(0.012)	(0.017)	(0.008)	(0.014)
$\hat{z}^{*3}$	-0.001	0.013***	-0.001	0.013***	0.003***	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	206798	206798	206798	206798	206798	206798
Number of pairs	23727	23727	23727	23727	23727	23727
R-squared	0.83	0.34	0.83	0.36	0.94	0.76
Joint significance test	51.74***	26.56***	51.80***	26.56***	21.23***	4.86***
Exclusion restriction	No	No	Yes	Yes	Yes	Yes
Country-year effects	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair effects	No	No	No	No	Yes	Yes

Standard errors (in parentheses) are adjusted for clustering on country pairs.
*Significant at 10%; **significant at 5%; ***significant at 1%.
All columns include a constant (not shown).

The results with the HMR correction are shown in Table 3 which includes coefficient estimates for $\widehat{\eta}^*_{od,t}$ and for the polynomial in $\widehat{z}^*_{od,t}$ and time-varying exporter and importer fixed-effects.Since some countries export to or import from all other countries in a particular year, fixed exporter and importer effects cannot be estimated in the probit equation, and all observations with that particular exporter

or importer are dropped. As a results, the number of observations declines marginally from 231,501 in Table 2 to 206,798 in Table 4. Columns 1 and 2 show the estimates for the two margins without any exclusion restriction; Columns 3 and 4 use the common religion index as the exclusion restriction while columns 5 and 6 add country-pair fixed effects to columns 3 and 4. Correcting for sample selection and heterogeneity bias, we see once again that common membership in the WTO increases the extensive margin and reduces the intensive margin of exports. Comparing column 1 in Table 2 (without the HMR correction) to the one in Table 3 (with the HMR correction) we observe nearly a 50% decline in the coefficient on the WTO for the extensive margin. On the other hand there is a marginal increase (in absolute terms) in the same coefficient for the intensive margin. Similar to HMR, we find that the bias correction are dominated by the influence of unobserved firm heterogeneity rather than sample selection and that this is true only for the extensive margin but not for the intensive. In columns 3 and 4, when we drop the exclusion restriction and rely on the non-linearity of the residuals for identification, we get nearly identical results for both margins. Comparing column 1 to column 3 and column 2 to column 4 we see that the coefficient and standard errors for all variables are nearly identical. Finally, when we add country-pair effects in columns 5 and 6, we see very similar result: WTO membership increases the extensive margin, reduces the intensive margin and the bias correction results in a decline in the coefficient for the extensive margin as compared to the estimates in Table 2.

As in Table 2, we see that once we account for country-pair effects, PTAs have a positive influence on total trade, with the entire positive effect operating through an increase in the intensive margin while GSP has no impact on overall trade. The inverse Mills ratio is significant at the 1%, so that the hypothesis of independence of the selection and regression equations is easily rejected. Finally, the polynomial in $\widehat{\widetilde{z}}^{*}_{od,t}$ are also statistically significant with signs similar to ones obtained in HMR, showing the importance of correcting for the heterogeneity bias.

5.3. Separating Out Effects of Trade Preferences

Subramanian and Wei (2007) bilateral preferences and the GSP unilateral preferences involve different degrees of liberalization; defining them as we do in Table 2 contaminates the estimates. They recommend that WTO, PTA and GSP be defined mutually exclusively in order to be able to isolate the impact of each ad identify what they dub as "the pure WTO effect." However, as Eicher and Henn (2011) point out that Subramanian and Wei's hierarchical classification of dummies, with PTAs at the top and WTO at the bottom of the classification hierarchy, assumes that PTA membership represents the culmination of trade integration. They show that such a coding their coding produced a WTO effect that was actually a PTA effect. Therefore, we use a different 7-fold classification to define trade preference dummies in a mutually exclusive and exhaustive fashion to identify a pure WTO effect. These are as follows.

1. Both countries of a country pair are WTO members but they do not belong to a PTA and the importer does not extend GSP to the exporter. This is the pure WTO effect.

TABLE 4. WTO, PTA & GSP defined mutually, exclusively, and exhaustively.

