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GATT/WTO Promotes Trade Strongly: Sample Selection and Model Specification[*]

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Abstract: Some recent research papers challenge the conventional view on the impact of the GATT/WTO on trade. This paper investigates the sample selection bias and the gravity model specification issues in the existing studies and provides strong evidence that the GATT/WTO has been very effective in trade creation. First, the GATT/WTO not only makes existing trading partners trade more (intensive margin), but also creates new trading relationships (extensive margin). Some existing studies exclude zero trade observations from their analyses and hence ignore the extensive margin. Secondly, the violation of some maintained assumptions in the traditional log-linear gravity regression accounts for the failure to uncover the role of the GATT/WTO even at the intensive margin. Using a large bilateral panel dataset including zero trade flows and a more appropriate econometric method, this paper finds that the GATT/WTO has been very effective in promoting the world trade at both the intensive and the extensive margins.

Keywords: GATT/WTO, Gravity Model, Bilateral Trade, Sample Selection, Poisson Regression

JEL Classification: F13, F15

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1. Introduction

The World Trade Organization (WTO) and its predecessor the General Agreements on Tariffs and Trade (GATT) were created to promote international trade and oversee the multilateral trading system. By now, the WTO has totally 150 members, and most global trade is covered by the WTO agreement. It is often taken for granted that the GATT/WTO has played an important role in creating trade after the World War II. A research paper by Rose [2004], however, challenges the conventional view on the impact of the GATT/WTO on trade. Using a large dataset on bilateral trade covering 175 countries over 50 years, Rose finds little evidence that the GATT/WTO members have different trade patterns from non-members. Although Rose [2004] himself provides some possible explanations for the results, he still views his finding as an interesting mystery. Recently several papers have attempted to solve this puzzle.

A subsequent study by Subramanian and Wei [2007] examines asymmetries in trade flows across countries and sectors. They find that the GATT/WTO effectively promotes trade in developed countries, but not in developing countries; in less protected sectors, but not in agriculture and textile sectors; and for new WTO members, but not for old GATT members. Another paper by Tomz, Goldstein and Rivers [2007] considers the measurement of the GATT/WTO memberships. By distinguishing formal members from non-member participants (NMPs), they find that NMPs are at least as liberalized as formal members.[1] After considering these NMPs, they find that bilateral trade is 70% higher if both trading partners are formal GATT/WTO members or NMPs compared with the baseline case of neither being a formal member nor an NMP.

The papers discussed above use only the observations with positive trade in the traditional log-linear gravity regressions. Excluding the zero trade observations, these studies lose the information on new trading relationships generated by the GATT/WTO when country pairs initially did not trade, but started

[1] NMPs include colonies of formal GATT members, newly–sovereign countries, and provisional applicants to the GATT.

to trade after one or both of them joined the GATT/WTO.[2] The zero trade observations are important for assessing the impact of the GATT/WTO on trade. GATT/WTO not only makes existing trading partners trade more ("intensive margin"), but also creates new trading relationships ("extensive margin"). By restricting analysis to observations with positive trade flows, these studies underestimate the effect of the GATT/WTO on trade. If the GATT/WTO provides any incentive for countries to start new trading relationships, then bilateral trade is less likely to be zero if both trading partners are the GATT/WTO members. This in turn implies that the zeros are not randomly dropped. This is a classic problem of sample selection bias. After including these zero trade observations, I find that the GATT/WTO has greatly promoted bilateral trade between its formal members.

Figures 1A-1C and Figures 2A-2B show graphically the extensive and intensive margins of the world trade over 1948-2003.[3] In Figure 1A, for each year, the number of total "one-directional" country pairs is calculated as N*(N-1), where N is the number of countries in that year. Each country pair appears twice a year corresponding to the import of country *i* from country *j* and vice versa. All the country pairs are put into three categories according to whether their import data are positive, zero or missing. The share of positive import observations increased from less than 10% around 1950 to almost 50% in 2003, and the share of zero trade observations decreased from about 50% to slightly more than 20% during the same period. The share of missing (i.e., unreported) import observations had stayed roughly at 30% over years. In Figure 1B, I consider only the country pairs with observed bilateral trade data in both directions (i.e., either positive or zero, and neither is missing). For each year, the number of total "two-directional" country pairs is calculated as N*(N-1)/2 minus the number of the pairs with missing import data in either direction. Therefore each country pair appears only once a year. All of the country pairs are again classified into three categories according to whether the two countries had positive trade in both directions; positive trade in only one direction or no trade in either direction (i.e., observed zeros in both

[2] The creation of new trading relationships might be due to the lowered MFN tariffs or due to more transparency in trade policies of the GATT/WTO members. For example, the Trade Policy Review of the WTO provides detailed information on the trade policies of its member countries.
[3] For all the figures, I consider carefully the inceptions or demises of nations during 1948-2003.

directions). The share of two-way trade observations increased from about 14% around 1950 to almost 60% in 2003, and the share of no-trade observations decreased from nearly 80% to slightly more than 20% during the same period. The share of one-way trade observations had increased slightly before 1980s.

Over the period of my sample, there had been many inceptions and demises of nations, such as the breakdown of the USSR into the 15 union republics. Hence the extensive margin described in the above figures might be contaminated by the new trading relationships added by those newly-born countries. To address this problem, in Figure 1C, I keep only the country pairs with complete series of import records over 1948-2003.[4] Although only slightly more than one third of total country pairs are left, this restricted sample covers almost 90% of the total world trade. The pattern of the extensive margin changes little from that shown in Figures 1A and 1B. Therefore the extensive margin is not driven by the new relationships added by new countries.

Not only have the new trading relations increased sharply over the last 50 years, but also the trade volumes added by these new trading pairs are huge. In Figure 2A, the three lines on the top represents respectively the time series of the total world imports of all the trading partners, the subset of world imports by the country pairs that already had positive imports in 1970 and subset of world imports by the country pairs that already had positive imports in 1948. The two lines at the bottom show the trade volumes added by new trading partners. The lowest line, calculated as the difference between "All Partners" and "Existing Partners in 1970", represents the imports of newly added trading partners since 1970. Similarly, the second line from the bottom, calculated as the difference between "All Partners" and "Existing Partners in 1948", represents the imports of newly added trading partners since 1948. The trade volumes added by new partners are significant. Up to 30% and 15% of total world trade had been added by new partners since 1948 and 1970 respectively. In Figure 2B, I use the restricted sample (the country pairs without missing import data over 1948-2003). The trade volumes added by new trading relationships since 1948 can still account for up to 25% of the world trade.

[4] The incomplete import data series can be due to either inceptions/demises of nations or missing data (i.e., unreported). Further distinguishing these two scenarios from each other should not change the described pattern of the extensive margin, given that 90% of world trade is already covered in the sub-sample.

Although including zero trade flows uncovers a positive role of the GATT/WTO in promoting the world trade, this only solves a part of the puzzle raised by Rose [2004]. It is still unclear why the GATT/WTO has not been effective at the intensive margin (i.e. using only positive trade flows). This suggests that the traditional econometric method (i.e., the log-linear gravity regression) should be reconsidered. When a large number of zeros present in the data, the Tobit model seems to be a good choice to treat zero trade as a corner solution problem. The Tobit model, however, is questionable in the presence of heteroskedastic or non-normal residuals and might be even more inconsistent than the OLS. Another approach, the Poisson regression, has been proposed by Flowerdew and Aitkin [1982] and more recently by Silva and Tenreyro [2006] to estimate the gravity model. The Poisson regression turns out to be more suitable to address the issues of heteroskedastic or non-normal residuals. Using the fixed effects Poisson regression with both positive and zero trade flows, this paper finds that the GATT/WTO has played an important role in creating trade at both the intensive and the extensive margins. All other things equal, two GATT/WTO members would trade 60% more compared to the baseline case of neither being a GATT/WTO member; a country pair with only one of them being a GATT/WTO member would still trade 23% more than the baseline case (externalities). These results imply that nearly one third of the total world trade during 1948-2003 was attributed to the GATT/WTO (41.6 trillion dollar, in 1995 price); and about 30% of the world trade created by the GATT/WTO can be explained by the extensive margin, with the rest 70% explained by the intensive margin.

Recently, Felbermayr and Kohler [2006] consider the intensive and the extensive margins of international trade in a similar way. There are some major differences between my work and theirs. Firstly, my paper focuses on the GATT/WTO membership dummy variables, while they focus on the distance variable. Secondly, a much larger and more reliable dataset is used in my paper. They adopt a sub-sample (1970-1990) from the bilateral trade dataset used by Rose [2004], who has already drops all

of the zero trade observations and even some positive ones.[5] Felbermayr and Kohler [2005] assume that all the other potential country pairs not covered in Rose's dataset had zero bilateral trade. As shown in Figure 1A, about one third of the country pairs had missing import data (i.e., the top category in Figure 1A) for some unknown reasons.[6] It is likely that more missing positive trade flows are incorrectly assigned as zero values during the earlier years than the later years because bilateral trade flows are more systematically recorded for the later years. If this error is positively correlated with the expansion of the GATT/WTO memberships over years, it will cause an overestimation of the role of the GATT/WTO at the extensive margin. The trade data used in my paper are from the original DOT dataset, the World Trade Flows (WTF) dataset and the World Export Data (WED), coving a long period from 1948 to 2003. Zero trade observations in my dataset are systematically recorded and account for more than half of the observations. Finally, a more appropriate econometric method is used in my paper to estimate the gravity model. Felbermayr and Kohler [2005] rely on the Tobit model to estimate the gravity model with zero trade observations. Because some maintained assumptions (normality and homoskedasticity) under the Tobit model are unlikely to hold, the Poisson regression is instead used in my paper and proved to be able to provide more reasonable estimates than the Tobit model.

