The effect of membership in a trade organisation on international trade

Auteur : Schumacher, Roxanne
Promoteur(s) : Tharakan, Joseph
Faculté : HEC-Ecole de gestion de l'Université de Liège
Diplôme : Master en sciences économiques, orientation générale, à finalité spécialisée en economic, analysis and policy
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THE EFFECT OF MEMBERSHIP IN A TRADE ORGANISATION ON INTERNATIONAL TRADE

Jury:

Supervisor:

Joseph THARAKAN

Readers:

Axel GAUTIER

Pierre COPEE

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Roxanne Schumacher

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Glossary

- GATT: General Agreement on Tariffs and Trade
- WTO: World Trade Organization
- NTB: Non-Tariff Barriers
- MFN: Most Favoured Nation
- OLS: Ordinary Least Square
- PPML: Poisson Pseudo-Maximum Likelihood
- FE: Fixed Effects
- FTA: Free Trade Agreement
- LOG: Logarithm
- GSP: General System of Preferences
- IMF: International Monetary Fund
- RTA: Regional Trade Agreement
- IV: Instrumental Variable
- S&D: Special and Differential treatment
- GDP: Gross Domestic Product
- WDI: World Bank's Development Indicators
- GNI: Gross National Income
- UN: United Nations
- BACI: Base pour l'Analyse du Commerce International
- CEPII: Centre d'études prospectives et d'informations internationales

Introduction

Created in 1947, the GATT (General Agreement of Trade and Tariffs) and its successor the WTO (World Trade Organisation from 1995) have assisted nine rounds of trade policies that allowed to reduce trade barriers and encouraged a better environment for international trade. Until the early 2000s, the general consensus among economists was that the GATT/WTO had a positive impact on global trade. This assumption was challenged when, in 2003, A. K. Rose published a paper questioning the liberal trade policy of WTO members and whether or not the organisation had succeeded in its mission ; to liberalize international trade for members. The paper sparked a new debate about the relevance of the institution. With all the responses that followed Rose's paper, it was obvious that there was no clear answer and that the effect of membership was no longer evident.

This thesis will contribute to the topic by mixing two parametric approaches from two different economists who have contradicting outcomes. First, we will recreate A. K. Rose (2003b)'s baseline work by doing OLS regressions with country-pair fixed effects but with a different dataset and during a different observation period. This method will show similar results as Rose's. The other method is a PPML estimation with high dimension fixed effects accounting for what is supposedly missing for a traditional Gravity model with OLS regression, unobserved heterogeneity and endogeneity as well as changes in multilateral error terms. Those issues will be accounted for with country-pair, importer-time and exporter-time fixed effects. The design of the PPML model will enable one to control for zero trade flows, the main problem when dealing with trade data.

Literature review

The general consensus of the effects of membership to the GATT/WTO was that it is definitely positive, and that the institution promotes trade heavily. However, little to no empirical studies existed before the year 2000. That is before A. K. Rose (2003b) published a paper analysing whether or not countries belonging to the WTO (previously named the GATT before 1995) really had more freedom when it came to trade.

This paper sparked a new debate as there were very few or no existing articles reviewing empirical analysis of the effective impact of the WTO on international trade. This link assumed by many economists between the trade organisation and the facilitation of trade globally was never deeply empirically questioned.

In this first paper, A. K. Rose (2003b) wanted to strictly study the connection between indicators of trade policy and the GATT/WTO membership. To do that, Rose did not provide new policy measures but used a variety of indicators that had been created and used by other researchers. This could have a negative impact on the process due to the fact that he was dealing with a large number of measures that he was not familiar with and that were created for different purposes (usually to observe the effect of these measures on growth). The observed set was composed of sixty-eight trade policy measures, each organised into seven groups ranging from trade-flows and tariffs to informal and qualitative measures. The dataset used included 168 countries from 1950 to 1998.

The members of the WTO have various historical and economical records as the founders of the organisation were mostly the victors of the WWII and, later, developing countries started acceding. To analyse the relationship between membership and the evolution of trade per countries, Rose opted for two separated methods. To allow one to see if there truly is a difference between members and non-members regarding the liberal trade policy, he compared the various measures of policy between the WTO members and the non-members using a cross-sectional approach. To observe if accession is associated with liberalisation, Rose compared policy measures before and after accession using a time-series approach. To those methods he applied variations: simple OLS, OLS with augmenting variables and an instrumental variable for the cross-sectional approach as well as a varied utilisation of fixed-effects for the time-series.

For the most part, his statistical evaluations showed the effect of membership insignificant. A. K. Rose (2003b) states that there could be two explanations as to why the results did not show an impact of the WTO on trade. First, the GATT does impose the same policies for every country and therefore permits countries the freedom to choose and follow their own policies. This could weaken the results as the variables and the observations do not necessarily represent reality. Second, an alternative explanation is that there are countries that are not members of the organisation that benefit from advantages with the status of *most favoured nations* (MFN). This status is extended by members of the organisation and ensures non-members are treated the same way as members.