	(1) extensive margin (count)	(2) intensive margin (exports per product)	(3) extensive margin (count)	(4) intensive margin (exports per product)
1. Both in WTO + No PTA + No GSP	0.364***	0.045	0.238***	-0.044
	(0.039)	(0.048)	(0.017)	(0.029)
2. PTA + At least one not in WTO + No GSP	0.033	0.082	0.066	0.018
	(0.070)	(0.104)	(0.043)	(0.068)
3. GSP + At least one not in WTO + No PTA	0.193***	0.441***	0.147***	0.287***
	(0.041)	(0.076)	(0.046)	(0.102)
4. Both in WTO + PTA + No GSP	0.200***	0.113**	0.217***	0.304***
	(0.050)	(0.056)	(0.025)	(0.037)
5. Both in WTO + No PTA + GSP	0.717***	0.282***	0.273***	0.016
	(0.045)	(0.060)	(0.042)	(0.098)
6. Both in WTO + PTA + GSP	0.574***	0.071	0.290***	0.304**
	(0.081)	(0.090)	(0.051)	(0.122)
7. At least one not in WTO + PTA + GSP	0.185	0.871**	0.230***	0.245
	(0.120)	(0.393)	(0.069)	(0.265)
Observations	231501	231501	231501	231501
Number of pairs	24594	24594	24594	24594
R-squared	0.84	0.53	0.95	0.77
Joint significance test	34.06***	27.96***	20.79***	5.41***
Country-year effects	Yes	Yes	Yes	Yes
Country-pair effects	No	No	Yes	Yes

Standard errors (in parentheses) are adjusted for clustering on country pairs.

*Significant at 10%; **significant at 5%; ***significant at 1%.

Columns 1 and 2 include other gravity variables and all columns include a constant (not shown).

2. Both are members of a common PTA, but at least one of them is not a member of the WTO and the importer does not extend GSP to the exporter. This is the pure PTA effect.
3. The importer extends GSP to the exporter but at least one of them is not a member of the WTO, nor do they belong to a common PTA. This is the pure PTA effect.
4. Both are members of the WTO, and at the same time, members of a common PTA, but the importer does not extend GSP to the exporter.
5. Both are members of the WTO, the importer does not extend GSP to the exporter, but they do not belong to a common PTA.
6. Both are members of the WTO, in a common PTA and the importer extends GSP to the exporter.
7. Both are members of a common PTA, the importer extends GSP to the exporter, and at least one country in the pair is not a WTO member.[15]

15. Note that our classification is simply mutually exclusive and not hierarchical. For example, the Subramanian-Wei classification would use only three dummy variables: one for countries that are members of a PTA, one for countries where the importer grants a GSP but where the country-pairs are not members of a PTA, and a third for where the countries are WTO members but not in a common PTA and where the importer does not extend GSP to the exporter.

TABLE 5. Gravity specification for the Feenstra–Kee measures of margin.

	(1)	(2)
	Coefficient and standard error for extensive margin (Feenstra-Kee)	Coefficient and standard error for intensive margin (Feenstra-Kee)
Country-year effects	0.209*	0.027
	(0.114)	(0.108)
Country-year + country-pair effects	0.219***	-0.061**
	(0.025)	(0.028)
Correction for selection and heterogeneity bias[a]	0.140***	-0.058**
	(0.026)	(0.029)
Both in WTO + No PTA + No GSP[a]	0.239***	-0.045
	(0.027)	(0.029)

Standard errors (in parentheses) are adjusted for clustering on country pairs.
*Significant at 10%; **significant at 5%; ***significant at 1%.
Both columns include country-year and country-pair fixed effects.

The results are shown in Table 4 where once again we show results for the two margins with exporter and importer country-year effects in columns 1 and 2 and with both country-year and country-pair effects in columns 3 and 4. Columns 1 and 2 also include the pair-specific gravity variables from Table 2 (not shown.) For extensive margins we observe a positive and significant coefficient whenever both countries in a pair are WTO members. More importantly, the coefficient in column 1 (reap., 3) on pure WTO effect implies that country-pairs who grant each other only multilateral preferences exhibit a 44% (reps., 27%) increase in the extensive margin of exports. The pure WTO effect on the intensive margin is negative once we include country-pair effects. The pure PTA effect on the two margins is insignificant while the pure GSP effect is positive on both margins of trade.