Another recent paper by Helpman, Melitz and Rubinstein [2006] uses a two-stage estimation procedure to investigate intensive and extensive margins of international trade. Similar to Felbermayr and Kohler [2005], they also assume that the country pairs without recorded positive trade had zero bilateral trade. Instead of using the Tobit estimation, they apply a Heckman-type sample selection procedure. A useful feature of their method is that they can control for the time-varying country-specific fixed effects. Their model is also better suited to explain zero trade flows than the traditional gravity model. For identification purpose, however, they assume that the common religion variable affects the probability of

[5] Some positive trade observations are dropped in the final stage of Rose's dataset due to the missing data on other covariates in the gravity equation, such as GDP. This is irrelevant to the regression results if the data on these covariates are also missing in Felbermayr and Kohler [2005], but affects the figures of total world trade.

[6] Ms. Dorota at the IMF-DOT Data Section told me that many missing trade data in DOT were due to primarily two reasons. First, some countries might not report the data. Second, some countries might report their trade data for a group of trading partners, such as "all the other countries" category, therefore the trade with each individual country in the group is unknown.

having positive trade flows (selection equation), but does not affect trade volumes. The validity of this exclusion condition is often hard to justify and the difficulty to find good instruments might be a concern of their proposed two-stage procedure. In addition, the criticism of Silva and Tenreyro [2006] also applies, as Helpman et al [2006] also adopt the log-linear specification in their bilateral trade regressions. Helpman et al [2006] use the trade data from the World Trade Flows dataset (1970-1997) and conclude that the extensive margin does not contribute in a major way to the growth of world trade. Different from their findings, I find that the extensive margin is very important when using the data with longer time period (1948-2003). Their sample period (1970-1997) excludes the period before 1970, which is the period when the role of the extensive margin was the most prominent. This is clear in Figures 1B and 2A, which correspond to Figures 1 and 2 in Helpman et al [2006].

The rest of this paper is organized as follows: Section 2 discusses the empirical framework and some econometrics issues; Section 3 describes the data; Section 4 shows the empirical results; and Section 5 concludes.

2. Gravity Model and Some Econometrics Issues

The gravity model has become the work-horse in trade literature to estimate bilateral trade flows. In its simplest form, the gravity model for bilateral trade states that import of country i from country j (T_{ij}) are proportional to the product of the two countries' GDPs (Y_iY_j) and inversely proportional to their geographic distance (D_{ij}), i.e.,

$$T_{ij} = \alpha_0 \frac{Y_i^{\alpha_1} Y_j^{\alpha_2}}{D_{ij}^{\alpha_3}} \qquad (1)$$

Different methods have been proposed in the literature to estimate this model empirically.

2.1. Traditional Gravity Regression

Traditionally, the gravity equation is usually specified as a log-linear regression. In practice, this model is often augmented with many other covariates that can potentially affect bilateral trade, such as

geography, culture, history and political or military relations. The functional form of the traditional gravity regression used in this paper is specified as follows:

$$\begin{aligned}\ln T_{ijt} = X\beta = {} & \beta_0 + \beta_1 Bothin_{ijt} + \beta_2 Onein_{ijt} + \beta_3 \ln(Y_{it}) + \beta_4 \ln(Y_{jt}) + \beta_5 \ln(Y_{it} / Pop_{it}) \\ & + \beta_6 \ln(Y_{jt} / Pop_{jt}) + \beta_7 \ln Dist_{ij} + \beta_8 \ln Area_i + \beta_9 \ln Area_j + \beta_{10} Border_{ij} + \beta_{11} Landlock_{ij} \\ & + \beta_{12} Island_{ij} + \beta_{13} ComLang_{ij} + \beta_{14} ComRelig_{ij} + \beta_{15} Colony_{ij} + \beta_{16} Colonizer_{ij} \\ & + \beta_{17} CurColony_{ij} + \beta_{18} CurColonizer_{ij} + \beta_{19} ComColony_{ij} + \beta_{20} Remote_{ijt} + \beta_{21} Hostility_{ij} \\ & + \beta_{22} Alliance_{ijt} + \beta_{23} CU_{ijt} + \beta_{24} RTA_{ijt} + \beta_{25} GSP_{ijt} + \beta_{26} GSP_{jit} + a_t + a_{ij} + \varepsilon_{ijt}\end{aligned} \tag{2}$$

where the subscripts i and j denote importer and exporter respectively, and t denotes year; T_{ijt} is the c.i.f import of i from j in year t; $Bothin_{ijt}$ dummy equals to one if both i and j were GATT/WTO members in year t; $Onein_{ijt}$ dummy equals to one if either i or j was a GATT/WTO member in year t; Y is real GDP and Pop is population; $Dist_{ij}$ is the great circle distance between i and j; $Area$ is the geographic area of a country; $Border_{ij}$ dummy equals to one if i and j share land border; $Landlock_{ij}$ is the number of landlocked nations in a pair (0, 1, or 2); $Island_{ij}$ is the number of island nations in a pair (0, 1, or 2); $ComLang_{ij}$ dummy equals to one if i and j have a common language; $ComRelig_{ij}$ dummy equals to one if i and j have a common religion; $Colony_{ij}$ dummy equals to one if i has ever been a colony of j; $Colonizer_{ij}$ dummy equals to one if i has ever been a colonizer of j; $CurColony_{ijt}$ dummy equals to one if i was currently a colony of j in year t; $CurColonizer_{ijt}$ dummy equals to one if i was currently a colonizer of j in year t; $ComColony_{ij}$ dummy equals to one if i and j has ever been colonized by the same colonizer; $Remote_{ijt}$ is the distance of a country pair to the rest of the world weighted by all the other countries' GDPs in year t; $Hostility_{ij}$ is the military conflict intensity between i and j; $Alliance_{ijt}$ dummy equals to one if i and j were in a formal alliance in year t; CU_{ijt} dummy equals to one if i and j used the same currency in year t; RTA_{ijt} dummy equals to one if i and j belonged to the same regional trade agreement in year t; GSP_{ijt} dummy equals to one if i offered GSP to j in year t; GSP_{jit} dummy equals to one if j offered GSP to i in year t; a_t is the year dummy variable; a_{ij} is the country pair dummy; ε_{ijt} is the residual; and $\{\beta\}$ is the coefficient vector to be estimated. More detailed information regarding the data sources and variable construction can be found in the Section 3.

In my log-linear gravity regressions, the dependent variable $ln(T_{ijt})$ is substituted by $ln(T_{ijt}+1)$ to keep the zero trade values after taking logarithms. The measurement error created is small because trade data are measured in dollars (rather than million or billion dollars). The coefficients of "*Bothin*" and "*Onein*" measure the "trade creation" and "trade diversion" effects of the GATT/WTO respectively. Their estimates are of my particular interest.

2.2. Beyond the OLS: A Tobit Model

It is well known that the coefficient estimates from log-linear regressions are inconsistent when a large number of zero trade observations present in the data. In my dataset, more than 50% of the country pairs have zero trade. This is a standard corner solution problem, and the Tobit model is often taken as a more appropriate method. The Tobit model explains mathematically why the zero trade flows matter.

The standard censored Tobit model assumes that

$$T^* = X\beta + u, \quad u \mid X \sim Normal(0, \sigma^2) \tag{3}$$

where T^* is the latent bilateral trade and X is a vector of covariates. We are interested in both $E(T \mid X)$ and $E(T \mid X, T > 0)$. According to the law of iterated expectations, the relationship between them can be shown as follows:

$$E(T \mid X) = P(T > 0 \mid X) * E(T \mid X, T > 0) \tag{4}$$

where $P(T > 0 \mid X)$ is the conditional probability of positive trade. Many previous papers focus only on $E(T \mid X, T > 0)$, which is not sufficient to evaluate the overall effect of the GATT/WTO. If the conditional probability of positive trade follows a probit model, i.e. $P(T > 0 \mid X) = \Phi(X\beta / \sigma)$, then we can have the following.

$$E(T \mid X, T > 0) = X\beta + \sigma\left[\frac{\phi(X\beta / \sigma)}{\Phi(X\beta / \sigma)}\right] = X\beta + \sigma\lambda(X\beta / \sigma) \tag{5}$$

$$E(T \mid X) = (X\beta / \sigma)X\beta + \sigma\phi(X\beta / \sigma) \tag{6}$$

Now I can show the inconsistencies of the OLS. The first inconsistency of the OLS results from using only the sub-sample for positive trade. In this case, the OLS effectively omits the variable $\lambda(X\beta/\sigma)$ in equation (5). Correlation between λ and X can cause inconsistency of the estimated β. Second, even when we use all the observations, the OLS estimators are still inconsistent. It is clear from equation (6) that $E(T \mid X)$ is nonlinear in X, β and σ. The overall effects of the GATT/WTO on trade are the partial effects of the dummy variables "*Bothin*" and "*Onein*" on $E(T \mid X)$ rather than $E(T \mid X, T > 0)$. Following McDonald and Moffitt [1980], the marginal effect of a binary covariate (*D*) can be obtained as follows:

$$\Delta E(t \mid x) = t^1 - t^0 = \Delta P(T > 0 \mid x) * E(t \mid x, T > 0) + P(T > 0 \mid x) * \Delta E(t \mid x, T > 0) \qquad (7)$$

where t^1 and t^0 are estimated *ln(T)* measured at *D=1* and *D=0* respectively, with other covariates usually but not necessarily measured at their mean values. The first and second terms on the right hand side of equation (7) account for the trade impact of the GATT/WTO at the extensive margin and the intensive margin respectively.

