GATT/WTO membership does promote international trade after all – Some new mmpirical evidence

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GATT/WTO Membership Does Promote International Trade After All – Some New Empirical Evidence

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Abstract: The declared objective of the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) is to promote free trade between member states. Nonetheless, an exhaustive study of bilateral merchandise trade based on a large panel data set led Rose (2004) to conclude that there is no compelling empirical evidence to show that GATT/WTO membership does actually encourage international trade. This unanticipated finding generated a great deal of attention in the literature and several scholars put forward various explanations for it. In this paper we set up a new international trade data set which, unlike Rose's, allows us to model exports and imports separately and to study the extensive margin of trade, *i.e.*, the number of bilateral trade relationships. Using this data set and a gravity framework, first we demonstrate how to obtain puzzling negative results and so explain the previous unintuitive findings. Then we show that GATT/WTO membership does indeed encourage international trade, so the most obvious reason for Rose's negative outcome is the lack of zero bilateral trade observations in his data set.

Key words: GATT/WTO, international trade, gravity model, panel data.

JEL classification: C23, F13, F49.

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1. Introduction

New data sets which are becoming larger, richer, more informative and more reliable by the day, combined with the latest econometric and modeling tools, urge the revision of many old problems and questions that have previously been assumed to be satisfactorily answered. A case in point is in modeling international trade. Since the pioneering studies of *Tinbergen* [1962] and *Pyhnen* [1963] the gravity model has been the workhorse in this field. Its popularity is partly due to its empirical success in capturing the impact of trade liberalization and in assessing the effect of geographic regions and international agreements on trade.

Probably the best known examples for these agreements are the General Agreement on Tariffs and Trade (GATT), which was first signed by 23 countries in 1947, and its successor the World Trade Organization (WTO), which was established in 1995 and currently has 153 member countries. Their declared objective is to promote free trade between member states. Even so, in his recent seminal paper Rose (2004) argued that in spite of this wishful thinking, conventional wisdom and casual empiricism, there is no compelling empirical evidence to support the widespread claim that GATT/WTO membership has actually encouraged international trade. However, the fact that time-after-time existing and acceding countries alike are willing to cover the increasing costs of accession clearly suggests a strong belief that it will promote trade between them (*Felbermayr and Kohler* [2007]).

Unsurprisingly, Rose (2004) attracted many critiques which focused primarily on: pooling developed and developing countries; the classification of participating and non-participating countries; multilateral resistance to trade; the neglect of the extensive margin of trade; the selection of the dependent variable; and the specification and estimation of the econometric model. We believe that there is merit in all of these critiques, although we also feel that the positive impact of GATT/WTO on trade should reveal itself quite straightforwardly. We perform our analyses on a new, updated international trade data set which has two major advantages over Rose's: it contains zero trade flows; and separately includes both export and import flows. The coverage of our sample is slightly larger than that of Rose's (180 countries), but its time span is a bit shorter (46 years). The temporal sample size is restricted so that the required measurements be as homogenous, reliable and comparable as possible.

Thus the key aim of this study is to shed some light on the puzzling findings of Rose (2004), who found little compelling evidence that GATT/WTO membership encourages trade. Using a range of techniques, we find unequivocal evidence to the

contrary, and that Rose's (2004) findings are probably attributable to the lack of zero bilateral trade flows in his data set.

2. Benchmark Study: Rose(2004)

In order to assess the effect of GATT/WTO membership on bilateral trade, Rose (2004) used a standard gravity model augmented by a number of conditioning variables related to culture, geography, history, and international trade agreements. The specification of the model was:

$$\begin{aligned}\ln ART_{ijt} = {} & \beta_0 + \beta_1 \ln(RGDP_{it} \times RGDP_{jt}) + \beta_2 \ln\left(\frac{RGDP_{it}}{POP_{it}} \times \frac{RGDP_{jt}}{POP_{jt}}\right) \\ & + \beta_3 \ln DIST_{ij} + \beta_4 \ln(LAND_i \times LAND_j) + \beta_5 CLANG_{ij} + \beta_6 CBORD_{ij} \\ & + \beta_7 NLLOCK_{ij} \beta_8 NISLAND_{ij} + \beta_9 EVCOL_{ij} + \beta_{10} COMCOL_{ij} \\ & + \beta_{11} ISCOL_{ijt} + \beta_{12} CNAT_{ij} + \beta_{13} MUNI_{ijt} + \beta_{14} RTA_{ijt} + \gamma_1 ONEIN_{ijt} \\ & + \gamma_2 BOTHIN_{ijt} + \gamma_3 GSP_{ijt} + \sum \varphi_t YD_t + \varepsilon_{ijt}\end{aligned} \tag{1}$$

where ln denotes the natural logarithm and i denotes source country, j target country and t time period (year). The variables are defined as: ART- average real bilateral trade between countries; $RGDP$- real GDP; POP-population; $DIST$- great circle distance; $LAND$- land areas; $CLANG$- dummy variable for common language; $CBORD$- dummy variable for common land border; $NLLOCK$- number of landlocked countries in the country pair; $NISLAND$- number of island countries; $EVCOL$- dummy variable for ever colonized; $COMCOL$- dummy variable for common colonizer; $ISCOL$- dummy variable for colonizing; $CNAT$- dummy variable for common nation; $MUNI$- dummy variable for monetary union; RTA- dummy variable for regional trade agreement; $ONEIN$- dummy variable for one country in GATT/WTO; $BOTHIN$- dummy variable for both countries in GATT/WTO; GSP- dummy variable for Generalized System of Preferences; and YD- year dummy variable.

Whilst the coefficients, $\beta_1, \ldots, \beta_4$ are elasticities, $\beta_5, \ldots, \beta_{14}$ and γ_1, γ_2, γ_3 are semi-elasticities. One would expect richer countries; countries that share a language, land border, or colonial history; countries that belong to the same trading group, monetary union, or have some special bilateral agreement; all to trade more with each other. On the other hand, countries that are far apart, or geographically larger are likely to trade less. Whether being landlocked or an island nation encourages trade or not seems to be ambiguous.

Turning to the key variables in this study ($ONEIN$ and $BOTHIN$) if GATT/WTO membership has a positive effect on trade, one would expect these variables to have positive coefficients (γ_1 and γ_2) and the latter to dominate. On the other hand, if these variables represent 'trade diversion' and 'trade creation' effects of GATT/WTO membership, then one would expect $\gamma_1 < 0$ and $\gamma_2 > 0$ (although γ_1 could still be positive due to the externalities of GATT/WTO on non-member countries).

Rose [2004] estimated this model using a two-dimensional (country-pair and time) unbalanced panel data set for 175 countries over the 1948-1999 sample period. The data were collected from various sources.[4] Most importantly, average real bilateral trade (ART) between any given pair of countries was calculated by taking the arithmetic mean of merchandise exports (f.o.b., free on board) and imports (c.i.f., cost, insurance and freight) in both directions, *i.e.*, of potentially four different measures. The nominal data on exports and imports in US dollars were taken from the IMF's *Direction of Trade Statistics* and were deflated by the US CPI for all urban consumers (1982-84 = 100). Population (POP) and real GDP ($RGDP$) data came from three sources: the *Penn World Tables*; the World Bank's *World Development Indicators*; and the IMF's *International Financial Statistics*. Data on GATT/WTO membership ($ONEIN$, $BOTHIN$) were obtained from the WTO's web site, and on the Generalized System of Preferences (GSP) from the UN's *Operation and Effects of the Generalized System of Preferences* booklets (published in 1974, 1979, and 1984).

Rose's 'default' OLS results are reproduced in *Table* 1. Overall, the results seem to be statistically satisfactory, the model explains close to 2/3 of the total variation in bilateral trade, and the significant coefficients have the expected signs. However, the GATT/WTO membership dummy variables are insignificant. In order to see how robust this finding was, Rose (2004) experimented with alternative specifications, estimation methods, subsets of countries, and sample periods, and concluded that none of the eighty-plus regressions lent support to the hypothesis that GATT/WTO membership systematically encourages trade.

[*Insert Table 1 here.*]

In the 'Country fixed effects' column of *Table* 1 we report only one of these regressions based on model (1) augmented with country specific fixed effects.[5] Compared to the

[4] The exact data sources can be found in *Rose* [2004], p. 101.