5.4. Feenstra-Kee Measure of Margins

Next, we replicate all the results with the Feenstra-Kee measure of extensive and intensive margins and present the gravity estimates for the decomposition based on equation (5). These results are shown in Table 5 where for brevity we report only the coefficient estimates for the "Both in WTO" dummy. Column 1 presents results with the extensive margin and column 2 with the intensive margin. As mentioned earlier, the sum of the coefficients is the coefficient on total bilateral exports since all specifications include county-year dummies, and this coefficient exactly matches the sum of the coefficient on the count measure and export per product measure. Row 1 is our baseline specification with exporter and importer country-year dummies; Row 2 adds country-pair fixed-effects; Row 3 includes the HMR correction for heterogeneity bias and selection bias; Row 4 reports the pure WTO effect from Table 4. Across

specifications, we see effects very similar to the previous definition of margins - common WTO membership significantly increases the extensive margin of exports and significantly reduces the intensive margin of exports. In the most demanding specification, with country-year and country-pair effects and with the HMR bias corrections, we find that WTO membership increases the Feenstra-Kee extensive margin of exports by 15% but reduces the intensive margin by 5.6%.

5.5. Developed vs. Developing Country

Developed countries undertook far greater trade liberalization under the auspices of GATT reducing their average tariffs from 15% in 1947 to about 4.5% (Subramanian and Wei, 2007). In contrast, developing countries had far fewer obligations to liberalize tariff barriers under the Special and Differentiated (S&D) treatment. Such an asymmetry implies that we should expect differential effects for GATT/WTO membership for developed vs. developing countries. For developed country importers, GATT/WTO membership should work by reducing the variable costs of trade, which should have a positive impact on the extensive margin of their exporting partners (in terms of product counts) and an ambiguous or zero impact on the intensive margin of exports (in terms of exports per product). For developing country importers, GATT/WTO membership may only be about reducing the fixed costs of trade. This should have a positive impact on the extensive margin and a negative impact on the intensive margin of their export partners. We examine this by estimating gravity specifications for the extensive and intensive margins separately for sub-samples of developed and developing country exporters. We use the Rose (2004a) categorization of countries into developed vs. developing.

These results are shown in Table 6 where all columns include country-year fixed effects. Columns 1 and 2 show the gravity estimates where the importer in a country-pair is a developed country. We observe that WTO membership increases the extensive margin for their export partners and has an insignificant effect on the intensive margin, in line with the role of WTO membership reducing variable trade costs for these exporters in the destination country. Columns 3 and 4 show the estimates for the margins when the importing country is a developing country. Here we see that WTO membership increases the extensive margin and significantly reduces the intensive margin. This in turn is consistent with conceiving WTO membership as reducing the fixed costs of trade.

5.6. Robustness[16]

So far we have interpreted the negative coefficient on the WTO membership dummy in gravity specifications with exports per product as the dependent variable as indicating that the WTO works by reducing the fixed costs of trade. However, in the original

16. All these results are available from the authors upon request.

TABLE 6. Developed vs. developing sub-samples.

	(1)	(2)	(3)	(4)
	Importer developed		*Importer developing*	
	extensive margin (count)	intensive margin (exports per product)	extensive margin (count)	intensive margin (exports per product)
Both in GATT/WTO	1.687***	0.253	0.311***	-0.264**
	(0.276)	(0.490)	(0.095)	(0.108)
None in GATT/WTO	-1.295***	0.242	-0.004	0.282**
	(0.315)	(0.528)	(0.101)	(0.115)
Preferential trading arrangement	-0.433***	-0.047	0.106***	0.111**
	(0.047)	(0.061)	(0.041)	(0.043)
GSP	0.167***	0.093	0.484***	0.171**
	(0.032)	(0.058)	(0.071)	(0.069)
Distance	-0.750***	-0.594***	-1.011***	-0.516***
	(0.025)	(0.035)	(0.013)	(0.014)
Contiguity	-0.509***	0.167	0.574***	0.019
	(0.152)	(0.102)	(0.072)	(0.062)
Common official language	0.137**	-0.122	0.546***	0.007
	(0.063)	(0.103)	(0.041)	(0.051)
Common language spoken by at least 9% of population	0.234***	0.178*	0.054	0.061
	(0.064)	(0.104)	(0.040)	(0.050)
Colonial relationship	0.671***	0.459***	0.842***	0.306***
	(0.068)	(0.087)	(0.112)	(0.065)
Common colonizer	0.046	-0.043	0.511***	0.429***
	(0.136)	(0.250)	(0.031)	(0.041)
Same country	0.265	-0.013	0.243**	0.096
	(0.328)	(0.178)	(0.107)	(0.081)
Observations	66112	66112	165389	165389
Number of pairs	4864	4864	19730	19730
R-squared	0.92	0.60	0.82	0.48
Joint significance test	35.37***	23.53***	26.95***	21.65***
Year effects	Yes	Yes	Yes	Yes
Country-year effects	Yes	Yes	Yes	Yes

Standard errors (in parentheses) are adjusted for clustering on country pairs.
*Significant at 10%; **significant at 5%; ***significant at 1%.
All columns include a constant.