The same year, A. K. Rose (2003a) published another paper this time directly analysing the impact of membership in multilateral organisations (GATT/WTO, IMF, GSP) on trade. His

research came to the same conclusion as the one for the study of the impact of membership on liberal trade policy. He stated that there was little evidence to prove the WTO had an impact on international trade.

This time, A. K. Rose (2003a) opted for a Standard Gravity model with added conditioning variables to account for as many extraneous factors as possible. He studied the evolution of trade following a variation of time and country. He chose to do OLS regressions with country-pairs and year-specific fixed effects to estimate the Gravity model. The dataset used for these estimations comes from the IMF with 178 entities from 1948 to 1999. In his estimations he had three parameters of interests, one that evaluated the effect if both countries were in the organisation on trade, another that studied the impact if one country was in the organisation and the other was not on international trade and a last one that evaluated the effect the GSP (Generalised System of Preferences) had on trade. The latter was a system that facilitated and gave opportunities to poor countries to be able to trade with the world and grow economically. The results were that membership had no significant effect on trade, but traditional Gravity independent variables had. For example, countries who share a common language see their commerce increased, countries who have the same currency as well. Also, even though membership in the WTO had little to no effect on trade, being part of an RTAs (Regional Trade Agreement) did. Rose believed that this outcome could be explained by an effect of the possible delay of accession to the organisation as well as an issue of industry. Indeed, the trade of textile and agricultural products was less liberalised than that of manufactured goods.

A. K. Rose (2003a) advised, for future research, the use of a better IV (instrumental variable). He recognized the same issues found in his previous paper, the status of *MFN* and the lack of uniformity of policies among members. In this case, he also admitted that there may have been a lack of data for smaller countries as well. Indeed, small countries may record their trade but may not keep track of their national data. Without which, the observations were dropped, reducing the sample size in a way that made it less random. This may have added bias to the analysis if not taken care of properly. There was also the status of *de facto* which was not an official members status but, due to their shared border for example, make non-members benefit of the same advantages. This could also impact the results if not included in the process.

In the end, A. K. Rose (2003a) shared the same conclusion as the one in their previous paper: there is not enough work and evidence to confidently say the WTO had a positive impact on trade.

These analyses started a discourse among economists and encouraged others to comment on the findings. The same year, Subramanian & Wei (2003) responded to Rose that the WTO did promote trade strongly but unevenly.

They started their study with the same dataset used by A. K. Rose (2003a) but by changing the dependent variable, they obtained different results. Indeed, Subramanian & Wei (2003) observed the effect WTO had on imports and not on openness (the addition of imports and exports divided by GDP) as Rose had. The choice to focus on imports was made because they thought it made more sense due to the design of the institution and the fact that exports mostly concern industrialised countries. They stated that Rose's analysis was incomplete for two reasons. There was a need to account for country fixed effect and to account for

asymmetries of the effect the design of the organisation provided. Subramanian and Wei showed three different asymmetries. First, there was an asymmetry regarding developed and developing countries, they do not experience the same effects when acceding the organisation. Second, an asymmetry occurred when developed countries join the organisation before or after the Uruguay round. Finally, some sectors are more or less protected than others and therefore countries who are heavily productive in these sectors may not react as expected.

The first asymmetry can be explained by the fact that developed countries have already reduced their tariff rates whereas developing countries have fewer obligations to liberalise. The principle of special and differential treatment (S&D) has not (as of the Uruguay round) forced developing countries to liberalise their tariff barriers, nor has it allowed these countries to manage non-tariff barriers as they would (before getting sanctioned).

The second asymmetry is observed around the Uruguay round which had for purpose to close the gap between developed and developing countries in terms of barriers liberalisation. Data shows that countries that joined the WTO after the Uruguay round "follow the rules" or apply the uniformization of regulations much quicker than those who joined before the round. The "new countries" are given a shorter phase-in to adapt. This was one of the point Rose mentioned that could have on impact on his results, the delay effect.

The last asymmetry Subramanian & Wei (2003) accounted for is that liberalisation of barriers was not necessarily possible in every sector and did not follow the progress of other sectors. Indeed, countries whose main sectors of activity are agriculture, textile, footwear or food are usually less developed and are part of an MFA (Mult-Fiber Agreement) which is a vast set of restrictions imposed by developed countries on the imports coming from developing countries. Which is, by definition, violating the core regulations of the GATT and therefore does not react expectedly to membership.

The economists used an extended Gravity model with country fixed effects.