2.3. The Poisson Model

Both the traditional log-linear gravity regression and the Tobit regression are questionable in the presence of heteroskedastic and nonnormal residuals. The Poisson quasi-maximum likelihood estimation, which has been proposed to fit the gravity model of bilateral trade flows by Silva and Tenreyro [2006], can solve these problems.[7] They argue that the standard log-linear regression for the gravity model is inconsistent due to heteroskedasticity of bilateral trade flows. Jensen's inequality says that the expected value of the logarithm of a random variable is different from the logarithm of its expected value, i.e., $E(\ln T) \neq \ln E(T)$. The expected value of the logarithm of a random variable depends both on its mean and on the higher-order moments of the distribution. The log-linear gravity regression only picks up

[7] In earlier regional science literature, the Poisson regression had been suggested by Flowerdew and Aitkin [1982] to estimate immigration flows under a gravity model framework.

the first order approximation, and leaves the higher-order moments in the residuals. This is one of the sources of heteroskedasticity. Moreover, the nonnegative nature of trade flows also causes heteroskedasticity because we only observe the deviations on one side. The heteroskedasticity is critical not only for the efficiency of an estimator but also for its consistency, as regressions produce the estimate of *ln(T)* rather than *T* itself. Although their criticism focuses on log-linear gravity regression, it also applies to the Tobit model. The Tobit model hinges crucially on the assumption of homoskedasticity and normality. If either of these assumptions fails, the entirely functional form of the conditional mean in Tobit will change and the Tobit model might do even worse than the simple OLS.

A natural solution to solve these problems is to estimate the gravity equation multiplicatively (without taking logarithm on *T*) and allow for heteroskedasticity. The Poisson regression turns out to be a good choice. Silva and Tenreyro [2006] justify the hypothesis that conditional variance is proportional to the conditional mean for the Poisson model,[8] although the Poisson regression is consistent even when the variance function is misspecified. Under this assumption, the Poisson quasi-maximum likelihood estimator can be used to estimate the gravity equation. Besides being consistent in the presence of heteroskedasticity, this method also provides a natural way to deal with zero values of the dependent variable. The most commonly used conditional mean specification in the Poisson model is $E(T_{ijt} \mid X_{ijt}) = \exp(X_{ijt}\hat{\beta})$, for which the coefficients can be explained as elasticity if dependent variable (T_{ijt}) is in level and covariates (X_{ijt}) are in logarithms. Using nonparametric tests, Henderson and Millimet [2006] also confirm that the concerns over estimation in levels versus logs, posed in Silva and Tenreyro [2006], are well-founded.

There are other ways to estimate the gravity equation multiplicatively, such as nonlinear least square (NLS) and the Gamma Quasi-Maximum Likelihood estimator (GQMLE). NLS gives more weight to large predicted trade observations in its first order condition. By contrast, GQMLE assumes that the

[8] This shows that the computationally cumbersome nonparametric estimation of the skedastic function as suggested by Delgado [1992] and Delgado and Kniesner [1997] is unnecessary, at least in the context of the gravity equation for bilateral trade flows.

conditional variance is proportional to the square of conditional mean and hence gives less weight to large predicted trade flows. There is a trade-off between the quantity of data and their variances because larger trade flows and GDPs usually have smaller measurement errors but have larger variances.[9] The Poisson regression emerges as a reasonable compromise. The first order conditions of the Poisson model give the same weight to all observations. Silva and Tenreyro [2006] use simulation study to show that the performance of the Poisson model is remarkably better than the other models under heteroskedasticity.[10]

Although Silva and Tenreyro [2006] analyze only cross sectional trade data, all the discussions extend naturally to panel data. The random effects and fixed effects Poisson procedures are proposed by Hausman, Hall and Griliches [1984]. Similar to the linear panel models, the random effects Poisson model (REP) need some additional assumptions to gain efficiency over the fixed effect model. These maintained assumptions are often rejected, according to a Hausman specification test. Some very nice robustness properties of the fixed effect Poisson model (FEP) have been shown by Wooldridge [1999]. The FEP estimator is consistent as long as the conditional mean assumption holds. The distribution of the dependent variable given X and the fixed effects components is entirely unrestricted. In particular, the FEP estimator is still consistent under over-dispersion or under-dispersion and there is no restriction on the serial correlation of the dependent variable over time.

Finally, it is important to note that, to apply the Poisson model, the dependent variable (bilateral trade in this paper) does not have to be count data. As emphasized by Wooldridge [2002, p.676], "while the leading application is to count data, the fixed effect Poisson estimator works whenever *the conditional mean assumption* holds, Therefore, the *dependent variables* could be a nonnegative continuous variable,

[9] Because smaller flows might have larger measurement errors, Frankel and Wei [1993] apply NLS and give more weight to larger flows.

[10] Some semiparametric methods might be useful to address the issues of the distribution assumptions under the Tobit. Powell's [1984] least absolute deviations (LAD) estimator appears to offer some promise. In the panel data setting, Honore [1992] extends Powell's approach and propose a panel Tobit procedure. I tried the LAD method but the results turn out to be problematic. This might be due to the fact that more than 50% of the observations in my dataset have zero trade flows. It is not clear whether an approach based on the conditional median is appropriate or not.

or even a binary response if we believe the unobserved effect is multiplicative..." (Italic parts added by author)

3. Data

The panel dataset used in this paper includes 210 countries or regions (see Appendix 1) over year 1948-2003, with more than one million observations.[11] The inceptions and demises of nations over the sample period are carefully considered. To my knowledge, this is by far the most complete dataset on bilateral trade at the country level.

The dependent variable of my gravity regressions is import, rather than the sum of import and export. Import data are usually regarded as more reliable than export because customs are more interested in tracking import for tariff revenue reasons. Moreover, country or country pair characteristics usually affect import and export differently. Multiple dyadic import data are used in this paper, that is, each country pair appears twice a year corresponding to the import of one country from the other and vice versa. Import data are mainly from the IFS Direction of Trade Statistics (DOT). The import of country *i* from country *j* is filled by the export of *j* to *i* when the former is missing and the latter is available. Other sources, including World Trade Flow dataset (WTF, 1980-1997) and World Export Dataset (WED, 1948-1983), are used when the data are missing in the DOT dataset. A 10% c.i.f. rate is assumed when the export data are used to mirror the missing import data.

GDP and Population data are from several standard sources, including the PWT6.1, PWT5.6, WDI2003, Maddison Historical Statistics, the IMF International Financial Statistics (IFS) and the United Nations Statistical Yearbooks (UNSYB). The US price index (CPI) is used to convert these GDP measures into 1995 real dollars. All the GDP data used in this paper, except those from the IFS, are measured by purchasing power parity (PPP) methods. Previous papers usually simply combine the GDP measures from different sources, ignoring the fact that different data sources may use distinct PPP

[11] There are 175 countries in Rose [2004] and Tomz et al [2007].

methods and hence produce very different GDP estimates.[12] I take this measurement problem into consideration when using multiple data sources to create the GDP series for a country. The PWT6.1 dataset is taken as the base source. The missing GDP data in PWT6.1 are substituted by other datasets after multiplied by a ratio calculated from the overlapped GDP data in the two datasets.[13] This ensures that the whole GDP series follows the same criteria as the PWT6.1.[14] Population data do not have measurement issues, so I simply combine the data from above sources.

GATT/WTO formal membership and regional trade agreement (RTA) data are from the WTO website. Currency Union data are from Glick and Rose [2001]. Following Rose [2004], GSP data are mainly from the UN publication: Operation and Effects of the Generalized System of Preferences. I use all the published reviews 1-10, which offers GSP data for year 1973, 1974, 1975, 1977, 1979, and 1984. In addition, I update the data to 2001 by using another source from the UN: Generalized System of Preferences List of Beneficiaries [2001]. All the gaps are filled by extending the GSP data backward or forward.[15] Some checks and changes are made to the original data according to specific government publications on GSP. The graduations or suspensions of some beneficiaries are also considered.

The following data are from the 2003 CIA Fact Book: geographic areas, latitudes, longitudes, land contiguity, languages, religions, landlocked and island status. The great circle distances are constructed from the latitudes and longitudes of country pairs. Following Dalgin, Mitra and Trindade [2004], "Remoteness" of a country is defined as the distance to the rest of the world weighted by all the other countries' GDPs in a given year. The remote variable for a country pair is simply the product of the two

[12] Maddison (International Comparisons of Output and Productivity Project, ICOP) uses production-based estimates; while PWT and UN (International Comparison Project, ICP) use expenditure-based estimates.

[13] For example, PWT6.1 may offer GDP data for a country over 1948-2000, while another dataset (e.g. WDI2003) has GDP data for this country over 1980-2002. Since we observe the GDP data from both sources for years 1980-2000, we can calculate the ratio of GDP measures from the two datasets. Over a recent five year period (1996-2000), if the GDP data in PWT6.1 is on average 1.2 times higher than WDI2003 data, then the missing data in PWT6.1 for years 2001-2002 will be filled by 1.2 times of the WDI2003 GDP data for 2001-2002.

[14] For my final GDP series, 57% of the observations are from PWT6.1 and 26% from Maddison, with the rest from other sources. The rank of the priority of other sources depends on the completeness of the series.

[15] I extend 1973 GSP back to the original extension date of GSP; assume that the GSP data in 1976 are the same as those in 1975 and data in 1978 are the same as in 1977; extend 1979 and 1984 forward and backward respectively for two years to fill 1980-1983; extend 1984 and 2001 forward and backward respectively for eight years to fill 1985-2000; and extend 2001 to 2003.

countries' remotenesses. For example, the remote variable corresponding to country *i* and *j* in year *t* is defined as

$$Remote_{ijt} = \left(\frac{\sum_{m \neq i} Distance_{mi} GDP_{mt}}{\sum_{m \neq i} GDP_{mt}} \right) \left(\frac{\sum_{m \neq j} Distance_{mj} GDP_{mt}}{\sum_{m \neq j} GDP_{mt}} \right)$$

This remoteness variable serves as a proxy for the "index of multilateral resistance" (Anderson and Wincoop [2003]).[16]

Two less frequently used variables on military conflict and alliance are also included in my regressions. Militarized Interstate Dispute Dataset (Ghosn and Palmer [2003]) provides information on conflicts in which one or more states threatened, displayed, or used force against one or more other states. They assign an ordinal number to each conflict, with higher numbers representing higher hostility.[17] The Formal Alliance dataset (Gibler and Sarkees [2004]) seeks to identify each formal alliance between at least two states that fall into the classes of defense pact, neutrality or non-aggression treaty, or entente agreement. The political and military relationship is expected to be important in determining bilateral trade.