Melitz model, if we do not assume that firm-productivities have a Pareto distribution the impact of variable trade barriers on exports per product is ambiguous. This in turn implies that we cannot completely rule out WTO membership as affecting variable trade barriers. The source of this ambiguity is that the export per product measure may decline in a mechanical fashion. This would happen, for example, whenever a country exports a new product, but the export value of the new product is small compared to the value of the previously exported products. To account for thus, we calculated the export per product while holding the set of goods constant, in a three-year window around each WTO accession date. When we hold the set of products constant, the change in exports per product comes entirely out of changes in exports

of incumbent exporters. Their exports should depend negatively on variable trade costs and be independent of fixed trade costs. We estimated gravity specifications for this adjusted intensive margin for each year of access with exporter and importer fixed-effects. With this adjusted measure of intensive margin, we find that in all years save one, WTO membership has an insignificant influence. This supports our earlier conjecture that our empirical results are consistent with WTO membership reducing the fixed costs of trade.

Second, we checked whether our results are not an artifact of the time frame and product classification used. To do this, we reran all our models using the World Trade Flows Database. While this database spans the time period 1962-1999, data are available only at the four digit level resulting in coarser measures of extensive and intensive margins. As with the COMTRADE data, we find that WTO membership has a positive and significant effect only on the extensive margin of trade.

Third, we evaluated whether the effect of the WTO was mainly due to multiple countries joining around the year of the switch from GATT to WTO. We did this by confining our sample to exporters who joined prior to 1994 or after 1996. Again, we find that the extensive margin is positively influenced by WTO membership. Similarly, when we confine our sample to importers who joined prior to 1994 or after 1996, the extensive margin of exports continues to be positively influenced by WTO membership. We also allowed the sample to vary across various GATT/WTO rounds. If we split the sample into pre-Uruguay round vs. post-Uruguay round, none of our results are qualitatively affected. As another sub-sample check, we dropped all the original members of GATT who signed the original GATT agreement in 1948. Again, this does not alter our conclusions regarding the importance of WTO membership for the extensive margin. In the final check, we evaluated if our results are simply driven by China's joining the WTO in the year 2001 (with other new members relatively unimportant in terms of their share in world trade). In both the overall sample which includes China and the sub-sample that excludes China, the coefficient on WTO membership is barely distinguishable in terms of magnitude and significance. Finally, we followed Tomz et al. (2007) and reclassified de facto members outside the WTO also as WTO members. This too does not alter our conclusions.

6. Discussion and Conclusion

Rose (2004a) highlights the WTO puzzle - that the biggest changes in international trade rules have failed to have an impact on the volume of trade between pairs of countries. Our paper decomposes the volume of trade into the extensive and intensive margin and shows that WTO membership has been instrumental in raising the extensive margin of trade while its impact on the intensive margin is negative. The positive impact on the extensive margin and the negative impact of the intensive margin are consistent with the role of the WTO as reducing the fixed rather than variable costs of trade. Our empirical results (with respect to the WTO) on the extensive margin are in line with the standard Melitz/Chaney models of trade. The

varying impact of WTO membership on the two margins hold across an array of permutations - accounting for the multilateral trade resistance terms and endogeneity of WTO and PTA membership via exporter and importer country-year effects and country-pair effects, for the prevalence of zeros in trade flows, and for various sub-samples and time periods. Unlike Rose (2004a), we do find that the overall impact of the WTO on total bilateral exports is positive and that it is the extensive margin channel through which WTO membership raises trade.