Accounting for the asymmetry of developed and developing countries, they obtained a positive and significant coefficient for the effect of membership on trade in developed countries but negative for developing countries. The data also showed an evolution of the coefficient over time where the coefficient is high and significant in the fifties and gets insignificant progressively. Also, results vary if the exporter is a member or not; the effect is greater if the exporter is also a member. As for the difference of effect when the country enters the organisation before or after the Uruguay round, the results showed that the impact is greater for those who joined after (in 2000). Finally, observing the difference of outcome between sectors is mainly observing the difference between high or low tariff rates. The industrialised liberalised sectors see an effect on trade when being part of the WTO whereas protected sectors do not. Worse for the agricultural industry, it has a negative and significant coefficient.

Subramanian & Wei (2003) concluded that unlike what A. K. Rose (2003a) said, the WTO promotes world trade accordingly to its design, but does not where it is not designed for.

The following year A. K. Rose (2004) responded to the claim his initial research was "incomplete and misleading" made by Subramanian & Wei (2003). He defended his work while agreeing on some of the content of the critique. Subramanian and Wei stated that Rose did not used

country fixed effects, and that could have caused the insignificant coefficient. Rose retorted that he did use country-pair fixed effect as well as country-specific fixed effects and that he was not sure the use of country fixed effect would change the outcome of his work drastically. Also, he reminded them that he did use country fixed effect, and that the outcome was insignificant (with openness as the dependant variable). Another response to the critique was that he did multilateral and bilateral analysis whereas Subramanian & Wei (2003) only looked bilateral data. Rose questioned also the lack of coherence between the results they brought and the data or information available. For example, A. K. Rose (2004) mentioned the fact that if WTO really did increase trade, we should be able to see an increase or a difference in trade policies, which is not the case. This could mean that it is true that world trade has increased these recent years but not necessarily because of WTO. Also, Rose did not agree with the statement Subramanian and Wei made about the fact that the WTO has been successful where the design intended it to. For him, it is not a true success if there need to have observations put aside. He stated that agriculture has had a great tradable history so if the WTO did not enhance its trade, it should not consider its missions as a success. In other words, Rose is not totally in agreement with the comments Subramanian and Wei made about his work and continue to claim that there is too little evidence to say the WTO had had an impact on the increase in global trade.

Another critique of Rose's initial work was published in 2005 by economists Tomz, Goldstein and Rivers stating that "membership has its privileges" (Tomz et al., 2005). Their explanation for the surprising results A. K. Rose (2003a) found lies in the understanding of the population observed.

Indeed, they argued that Rose, at times, misused or misplaced countries into the categories of insiders and outsiders of the WTO. To them, a lot of territories that were considered as outsiders by A. K. Rose (2003a) or Subramanian & Wei (2003) were in fact non-members participants and they did respond to the same rights and obligations as formal members. These participants could be classified into three distinct categories: colonies, de facto members, or provisional members. Being a participant derived from the colony category means that the participant benefitted from the membership of its connection with their metropole. Formal members decided, for the most part, to extend the agreement to the totality of their colonies but some chose to extend it only to a part. Many non-members participants exist due to the fact that the GATT was created in 1947 and at that time a lot of nations still owned a number of territories. This leads us to the *de facto members* category. This category regrouped countries that are, among other things, ex-colonies and newly independent territories. They get this status while deciding on their commercial strategy for their "new country." They benefit from the same advantages as formal members but do not have voting rights. This status was also temporary with a deadline set for the country to decide on membership or not. It was usually exceeded and finally the possibility of being a de *facto member* has been eliminated when the GATT became the WTO. The last category included provisional or temporary members who have signed the declaration for a set amount of time with a set number of members. Members who were not a part of this exchange were not forced to treat the provisional members as if they were formal members. But for the rest, provisional members had the same rights and obligations as the formal members.

Tomz et al. (2005) explained that if non-members participants are treated as outsiders, there will be a downward bias and the results will come out as insignificant. Those participants have been placed in the control group when they should have been in the treatment group (or a new treatment group). They used the same dataset and methods as A. K. Rose (2003a), only using the logarithm of openness for the dependent variable in place of regular openness. They obtain high and significant results when observing strictly formal members and non-members participants.

They recommend using fixed effects for this analysis as it accounts for endogeneity and is robust to misspecification. Also, they correct Subramanian & Wei (2003) by stating that when classifying the participants correctly, GATT also increases trade for developing countries (Subramanian & Wei (2003) claimed that the GATT promoted trade strongly but unevenly, with developing countries not benefitting greatly from it). They concluded that the status of *Most Favoured Nation* might play a key role in the GATT effect.

A. K. Rose (2005b) agreed with a lot of content from Tomz et al. (2005)'s paper but questioned some parts of it. In particular the foundation of the question answered. Indeed, Rose wonders if Tomz et al. (2005)'s approach is relevant to the research question as they appear to say that "the relevance of GATT can be saved when including developing countries". This is in total opposition to what the literature has been saying (as seen with Subramanian & Wei (2003); only when including developing countries, the GATT shows negligible effect). A. K. Rose (2005b) also does not understand why informal participation would increase trade more than formal membership when the organisation was design to help the members. He also states that the three categories of non-members participants do not have the same economical and statistical effect on trade and that *de facto* members have more influence than the other two. Without *de facto* members, Rose points out that the effect of GATT/WTO on trade is negative and insignificant.