In my final regressions, the number of observation can be as large as 1.2 million. Among these observations, zero flows account for 52%. The observations with positive trade can be as large as 0.57 million. If my data were in single dyadic format, the total number of positive observation should be 0.57/2=0.285 million, which is comparable to the observations in Rose [2004] (0.236 million). The

[16] Recent theoretical developments in gravity model suggest that time-varying country fixed effects can fully absorb the "multilateral resistance" effects in a panel data gravity regression. Using time-varying exporter and importer dummies, however, requires extremely large number of interaction terms in the regressions. Given that 210 countries and 56 years are covered in this paper, the number of additional dummies for exporter*year and importer*year can be as large as 210*56*2 = 23,520. It is computationally cumbersome and impossible to run regressions with such a large number of dummies. To my knowledge, no paper has done this with so many countries and years. I have tried to apply the time-varying country dummies to a sub-sample of my data, but obtained very unreasonable estimates. To reduce the number of dummies, I keep only six years (1950, 1960, 1970, 1980, 1990 and 2000) and run a traditional gravity regression with year-varying importer and exporter dummies on the data with both positive and zero trade flows. The coefficients on "Bothin" and "Onein" are unbelievably large and negative (-25.5 and -13.1 respectively). This signals some serious problems of using these dummies. Therefore, these dummies are not included in the regressions in this paper.

[17] Because the effect of military conflict might persist for many years after the conflict, the data should not be used on a yearly base. Instead, I use the average hostility level over 1946-2001 to measure the conflict *intensity*. This measure considers both the hostility level of each conflict and the frequency of conflicts after World War II.

differences are due to my expanded trade data from the WED, WTF, DOT and their reverse flows, the expanded GDP data and the added recent years (2000-2003). Please refer to Table 1 for some descriptive statistics of the variables used in this paper.

4. Empirical Results

4.1. Traditional Log-Linear Regression Results

The results from pooled OLS, fixed effects and random effects panel regressions are shown in Tables 2 and 3. All the standard errors are the Huber/White/sandwich robust estimates.[18] Table 2 shows the results using only positive trade flows. The coefficients on "*Bothin*" and "*Onein*" dummies are both negative and significant in the pooled OLS regression. "*Bothin*" has a positive and significant coefficient when country pair random or fixed effects are used. The magnitude of the positive coefficients, however, is very small (0.02 and 0.04 respectively). This finding is largely consistent with Rose [2004].

Table 3 reports the results using the full sample. In the first three regressions, "*Bothin*" and "*Onein*" both have large positive and significant coefficients.[19] Based on the Hausman specification test, the fixed effects model is preferred to the random effects model. According to the fixed effects results, all other things equal, two GATT/WTO members would trade 339% more ($e^{1.45}-1=339\%$) than the baseline case of neither being a GATT/WTO member. If one of the two trading partners is not a GATT/WTO member, they would actually trade 55% more ($e^{0.44}-1=55\%$) than the baseline case. The positive coefficient on "*Onein*" may be due to the externalities of the GATT/WTO on non-members.[20] These big numbers show very strong trade creation effects of the GATT/WTO, and no trade division effects at all.

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[18] Due to the multiple dyadic import data used in this paper, others may worry about the correlation between the import of country *i* from *j* and the import of *j* from *i*. Clustering by directional pairs (i.e., taking country pair *ij* and *ji* as a cluster), however, yields little changes in the standard errors.

[19] Similar patterns hold for most of the other covariates, such as RTAs, GSP, currency unions and language ties, that is, their coefficients are much bigger in the full sample regressions (Table 3) than in the positive trade regressions (Table 2). Although the focus of this paper is on the GATT/WTO, the extensive margin is also important in understanding many other factors that might affect trade.

[20] As we know, the United States virtually extends the MFN tariffs to almost all the countries, no matter if a partner is a GATT/WTO member or not. One prominent example is the normal trading relation (NTR) status extended to China by the U.S. before China joined the WTO.

As discussed before, the missing trade data are different from observed zeros and incorrectly assigning zero values to missing trade data can overestimate the role of the GATT/WTO at the extensive margin. To empirically test this hypothesis, I modify the data by assuming that all of the non-positive (zero or missing) import data are zeros. The last regression in Table 3 shows the results using the modified import data. All other things equal, two GATT/WTO members would trade 555% more ($e^{1.88}-1=555\%$) than the baseline case of neither being a GATT/WTO member. The magnitude of this estimate is much larger than that of the corresponding estimate obtained from regression (3) in Table 3 (i.e. 339%). The coefficient estimates on other covariates also differ a lot from those in the regression (3). For example, the coefficients on GDPs halve and those on GSP double. These results show that the consequences of incorrectly assigning zero values to missing trade data are nontrivial.

Overall, one message from the above results is clear: the GATT/WTO had been very effective in creating new trade relationships (extensive margin). The role of the GATT/WTO at the extensive margin can also clearly be shown by a probit regression, where the dependent variable is a dummy indicating whether the import is positive or zero. With country pair random effects, the coefficients on "*Bothin*" and "*Onein*" are both significantly positive (0.27 and 0.09).[21] In terms of marginal effects, all other things equal, a country pair is 11% more likely to trade with each other if both are GATT/WTO members compared with the baseline case of neither being a GATT/WTO member. If only one country is a GATT/WTO member, the country pair is still 4% more likely to trade with each other compared with the baseline case.[22] This is a strong direct evidence of the impact of the GATT/WTO at the extensive margin of international trade.

Although above results send an encouraging message to the GATT/WTO, the estimated positive impact of the GATT/WTO on trade seems bigger than what we expect. The same concern arises from the

[21] No consistent fixed effects Probit estimation is available, as there is no sufficient statistic allowing the fixed effects to be conditioned out the likelihood.

[22] These results are in line with the descriptive statistics shown in Table 1. According to Table 1, 45% of the observations have both countries in a pair as GATT/WTO members when T>0, while this number is only 32% for the full sample. By a simple calculation, only 19% of the zero trade observations have both countries in a pair as GATT/WTO members.

coefficients of some other covariates. Let us again take the fixed effects regression (3) in Table 3 as an example, GSP on average increases bilateral trade by 380% ($e^{(1.48+1.66)/2}-1=380\%$) and currency union raises trade by staggering 2666% ($e^{3.32}-1=2666\%$). Moreover, the elasticity of GDP is always significantly larger than one, which contradicts with the fact that large countries usually are less open in terms of the Trade/GDP ratio. These problems make it necessary to go beyond the traditional log-linear specification and search for more appropriate methods.[23]

4.2. Random Effects Tobit Regression Results

The right panel in Table 4 reports the results from the country pair random effects Tobit regression.[24] As a rule of thumb, the coefficients from Tobit should be multiplied by the share of nonzero observations (48% in my sample) when compared with the coefficients from the OLS regressions. As expected, the coefficients on "*Bothin*" and "*Onein*" are even bigger than those from the log-linear regressions.[25] All other things equal, two GATT/WTO members would trade 730% more ($e^{4.41*48\%}-1=730\%$) than the baseline case of neither being a GATT/WTO member. If one of the two trading partners is not a GATT/WTO member, they would trade 318% more ($e^{2.98*48\%}-1=318\%$) than the baseline case. These numbers seem too high to be true. The same problem happens to many other covariates, such as currency union and GDPs. And surprisingly, the impact of RTAs on trade is significantly negative. All of these problems signal some serious drawbacks of the Tobit regression. As we mentioned before, the Tobit model relies crucially on the assumptions of homoskedastic and normal residuals as in equation (3). Violations of these assumptions will entirely change its functional form. As a rough idea on the appropriateness of the Tobit model, we can compare the coefficients from the Tobit model to those from

[23] I have tried including a lagged dependent variable and estimating the Arellano and Bond's Dynamic panel model. However, I cannot reject the null hypothesis of no second-order autocorrelation, which implies that the estimates are inconsistent. Moreover the coefficients are very sensitive to the number of lags of the dependent variable and instruments, and some coefficients can be very large. Therefore, these results are not reported.

[24] No fixed effect Tobit procedure is available, as there is no sufficient statistic allowing the fixed effects to be conditioned out the likelihood.

[25] Because trade does not vary with gravity regressors when it is censored, standard least squares regression will underestimate the coefficients.

the probit estimates on the left panel of Table 4. Six covariates have the opposite signs in Tobit from those in probit. It signals some serious specification problems of the Tobit model.[26] Ideally we would like to test the residual from the Tobit regression for normality and homoskedasticity. However, this is impossible because we can not observe the latent variable (T^* in equation (3)). It prevents us from estimating the residual (u in equation (3)), which is assumed to be homoskedastic and normally distributed.

Using only the sub-sample (1970-1990) of Rose's dataset, Felbermayr and Kohler [2005] get moderate estimates of the impact of the GATT/WTO from their Tobit regressions and take those results as preferred.[27] There are a number of differences between our data and model specifications. I have tried using the same time period (1970-1990) and similar specifications, but still get larger coefficient estimates on the GATT/WTO dummies.[28] This might be due to the fact that the Tobit model is very sensitive to even small differences in the data or specifications.

4.3. Poisson Regression Results

The results from the Poisson regressions are reported in Tables 5 and 6. For these regressions, the dependent variable is now in levels rather than in logarithms. The conditional mean of the Poisson model, $E(T_{ijt} \mid x_{ijt}) = \exp(x_{ijt}\hat{\beta})$, is estimated multiplicatively.