[5] At one stage *Rose* [2004], p. 100 mentions that "unless otherwise noted, fixed and random effects are always country-pair specific", but he must have used country specific fixed effects since a set of country-pair dummy variables would be perfectly multicollinear with all those independent variables which change in the ij dimension

'default' results, the qualitative effect of these fixed effects is striking: the coefficient of $BOTHIN$ too became significantly positive. It suggests that bilateral trade between two GATT/WTO members is expected to be about 16% more than between non members.[6] Although *Rose* [2004], p. 104 light-heartedly dismissed this finding on the ground that the estimated effect of GATT/WTO membership on trade is small compared to other effects, it still raises doubts about Rose's (2004) overall conclusion.

3. Follow-up Studies and Related Literature

Since its publication, *Rose* [2004] has attracted much attention and inspired a new field of research that focuses on the impact of trade treaties and organizations. Specifically, the outright rejection of a positive link between GATT/WTO membership and bilateral trade attracted many critiques. A number of potential reasons behind this seemingly implausible negative result have been raised in the literature, some of them related to the data set, others to the specification and estimation of the gravity equation.[7] In this section we briefly consider the six most relevant of them in turn (homogeneity of group members, formal and informal membership, absolute and relative trade barriers, endogeneity, zero trade flows and heteroskedasticity).

First, although the GATT/WTO was set up to promote world trade, in terms of trade policy the formal members have never been, and are not currently, a homogeneous group of countries neither in comparison to each other nor to non-members. This is partly due to the fact that prior to 1994 developing countries wishing to accede were not required to reduce their own trade barriers significantly, and that many developing countries are net exporters of fuels and minerals which traditionally face relatively low tariffs in developed countries. Consequently, the impact of GATT/WTO membership is likely to be greater on trade for developed countries, but this impact might be blurred in a mixed sample of developed and developing countries.

This is one of the key arguments of *Subramanian and Wei* [2007]. Similarly to Rose, they relied on a gravity equation, but they distinguished developed and

but not in time, as for example, $DIST_{ij}$. However, country specific fixed effects do not fit naturally into a country-pair and time framework and their application tacitly assumes that the group of country specific variables that are not considered explicitly has a constant impact on a country's international trade; let it be export or import and irrespectively of the trading partner.

6 $\frac{ART_{ijt,BOTHIN=1}}{ART_{ijt,BOTHIN=0}} - 1 = e^{0.15} - 1 = 0.1618$.

7 See *Piermartini and Teh* [2005], pp. 47-52 for a brief summary. This review and the related articles make reference to several unpublished manuscripts, but whenever it is possible we rely on their final paper versions.

developing GATT/WTO member countries. Moreover, since the relevant trade theories focus on unidirectional trade rather than total trade, their dependent variable was imports by country i from country j (as opposed to the average of the four potential flows between them). Finally, in order to proxy for 'multilateral trade resistance' in a panel data context, following *Anderson and van Wincoop* [2003], they augmented equation (1)with time-varying importer and exporter fixed effects and dropped the country-specific variables.

Using an updated version of Rose's data set,[8] containing five-yearly observations between 1950 and 2000 inclusively, *Subramanian and Wei* [2007] managed to show that GATT/WTO membership had a statistically significant and economically substantial positive effect on world trade, amounting to about 120 percent of additional world trade. This impact, however, is uneven: it is important for the imports of developed countries, for trade in the non-protected sectors, and for the new members, but it is marginal for the imports of developing countries, for trade in the protected sectors, and for the long term members.

A second thematic critique of Rose was investigated by *Tomz et all* [2007]. The tenet here was that many countries aspiring for membership enjoyed preferential treatment, most favored nation status, or voluntarily reduced their own trade barriers before accession, while member countries were allowed fairly lengthy transition periods for tariff reduction (usually 5 to 10 years); and that GATT/WTO agreements, rights and obligations have been applied not only to formal members but also to non-member participants, such as colonies, newly independent states and provisional members.[9] Using the same data and methods as Rose but classifying countries by actual participation rather than formal membership, they showed that GATT/WTO increased the trade of both formal members and non-member participants substantially. In particular, according to the benchmark specification, compared with countries outside the agreement, trade is about 31 percent higher when one of the two trading partners participates in GATT/WTO, and it is 72 percent higher when both trading partners participate.[10]

[8] The observations for the new dependent variable, imports, were obtained directly from the IMF's Direction of Trade Statistics, while observations for variables not present in equation (1) were obtained from additional UN sources (TRAINS and COMTRADE databases).

[9] According to *Tomz et. all* [2007] p. 2016, "Over half of the observations that Rose classified as involving no GATT members actually involved countries that were bound by the agreement."

[10] Strangely, however, non-member participation seems to have a larger positive impact on trade than formal membership.

Third, *Anderson and van Wincoop* [2003] argued that bilateral trade is affected not simply by the absolute trade barriers between the two countries, but by the relative trade barriers, *i.e.*, by the barriers between them relative to the average trade barriers they face with all their trading partners. For this reason, equation (1) has to be augmented with some multilateral resistance terms which are functions of all bilateral trade barriers. In practice, these terms are often proxied with remoteness variables, though according to *Anderson and van Wincoop* [2003] they are rather related to some unobservable implicit price indices of the trading partners. The main contribution of this paper is the development of a theory-consistent gravity equation. However, for illustration, the authors estimated their model for the 10 provinces of Canada and 30 states of the US that account for about 90 percent of trade between these two countries using 1993 data and showed that the McCallum border puzzle is mainly due to model misspecification.[11]

Fourth, Rose tacitly assumed that all right-hand side variables in equation (1) are determined exogenously. However, obvious candidates for endogeneity are the GDPs of the partner countries which, by definition, include trade balances. This might not be a major problem though because net exports are typically fairly small compared to GDP and the shares of individual bilateral trade flows are even smaller (*Baier and Bergstrand* [2007], p. 79. A potentially more serious endogeneity bias is due to the fact that GATT/WTO or RTA membership might be influenced by bilateral trade flows and that countries "self-select" themselves into these "treatment" variables.[12]

Magee [2003] also considered the possible presence of endogeneity in gravity models and accordingly used instrumental variables (IV) in a cross-sectional model. *Baier and Bergstrand* [2007], however, rejected the IV method for addressing endogeneity bias in cross-sectional gravity models due to unconvincing instrument validity. Instead, they advocated the use of panel data (in levels) with country-pair and country-and-time fixed effects; or first-differenced panel data with country-and-time fixed effects. Based on five-yearly data[13] from 1960 to 2000 for 96 countries, the results of Baier and Bergstrand indicate that, on average, a free trade agreement increases partner country trade by about 100% after 10 years.

[11] The so called border puzzle refers to *McCallum* [1995] finding that intranational trade among Canadian provinces in 1988 was more than twenty times larger than international trade between country-regionplaceU.S. states and Canadian provinces.

[12] *Trefler* [199]) and *Lee and Swagel* [1997] focused on a similar endogeneity bias in estimating the effect of non-tariff barriers on trade flows.

[13] Nominal trade flows from the IMF's Direction of Trade Statistics and nominal GDP from the World Bank's World Development Indicators had been scaled by GDP deflators, while the data for most other variables were compiled from the CIA's $WorldFactbook$.

The next issue related to Rose's findings is to do with the issue of zero trade observations. The log-linear specification gravity equations require that all trade flow observations be positive. This is an important restriction because about half of all country pairs do not trade with each other at all, while many others do but relatively little so in the IMF's *Direction of Trade Statistics* (and similar data banks) their bilateral trade flows are recorded as zero. Unfortunately, in these datasets the 'genuine' and 'rounded' zeros cannot be distinguished, and it is similarly impossible to distinguish between zero and missing trade flows.

A simple pragmatic solution to zero observations in general is to increase all trade flow measurements by a small amount, as for example in *Harris et. all* [2002].[14] Yet, Rose and several other empirical studies rather dropped zero trade observations and focused on those country pairs and time periods for which positive trade flows were recorded. Among others, *Helpman et al* [2008] and *Felbermayr and Kohler* [2006] criticized this practice because by considering the intensive margin of trade (the growth of trade in existing relationships) but ignoring the extensive margin of trade (the change in the number of bilateral trade relationships) these studies produced biased estimates with dubious interpretations.