Tomz et al. (2005) have recommended the use of fixed effects over OLS regression to answer the research question as the most efficient estimator, but Rose argues that the two do not give the same results and do not answer the same question. A. K. Rose (2005b) states that an OLS regression includes cross sectional as well as time series variations whereas fixed effects do not account for cross section. He says that using OLS estimator allows one to answer the question of "Do GATT insiders trade more or less than outsiders?" while using fixed effects answers the question "For a typical pair of countries, does a change in GATT status raise or lower trade?". In the end, Rose does not understand how participation in the organisation can have an impact on trade when it has no impact on trade policy.

A. Rose (2006) summarized the various works he has done the past few years and the reviews written about the subject as well as some self-critiques. He went back to his previous work and stated that these different approaches, methods used and different research questions (A. Rose, 2005; A. K. Rose, 2003a, 2005a) came out with insignificant results and too little evidence that membership had an effect on trade.

Indeed, in (A. K. Rose, 2005a) he analysed whether the WTO made trade more stable with the general public assumption that a big part of membership in the GATT/WTO is on the stability and predictability of trade policy. He focused on the second part of trade flows instead of the

first but found little evidence of a large effect. A. Rose (2005), in a paper that analysed which institution had the best effect on trade, found that the OCDE had the largest effect and the GATT/WTO had little to none.

A. Rose (2006) summarised the main three reasons he might be wrong that were provided by critiques. First, economists such as Subramanian and Wei affirmed that his use of fixed effects was not optimal. Rose still does not agree. He also adds that using the *within* estimator is tricky due to the fact that accession does not necessarily equal liberalisation. This can be explained by the phase-in that is granted when acceding the organisation and the fact that some countries are already liberalised when entering.

A second critique states that his approach of looking at all trade simultaneously reduces the effect of GATT/WTO and that looking at distinct parts of the data can deliver significant effect if disentangled. Rose acknowledged the comment but does not totally agree with it. He does not understand why economists say the GATT/WTO has significant effects when looking only at half of the population observed. It could equally mean it is a failure. Also, he finds it odd that for Subramanian & Wei (2003) the GATT has tremendous effects when not accounting for developing countries at all, whereas for Tomz et al. (2005), the effect of the GATT is only visible when accounting for developing countries (members or participants). But Rose is less convinced by the explanation of Tomz et al. (2005), because it does not make sense that trade is higher for non-members than for members. Tang & Wei (2006) show that even more by demonstrating that more rigorous entry requirements for membership in GATT/WTO are associated with better results. Therefore, Rose understands more the explanation of Subramanian & Wei but does not agree with the interpretation.

Lastly, A. Rose (2006) addresses an issue of selection bias in his previous analysis. He was reproached for not accounting for extensive trade margins (whether a pair of countries trade at all) and focusing only on intensive margins (the variations of non-zero trade across countries). This problem has been analysed by Felbermayr & Kohler (2006) and Helpman et al. (2008) and proves that ignoring extensive margins of trade induces an underestimation of the effects of GATT/WTO.

All works done on this subject, their critiques and the follow-up studies have somehow always used a traditional parametric approach. In 2011, Chang and Lee published a paper on the effect of WTO on trade using nonparametric approaches such as pair matching and permutation tests with sensitivity analysis Chang & Lee (2011). They argue that the conventional parametric approaches tend to have misspecification bias and wrong accounting of heterogenous effects as well as hidden selection bias, which non-parametric methods account for.

The main difference is the use of covariates where others used variables as proxies for the concept of trade resistance. Traditionally, researchers have assumed homogenous effect of membership when they might be heterogenous. Their search indicates that the misspecification of the traditional Gravity method can be because of the assumption of homogeneous treatment effects.

The pair-matching method, by design, allows for the treatment effect to vary with the observed covariates, therefore adapting to arbitrary forms of heterogeneous treatment effects. They applied these methods to the same dataset A. K. Rose (2003a) used and found large and

significant effects on trade. The sensitivity tests the conducted, inspired by Rosenbaum (2002), eliminated the possibility of hidden selection bias. They also used the difference-in-difference method to compare the difference overtime of trade volume for members and non-members. The estimates indicated that the effects of membership on trade are insignificant the first five to six years but become statistically and economically significant afterwards.

Chang & Lee (2011) concluded that their non-parametric approach addressed the problem of traditional Gravity model (parametric misspecification, heterogeneous membership effects and hidden selection bias) used in the literature about the trade effects of the GATT/WTO. Their findings suggest the effect is large between two countries belonging to the organisation. Also, the results do not change when choosing non-members participants over formal members. For them, the main explanation of the difference between their results and those of A. K. Rose (2003a) is because of assumption of homogeneous effects.