Table 5 shows the results from the Poisson regressions using only positive trade observations (intensive margin). Again, Hausman test prefers the country pair fixed effects to the random effects. According to the fixed effects results from regression (3), all other things equal, two GATT/WTO members would trade 39% more ($e^{0.33} - 1 = 39\%$) compared to the baseline case of neither being a

[26] Moreover, the random effects Tobit regressions are difficult to converge and can take extremely long time to run due to the using of quadrature to approximate the integrals in the likelihood function.
[27] Their estimates imply that, all other things equal, two GATT/WTO members would trade 163% more than their baseline case of only one country in a pair being a GATT/WTO member (different from my baseline category). If neither country is a GATT/WTO member, they would trade 93% less than their baseline case (trade diversion).
[28] For example, I assume that all missing trade data are zeros; use total trade as the dependent variable; replace the year dummies with a time trend variable; interact time with distance; and replace country pair dummies with importing and exporting country dummies.

GATT/WTO member. If one of the two trading partners is not a GATT/WTO member, they still trade 8% more ($e^{0.08}-1=8\%$) than the baseline case. These results imply that, at the intensive margin, the GATT/WTO had also been effective. Most of the coefficients on other covariates have the expected signs and magnitudes. The coefficients on currency union are very stable (around 0.50-0.60). The elasticity of trade with respect to income is always significantly less than one, which is consistent with the fact that larger countries are on average less open in terms of the Trade/GDP ratio. However, GSP now negatively affects bilateral trade at the intensive margin.

Table 6 shows the results from Poisson regressions using the full sample. Again, the fixed effects regression (3) is taken as the preferred specification. All other things equal, two GATT/WTO members would trade 60% more ($e^{0.47}-1=60\%$) compared to the baseline case of neither being a GATT/WTO member. If one of the two trading partners is not a GATT/WTO member, they still trade 23% more ($e^{0.21}-1=23\%$) than the baseline case. Together with the previous estimates at the intensive margin, these results imply that the extensive margin accounts for 21% (=60%-39%) increase in the trade between two GATT/WTO members (trade creation effects) and 15% (=23%-8%) increase in the trade between GATT/WTO members and non-members (externalities). Considering both the trade creation effects and the externalities, these estimates imply that 41.6 trillion dollars (in 1995 price) of the world import from 1948 to 2003 (one third of the total world import over the same period) was attributed to the GATT/WTO and about 30% of the world import created by the GATT/WTO can be explained by the extensive margin, with the rest 70% explained by the intensive margin.[29] The magnitude of the impact at the extensive margin (30%) is consistent with Figure 2A (30%). This draws a very different picture from the previous log-linear regression results, where almost all of the contributions are explained by the extensive margin. Most of the coefficients on other covariates have the expected signs and magnitudes. According to the regression (3), RTAs increase trade by 38% ($e^{0.32}-1=38\%$) and currency unions almost double the trade within blocs $(e^{0.69}-1=99\%)$. The coefficient on GSP turns positive and significant.

[29] The total world trade from 1948 to 2003 in my sample is 128.2 trillion US dollars (in 1995 price).

4.4. GATT/WTO over Time

It is possible that the GATT/WTO has played different roles over time. To test this hypothesis, I divide my sample period 1948-2003 into five sub-periods according to the GATT trade rounds. Table 7 lists the trade rounds of the GATT, as well as the period for the WTO. According to the subjects covered in each round, I group the first five rounds (1947-1963) as Period 1. The Kennedy, Tokyo and Uruguay Rounds are taken as Periods 2, 3 and 4 respectively. The period since 1995 is taken as the Period 5 (WTO). Table 8 (Panel A) reports the country pair fixed effects regression results for each period, with and without zero trade flows. When considering only positive trade observations, "*Bothin*" is positive and significant only in the first and the last period (Periods 1 and 5). This implies that the GATT had been effective at the intensive margin during the first five trade rounds. After that, more subjects were covered, such as anti-dumping measures, non-tariffs barriers, services, intellectual property rights, dispute settlement, textiles, agriculture, etc, but the progress seemed harder to make. As shown in Table 7, according to the calculation by the WTO, the weighted tariffs reductions are similar in percentage over the five periods. The implied tariffs cut in levels, however, became smaller and smaller as shown by Subramanian and Wei [2007].[30] If countries raised their non-tariff barriers after their tariffs were reduced under certain levels, the tariff reductions alone cannot reflect the effective protection. The insignificant GATT impact after the first five trade rounds might be due to two factors: the smaller room left for further tariff cuts and the increased protection by non-tariff barriers. The significant coefficient on "*Bothin*" for the period since 1995 shows the stronger impact of the WTO than its predecessor. When the zero flows are included, "*Bothin*" is positive and significant for all the periods, except the Uruguay round (actually negative and significant). Overall the magnitudes of the coefficients are moderate compared to those from the regressions using all the 56 years, but very unreasonably large estimates still exist during some periods for currency union, GDPs, etc (not shown in the table to save space).

[30] We should use caution when comparing these numbers over periods because different countries' tariffs data are used in the calculation for different periods.

In the Panel B of Table 8, I show the results from country pair fixed effects Poisson regressions for each period, with and without zero trade observations. With only positive trade flows (at the intensive margin), "*Bothin*" is positive and significant only during the last period (WTO). With the full sample, "*Bothin*" is positive and significant only during the first and the last period.[31] For the last period (WTO), including zero trade flows yields little changes in the results.[32] These results show that the extensive margin of the GATT impact dominated during the first five rounds of the GATT trade talks. However, since the WTO came into being in 1995, the intensive margin dominates. During the periods in between, the GATT did not seem to be effective in promoting the world trade. Although these results are somewhat different from the log-linear regression results in the Panel A, the pattern of the coefficients on "*Bothin*" and "*Onein*" is similar. Table 8 shows that the GATT was the most effective at the beginning (first five rounds), then did little since the Kennedy round, but has fared better after the WTO came into force. It is likely the very reason why Helpman et al [2006] find that the extensive margin does not contribute in a major way to the growth of world trade. Their sample period (1970-1997) excludes the period 1 (1947-1963), which is the period when the role of the extensive margin was the most prominent. My Figure 1B shows that the extensive margin (i.e., the reduction in the share of no-trade observations and the increase in the share of two-way and one-way trade observations) was the most pronounced before 1970, which is not captured by Figure 1 in Helpman et al [2006]. Comparing my Figure 2A to the Figure 2 in Helpman et al [2006], I find that the extensive margin added by the new partners since 1970 is still bigger in my figure than theirs, possibly due to the bigger dataset I use. According to my Figure 2A, the extensive margin added by the new partners since 1948 is even larger. In sum, both my regression results and figures show that the different conclusions drawn in my paper and Helpman et al [2006] are largely at least partially due to the different sample coverage.

5. Conclusions

[31] The insignificant coefficients might be partially due to the relatively short panels for each period.
[32] Many country pairs are dropped in the Poisson regressions in the Panel B either because these country pairs had all zero outcomes throughout the sub-period or because there is only one observation per country pair. Therefore, the numbers of observations used in the Panel B are much smaller than those in the Panel A.

To address the puzzle raised by Rose [2004] on the ineffectiveness of the GATT/WTO in promoting international trade, this paper provides two explanations: sample selection bias and gravity model specification. Firstly, the GATT/WTO not only promotes trade between existing trading partners (intensive margin), but also creates new trading relationships (extensive margin). By restricting analysis to observations having positive trade flows, Rose [2004] and several follow-up papers ignore the new trading relations created by the GATT/WTO and hence underestimate the effect of the GATT/WTO on trade. Secondly, the traditional log-linear gravity model regressions are incapable of handling issues of heteroskedastic and non-normal residuals. This specification problem accounts for the failure in some existing studies to uncover the role of the GATT/WTO at the intensive margin. The Poisson quasi-maximum likelihood estimation turns out to be a more appropriate approach to estimate the gravity model in this context. My fixed effects Poisson regression shows that 41.6 trillion dollars (in 1995 price) of the world import from 1948 to 2003 (one third of the total world import over the same period) are attributed to the GATT/WTO and about 30% of the world import created by the GATT/WTO can be explained by the extensive margin, with the rest 70% explained by the intensive margin. This paper also finds that the extensive margin was the most prominent during the first five GATT rounds, while the intensive margin dominates after the WTO was established. This paper contributes to the existing literature by considering those zero trade flows and investigating appropriate econometric methods to estimate the gravity equation.

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Figure 1A: The Distribution of Country Pairs, One Directional (1948-2003)

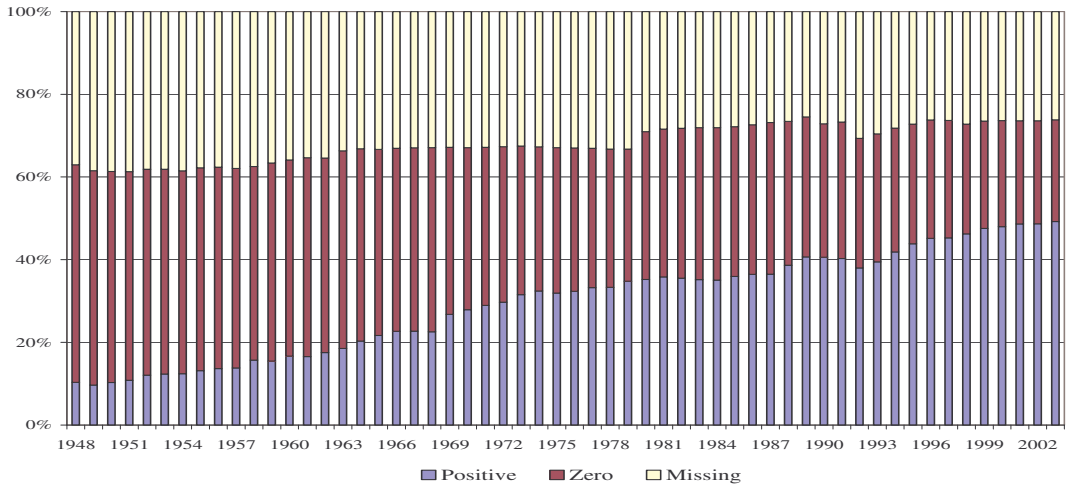

Figure 1B: The Distribution of Country Pairs, Two Directional (1948-2003)