While the effect of WTO as reducing the fixed costs of trade is consistent with our results, there exists another intriguing possibility. Perhaps WTO is not at all about reducing trade barriers, variable or fixed. Rather it serves to resolve uncertainty in the mind of potential exporters regarding the evolution of international trade rules and they respond by exporting newer products into newer markets. This is the argument made most forcefully in Bagwell and Staiger (2001). The authors argue that GATT/WTO is not simply about market access through tariff reductions. Rather, WTO rules allow governments to credibly commit to market access and secure this access against unilateral policy interventions that undermine the link between market access and negotiated tariff reductions.[17] Handley and Limão (2010) use a dynamic, heterogeneous firms model to show that show how reduction in trade policy uncertainty increases firm entry and trade. Empirically, they show that Portugal's accession to the European Community (EC) in 1986 reduced trade policy uncertainty and led to substantial investment and entry of Portuguese exporters into EC markets. Hankley (2012) uses Australian data to show that multilateral policy commitments at the WTO reduce uncertainty and increase the extensive margin of exports. Our results that show that WTO accession increases the extensive margin of exports when we consider all participants in world trade, are in the same vein.

The impact of the WTO on the extensive margin and thus on export diversification also has important consequences on the role of WTO in economic development. Acemoglu and Zilibotti (1997) show that development goes hand in hand with diversification opportunities. Hausmann et al. (2012) show that the type of goods countries export matters—exporting goods associated with higher productivity levels leads to rapid economic growth grow more rapidly, after controlling for standard growth regressors such as initial income per head, human capital levels, etc. Broda et al. (2006) show that, across a wide sample of countries, the growth in the extensive margin of imports can also account for an important component of that country's productivity growth. The WTO by permitting diversification of trade can potentially play an important role in economic development.

17. The WTO's website emphasizes that one of the principle role of the WTO is to reduce uncertainty and increase predictability. It explicitly states: "The multilateral trading system is an attempt by governments to make the business environment stable and predictable."

Appendix: Additional Tables

TABLE A.1. Countries that joined the WTO After 1988 (the first year of our sample).

Country	Year of WTO Accession	Country	Year of WTO Accession
Albania	2000	Lesotho	1988
Angola	1994	Lithuania	2001
Armenia	2003	Macao, China	1991
Bahrain	1993	Macedonia	2003
Bolivia	1990	Mali	1993
Brunei	1993	Moldova	2001
Bulgaria	1996	Mongolia	1997
Cambodia	2004	Mozambique	1992
China	2001	Namibia	1992
Costa Rica	1990	Nepal	2004
Croatia	2000	Oman	2000
Czech Republic	1993	Panama	1997
Djibouti	1994	Papua New Guinea	1994
Dominica	1993	Paraguay	1994
Ecuador	1996	Qatar	1994
El Salvador	1991	Saudi Arabia	2005
Estonia	1999	Slovak Republic	1993
Fiji	1993	Slovenia	1994
Georgia	2000	Solomon Islands	1994
Grenada	1994	St. Kitts and Nevis	1994
Guatemala	1991	St. Lucia	1993
Guinea	1994	St. Vincent and the Grenadines	1993
Guinea-Bissau	1994	Swaziland	1993
Honduras	1994	Tunisia	1990
Jordan	2000	United Arab Emirates	1994
Kyrgyz Republic	1998	Venezuela	1990
Latvia	1999		

TABLE A.2. Summary statistics.

Variable	*No. of obsv.*	*Mean*	*Std. Dev.*
Extensive margin (count)	231501	3.431	2.335
Intensive margin (exports per product)	231501	11.130	2.277
Feenstra-Kee extensive margin	231501	-4.121	2.616
Feenstra-Kee intensive margin	231501	-4.970	2.219
Both in GATT/WTO	231501	0.671	0.470
None in GATT/WTO	231501	0.027	0.163
Preferential trading arrangement	231501	0.062	0.242
GSP	231501	0.120	0.325
Distance (log)	231501	8.625	0.852
Contiguity	231501	0.025	0.156
Common official language	231501	0.151	0.358
Common language spoken by at least 9% of population	231501	0.156	0.363
Colonial relationship	231501	0.019	0.137
Common colonizer	231501	0.085	0.278
Same country	231501	0.012	0.110
Common religion	453996	0.373	0.323

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A Appendix

A.1 A Simple Melitz-Chaney Model

We develop a simple mode of trade with heterogeneous firms and trade costs, along the lines of Melitz(2003) and Chaney (2008), to look at the impact of trade costs on the extensive and intensive margins.