Finally, in 2018, Esteve-Pérez et al. (2018) wrote a paper agreeing with A. K. Rose (2003a) on the subject of the effect on trade of the GATT.

With the existing literature on the subject including on the econometric methods used (mainly the Gravity model), Esteve-Pérez et al. came to the conclusion that the varied results of the different works done in the past years were due to a computational issue. This means that even though the Gravity framework is coherent in the context of analysing the effects of GATT/WTO on trade, the choice of the estimators was restricted because they do not account simultaneously for all sources of estimation bias relevant in this case. EP chose to estimate "structural gravity equations with Poisson pseudo-maximum likelihood (PPML) "with high dimensional fixed effects to overcome those computational limitations. They included three types of fixed effects: country-pair fixed effects, exporter-time fixed effects and importer-time fixed effects. They used a dataset including 200 countries from the years 1948 to 2013.

The limitations solved with these fixed effects are: "accounting simultaneously for unobserved bilateral heterogeneity (with country-pair fixed effects), for multilateral resistance terms (with exporter-time and importer-time fixed effects), as well as for heteroskedastic residuals and zero trade flows (with PPML)."

As benchmarks, they used three estimators that did not control simultaneously for every source of bias possible. First, an OLS regression with exporter and importer-time fixed effects. The results were positive and in line with the existing literature but did not take care of issues related to heteroskedasticity and zero trade flows. Then, they did a PPML estimation with country-pair fixed effects. This method did not account for multilateral resistance terms but showed a positive effect. The last estimation was also PPML with time varying, directional country-specific dummies. Once again, the results were positive and significant but did not control for endogeneity and bilateral heterogeneity. Esteve-Pérez et al., stated that the positive results are possible due to the sources of bias not taken into consideration simultaneously.

In the end, when including the three high dimensional fixed effects mentioned above with the PPML estimator, Esteve-Pérez et al. got robust results of no positive effects of the GATT/WTO on trade. The results are robust and unchanging across time periods and country groups.

Overall, the literature reviewed about the effect of GATT/WTO on trade varies a lot. Following A. K. Rose (2003a)'s insignificant and surprising results, economists have tried to study this subject by changing method or data. Some of them, like Eicher & Henn (2011) as well as Roy (2011) and Esteve-Pérez et al. (2018) got the same conclusion as A. K. Rose (2003a). But others, like Subramanian & Wei (2003), Tomz et al. (2005), and Chang & Lee (2011) suggested otherwise. Their differences lied in their approach: most of them did a parametric approach with Gravity framework whereas Chang & Lee (2011) did a non-parametric approach with pair matching estimators and permutation tests, which showed good results. The others who chose the parametric approach either chose to change the estimators used in the Gravity model (Esteve-Pérez et al., 2018) or changed the population observed or their viewing angle (Subramanian & Wei, 2003; Tomz et al., 2005). Subramanian & Wei (2003) and Tomz et al. (2005) got positive results but with contradicting approaches and interpretations. Subramanian & Wei (2003) stated that the results gotten by A. K. Rose (2003a) were due to the inclusion of developing countries, whereas Tomz et al. (2005) argued that the effect was not positive because he didn't include enough developing countries.

Through this literature review, it is evident that there is a compelling need for further research in WTO trade effects and this thesis seeks to fill that void, offering new perspectives and insights that will inform both academic discourse and practical implementation.

Models

For this study, two different methods that will allow one to observe results that account for various computational or extraneous issues have been chosen. First, for benchmarking, we will be doing a traditional OLS regression analysis with country pair fixed effects in a Gravity model framework. To this model, as seen in A. K. Rose (2003a)'s work, will be added conditioning variables. They will allow one to control for as much extraneous factors as possible. Then, we will conduct a PPML estimation with three high dimensional fixed effects (country-pair, importer-year, exporter-year fixed effects), inspired by Esteve-Pérez et al. (2018), that will control for computational issues by incorporating all three fixed effects at the same time and therefore avoid biased estimates and misleading inference.

Gravity model

The purpose of this study is to analyse the relevance of the GATT/WTO on increase in trade. As said earlier, this subject was first empirically brought up by A. K. Rose (2003a and 2003b) using a Gravity model and a sample of 178 entities and their trade information from 1948 to 1999. This traditional trade model was introduced by Tinbergen (1962) and became an important empirical tool for trade research.