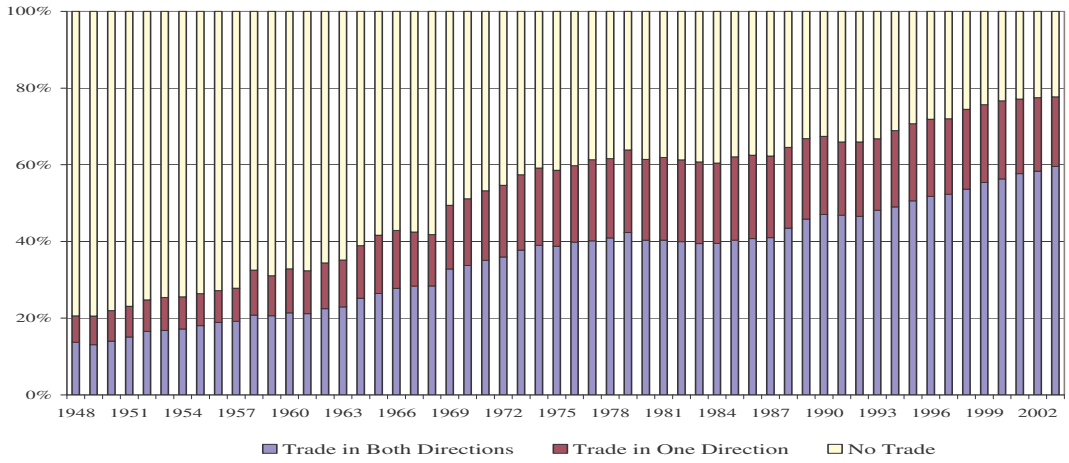

Figure 1C: The Distribution of Country Pairs, One Directional (1948-2003), Including Only Country Pairs Having No Missing Import Data Over 1948-2003

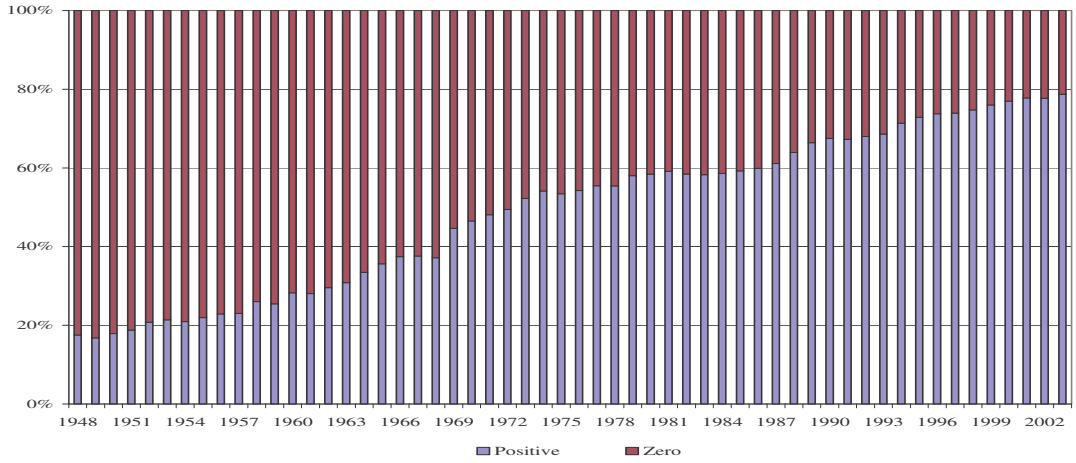

Figure 2A: Trading Partners and Trading Volumes (1948-2003)

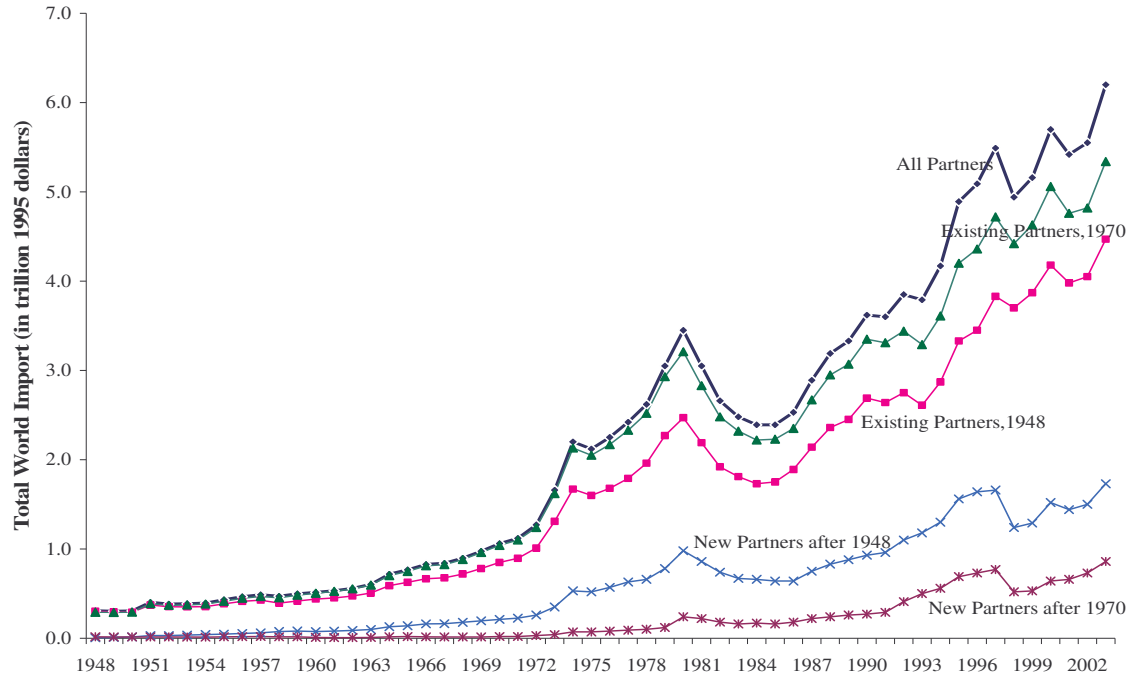

Figure 2B: Trading Partners and Trading Volumes (1948-2003), Including Only Country Pairs Having No Missing Import Data Over 1948-2003 (one third of the country pairs and 90% of world total import are covered)

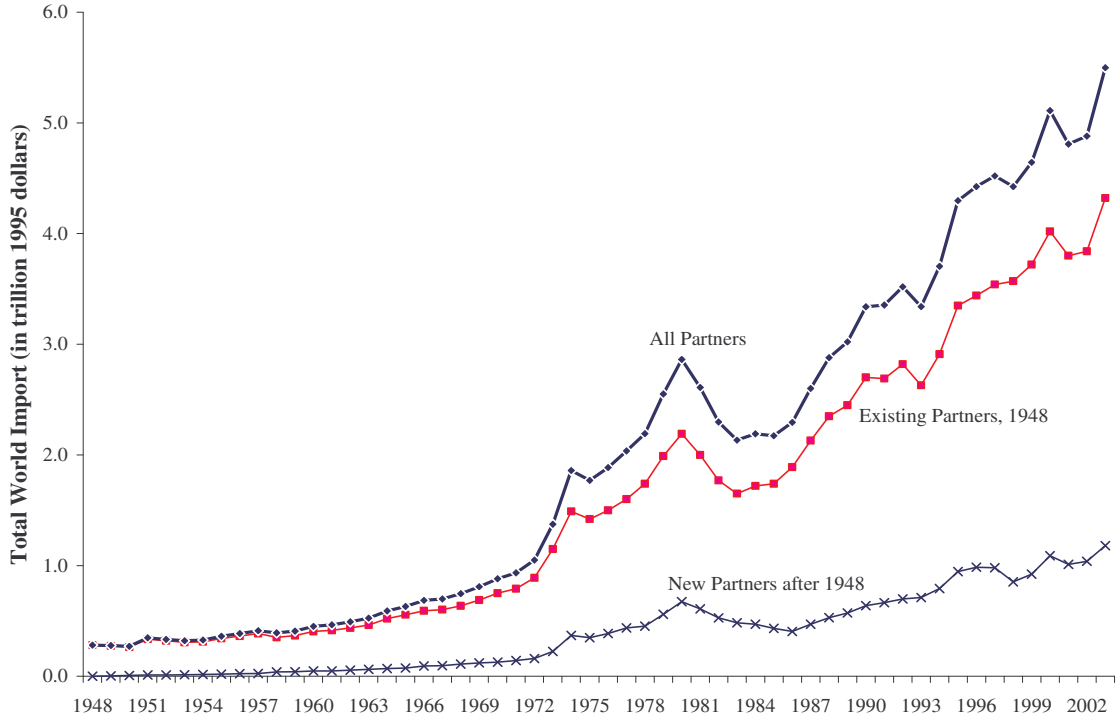

Table 1: Data Description

Variables	Full Sample				T>0 Sample			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
log(Import)ij	7.22	7.86	0	26.1	15.02	3.37	0	26.1
Both in GATT/WTO	0.316	0.47	0	1	0.450	0.50	0	1
One in GATT/WTO	0.470	0.50	0	1	0.448	0.50	0	1
log(GDPi)	9.84	2.20	0.12	16.1	10.45	2.16	0.82	16.1
log(GDPj)	9.87	2.19	0.12	16.1	10.79	2.04	0.82	16.1
log(GDPPCi)	1.31	1.07	-1.97	3.9	1.58	1.07	-1.97	3.9
log(GDPPCj)	1.30	1.07	-1.97	3.9	1.63	1.05	-1.97	3.9
log(Distance)	8.71	0.78	4.15	9.9	8.58	0.85	4.15	9.9
log(AREAi)	11.70	2.54	3.04	16.9	11.83	2.50	3.04	16.9
log(AREAj)	11.74	2.52	3.04	16.9	12.07	2.39	3.04	16.9
Land Adjacency	0.021	0.14	0	1	0.032	0.18	0	1
Landlocked	0.301	0.50	0	2	0.276	0.49	0	2
Island	0.403	0.57	0	2	0.356	0.55	0	2
Same Language	0.114	0.32	0	1	0.120	0.33	0	1
Same Religion	0.504	0.50	0	1	0.551	0.50	0	1
Colony	0.007	0.08	0	1	0.012	0.11	0	1
Colonizer	0.007	0.08	0	1	0.012	0.11	0	1
Current Colony	0.001	0.04	0	1	0.002	0.04	0	1
Current Colonizer	0.001	0.04	0	1	0.002	0.04	0	1
Common Colony	0.162	0.37	0	1	0.153	0.36	0	1
Remoteness	0.832	1.71	0	4.5	0.901	1.76	0	4.5
RTA	0.062	0.24	0	1	0.101	0.30	0	1
GSPij	0.086	0.28	0	1	0.140	0.35	0	1
GSPji	0.086	0.28	0	1	0.154	0.36	0	1
Currency Union	0.023	0.15	0	1	0.028	0.17	0	1
Alliance	0.064	0.24	0	1	0.098	0.30	0	1
Hostility	0.011	0.10	0	3.3	0.017	0.11	0	3.3
No. of Obs	1,184,525				568,983			

Note: Please refer to Sections 2 and 3 in the text for explanations of each variable, their data sources and construction details.