To avoid this bias, *Helpman et al* [2008] proposed a simple two-equation model, along the lines of *Heckman* [1979], based on differentiated products and heterogeneous firms. They implemented three two-stage estimation procedures that make use of the information contained not only in the data of trading partners but that of non-trading countries too: a fully parameterized non-linear least squares (NLS) method; a semi-parametric method; and a non-parametric method. In each case, the first stage involved the estimation of a probit selection equation of the trading partners and subsequently the predicted probabilities of trading were used in the second stage estimation of a gravity equation with importing and exporting country fixed effects. The results based on the real exports between 158 countries in 1986 indicate that the traditional estimates are biased and that most of the bias is due to the oversight of

[14] Although in theory this data manipulation results in inconsistent estimates, if the constant is indeed small relative to the positive trade flows, then one would expect the asymptotic biases to be small. Still, *Silva and Tenreyro* [2006] advised against this procedure because according to their cross-sectional simulation study the performance of the OLS estimator for the log-linear version of a constant elasticity model where the dependent variable is the log of $(y_i + 1)$ is rather poor. It has to be mentioned though, that in these simulations the expected value of y_i was only 1.49, not much larger than the additive constant.

the extensive margin of trade.[15] Yet, the rapid growth of world trade from 1970 to 1997 was predominantly due to the growth on the intensive margin of trade.

Felbermayr and Kohler [2006] highlighted the importance of the extensive margin by showing that while exporter and importer fixed effects alone are insufficient to solve Rose's GATT/WTO puzzle, a probit gravity equation indicates that the probability to find an existing trade relationship is about 10 percentage points higher for two GATT/WTO member countries than for two non-members. A similar, though numerically smaller estimate resulted from the Tobit approach to a gravity model characterized by corner-solutions, meaning that in any given relationship bilateral trade is supposed to be equal to its full potential if it exceeds some threshold level, and zero otherwise.

The final potential estimation problem is related to heteroskedasticity, which is almost inevitably present in gravity models because trade flows between relatively small countries are likely to vary less than between relatively large countries. As heteroskedasticity only affects the efficiency of the OLS estimator, often OLS point estimates are given along with heteroskedasticity-robust standard errors (as in Rose, 2004). However, as *Silva and Tenreyro* [2006], p. 644 pointed out, even if a gravity equation is correctly specified, in the presence of heteroskedasticity the OLS estimators of the coefficients of its log-linear version can still be seriously biased.

For this reason, Silva and Tenreyro warned against log-linearized regressions in general in favor of the Poisson pseudo-maximum-likelihood (PPML) method. This estimator is consistent so long as the conditional mean of the dependent variable is correctly specified, even if the data is not Poisson distributed. Silva and Tenreyro estimated a cross-sectional gravity equation of aggregate export flows between 136 countries in 1990 without and with exporter- and importer-specific fixed effects and showed that the PPML parameter estimates differ considerably from those generated by other methods, and that all methods except PPML produce some point estimates with illogical signs and bewildering asymmetries between the effects of importer and exporter country characteristics.

Several of these preceding issues were dealt with by *Liu* [2007]. For example, he warned that if GATT/WTO membership is a catalyst for new trading relationships, then bilateral trade is less likely to be zero between GATT/WTO members than between non-members, so the dismissal of the non-random zero trade flows results in sample selection bias. Still, the fact that Rose (2004) found GATT/WTO ineffective

[15] This conclusion is not specific to 1986, *Helpman et al.* [2008] obtained similar results when the gravity equation was augmented with year fixed effects and re-estimated for the 1980s.

at the intensive margin is puzzling and might indicate the failure of the traditional approach to gravity modeling based on log-linear regressions. According to Liu, the Tobit approach does not resolve this problem because in the presence of non-normal or heteroskedastic errors it might perform even worse than the traditional approach. Instead, the gravity equation should be estimated in its non-linear multiplicative form with NLS, PPLM or gamma pseudo-maximum likelihood (GPML) with allowance for heteroskedasticity.

The empirical analysis in *Liu* [2007] was based on a panel data set of real imports of 210 countries or regions from 1948 and 2003. This huge data set was used to estimate a standard gravity equation in various ways: as a pooled log-linear regression; log-linear regression with country-pair fixed and random effects; random effect Probit and Tobit regressions; and Poisson regressions with country-pair fixed and random effects. In order to distinguish the intensive and extensive margins of trade and to illustrate the impact of zero or missing imports on the results, the gravity equations were first estimated from the positive trade flows only, and then from a modified import data set whereby all non-positive (*i.e.* zero or missing) trade flows were replaced with zeros.[16] The results from the preferred fixed effects Poisson regression indicated that about one third of world imports can be attributed to the GATT/WTO, and that 30% of this can be explained by the extensive margin. This latter finding is in stark contrast with the conclusion of *Helpman et al.* [2008] that the extensive margin does not contribute in a major way to the growth of world trade. According to Liu, this discrepancy is mainly due to the fact that the sample period of Helpman et al. is much shorter and excludes the 1950s and 1960s when the growth on the extensive margin was the most prominent.

Finally, in a summary study, *Martin and Pham* [2008] find that the PPML method advocated by *Silva and Tenreyro* [2006] is indeed the best option for the estimation of gravity models when heteroskedasticity is the only problem. However, it performs poorly and yields severely biased estimates when zero trade flows are frequent. The Heckman maximum likelihood estimator appears to cope far better in the presence of strong identifying exclusion restrictions. As an illustration, they borrowed the data set from Silva and Tenreyro and found that their preferred estimation method yields estimates that are much more similar to the ones obtained from the traditional approaches, like truncated OLS, than to the ones produced by PPML.

[16] Heteroskedasticity was accounted for by Huber-White standard errors, and in the traditional log-linear regression every trade flow was increased by one.

To sum up, none of the follow-up studies confirmed Rose's bewildering result and offer various explanations for his apparent lack of a positive relationship between bilateral trade and GATT/WTO membership. Although we agree with most of the assessments of these follow up studies, it is still possible that Rose's (2004) negative finding is specific to the actual dataset he used and to the choice of the dependent variable. We believe that, in spite of all the potential short-comings of his methodology as noted in subsequent critiques, the positive impact of GATT/WTO on trade should reveal itself quite straightforwardly. For this reason, we turn our attention to a new, updated international trade data set, presented in the next section.

4. A New Data Set

An important question is how robust Rose's principal conclusion is to alternative model specifications, estimation methods, and to the choice of dependent variable?[17] According to Rose, the answer for the first and second parts of this question is a definite yes. The third part, however, cannot be addressed using Rose's downloadable dataset[18] because it contains many secondary data but not the original raw data and is therefore unsuitable for three-dimensional (*i.e.*, exporter, importer, and time) analyses. In particular, it has average bilateral trade values and many (country-combined) variables which cannot be traced back to the original country-specific measurements. Another shortcoming of Rose's dataset is that it does not contain zero trade flows so it cannot be used to study the extensive margin of trade. For these reasons we created a new data set. Although we tried to make it as similar to Rose's as possible, there are several important differences.

Our sample period dates from 1960 (as opposed to 1948), which coincides with the start of the fifth (Dillon) round of GATT; so as to assure homogeneity of measurements as far as possible. As previously mentioned, Rose (2004) obtained population and GDP data from three different sources: the *Penn World Table*; the World Bank's *World Development Indicators*; and the IMF's *International Financial Statistics*. These data sources, however, are not directly comparable (especially not the first to the latter). By focusing on the sample period from 1960 to 2005 we can collect all population and real GDP data from a single source (the 2006 edition of the World Bank's *World Development Indicators* CD-ROM).

Rose obtained some of the Generalized System of Preferences (GSP) observations from (UN) sources not available to the general public and then somewhat arbitrarily

[17] Although *Rose* [2004], p. 111 mentioned that "It is possible that GATT/WTO accession has different effects on exports and imports", he did not pursue this idea.

[18] http://faculty.haas.berkeley.edu/arose/RecRes.htm #Software.

extended them backwards and forwards for the numerous missing periods. Given the uncertainty surrounding *GSP*, we dropped this variable from our data set. We also decided to omit the *CNAT* variable as in Rose's sample it is equal to one in only 0.02% of all cases and, unsurprisingly, always turned out to be insignificant.

The remaining variables are defined as per Rose, with the exception of:

$REXPORT_{ijt}$: Real exports of country i to country j in year t (f.o.b., 2000 US$);

$RIMPORT_{ijt}$: Real imports of country i from country j in year t (c.i.f., 2000 US$).