Gravity equation

The Gravity model is employed to estimate the effects of various phenomena on international trade. This model provides traditionally estimates of trade flows of goods between two or more locations. The specific equation on which we base the research is from A. K. Rose (2003a) and is constituted as follows:

$$\begin{aligned}\ln(X_{ijt}) = {} & \beta_0 + \beta_1 lnD_{ij} + \beta_2 \ln(Y_i Y_j)_t + \beta_3 ln(\frac{Y_i Y_j}{Pop_i Pop_j})_t + \beta_4 Lang_{ij} + \beta_5 Cont_{ij} \\ & + \beta_6 Landl_{ij} + \beta_7 Island_{ij} + \beta_8(Area_i Area_j) + \beta_9 ComCol_{ij} \\ & + \beta_{10} CurCol_{ijt} + \beta_{11} Colony_{ij} + \beta_{12} ComNat_{ij} + \beta_{13} CU_{ijt} + \beta_{14} FTA_{ijt} \\ & + \Sigma_t \varphi_t T_t + \gamma_1 Bothin_{ijt} + \gamma_2 Onein_{ijt} + \gamma_3 GSP_{ijt} + \varepsilon_{ijt}\end{aligned}$$

Where i and j denote trading partners, t denotes time, and the variables are defined as:

- X_{ijt} denotes the average value of real bilateral trade between i and j at time t,
- Y is real GDP,
- Pop is population,
- D is the distance between i and j,
- $Lang$ is a binary "dummy" variable which is unity if i and j have a common language and zero otherwise,
- $Cont$ is a binary variable which is unity if i and j share a land border,
- $Landl$ is the number of landlocked countries in the country-pair (0, 1, or 2),
- $Island$ is the number of island nations in the pair (0, 1, or 2),
- $Area$ is the area of the country (in square kilometres),
- $ComCol$ is a binary variable which is unity if i and j were ever colonised after 1945 with the same colonizer,
- $CurCol$ is a binary variable which is unity if i is a colony of j at time t or vice versa,
- $Colony$ is a binary variable which is unity if i ever colonized j or vice versa,
- $ComNat$ is a binary variable which is unity if i and j remained part of the same nation during the sample (e.g., France and Guadeloupe),
- CU is a binary variable which is unity if i and j use the same currency at time t,

- FTA is a binary variable which is unity if i and j both belong to the same regional trade agreement,
- $\{T_t\}$ is a comprehensive set of time "fixed effects",
- β and φ are vectors of nuisance coefficients,
- $Bothin_{ijt}$ is a binary variable which is unity if both i and j are GATT/WTO members at t,
- $Onein_{ijt}$ is a binary variable which is unity if either i or j is a GATT/WTO members at t,
- GSP_{ijt} is a binary variable which is unity if i was a GSP beneficiary of j or vice versa at t, and
- ε_{ij} represents the omitted other influences on bilateral trade, assumed to be well behaved.

General critiques of this equation

Subramanian & Wei (2003) argue that A. K. Rose (2003a)'s work is "incomplete and could be misread" in two different ways. First, they claimed that his econometric work on bilateral flows was missing country-specific fixed effects and secondly, he did not account for three asymmetries the design of the GATT/WTO institution was based on; the difference between industrialized countries an developing countries, the difference between the nations that joined before and after the Uruguay round, and the differences across sectors of activity with different levels of liberalisation. Tomz et al. (2005), agreed with Subramanian & Wei that the results Rose got were wrong but stated that it was because the institution was valid for developing countries and for countries that were not official members but participants with rights and obligations.

Unobserved heterogeneity and omitted variables

Esteve-Pérez et al. (2018) argue that this model is based on homogenous treatment effects assumption and that actually, this method calls for control of unobserved heterogeneity with the lack of variables that impact the dependant variable. These variables may be correlated to the dependent variable and therefore cause biased estimates. They also argue that the assumptions on which Rose relied, of "selection on observables" may not sustain if there are too may omitted variables. That is the non-random selection of observations into the treatment group that could lead to serious bias with too many omitted variables.

Computation issues and endogeneity

We learn that, with the work of Esteve-Pérez et al. (2018), what is missing from this method is the simultaneity of various fixed effects to control for as much extraneous factors as possible and to account for the computational issue faced when doing a regular Gravity equation. This can be resolved with another estimator, PPML augmented with three high dimensional fixed effects, similar to the ones Esteve-Pérez et al. used. The problem of endogeneity that can be faced with the traditional Gravity equation is controlled for with time-invariant fixed effects.

The high dimensional fixed effects Esteve-Pérez et al. (2018)offered also account for multilateral resistance terms, heteroskedastic residuals and zero-trade flows.

Solutions

To tackle the heterogeneous treatment effects, we will be adding fixed effects and use panel data. The fixed effects will allow to control for the time-invariant variables that may be

contained into the error term ε_{ij}. For the other method that we will talk about later, we will also add high dimensional fixed which does not have the same model assumptions as the other methods.