Table 2: Results from Log-linear Gravity Regressions, Using Only Positive Trade Flows

Variables	(1) Pooled OLS		(2) Random Effects		(3) Fixed Effect	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Both in GATT/WTO	-0.08*	0.04	0.02*	0.01	0.04**	0.01
One in GATT/WTO	-0.23**	0.03	-0.10**	0.01	-0.07**	0.01
log(GDPi)	0.85**	0.01	0.85**	0.01	1.02**	0.02
log(GDPj)	0.91**	0.01	0.75**	0.01	0.29**	0.02
log(GDPPCi)	0.27**	0.01	0.16**	0.01	-0.01	0.02
log(GDPPCj)	0.47**	0.02	0.66**	0.01	1.07**	0.02
log(Distance)	-1.04**	0.02	-1.13**	0.02		
log(AREAi)	-0.08**	0.01	-0.09**	0.01		
log(AREAj)	-0.07**	0.01	0.06**	0.01		
Land Adjacency	0.68**	0.08	1.04**	0.08		
Landlocked	-0.38**	0.02	-0.50**	0.02		
Island	0.11**	0.03	0.09**	0.03		
Common Language	0.03	0.05	-0.06	0.05		
Common Religion	0.03	0.02	0.08**	0.03		
Colony	1.38**	0.12	2.33**	0.09		
Colonizer	1.46**	0.12	2.28**	0.12		
Current Colony	1.50**	0.21	0.47**	0.04	0.49**	0.04
Current Colonizer	1.00**	0.25	0.53**	0.06	0.44**	0.06
Common Colony	0.64**	0.04	0.67**	0.05		
Remoteness	-0.02*	0.01	-0.02*	0.01	9.89**	0.32
RTA	0.66**	0.03	0.49**	0.01	0.40**	0.01
GSPij	0.61**	0.03	0.12**	0.01	0.17**	0.01
GSPji	0.59**	0.03	0.27**	0.01	0.12**	0.01
Currency Union	0.66**	0.08	0.68**	0.04	0.67**	0.04
Alliance	0.09*	0.04	0.18**	0.01	0.12**	0.02
Hostility	-0.41**	0.13	-0.18**	0.15		
Year Dummies	Yes		Yes		Yes	
R-squared	0.61					
No. of Obs	568,983					

Notes:
1. Dependent variable is the logarithm of the real import of country *i* from *j*;
2. The standard errors are clustered by country pairs in the pooled OLS;
3. All the standard errors are Huber/White/sandwich robust estimates;
4. "**" and "*" denote 1% and 5% significance level respectively.

Table 3: Results from Log-linear Gravity Regressions, Using the Full Sample

Variables	(1) Pooled OLS		(2) Random Effects		(3) Fixed Effects		(4) Modified data Fixed Effects	
	Coef.	S.E.	Coef.	Coef.	Coef.	S.E.	Coef.	S.E.
Both in GATT/WTO	2.08**	0.06	1.56**	0.02	1.48**	0.02	1.88**	0.02
One in GATT/WTO	0.97**	0.05	0.54**	0.02	0.44**	0.02	0.29**	0.01
log(GDPi)	1.25**	0.02	1.36**	0.01	1.71**	0.03	0.70**	0.02
log(GDPj)	1.74**	0.02	1.90**	0.01	2.25**	0.03	1.22**	0.02
log(GDPPCi)	0.71**	0.03	0.54**	0.02	0.23**	0.03	0.35**	0.02
log(GDPPCj)	0.59**	0.03	0.08**	0.02	-0.39**	0.03	-0.14**	0.02
log(Distance)	-2.08**	0.04	-2.08**	0.03				
log(AREAi)	-0.19**	0.01	-0.22**	0.01				
log(AREAj)	-0.24**	0.01	-0.34**	0.01				
Land Adjacency	1.13**	0.18	1.04**	0.17				
Landlocked	-0.45**	0.04	-0.52**	0.04				
Island	0.24**	0.05	0.44**	0.04				
Common Language	0.30**	0.08	0.28**	0.07				
Common Religion	0.45**	0.04	0.62**	0.04				
Colony	2.84**	0.21	4.08**	0.22				
Colonizer	3.43**	0.24	4.08**	0.25				
Current Colony	-1.10	0.67	-3.81**	0.21	-4.16**	0.21	-3.38**	0.14
Current Colonizer	-0.47	0.68	-3.40**	0.22	-3.65**	0.22	-3.10**	0.14
Common Colony	1.12**	0.07	1.03**	0.06				
Remoteness	0.00	0.02	-0. 05**	0.01	-20.7**	0.86	-28.2**	0.39
RTA	1.27**	0.07	0.74**	0.02	0.72**	0.03	0.58**	0.01
GSPij	2.84**	0.07	1.56**	0.02	1.48**	0.03	3.10**	0.02
GSPji	3.10**	0.06	1.73**	0.02	1.66**	0.03	3.39**	0.02
Currency Union	1.55**	0.15	2.91**	0.09	3.32**	0.1	3.22**	0.07
Alliance	1.10**	0.09	1.38**	0.03	1.46**	0.04	2.46**	0.03
Hostility	-1.48**	0.39	-1.29**	0.28				
Year Dummies	Yes		Yes		Yes		Yes	
R-squared	0.51							
No. of Obs	1,184,525		1,184,525		1,184,525		1,832,054	

Notes:
1. Dependent variable is log(T+1), where *T* is the real import of country *i* from *j*;
2. "**" and "*" denote 1% and 5% significance level respectively;
3. In regression (4), the import data are assumed as zeros if they are missing.

Table 4: Results from the Random Effects Probit and Tobit Regressions

Variables	Probit		Tobit	
	Coef.	S.E.	Coef.	S.E.
Both in GATT/WTO	0.27**	0.01	4.41**	0.04
One in GATT/WTO	0.09**	0.01	2.98**	0.04
log(GDPi)	0.30**	0.00	2.30**	0.03
log(GDPj)	0.52**	0.00	3.53**	0.02
log(GDPPCi)	0.26**	0.01	0.35**	0.03
log(GDPPCj)	0.02**	0.01	-0.86**	0.03
log(Distance)	-0.52**	0.01	-2.44**	0.05
log(AREAi)	-0.01**	0.00	-0.43**	0.02
log(AREAj)	-0.08**	0.00	-0.73**	0.02
Land Adjacency	0.02**	0.03	1.87**	0.13
Landlocked	-0.12**	0.01	-0.79**	0.05
Island	0.19**	0.01	0.96**	0.07
Common Language	0.21**	0.02	2.42**	0.10
Common Religion	0.22**	0.01	1.81**	0.06
Colony	1.28**	0.07	-1.42**	0.00
Colonizer	1.46**	0.07	6.64**	0.24
Current Colony	-1.72**	0.09	-3.60**	0.26
Current Colonizer	-1.50**	0.09	-2.89**	0.27
Common Colony	0.33**	0.02	1.31**	0.09
Remoteness	0.58**	0.01	-37.7**	0.60
RTA	0.52**	0.01	-0.65**	0.04
GSPij	0.49**	0.01	0.67**	0.04
GSPji	0.85**	0.03	0.56**	0.04
Currency Union	-3.19**	0.13	5.64**	0.12
Alliance	0.46**	0.01	2.59**	0.07
Hostility	0.15**	0.00	-2.31**	0.19
Year Dummies	Yes		Yes	
Country Pair RE/FE	RE		RE	
No. of Obs	1,184,525		1184525	
Pseudo R2				
rho	0.49		0.36	

Notes:
1. Dependent variable in Probit regressions is a dummy which equals to one if the import of *i* from *j* is positive and equals to zero if the import is zero (not missing);
2. Dependent variable in Tobit regression is log(T+1), where *T* is the real import of country *i* from *j*;
3. "**" and "*" denote 1% and 5% significance level respectively;

Table 5: Results from the Poisson Regressions, Using Only the Positive Trade Flows