$LLOCK_i$, $LLOCK_j$: Dummy variables for landlocked country (1 = country i (j is landlocked);

$ISLAND_i$, $ISLAND_j$: Dummy variables for island country (1 = country i (j is an island nation);

$ISCOL_{ijt}$: Dummy variable for colonizing (1 = country i is the colonizer of country j in year t);

$EVCOL_{ij}$: Dummy variable for ever colonized (1 = i ever colonized j).

From these variables we generated ART, and the country-pair specific versions of $EVCOL$ and $ISCOL$.

Trade flows reported by the exporting countries often differ from the corresponding trade flows reported by the importing countries. The discrepancies are partly due to the fact that exports are usually recorded as f.o.b. and imports as c.i.f. values, but they might also originate from the different qualities of the exporting and importing countries' trade statistics. In any case, gravity model estimates might be sensitive to the choice of export or import flows. According to *Piermartini and Teh* [2005], p. 46), by-and-large import data are more reliable than export data. However, since they are based on c.i.f. prices, in import gravity equations (as in *Liu* [2007]), distance and all other explanatory variables that are related to transport costs might be correlated with the error term. For this reason we perform all subsequent analyses on export and import flows alike.

Most of our updated data came from the same sources as Rose's. In particular, the data on exports and imports were obtained from the December 2006 edition of the IMF's *Direction of Trade Statistics* CD-ROM. These nominal trade values (given in US dollars) were deflated by the US CPI (all items, city average, 2000 = 100) taken from the December 2006 edition of the IMF's *International Financial Statistics* CD-ROM. The population and real GDP data (in constant 2000 US dollars) were obtained from the 2006 edition of the World Bank's *World Development Indicators* CD-ROM

and then updated from the World Bank's website.[19] The lists of GATT/WTO membership, economic communities and free trade agreements (trade blocks and bilateral trade agreements) were downloaded from the World Trade Organization's website[20] and from *Wikipedia*.[21] Data on colonization were also collected from *Wikipedia*. The list of mostly spoken languages in each country is from the CIA's *World Factbook*.[22] Distances between trading countries were estimated as the averages of great circle distances (in nautical miles) between 1-3 major cities.[23] Other geographical data (lists of island countries, landlocked countries, and land borders) are from the CIA's *World Factbook* and from *Wikipedia*.

Our data set includes 27 variables for 180 countries and 46 years (1960-2005), so there are potentially 1,482,120 (ijt) cases. However, not all 180 countries existed throughout the sample period and the size of our data set is also limited by the availability of GDP observations. For the remaining 947,846 cases the data on all explanatory variables is complete, but there are still 275,901 missing *REXPORT* and 274,158 missing *RIMPORT* observations. Unfortunately, we do not have any information about these missing values and it is impossible to tell whether the corresponding countries traded with each other at all. There are also 278,273 zero *REXPORT* and 257,402 zero *RIMPORT* observations, which are either genuine zeros, or are rounded figures and represent nominal flows below half a million US$. This leaves us with 393,672 positive *REXPORT* and 416,286 positive *RIMPORT* observations.

There is no agreement in the trade literature on how to handle zero and missing trade observations. For example, while *Helpman et al.* [2008] treated zero trade observations as missing values, *Felbermayr and Kohler* [2006] replaced missing observations with zero trade flows. In this paper we consider the zero and missing trade flows as conceptually different. A zero means that for the given year there was no positive export/import flow recorded between the two countries or that the nominal value of exports/imports was less than half a million US$. As regards the missing values, we accept the lack of information and do not assume that the missing

[19] http://web.worldbank.org.
[20] http://www.wto.org.
[21] http://en.wikipedia.org.
[22] https://www.cia.gov/library/publications/the-world-factbook/index.html.
[23] Great circle distances were calculated from latitudes and longitudes of major cities taken from the $Almanacsof Infoplease$ (http://www.infoplease.com) using the formula from the web site of $PearsonSoftwareConsulting$ (http://www.cpearson.com/excel/latlong.htm).

trade flows are equal to zero. Moreover, unlike some other researchers, we do not make any attempt to estimate these missing values either.[24]

5. Gravity Models

In this section we use our new data set to estimate numerous versions of "standard" gravity models. An important difference from Rose (2004), however, is that we study exports and imports separately and we do not restrict the characteristics of the local and target countries to have identical impacts on the bilateral trade between them.

For both dependent variables we consider three sets of regressions. We start with simple OLS regressions with period fixed effects: for positive trade flows only (as in *Rose* [2004]; and for all available zero and positive trade flows. As the results clearly indicate the importance of zero observations, we estimate all subsequent models on the full sample. Next, we estimate Logit regressions for zero *versus* positive trade flows to see whether the models that explain the magnitudes of trade flows differ from the models that explain its existence. Finally, we estimate Tobit regressions in order to allow for censoring of trade flows at zero.

Each OLS, Logit and Tobit regression on the full sample is estimated with and without unobserved specific effects. In particular, we consider four specifications: no specific effects; period effects only; period and separate local and target country effects (after *Matyas* [1997, 1998]; and period and 'ordered' country-pair effects (after *Hummels and Levinsohn* [1995]). According to *Egger* [2000], both simple intuitive arguments and empirical evidence based on Hausman's χ^2-test suggest that in most applications these unobserved effects are better treated as fixed, so whenever it is feasible, we use a fixed effects (*FE*) approach. As regards separate local and target country fixed effects *versus* country-pair fixed effects, although in principle country-pair fixed effects are more flexible, we prefer the country fixed effects as they require only 360 country dummy variables while the country-pair fixed effects necessitate 32,220 country-pair dummies. Moreover, while the country dummies are perfectly correlated with all time invariant exporter and importer country variables ($LAND_i$, $LAND_j$, $LLOCK_i$, $LLOCK_j$, $ISLAND_i$, $ISLAND_j$), the country-pair dummy

[24] Missing GDP and trade data is a problem in empirical research in general, but they are particularly hampering in studies focusing on the relationship between international trade and conflicts. For this reason, on the basis of some strong but hardly verifiable assumptions, *Gleditsch* [2002] attempted to estimate missing data from observations available for similar countries or periods. While in conflict research missing data might indeed constitute a more serious problem than the list-wise deletion of all cases where GDP and/or trade flows are unavailable, we still prefer listwise deletion because incorrect assumptions in general might result in seriously biased estimates.

variables are perfectly correlated not only with these variables but also with the time invariant country-pair variables ($CLANG_{ij}$, $CBOARD_{ij}$, $EVCOL_{ij}$, $COMCOL_{ij}$), further diluting the economic content of the gravity model.

For the sake of brevity, we do not report constants or fixed effects, nor the overall *F*- and Wald χ^2-test results (which are always strongly significant. Unless stated otherwise, the reported standard errors are Huber-White standard errors clustered for country pairs.[25]

The Standard Approach

The "traditional" OLS results for exports and imports with period *FE* are presented in *Table* 2. The dependent variable is the logarithm of exports, or imports, when only strictly positive trade flows are used, but each trade flow is increased by one when all available zero and positive trade observations are used in the estimation.

[*Insert Table 2 here.*]

It is clear from the results that the inclusion of the zero trade observations is critical. The most profound discrepancy is that when zero flows are excluded, quite inexplicably, the coefficients of *ONEIN* and *BOTHIN* are both significantly *negative*, *i.e.*, GATT/WTO membership appears to generate a negative impact on both exports and imports. On the other hand, when zero flows are included these coefficients become significantly *positive*. For this reason, despite the issues surrounding the zero trade observations, we perform all subsequent analyses on the full sample.

The export and import OLS regressions without and with *FE* (period only, period and country, period and country-pair) are shown in Tables 3 and 4.

[*Insert Tables 3 and 4 here.*]

All-in-all, the models fit the data well and none of the significant coefficients have a perverse sign. Crucially, apart from the exports regression with period and country *FE*, the coefficients of the $ONEIN$ and $BOTHIN$ membership dummies are always significantly positive. They suggest that, exports are about 90% (no *FE*), 178% (period *FE*), 35% (period and country-pair *FE*) higher between a member and a non-member country, and 300% (no *FE*), 257% (period *FE*), 51% (period and country *FE*), 127% (period and country-pair *FE*) higher between two member countries than between two non-member countries. Similarly, imports are about 119% (no *FE*), 108% (period *FE*), 35% (period and country *FE*), 45% (period and country-pair *FE*) higher between a member and a non-member country, and 358% (no *FE*), 320% (period *FE*),

[25] All models were estimated with *Stata*/*SE* 10.0. The unreported results are available on request.