Model specifications

With a different database and other dependent variables than A. K. Rose (2003a), we used the following equation as the baseline of our work with two variations of the dependant variables :

$$\ln(X_{ijt}) = \beta_0 + \beta_1 lnDist_{ij} + \beta_2 \ln(Y_i Y_j)_t + \beta_3 ln(\frac{Y_i Y_j}{Pop_i Pop_j})_t + \beta_4 Comlang\_off_{ij} + \beta_5 contig_{ij} + \beta_9 comcol_{ij} + \beta_{10} col\_dep_{ijt} + \beta_{14} fta\_wto_{ijt} + \gamma_1 BothinGW_{ijt} + \gamma_2 OneinGW_{ijt} + \Sigma_t \varphi_t T_t + \varepsilon_{ijt}$$

Or,

$$\ln(trade_{ijt}) = \beta_0 + \beta_1 lnDist_{ij} + \beta_2 \ln(Y_i Y_j)_t + \beta_3 ln(\frac{Y_i Y_j}{Pop_i Pop_j})_t + \beta_4 comlang\_off_{ij} + \beta_5 contig_{ij} + \beta_9 comcol_{ij} + \beta_{10} col\_dep_{ijt} + \beta_{14} fta\_wto_{ijt} + \gamma_1 BothinGW_{ijt} + \gamma_2 OneinGW_{ijt} + \Sigma_t \varphi_t T_t + \varepsilon_{ijt}$$

Where i and j denote trading partners, t denotes time, and the variables are defined as:

- X denotes the aggregate *op*enness, which is exports plus imports divided by real GDP for a country i and a country j at time t,
- $trade$ denotes a quantification of real trade, which is the sum of exports and imports for a country i and a country j at time t,
- Y is real GDP,
- Pop is population,
- $Dist$ is the distance between i and j,
- $comlang\_off$ is a binary "dummy" variable which is unity if i and j have a common language and zero otherwise,
- $contig$ is a binary variable which is unity if i and j share a land border,
- $comcol$ is a binary variable which is unity if i and j were ever colonised after 1945 by the same colonizer,
- col_dep is a binary variable which is unity if i is a colony of j at time t or vice versa,
- fta_wto is a binary variable which is unity if i and j both belong to the same regional trade agreement,
- $\{T_t\}$ is a comprehensive set of time "fixed effects",
- β and φ are vectors of nuisance coefficients,
- $BothinGW_{ijt}$ is a binary variable which is unity if both i and j are GATT/WTO members at t,
- $OneinGW_{ijt}$ is a binary variable which is unity if either i or j is a GATT/WTO members at t,
- ε_{ij} represents the omitted other influences on bilateral trade, assumed to be well behaved.

Compared to the original equation of A. K. Rose (2003a), we do not analyse the variables that regard currency union and lessen the number of independent variables to fit the database. The parameters of interest are γ_1 and γ_2. They measure respectively the effect on trade of membership of two or only one country in the GATT/WTO in a pair of countries. This means that if the coefficient γ_1 is of 0.5, when two countries are members of the GATT/WTO, there trade should increase of about fifty percent. To quantify trade, we changed the dependent variable from Rose's model from "openness" to "real trade". Which are respectively imports plus exports divided by real GDP and the sum of imports and exports. We regressed both to observe differences if any were present. The model is augmented with conditional variables that may affect trade, to control for as many extraneous factors as possible (for example: distance, language, colonizer, FTA…). We included year-specific fixed effects to control for factor change such as inflation, oil shocks, globalisation, the value of money and so forth, …

This equation and the results it provided are not meant to be sensational and groundbreaking as they were used to observe the difference of results with the same method but different database, time period, and independent variables as A. K. Rose (2003a). These are the benchmark results.

Model assumptions

In order to have an unbiased and consistent Gravity model that provides efficient estimates, some assumptions must be checked. We will go through the most important ones. This will allow one to understand more deeply the results we will get, and it will explain the limitations if there are any.

No perfect multicollinearity

First, for this model to work, the independent variables should not be perfectly collinear. If they are perfectly multicollinear, that would make it impossible to estimate the coefficients uniquely. With the Table 10, that shows the correlation matrix for all variables, no variable is perfectly collinear with another. Therefore, the assumption of no perfect multicollinearity is verified. One can note that the highest correlation coefficient is between the variables that correspond to GDP and trade with a bit more than 0.65.

Homoscedasticity

To have homoscedasticity means that the variance of the error term is constant over time and across observations. To test this assumption, one can do a Breusch-Pagan test to check for heteroscedasticity. If the heteroscedasticity is present in the model, standard errors can be biased and can lead to incorrect inferences. The results are shown in Table 13 in the appendix. The results came out significant, therefore one cannot reject the null hypothesis of constant variance. This means that there could be heteroscedasticity in this model and to take care of this issue we will use robust standard errors going forwards.

No serial correlation

As this is a context of panel data, there should be no correlation between the error terms from one period of time to another. This means that the error terms should not be serially correlated. To verify this assumption, we performed a Durbin-Watson test. The test has reported a statistic of about 1.4281277, suggesting a slightly positive serial correlation in the residuals of the

model. This can affect the efficiency of the estimator used and can lead to biased standard errors.