Variables	(1) Pooled Data		(2) Random Effects		(3) Fixed Effects	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Both in GATT/WTO	-0.46**	0.11	-0.04	0.03	0.33**	0.04
One in GATT/WTO	-0.36**	0.10	-0.16**	0.03	0.08**	0.04
log(GDPi)	0.79**	0.02	0.75**	0.01	0.59**	0.04
log(GDPj)	0.74**	0.03	0.62**	0.01	0.38**	0.03
log(GDPPCi)	0.60**	0.05	0.36**	0.01	0.44**	0.03
log(GDPPCj)	0.60**	0.06	0.66**	0.01	0.90**	0.03
log(Distance)	-0.54**	0.07	-0.76**	0.02		
log(AREAi)	-0.08**	0.03	-0.06**	0.01		
log(AREAj)	-0.03	0.02	0.05**	0.01		
Land Adjacency	0.52**	0.10	0.69**	0.06		
Landlocked	-0.48**	0.06	-0.47**	0.03		
Island	0.09	0.07	0.29**	0.03		
Same Language	0.54**	0.14	0.06	0.05		
Same Religion	-0.50**	0.09	-0.34**	0.02		
Colony	0.24	0.17	1.24**	0.09		
Colonizer	-0.02	0.16	0.95**	0.09		
Current Colony	1.34**	0.27	0.78**	0.09	0.66**	0.10
Current Colonizer	1.32**	0.24	0.85**	0.10	0.75**	0.10
Common Colony	0.31**	0.13	0.41**	0.04		
Remoteness	0.02	0.03	-0.05**	0.01	4.11**	0.35
RTA	0.30**	0.07	0.36**	0.01	0.33**	0.01
GSPij	0.08	0.10	-0.08**	0.02	-0.06**	0.02
GSPji	0.00	0.07	-0.26**	0.02	-0.23**	0.02
Currency Union	0.49**	0.14	0.55**	0.06	0.59**	0.07
Alliance	0.14*	0.07	0.38**	0.02	0.44**	0.03
Hostility	0.05	0.18	0.10	0.08		
Year Dummies	Yes		Yes		Yes	
Country Pair RE/FE	No		RE		FE	
No. of Obs	568,983		568,983		566,119	
Alpha			0.75**	0.02		
Log Likelihood	-134139		-107837		-84557	

Notes:
1. The dependent variable, import, is measured in level;
2. "**" and "*" denote 1% and 5% significance level respectively;

Table 6: Results from the Poisson Regressions, Using the Full Sample

Variables	(1) Pooled Data		(2) Random Effects		(3) Fixed Effects	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Both in GATT/WTO	-0.16	0.11	0.22**	0.03	0.47**	0.04
One in GATT/WTO	-0.13	0.10	0.07**	0.03	0.21**	0.03
log(GDPi)	0.80**	0.02	0.80**	0.01	0.76**	0.03
log(GDPj)	0.76**	0.03	0.71**	0.01	0.62**	0.03
log(GDPPCi)	0.61**	0.05	0.36**	0.01	0.31**	0.03
log(GDPPCj)	0.60**	0.06	0.63**	0.01	0.71**	0.03
log(Distance)	-0.54**	0.07	-0.86**	0.02		
log(AREAi)	-0.08**	0.03	-0.08**	0.01		
log(AREAj)	-0.02	0.02	0.03**	0.01		
Land Adjacency	0.51**	0.10	0.70**	0.06		
Landlocked	-0.46**	0.06	-0.48**	0.03		
Island	0.09	0.07	0.29**	0.03		
Same Language	0.49**	0.15	0.10**	0.05		
Same Religion	-0.50**	0.09	-0.29**	0.02		
Colony	0.28*	0.17	1.34**	0.10		
Colonizer	0.00	0.16	1.09**	0.10		
Current Colony	1.30**	0.27	0.62**	0.09	0.49**	0.09
Current Colonizer	1.29**	0.26	0.63**	0.10	0.53**	0.10
Common Colony	0.33**	0.13	0.44**	0.04		
Remoteness	0.03	0.03	-0.07**	0.01	5.05**	0.34
RTA	0.31**	0.07	0.36**	0.01	0.32**	0.01
GSPij	0.13	0.10	-0.03	0.02	0.06**	0.02
GSPji	0.08	0.07	-0.22**	0.02	0.22**	0.02
Currency Union	0.57**	0.14	0.62**	0.06	0.69**	0.07
Alliance	0.14**	0.07	0.43**	0.02	0.49**	0.03
Hostility	-0.05	0.19	0.03	0.09		
Year Dummies	Yes		Yes		Yes	
Country Pair RE/FE	No		RE		FE	
No. of Obs	1,184,525		1,184,525		1,119,372	
Alpha			0.82**	0.02		
Log Likelihood	-138820		-111272		-87267	

Notes:
1. The dependent variable, import, is measured in level;
2. "**" and "*" denote 1% and 5% significance level respectively.

Table 7: The GATT Trade Rounds and the WTO

Period	Years Covered	Round	Subjects Covered (a)	Weighted Tariff Reduction (b)	Implied Tariff Level at the beginning (c)
1	1948-1963	Geneva	Tariffs	36 percent (1)	15.4
		Annecy	Tariffs		
		Torquay	Tariffs		
		Geneva	Tariffs		
		Dillon Round	Tariffs		
2	1964-1972	Kennedy Round	Tariffs and anti-dumping measures	37 percent (2)	11.3
3	1973-1985	Tokyo Round	Tariffs, non-tariff measures, "framework" agreements	33 percent (3)	8.3
4	1986-1994	Uruguay Round	Tariffs, non-tariff measures, rules, services, intellectual property, dispute settlement, textiles, agriculture, creation of WTO, etc	38 percent (4)	6.2
5	1995-2003	WTO			

Notes :
* Years between two consecutive rounds are included in the previous round.
* Industrial products excluding petroleum in the tariffs calculations:
  (1) US only;
  (2) US, Japan, EC(6), and UK;
  (3) US, EU(9), Japan, Austria, Finland, Norway, Sweden and Switzerland;
  (4) US, EU(12), Japan, Austria, Finland, Norway, Sweden, and Switzerland.

Sources:
  (a). http://www.wto.org/english/thewto_e/whatis_e/tif_e/fact4_e.htm
  (b). http://www.wto.org/english/thewto_e/minist_e/min99_e/english/about_e/22fact_e.htm#tariffcuts
  (c). Subramanian and Wei [2007], Table 1.

Table 8: Results from the Fixed Effects Regressions by the GATT/WTO Rounds

	Period 1 (Pre-Kennedy)				Period 2 (Kennedy)				Period 3 (Tokyo)				Period 4 (Uruguay)				Period 5 (WTO)			
	T>0 Sample		Full Sample		T>0 Sample		Full Sample		T>0 Sample		Full Sample		T>0 Sample		Full Sample		T>0 Sample		Full Sample	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Panel A: log-linear																				
Bothin	0.22**	0.03	1.01**	0.08	-0.03	0.04	0.56**	0.09	-0.08	0.06	0.34**	0.11	-0.08	0.05	-0.24**	0.08	0.32**	0.05	0.53**	0.10
Onein	0.16**	0.02	0.50**	0.05	-0.06	0.03	0.22**	0.06	-0.02	0.05	0.41**	0.08	-0.10*	0.05	-0.25**	0.06	0.07	0.04	0.31**	0.09
No. of Obs	64892		238573		70216		175553		148916		297336		128242		232721		156717		240342	
Panel B: Poisson																				
Bothin	0.19	0.15	0.38*	0.15	-0.06	0.17	-0.05	0.17	-0.03	0.22	0.01	0.22	-0.17	0.22	-0.15	0.22	0.33*	0.14	0.32*	0.14
Onein	0.13	0.13	0.26*	0.13	-0.04	0.14	-0.04	0.14	0.06	0.20	0.08	0.20	-0.14	0.21	-0.13	0.21	0.18	0.13	0.17	0.13
No. of Obs	63910		109314		68428		104354		146486		229208		124250		182991		154095		201674	

Notes:
1. The definition of the periods can be found in Table 7;
2. "**" and "*" denote 1% and 5% significance level respectively;
3. The Panel A shows the results from the traditional log-linear gravity regressions, with country pair fixed effects;
4. The Panel B shows the results from the Poisson regressions, with country pair fixed effects.

Appendix 1: Countries or Regions Covered in this Paper (Total #: 210)

Afghanistan
Albania
Algeria
Andorra
Angola
Anguilla
Antigua & Barbuda
Argentina
Armenia
Aruba
Australia
Austria
Azerbaijan
Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin
Bermuda
Bhutan
Bolivia
Bosnia & Herzegovina
Botswana
Brazil
Brunei
Bulgaria
Burkina Faso
Burma
Burundi
Cambodia
Cameroon
Canada
Cape Verde
Cayman Islands
Central African Rep.
Chad
Chile
China
Colombia
Comoros
Congo, Dem. Rep. of
Congo, Rep. of
Costa Rica
Cote D Ivoire
Croatia
Cuba
Cyprus
Czech Rep.
Czechoslovakia
Denmark
Djibouti
Dominica
Dominican Rep.
East Timor
Ecuador
Egypt
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Fiji
Finland
France
French Guiana
French Polynesia
Gabon
Gambia
Georgia
Germany, Dem. Rep.
Germany, Fed. Rep.
Ghana
Greece
Greenland
Grenada
Guadeloupe
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Kiribati
Korea, North
Korea, South
Kuwait
Kyrgyzstan
Laos
Latvia
Lebanon
Lesotho
Liberia
Libya
Lithuania
Luxembourg
Macao
Macedonia
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Martinique
Mauritania
Mauritius
Mexico
Moldova
Mongolia
Morocco
Mozambique
Namibia
Nauru
Nepal
Netherlands
Netherlands Antilles
New Caledonia
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Palau
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Reunion
Romania
Russia
Rwanda
St. Helena
St. Kitts & Nevis
St. Lucia
St. Vincent & Grenadines
Samoa
Sao Tome & Principe
Saudi Arabia
Senegal
Serbia & Montenegro
Seychelles
Sierra Leone
Singapore
Slovakia
Slovenia
Solomon Islands
Somalia
South Africa
Spain
Sri Lanka
Sudan
Suriname
Swaziland
Sweden
Switzerland
Syria
Taiwan
Tajikistan
Tanzania
Thailand
Togo
Tonga
Trinidad & Tobago
Tunisia
Turkey
Turkmenistan
Tuvalu
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
USSR
Uzbekistan
Vanuatu
Venezuela
Vietnam
West Bank
Western Sahara
Yemen, Arab Rep.
Yemen, People's Rep.
Yemen, Rep. of
Yugoslavia
Zambia
Zimbabwe