102% (period and country *FE*), 174% (period and country-pair *FE*) higher between two member countries than between two non-member countries.

Including the period *FE* (whilst jointly significant) has only a marginal impact on the results; it slightly alters the point estimates but not their signs or significances. The country and country-pair *FE*, however, appear more important. In particular, the fact that the $ONEIN$ and $BOTHIN$ coefficients are much larger in the regressions without country or country-pair *FE* suggests that in these cases these coefficients pick-up some of the effects of certain omitted variables which are captured by the country and country-pair *FE*.

Comparing the export and import regressions, the most noticeable difference is that both $ONEIN$ and $BOTHIN$ seem to have a larger impact on bilateral imports. Otherwise the corresponding sets of results are qualitatively quite similar except that: *i*) without *FE* or with only period *FE*, a landlocked country appears to export more than a similar country with direct access to sea, and exports from a landlocked country appear to be significantly smaller than that from a similar country with direct access to sea, but being landlocked seems to have no significant impact on imports; and *ii*) with period and country *FE*, export flows between a GATT/WTO member and a non-member country seem to be no different from that of between two non-member countries, whereas import flows between a member and a non-member country are significantly greater than between two non-members.

$ISCOL$ is the only variable which is insignificant across all specifications, so current colonial relationship does not appear to influence bilateral trade. This might be due to the fact that we mainly study the post-colonialism era and in our sample there are only 35 active colonial ties in 1960 and none by 2000 (in the subsequent Logit and Tobit regressions however, $ISCOL$ is mostly significant).

Recall that, as with Rose, we deflated all bilateral nominal export and import data by the US consumer price index (for all items averaged across all major cities) irrespective of the partner countries. This is clearly not an ideal solution, although it would be an enormous task to apply country or country-pair specific deflators. It is possible, though, to choose other deflators which are possibly more appropriate to many economies than the US CPI, such as the price index for emerging and developing economies, the world commodity price index (WCPI) for metals, WCPI for food, and WCPI for agricultural raw materials. In order to study the sensitivity of the results, we re-estimated all equations with period *FE* using real trade volumes based on these

four alternative deflators.[26] The quantitative results (not reported) are unaffected, although the coefficients of $ONEIN$ and $BOTHIN$ (whilst still significantly positive) are 2 to 14 percent smaller than the ones reported in the *FE: Period* columns of *Tables* 3 and 4.

We conducted *Wald* tests on each regression to check whether the corresponding local and target country coefficients significantly differ and found that when both coefficients are significant individually they are significantly different from each other as well, supporting our decision not to impose equality on them. Nevertheless, for the sake of comparison, we also estimated a specification similar to Rose's (2004), and found further support to the expected positive impact of GATT/WTO membership on bilateral trade. In fact, compared to the separate export and import regressions, this impact appears to be even stronger, while the effects of the other regressors are smaller.

The Logit Approach

As seen in *Table* 2, the gravity models estimated exclusively from positive trade flows yield perverse results, calling for the consideration of the extensive margin of trade as well. Thus we now turn our attention to the factors that contribute to the existence (or not) of bilateral trade.

We created two dummy variables, $REXPORT\_CODE$ and $RIMPORT\_CODE$, for positive *versus* zero export and import flows, and estimated binary Logit models without and with *FE*. The results are summarized in Tables 5 and 6.

[*Insert Tables 5 and 6 here.*]

As before, the period *FE* does not substantially affect results. Moreover, the Logit results without *FE* and with only period *FE* are qualitatively similar to the corresponding OLS results. Exceptions are now that the partner country's real GDP per capita is significant in the export equation; being landlocked has a significantly positive coefficient in the import equation; and that (puzzlingly) a current colonial relationship seems to reduce the likelihood of bilateral trade. Most importantly, however, the Logit coefficients of $ONEIN$ and $BOTHIN$ are both significantly positive, that is the estimated probability of two countries trading with each other increases by the number of GATT/WTO members in the dyad.

[26] These price indices were obtained from the December 2006 edition of the IMF's $International Financial Statistics$ CD-ROM. The results based on these deflators are not reported in this paper.

Turning to the remaining two pairs of Logit regressions, it is clear that the presence of country and country-pair *FE* is critical. They not only change most of the coefficients considerably, but some significance levels as well. In particular, in the export equation with period and country *FE*, $BOTHIN$ is insignificant while the coefficient of $ONEIN$ is significantly negative, suggesting that the estimated probability of trading is smaller between a GATT/WTO member and a non-member country, than either between two non-member countries or between two member countries. In the export equation with period and country-pair *FE* and in the import equation with period and country *FE*, $ONEIN$ becomes insignificant but the coefficient of $BOTHIN$ is still significantly positive, so two member countries are more likely to trade with one another than two non-member countries or a member and a non-member country.

Finally, although in the export equations the coefficient of the local country's GDP is either insignificant or significantly negative, due to the significantly positive and relatively large coefficient of GDP per capita, real GDP of the local country still has a significantly positive impact on the likelihood of bilateral trade.

The Tobit Approach

In our sample about 40 percent of all non-missing trade flows are zero. Given this high proportion, we finally estimate Tobit regressions based on left censoring at zero.[27] However, due to estimation problems, instead of a Tobit model with period and country-pair *FE*, we consider a specification with period fixed effects and country-pair random effects (*RE*).[28] The results are shown in *Tables* 7 and 8.

[*Insert Tables 7 and 8 here.*]

In each case, the coefficients of $ONEIN$ and $BOTHIN$ are significantly positive, so GATT/WTO membership clearly has a strong positive impact on trade.ljAlthough in the 'FE : *period*, and RE : $country - pair$' cases only the unadjusted standard errors are available, they are so small for $ONEIN$ and $BOTHIN$ that even if

[27] Rose also estimated a Tobit regression, but still rejected any economically substantial effect of the GATT/WTO on trade. As his data set did not contain zero trade flows he experimented with Tobit regression only by replacing the smallest 5 percent of the sample trade observations by zero. This proportion of zeros, however, is far too low and therefore casts doubts on Rose's (2004) conclusions.

[28] According to *Stata Help xtTobit*, "There is no command for a conditional fixed-effects model, as there does not exist a sufficient statistic allowing the fixed effects to be conditioned out of the likelihood. ... Unconditional fixed-effects Tobit models may be fitted with Tobit command with indicator variables for the panels. ... However, unconditional fixed-effects estimates are biased." According to *Green* [2004], the small T bias of the ML estimator disappears quickly in T (which here is "large").

clustering inflated them tenfold, our conclusion would remain the same. The export and import regressions are again similar to each other qualitatively, apart from a few minor differences.

All in all, the standard, Logit and Tobit approaches all imply very similar conclusions. Namely, the most important factors behind bilateral exports and imports are the real GDPs of the partner countries, the geographical distance between them, and our main focus variable(s), their GATT/WTO membership.

6. Conclusion

On the basis of close to eighty variants of a standard gravity model of bilateral trade estimated for 175 countries over 1948 and 1999, *Rose* [2004], p. 112) concluded that "Even if one believes that the GATT/WTO acts as an immeasurable trade-promoting externality, we do not *know* that the multilateral system has stimulated trade."

Since this finding is inconsistent with the fact that many countries are ready to pay huge "prices" for membership, it is not surprising that it invited many criticisms concerning, for example, pooling developed and developing countries, not discerning non-member countries that are bound by GATT/WTO agreements, ignoring relative trade barriers, potential endogeneity bias, considering only the intensive margin of trade, and the log-linearised specification of model employed. Although most of these criticisms are pertinent, in our opinion the key problem is that Rose's data set contains only positive average trade flows. To rectify this shortcoming, we created a new international trade data set, mostly from the same sources as Rose, which importantly contains zeros as well and, also, separate bilateral export and import flows.

Using a specification similar to *Rose's* [2004], we estimated standard, Logit and Tobit gravity models. For the sake of comparison, in the first case we used not only the full sample but also the sub-sample(s) of the strictly positive trade flows as well (clearly, the other models/estimation techniques are not identified on the positive flow only samples). However, the OLS results obtained from this sub-sample seemed dubious as they implied that GATT/WTO membership has a negative impact on international trade. On the other hand, the standard, Tobit and Logit gravity equations estimated from all available zero and positive trade observations clearly imply that GATT/WTO membership encourages international trade, most likely both among member countries and with non-member countries. Although our study differs from Rose's, both in terms of the sample and model specification, the conflicting results based on the positive flows and on all flows suggest that Rose's negative

finding is most likely due to his omission of zero bilateral trade flows, supporting the criticisms of *Helpman et al.* [2008] and *Felbermayr and Kohler* [2006].