There are N countries asymmetric countries with sizes $(L_d)_{d=1}^N$. Each country has one homogeneous good sector and a differentiated goods sector. There are a continuum of $\tilde{K}$ differentiated goods, imports plus those produced domestically and where each good is produced by a single firm. Preferences in country d are given by

$$U_d = q_o^{1-\mu} \left[\int_{k \in \tilde{K}} q_d^{\frac{\varepsilon-1}{\varepsilon}}(k) dk \right]^{\frac{\varepsilon}{\varepsilon-1}\mu} \tag{A.1}$$

where $\varepsilon > 1$ is the elasticity of substitution. The homogeneous good is freely traded, produced under constant returns to scale, and μ is low enough to ensure that it will be produced in all countries in equilibrium. Setting the homogenous good as the numeraire, these assumptions imply that the $w_i = 1$ for all i. Workers worldwide hold a diversified portfolio of all firms in the world and share in aggregate world profits, with the homogenous good used to repatriate dividends. Therefore, the total income in country d is the sum of workers' labor income and dividends from their share in the world portfolio, $Y_d = \left(1 + \frac{\Pi}{L}\right) L_d$. $L \equiv \sum_{d=1}^N L_d$ is the total labor force in the world, and Π is the equal dividend share.

Demand for differentiated good k in county d

$$q_d(k) = \frac{p_d^{-\varepsilon}(k)}{P_d^{1-\varepsilon}} \mu Y_d, \quad P_d^{1-\varepsilon} = \int_{k \in \tilde{K}} p_{kd}^{1-\varepsilon}(k) dk \tag{A.2}$$

Now we focus on the goods produced by the firms in country o, which is the subset $K_o \subset \tilde{K}$. In country o, each good k faces a unit production cost of $1/a_k$, where a_k is firm-specific productivity. The distribution of productivity in country o is captured by the density $g(a)$ on the support $[1, +\infty]$. Following Chaney (2008), we assume that g follows a Pareto distribution, with a scaling parameter γ, such that: $g(a) = \gamma a^{-(\gamma+1)}$ and $\Pr(a > \bar{a}) = \bar{a}^{-\gamma}$.[1] Finally, in any country o, the mass of entrepreneurs that are allowed to draw a value from $g(a)$ is proportional to their population size L_o.

[1] We also assume that $\gamma > \varepsilon - 1$ to ensure that the size distribution of firms has a finite mean.

Trade costs of good to d to country o, involve a variable (iceberg component), τ_{od},[2] and a fixed component, F_{od}. Taking the traditional markup pricing rule, the price of good from o to d is given by

$$p_{od}(k) = \frac{\varepsilon}{\varepsilon - 1} \frac{\tau_{od}}{a_k} \tag{A.3}$$

The profit from exporting good k from o to d is

$$\pi_{od}(k) = \frac{1}{\varepsilon} \left(\frac{\varepsilon - 1}{\varepsilon} \frac{P_d}{\tau_{od}} a_k \right)^{\varepsilon - 1} \mu Y_d - F_{od}$$

This in turn implies that good k will actually be exported from o to d iff $\pi_{od}(k) \geq 0$ which implies that productivity for good k should be above a threshold

$$a_k \geq \frac{\varepsilon}{\varepsilon - 1} \left(\frac{\varepsilon F_{od}}{\mu Y_d} \right)^{\frac{1}{\varepsilon - 1}} \frac{\tau_{od}}{P_d} = \bar{a}_{od} \tag{A.4}$$

This establishes a cutoff $\bar{a}_{od}$, such that all firms in o with $a_k \geq \bar{a}_{od}$ are exporters and these exporters are the subset of the most-productive domestic firms. This cut-off level of productivity is increasing in both variable and fixed trade costs, and decreasing in import country GDP and the price level in country d. That is, more firms find it easier to export to proximate, less protected, and larger markets (countries) as well as to markets with higher prices.

The value of exports (sales) of good k from county o to country j is given by

$$x_{od}(k) = p_{od}(k) q_{od}(k) = \left(\frac{\varepsilon - 1}{\varepsilon} \frac{P_d}{\tau_{od}} a_k \right)^{\varepsilon - 1} \mu Y_d \text{ if } a_k \geq \bar{a}_{od} \tag{A.5}$$

$$= 0 \text{ otherwise} \tag{A.6}$$

Therefore exports of a good from o to d depends positively on importer GDP and price, and negatively on variable trade costs, while they are independent of fixed trade costs. Once the firm has started exporting to d, fixed costs have no impact on export sales.

[2] If one unit of any differentiated good k is shipped from country o to country d, only a fraction $\frac{1}{\tau_{od}}$ arrives.

The price index P_d is given by

$$\begin{aligned} P_d^{1-\varepsilon} &= \sum_{o=1}^{N} L_o \int_{\bar{a}_{od}}^{\infty} (p_{od}(k))^{1-\varepsilon} g(a) da \\ &= \sum_{o=1}^{N} L_o \int_{\bar{a}_{od}}^{\infty} \left(\frac{\varepsilon}{\varepsilon - 1} \frac{\tau_{od}}{a} \right)^{1-\varepsilon} \gamma a^{-(\gamma+1)} da \\ &= \sum_{o=1}^{N} L_o \left(\frac{\varepsilon}{\varepsilon - 1} \tau_{od} \right)^{1-\varepsilon} \frac{\gamma}{\gamma - (\varepsilon - 1)} (\bar{a}_{od})^{\varepsilon - 1 - \gamma} \end{aligned}$$

Substituting from (A.4), we get

$$P_d^{1-\varepsilon} = \lambda_2^{-\gamma} (\mu Y_d)^{\frac{\gamma}{\varepsilon-1}-1} P_d^{1-\varepsilon+\gamma} \theta_d^{-\gamma} L$$

where

$$\theta_d^{-\gamma} = \sum_{o=1}^{N} \frac{Y_o}{Y} \tau_{od}^{-\gamma} F_{od}^{(\varepsilon-1-\gamma)/\varepsilon-1}$$

may be interpreted as a measure of country d's remoteness from the rest of the world similar to a multilateral trade-resistance index, λ_2 is a constant and $\frac{Y_o}{Y} = \frac{L_o}{L}$because of the equal dividend share assumption. Simplifying, we get

$$P_d = \lambda_2 \theta_d (\mu Y_d)^{\frac{1}{\gamma} - \frac{1}{\varepsilon-1}} L^{-\frac{1}{\gamma}} \tag{A.7}$$

Substituting the expression for the price index in the expression for the productivity threshold and the value of exports in equations (A.4) and (A.5) gives

$$\bar{a}_{od} = \lambda_3 (\mu Y_d)^{-\frac{1}{\gamma}} \frac{\tau_{od}}{\theta_d} F_{od}^{\frac{1}{\varepsilon-1}} L^{\frac{1}{\gamma}} \tag{A.8}$$

$$\begin{aligned} x_{od}(k) &= \left(\frac{\varepsilon - 1}{\varepsilon} \lambda_2 \right)^{\varepsilon-1} \left(\frac{a_k \theta_d}{\tau_{od}} \right)^{\varepsilon-1} (\mu Y_d)^{\frac{\varepsilon-1}{\gamma}} L^{-\frac{\varepsilon-1}{\gamma}} \text{ if } a_k \geq \bar{a}_{od} \quad \text{(A.9)} \\ &= 0 \text{ otherwise} \end{aligned}$$

where λ_3 is a constant.

Finally, integrating export sales per product across all productivity levels above the cut-off level for export participation, total exports from o to d are

given by

$$\begin{aligned} X_{od} &= \int_{a_k > \bar{a}_{od}}^{\infty} x_{od}(k) L_0 g(a) da \\ &= \int_{a_k > \bar{a}_{od}}^{\infty} \left(\frac{\varepsilon - 1}{\varepsilon}\lambda_2\right)^{\varepsilon-1} \left(\frac{a\theta_d}{\tau_{od}}\right)^{\varepsilon-1} (\mu Y_d)^{\frac{\varepsilon-1}{\gamma}} L^{-\frac{\varepsilon-1}{\gamma}} L_o \gamma a^{-(\gamma+1)} da \\ &= \left(\frac{\varepsilon - 1}{\varepsilon}\lambda_2\right)^{\varepsilon-1} \left(\frac{\theta_d}{\tau_{od}}\right)^{\varepsilon-1} (\mu Y_d)^{\frac{\varepsilon-1}{\gamma}} L^{-\frac{\varepsilon-1}{\gamma}} L_o \gamma \frac{\bar{a}_{od}^{\varepsilon-1-\gamma}}{\gamma - (\varepsilon - 1)} \end{aligned}$$

Substituting for $\bar{a}$ and simplifying, we get bilateral exports from o to d in the form of a standard gravity equation

$$X_{od} = \mu \frac{Y_o Y_d}{Y} \left(\frac{\tau_{od}}{\theta_d}\right)^{-\gamma} F_{od}^{-\left(\frac{\gamma}{\varepsilon-1}-1\right)} \tag{A.10}$$

where $Y = L + \Pi$ is world income.