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Table 1: Rose's (2004) benchmark results

Dependent Variable: $\ln ART_{ijt}$	*Coefficient (standard error)*	
	Default[b]	*Country fixed effects*[c]
$ONEIN_{ijt}$	-0.06 (0.05)	0.05 (0.04)
$BOTHIN_{ijt}$	-0.04 (0.05)	**0.15** (0.05)
$\ln (RGDP_{it} \times RGDP_{jt})$	**0.92** (0.01)	**0.16** (0.05)
$\ln (RGDP_{it} / POP_{it} \times RGDP_{jt} / POP_{jt})$	**0.32** (0.01)	**0.54** (0.05)
$\ln DIST_{ij}$	**-1.12** (0.02)	**-1.31** (0.02)
$\ln (LAND_i \times LAND_j)$	**-0.10** (0.01)	**0.38** (0.03)
$CLANG_{ij}$	**0.31** (0.04)	**0.27** (0.04)
$CBORD_{ij}$	**0.53** (0.11)	**0.28** (0.11)
$NLLOCK_{ij}$	**-0.27** (0.03)	**-1.54** (0.32)
$NISLAND_{ij}$	0.04 (0.04)	**-0.87** (0.19)
$EVCOL_{ij}$	**1.16** (0.12)	**1.27** (0.11)
$COMCOL_{ij}$	**0.58** (0.07)	**0.60** (0.06)
$ISCOL_{ijt}$	**1.08** (0.23)	**0.72** (0.26)
$CNAT_{ij}$	-0.02 (1.08)	0.31 (0.58)
$MUNI_{ijt}$	**1.12** (0.12)	**1.19** (0.12)
RTA_{ijt}	**1.20** (0.11)	**0.94** (0.13)
GSP_{ijt}	**0.86** (0.03)	**0.70** (0.03)
R^2	0.65	0.70

Note: a) The sample period is from 1948 through 1999, the number of countries is 175, and the number of observations is 234,597.
b) Both specifications also include period fixed effects, but they are not reported in this table. Slope estimates in bold are significant at the five percent level. The numbers in the parentheses are Huber-White standard errors robust to clustering by country-pairs.

Table 2: OLS Regressions with Period Fixed Effects for Export and Import Flows

Independent Variables	*Coefficient (standard error)*			
	Exports		*Imports*	
	Positive	*All*	*Positive*	*All*
$ONEIN_{ijt}$	**-0.441** (0.049)	**0.578** (0.078)	**-0.359** (0.049)	**0.733** (0.078)
$BOTHIN_{ijt}$	**-0.421** (0.052)	**1.272** (0.854)	**-0.304** (0.051)	**1.434** (0.085)
ln ($RGDP_{it}$)	**1.074** (0.011)	**1.980** (0.020)	**0.955** (0.010)	**1.439** (0.020)
ln ($RGDP_{jt}$)	**0.897** (0.010)	**1.565** (0.020)	**1.059** (0.010)	**2.015** (0.019)
ln ($RGDP_{it}$ / POP_{it})	**0.041** (0.013)	**0.206** (0.026)	**-0.059** (0.013)	**0.293** (0.026)
ln ($RGDP_{jt}$ / POP_{jt})	**-0.067** (0.013)	0.027 (0.026)	**0.032** (0.012)	-0.028 (0.027)
ln ($DIST_{ij}$)	**-0.949** (0.019)	**-2.174** (0.038)	**-0.932** (0.018)	**-2.023** (0.038)
ln ($LAND_i$)	**-0.087** (0.008)	**-0.244** (0.017)	**-0.109** (0.008)	**-0.167** (0.016)
ln ($LAND_j$)	**-0.109** (0.008)	**-0.165** (0.017)	**-0.083** (0.008)	**-0.209** (0.016)
$CLANG_{ij}$	**0.364** (0.031)	**0.658** (0.060)	**0.344** (0.029)	**0.618** (0.059)
$CBORD_{ij}$	**0.989** (0.088)	**1.674** (0.230)	**0.905** (0.090)	**1.448** (0.221)
$LLOCK_i$	0.040 (0.036)	**0.286** (0.073)	**-0.229** (0.035)	0.077 (0.072)
$LLOCK_j$	**-0.465** (0.034)	**-0.568** (0.070)	-0.031 (0.035)	0.036 (0.069)
$ISLAND_i$	-0.031 (0.037)	0.059 (0.069)	-0.015 (0.035)	**0.203** (0.068)
$ISLAND_j$	0.049 (0.038)	**0.174** (0.072)	0.065 (0.034)	**0.282** (0.071)
$EVCOL_{ij}$	**0.812** (0.105)	**1.599** (0.237)	**1.150** (0.118)	**2.757** (0.266)
$COMCOL_{ij}$	**0.284** (0.047)	**1.138** (0.088)	**0.359** (0.045)	**1.123** (0.087)
$ISCOL_{ijt}$	**0.762** (0.255)	-1.237 (1.461)	**0.924** (0.307)	-0.285 (1.410)
$MUNI_{ijt}$	**1.138** (0.072)	**1.906** (0.158)	**1.057** (0.071)	**1.619** (0.148)
RTA_{ijt}	**0.771** (0.038)	**1.152** (0.087)	**0.746** (0.039)	**1.085** (0.085)
R^2	0.630	0.545	0.642	0.533
n	393672	671945	416286	673688

Notes: a) The dependent variable is *ln*(*REXPORT*) or *ln*(*RIMPORT*) for positive trade flows and *ln*(*REXPORT*+1) or *ln*(*RIMPORT*+1) for all available, *i.e.* zero and positive trade flows.
b) The sample period is from 1960 through 2005, the number of countries is 180, and *n* denotes the total sample size. Slope estimates in bold are significant at the five percent level.
c) Each group of fixed effects is significant at any reasonable level.

Table 3: OLS Regressions for Export Flows

Independent Variables	*Coefficient (standard error)*			
	FE			
	No	*Period*	*Period and Country*	*Period and Country-Pair*
$ONEIN_{ijt}$	**0.643** (0.076)	**0.578** (0.078)	0.053 (0.067)	**0.299** (0.067)
$BOTHIN_{ijt}$	**1.387** (0.081)	**1.272** (0.854)	**0.412** (0.079)	**0.819** (0.080)
$\ln(RGDP_{it})$	**1.988** (0.020)	**1.980** (0.020)	**1.302** (0.143)	**1.805** (0.139)
$\ln(RGDP_{jt})$	**1.574** (0.020)	**1.565** (0.020)	**2.335** (0.135)	**2.558** (0.137)
$\ln(RGDP_{it} / POP_{it})$	**0.203** (0.026)	**0.206** (0.026)	0.073 (0.131)	**-0.523** (0.126)
$\ln(RGDP_{jt} / POP_{jt})$	0.025 (0.026)	0.027 (0.026)	**-1.159** (0.127)	**-1.444** (0.130)
$\ln(DIST_{ij})$	**-2.169** (0.038)	**-2.174** (0.038)	**-2.430** (0.042)	
$\ln(LAND_i)$	**-0.254** (0.016)	**-0.244** (0.017)		
$\ln(LAND_j)$	**-0.175** (0.016)	**-0.165** (0.017)		
$CLANG_{ij}$	**0.648** (0.060)	**0.658** (0.060)	**1.000** (0.064)	
$CBORD_{ij}$	**1.667** (0.231)	**1.674** (0.230)	**1.378** (0.250)	
$LLOCK_i$	**0.315** (0.072)	**0.286** (0.073)		
$LLOCK_j$	**-0.543** (0.070)	**-0.568** (0.070)		
$ISLAND_i$	0.045 (0.069)	0.059 (0.069)		
$ISLAND_j$	**0.161** (0.072)	**0.174** (0.072)		
$EVCOL_{ij}$	**1.581** (0.238)	**1.599** (0.237)	**1.459** (0.274)	
$COMCOL_{ij}$	**1.137** (0.088)	**1.138** (0.088)	**1.378** (0.083)	
$ISCOL_{ijt}$	-1.349 (1.461)	-1.237 (1.461)	-1.135 (1.422)	-2.629 (1.437)
$MUNI_{ijt}$	**1.812** (0.156)	**1.906** (0.158)	**1.085** (0.147)	0.231 (0.122)
RTA_{ijt}	**1.232** (0.087)	**1.152** (0.087)	**1.016** (0.084)	**0.369** (0.075)
R^2	0.544	0.545	0.615	0.456

Notes: a) The dependent variable is $ln(REXPORT+1)$. The country fixed effects are separate local and target country fixed effects and the country-pair fixed effects are ordered, *i.e.*, *ij* is distinguished from *ji*.

b) The sample period is from 1960 through 2005, the number of countries is 180, and the sample size is 671,945.

c) Slope estimates in bold are significant at the five percent level. Each group of fixed effects is significant at any reasonable level, except the local country effects in the 'period and country' case.

d) In the 'period and country-pair' case R^2 is the between R^2 statistic and it is incomparable to the other three R^2 statistics.

Table 4: OLS Regressions for Import Flows

Independent Variables	*Coefficient (standard error)*			
	FE			
	No	*Period*	*Period and Country*	*Period and Country-Pair*
$ONEIN_{ijt}$	**0.784** (0.076)	**0.733** (0.078)	**0.299** (0.067)	**0.371** (0.065)
$BOTHIN_{ijt}$	**1.522** (0.081)	**1.434** (0.085)	**0.704** (0.079)	**1.007** (0.076)
$\ln(RGDP_{it})$	**1.443** (0.020)	**1.439** (0.020)	**1.743** (0.137)	**2.144** (0.106)
$\ln(RGDP_{jt})$	**2.018** (0.019)	**2.015** (0.019)	**2.308** (0.135)	**2.911** (0.112)
$\ln(RGDP_{it} / POP_{it})$	**0.295** (0.026)	**0.293** (0.026)	**-0.457** (0.125)	**-0.691** (0.118)
$\ln(RGDP_{jt} / POP_{jt})$	-0.025 (0.027)	-0.028 (0.027)	**-1.117** (0.128)	**-1.632** (0.122)
$\ln(DIST_{ij})$	**-2.022** (0.038)	**-2.023** (0.038)	**-2.235** (0.042)	
$\ln(LAND_i)$	**-0.172** (0.016)	**-0.167** (0.016)		
$\ln(LAND_j)$	**-0.213** (0.016)	**-0.209** (0.016)		
$CLANG_{ij}$	**0.613** (0.059)	**0.618** (0.059)	**1.009** (0.064)	
$CBORD_{ij}$	**1.448** (0.222)	**1.448** (0.221)	**1.208** (0.241)	
$LLOCK_i$	0.097 (0.071)	0.077 (0.072)		
$LLOCK_j$	0.053 (0.069)	0.036 (0.069)		
$ISLAND_i$	**0.189** (0.068)	**0.203** (0.068)		
$ISLAND_j$	**0.271** (0.071)	**0.282** (0.071)		
$EVCOL_{ij}$	**2.746** (0.266)	**2.757** (0.266)	**1.719** (0.297)	
$COMCOL_{ij}$	**1.122** (0.087)	**1.123** (0.087)	**1.361** (0.083)	
$ISCOL_{ijt}$	-0.344 (1.411)	-0.285 (1.410)	-0.881 (1.400)	-2.692 (1.429)
$MUNI_{ijt}$	**1.531** (0.146)	**1.619** (0.148)	**0.949** (0.136)	0.156 (0.120)
RTA_{ijt}	**1.127** (0.084)	**1.085** (0.085)	**0.970** (0.083)	**0.387** (0.074)
R^2	0.532	0.533	0.597	0.456

Note: a) The dependent variable is $ln(RIMPORT+1)$. The country fixed effects are separate local and target country fixed effects and the country-pair fixed effects are ordered, *i.e.*, *ij* is distinguished from *ji*.
b) The sample period is from 1960 through 2005, the number of countries is 180, and the sample size is 673,688.
c) Slope estimates in bold are significant at the five percent level. The fixed effects are jointly significant at any reasonable significance level.

Table 5: Logit Regressions for Export Flows

Independent Variables	*Coefficient (standard error)*			
	FE			
	No	*Period*	*Period and Country*	*Period and Country-Pair*
$ONEIN_{ijt}$	**0.403** (0.032)	**0.330** (0.033)	**-0.107** (0.033)	0.024 (0.025)
$BOTHIN_{ijt}$	**0.825** (0.033)	**0.665** (0.035)	0.003 (0.041)	**0.121** (0.030)
ln ($RGDP_{it}$)	**0.720** (0.010)	**0.705** (0.010)	-0.137 (0.080)	**-0.408** (0.053)
ln ($RGDP_{jt}$)	**0.554** (0.009)	**0.540** (0.009)	**0.656** (0.073)	**0.860** (0.052)
ln ($RGDP_{it}$ / POP_{it})	**0.088** (0.011)	**0.102** (0.011)	**0.818** (0.076)	**1.390** (0.051)
ln ($RGDP_{jt}$ / POP_{jt})	**0.045** (0.011)	**0.056** (0.011)	-0.058 (0.070)	**-0.122** (0.049)
ln ($DIST_{ij}$)	**-0.898** (0.019)	**-0.909** (0.019)	**-1.255** (0.022)	
ln ($LAND_i$)	**-0.123** (0.007)	**-0.101** (0.007)		
ln ($LAND_j$)	**-0.079** (0.007)	**-0.058** (0.007)		
$CLANG_{ij}$	**0.196** (0.025)	**0.226** (0.025)	**0.441** (0.029)	
$CBORD_{ij}$	**0.857** (0.137)	**0.903** (0.138)	**0.871** (0.150)	
$LLOCK_i$	**0.233** (0.029)	**0.174** (0.029)		
$LLOCK_j$	**-0.115** (0.029)	**-0.160** (0.030)		
$ISLAND_i$	0.008 (0.029)	0.034 (0.029)		
$ISLAND_j$	0.042 (0.030)	**0.061** (0.029)		
$EVCOL_{ij}$	**1.075** (0.166)	**1.057** (0.164)	**0.573** (0.187)	
$COMCOL_{ij}$	**0.455** (0.037)	**0.472** (0.037)	**0.610** (0.038)	
$ISCOL_{ijt}$	**-1.918** (0.459)	**-1.711** (0.448)	**-1.811** (0.492)	**-5.024** (1.052)
$MUNI_{ijt}$	**0.611** (0.077)	**0.772** (0.080)	**0.450** (0.082)	**0.130** (0.050)
RTA_{ijt}	**0.784** (0.047)	**0.629** (0.049)	**0.634** (0.046)	**-0.131** (0.030)
Pseudo R^2	0.352	0.358	0.456	

Note: a) The dependent variable is *REXPORT_CODE*, a dummy variable for positive and zero export flows. The country fixed effects are separate local and target country fixed effects and the country-pair fixed effects are ordered, *i.e.*, they distinguish *ij* from *ji*.
b) The sample period is from 1960 through 2005, the number of countries is 180, and the sample size is 671,945.
c) Slope estimates in bold are significant at the five percent level. The fixed effects are jointly significant at any reasonable significance level.
d) *Pseudo* R^2 is not available in the 'period and country-pair' case.