A.2 Extensive and Intensive Margins

Following Bernard, Jensen, Redding & Schott (2007), Flam and Nordstrom (2004), and Eaton, Kortum, and Kramarz (2004) we define the extensive margin as the number of products exported from o to d and the intensive margin as the average exports per product. The extensive margin from o to d is

$$\begin{aligned} EM_{od} &\equiv \int_{a_k > \bar{a}_{od}} g(a) L_o da = \bar{a}_{od}^{-\gamma} L_o = L_o \left[\lambda_3 (\mu Y_d)^{-\frac{1}{\gamma}} \frac{\tau_{od}}{\theta_d} F_{od}^{\frac{1}{\varepsilon-1}} L^{\frac{1}{\gamma}}\right]^{-\gamma} \\ EM_{od} &= \lambda_{XM} \mu \frac{Y_o Y_d}{Y} \left(\frac{\tau_{od}}{\theta_d}\right)^{-\gamma} F_{od}^{-\frac{\gamma}{\varepsilon-1}} \end{aligned} \tag{A.11}$$

From here we can see that a reduction in either the fixed or the variable costs of trade increases the extensive margin of exports. Reduction in trade costs, either fixed or variable, makes exporting more profitable, lowering the productivity threshold allowing more firms in o to export to d.[3]

[3] Please note that this result is not conditional upon the assumption of Pareto distribution for firm productivities.

The intensive margin from o to d defined as the average exports per product, is given by

$$IM_{od} \equiv \frac{X_{od}}{EM_{od}} = \frac{\mu \frac{Y_o Y_d}{Y} \left(\frac{\tau_{od}}{\theta_d}\right)^{-\gamma} F_{od}^{-\left(\frac{\gamma}{\varepsilon-1}-1\right)}}{\lambda_{XM} \mu \frac{Y_o Y_d}{Y} \left(\frac{\tau_{od}}{\theta_d}\right)^{-\gamma} F_{od}^{-\frac{\gamma}{\varepsilon-1}}} = \lambda_{IM} F_{od} \tag{A.12}$$

which implies that the intensive margin depends positively on the fixed costs of trade and is independent of the variable costs of trade. The intuition behind this result is as follows: a reduction in the fixed costs of trade F_{od} brings in new entrants who were previously not productive enough to cover the fixed costs of exporting to d. At the same time, a change in the fixed costs of trade leaves the export sales of incumbents unchanged (x_{od} is independent of F_{od}). Since the new exporters sell at a small scale, the overall effect is to reduce the intensive margin. A decline in variable costs, on the other hand has two effects. First, it raises the exports of existing exporters, which raises average export per firm. But by permitting entry of new small exporters, it reduces the average export per firm. The two opposing effects cancel out exactly when productivities have a Pareto distribution.[4]

Equation (A.12) implies that the intensive margin is independent of variable trade costs, which seems counter-intuitive. Various perturbations to this basic model can yield a negative relation between the intensive margin and variable trade costs. For example, perturbing the Pareto distribution and setting an upper bound on productivity can produce such a negative relation. Hanson and Xiong (2012) present a model with a global fixed cost of exporting (rather than bilateral fixed costs of exporting.) Each exporter in their model has to pay a common fixed cost in order to transit from being a purely domestic producer to an exporter. In their model a decline in variable trade costs again has two opposing effects - the increase in incumbents' exports raises the intensive margin, while the entry of small exporters reduces the intensive margin. However, in the presence of the global fixed costs of entry, the positive effect on incumbents outweighs the negative effect via entrants. Therefore, the intensive margin depends positively on the bilateral fixed costs of trade and negatively on the variable costs of trade. Finally, a simple way to obtain such comparative statics is to introduce heterogeneity of the fixed costs, in addition to heterogeneity of the marginal costs. If the marginal productivities follow a Pareto distribution and a firm's fixed cost

[4] If we relax the Pareto distribution assumption then variable trade costs have an ambiguous impact on the intensive margin.

is an increasing function of its marginal cost, then a decrease in trade costs causes the intensive margin to rise.

In all such cases, IM_{od} will depend negatively on variable trade costs. Importantly, in all such cases IM_{od} depends positively on the fixed costs of trade. If we find that WTO membership raises the extensive margin but reduces the intensive margin we can conjecture that WTO membership works via reducing bilateral fixed costs of trade.