Table 6: Logit Regressions for Import Flows

Independent Variables	*Coefficient (standard error)*			
	FE			
	No	*Period*	*Period and Country*	*Period and Country-Pair*
$ONEIN_{ijt}$	**0.435** (0.030)	**0.362** (0.031)	0.013 (0.031)	**0.095** (0.024)
$BOTHIN_{ijt}$	**0.859** (0.031)	**0.697** (0.033)	**0.161** (0.040)	**0.267** (0.029)
$\ln(RGDP_{it})$	**0.459** (0.009)	**0.442** (0.009)	**0.316** (0.072)	**0.128** (0.049)
$\ln(RGDP_{jt})$	**0.711** (0.009)	**0.700** (0.009)	**0.418** (0.076)	**0.438** (0.049)
$\ln(RGDP_{it} / POP_{it})$	**0.177** (0.011)	**0.193** (0.011)	**0.414** (0.067)	**0.992** (0.045)
$\ln(RGDP_{jt} / POP_{jt})$	-0.018 (0.011)	-0.008 (0.011)	0.132 (0.071)	**0.157** (0.046)
$\ln(DIST_{ij})$	**-0.792** (0.018)	**-0.805** (0.019)	**-1.085** (0.021)	
$\ln(LAND_i)$	**-0.075** (0.007)	**-0.053** (0.007)		
$\ln(LAND_j)$	**-0.106** (0.007)	**-0.084** (0.007)		
$CLANG_{ij}$	**0.184** (0.025)	**0.214** (0.025)	**0.425** (0.028)	
$CBORD_{ij}$	**0.701** (0.120)	**0.741** (0.122)	**0.770** (0.131)	
$LLOCK_i$	**0.178** (0.029)	**0.126** (0.029)		
$LLOCK_j$	**0.109** (0.027)	**0.056** (0.028)		
$ISLAND_i$	**0.077** (0.028)	**0.095** (0.029)		
$ISLAND_j$	**0.099** (0.030)	**0.129** (0.030)		
$EVCOL_{ij}$	**1.438** (0.166)	**1.430** (0.164)	**0.578** (0.168)	
$COMCOL_{ij}$	**0.415** (0.036)	**0.436** (0.036)	**0.559** (0.037)	
$ISCOL_{ijt}$	**-1.255** (0.487)	**-1.047** (0.475)	**-1.243** (0.441)	**-2.952** (0.466)
$MUNI_{ijt}$	**0.459** (0.072)	**0.620** (0.075)	**0.357** (0.073)	**0.171** (0.047)
RTA_{ijt}	**0.730** (0.045)	**0.576** (0.047)	**0.592** (0.043)	0.009 (0.030)
Pseudo R^2	0.325	0.333	0.425	

Note: a) The dependent variable is *RIMPORT_CODE*, a dummy variable for positive and zero import flows. The country fixed effects are separate local and target country fixed effects and the country-pair fixed effects are ordered, *i.e.*, they distinguish *ij* from *ji*.
b) The sample period is from 1960 through 2005, the number of countries is 180, and the sample size is 673,688.
c) See *Note c* of *Table* 5.
d) See *Note d* of *Table* 5.

Table 7: Tobit Regressions for Export Flows

Independent Variables	*Coefficient (standard error)*			
	FE			*FE: Period RE: Country-pair*
	No	*Period*	*Period and Country*	
$ONEIN_{ijt}$	**1.796** (0.146)	**1.598** (0.149)	**0.713** (0.128)	**1.373** (0.048)
$BOTHIN_{ijt}$	**2.925** (0.151)	**2.568** (0.157)	**1.145** (0.143)	**2.094** (0.054)
$\ln(RGDP_{it})$	**2.921** (0.034)	**2.890** (0.034)	**4.027** (0.238)	**3.451** (0.032)
$\ln(RGDP_{jt})$	**2.273** (0.033)	**2.242** (0.033)	**4.736** (0.225)	**2.883** (0.032)
$\ln(RGDP_{it} / POP_{it})$	**0.227** (0.041)	**0.244** (0.042)	**-1.760** (0.221)	**-0.806** (0.038)
$\ln(RGDP_{jt} / POP_{jt})$	0.017 (0.042)	0.031 (0.042)	**-2.683** (0.211)	**-1.023** (0.037)
$\ln(DIST_{ij})$	**-3.163** (0.062)	**-3.184** (0.062)	**-3.471** (0.070)	**-3.492** (0.059)
$\ln(LAND_i)$	**-0.379** (0.026)	**-0.344** (0.027)		**-0.608** (0.027)
$\ln(LAND_j)$	**-0.260** (0.026)	**-0.224** (0.026)		**-0.519** (0.027)
$CLANG_{ij}$	**0.871** (0.097)	**0.912** (0.097)	**1.411** (0.109)	**1.295** (0.101)
$CBORD_{ij}$	**1.809** (0.366)	**1.854** (0.361)	**1.463** (0.387)	**2.050** (0.316)
$LLOCK_i$	**0.563** (0.121)	**0.453** (0.122)		**0.448** (0.119)
$LLOCK_j$	**-0.820** (0.119)	**-0.914** (0.119)		**-0.912** (0.117)
$ISLAND_i$	-0.091 (0.112)	-0.042 (0.112)		**0.493** (0.123)
$ISLAND_j$	0.096 (0.116)	0.140 (0.116)		**0.975** (0.124)
$EVCOL_{ij}$	**1.011** (0.387)	**1.092** (0.380)	**1.452** (0.430)	0.872 (0.504)
$COMCOL_{ij}$	**1.967** (0.141)	**1.974** (0.142)	**2.264** (0.138)	**1.599** (0.144)
$ISCOL_{ijt}$	-0.736 (1.921)	-0.212 (1.909)	-0.069 (1.882)	**-1.845** (0.465)
$MUNI_{ijt}$	**2.393** (0.241)	**2.687** (0.246)	**1.864** (0.231)	**0.287** (0.074)
RTA_{ijt}	**1.578** (0.135)	**1.271** (0.136)	**0.984** (0.133)	**-0.374** (0.044)
Pseudo R^2	0.123	0.123	0.148	

Note: a) The sample period is from 1960 through 2005, the number of countries is 180, the number of observations is 671,945, and the number of left-censored observations is 278,273.
b) Slope estimates in bold are significant at the five percent level. The fixed effects are jointly significant at any reasonable significance level, and the random effects are supported by the likelihood ratio test.
c) In the *'FE: period, RE: country-pair'* cases the standard errors are the usual unadjusted standard errors and the *Pseudo* R^2 is unavailable.

Table 8: Tobit Regressions for Import Flows

Independent Variables	*Coefficient (standard error)*			
	FE			*FE: Period RE: Country-pair*
	No	*Period*	*Period and Country*	
$ONEIN_{ijt}$	**1.907** (0.136)	**1.736** (0.138)	**1.064** (0.121)	**1.477** (0.046)
$BOTHIN_{ijt}$	**3.010** (0.141)	**2.705** (0.146)	**1.576** (0.137)	**2.257** (0.052)
$\ln(RGDP_{it})$	**1.967** (0.031)	**1.941** (0.031)	**3.774** (0.224)	**2.462** (0.030)
$\ln(RGDP_{jt})$	**2.847** (0.031)	**2.825** (0.031)	**4.825** (0.215)	**3.386** (0.030)
$\ln(RGDP_{it} / POP_{it})$	**0.445** (0.040)	**0.457** (0.040)	**-1.557** (0.202)	**-0.315** (0.035)
$\ln(RGDP_{jt} / POP_{jt})$	**-0.119** (0.040)	**-0.113** (0.040)	**-3.039** (0.203)	**-1.336** (0.036)
$\ln(DIST_{ij})$	**-2.808** (0.058)	**-2.824** (0.058)	**-3.034** (0.065)	**-2.987** (0.055)
$\ln(LAND_i)$	**-0.242** (0.024)	**-0.212** (0.024)		**-0.433** (0.025)
$\ln(LAND_j)$	**-0.312** (0.024)	**-0.285** (0.025)		**-0.631** (0.025)
$CLANG_{ij}$	**0.784** (0.091)	**0.817** (0.091)	**1.374** (0.102)	**1.172** (0.095)
$CBORD_{ij}$	**1.563** (0.333)	**1.591** (0.329)	**1.334** (0.357)	**1.878** (0.298)
$LLOCK_i$	**0.237** (0.112)	0.147 (0.113)		**0.291** (0.112)
$LLOCK_j$	0.122 (0.111)	0.041 (0.112)		**-0.224** (0.109)
$ISLAND_i$	0.204 (0.105)	**0.241** (0.105)		**0.820** (0.115)
$ISLAND_j$	0.204 (0.108)	**0.247** (0.108)		**1.014** (0.116)
$EVCOL_{ij}$	**3.056** (0.404)	**3.120** (0.399)	**1.905** (0.456)	**2.268** (0.465)
$COMCOL_{ij}$	**1.841** (0.133)	**1.849** (0.133)	**2.095** (0.131)	**1.389** (0.135)
$ISCOL_{ijt}$	0.412 (1.884)	0.851 (1.873)	0.189 (1.947)	**-1.809** (0.458)
$MUNI_{ijt}$	**1.885** (0.219)	**2.166** (0.223)	**1.516** (0.206)	**0.233** (0.071)
RTA_{ijt}	**1.397** (0.125)	**1.158** (0.126)	**0.946** (0.124)	-0.056 (0.043)
Pseudo R^2	0.115	0.116	0.138	

Note: a) The sample period is from 1960 through 2005, the number of countries is 180, the number of observations is 673,688, and the number of left-censored observations is 257,402.
b) See *Note b* of *Table* 7.
c) See *Note c* of *Table* 7.