Normality of errors

The assumption of normally distributed error terms should be checked even more so for a smaller sample. As the sample of data we are using contains more than four million observations, this assumption is of smaller importance for us. Due to the Central Limit Theorem, larger samples are in a less critical position regarding the normality assumption. We will go on with the study by assuming our estimators are normally distributed.

Linearity

To check for the linearity assumption, we plotted the residuals of the regression, with real trade as the dependent variable, against the fitted values. In Figure 1, in the appendix, one can see the residuals randomly distributed around the mean, this implies linearity.

Zero conditional mean assumption

This assumption means that the error term has an expected value of zero for every value of explanatory variables. This ensures no systematic relationships between the error term and the explanatory variables. If not respected, this assumption would lead to biased and inconsistent estimates. To check for it, in addition of Figure 1 that shows random distribution, we conducted a RESET test. The RESET test (Table 11) indicates that there may be misspecifications in the model. It is to be kept in mind for the continuation of the study.

Poisson Pseudo-Maximum Likelihood

PPML is a statistical technique often used to estimate count data (where the dependent variable is non-negative) especially when there is a high number of zeros, which is the case for this study. It is typically employed in the domain of health economics, but also largely integrated in a Gravity context for international trade. The model we will be using is inspired by Esteve-Pérez et al. (2018)and their use of the PPML, which is also inspired by Larch et al., 2017).

Larch et al. (2017)proposed a model that accounts for all the issues Esteve-Pérez et al. (2018) found in the traditional Gravity model, with high dimensional fixed effects. Those issues are: unobserved bilateral heterogeneity and endogeneity, multilateral resistance terms, heteroscedastic residuals and zero trade flows.

Model specifications

Using a PPML methodology with high dimensional fixed effects, here is the equation used to estimate the effect of membership in GATT/WTO on trade:

$$X_{ijt} = \exp\big(\beta_1 gdp_{it} + \beta_2 gdp_{jt} + lnDist_{ij} + \beta_4 comlang_{ij} + \beta_5 contig_{ij} + \beta_6 comcol_{ijt} + \beta_2 fta_{ijt} + \beta_3 BothinGW_{ijt} + \beta_4 OneinGW_{ijt} + \chi_{it} + \lambda_{it} + \eta_{ij}\big) + u_{ijt}$$

Where i denotes the exporter, j denotes the importer, and t is time. The variables are defined as follows:

- X_{ijt} denotes trade flows between the exporting country i and the importing country j at time t,
- $Dist$ is the distance between i and j,
- gdp is the GDP for county i or j at time t in thousands of US dollars,
- $comlang$ is a dummy variable that is unity if country i and country j share a language,
- $contig$ is a binary variable which is unity if country i and country j share a land border,
- $comcol$ is a binary variable which is unity if country i and country j share a common colonizer post 1945,
- fta is a binary variable which is unity if i and j both belong to the same regional trade agreement,
- $BothinGW_{ijt}$ is a binary variable which is unity if both i and j are GATT/WTO members at t,
- $OneinGW_{ijt}$ is a binary variable which is unity if either i or j is a GATT/WTO members at t,
- χ_{it} are exporter-time fixed effects,
- λ_{it} are importer-time fixed effects,
- η_{ij} are country-pair fixed effects and,
- u_{ijt} is the error term.

Potential critiques

While PPML has advantages, such as handling zero trade flows and heteroskedasticity better than Ordinary Least Squares (OLS), it also has several potential critiques and limitations:

Overdispersion

Generally, the Poisson model wants the mean and the variance of the dependant variable to be equal. But with this specification of the model, this assumption is not required to be fulfilled. Also, the model assumes to follow a Poisson distribution. If it is not the case, the estimates might be biased.

Complexity of implementation and interpretation of coefficients

PPML models are more complicated to implement and to interpret than a traditional OLS regression. Errors of misinformation or misspecification can occur more frequently and easily when not being careful. Also, the coefficient must be analysed differently than for an OLS regression, as they are in the log-scale. To interpret them, one should exponentiate the coefficient to get the multiplicative effect on the dependent variable.

Endogeneity

In some cases, endogeneity issues can arise when one or more variables are correlated with the error term. This can, then, lead to biased and inconsistent estimates.

Collinearity

As for the previous method, multicollinearity for one or more independent variables can lead to issues such as unstable coefficient or hard to interpret results. To avoid that, we either combine or drop the variables.

Correct model specification

It is important for the PPML model to be well specified in order to show great results. Indeed, this technique requires the right covariates to be functional, if not it can lead to biased estimates. To make sure the model is correctly specified, we run robustness checks.

Model assumptions

No perfect multicollinearity

This assumption, as seen in the section for the Gravity model's assumptions, expects no perfect collinearity among independent variables. Otherwise, the estimates are biased and it is impossible to estimate the coefficients uniquely. The Table 12 shows the results of the correlation matrix for our collinearity check. We see that no variables are perfect linear combination, therefore we can verify this assumption. Nevertheless, some variables have high coefficient of correlation such as *BothinGW* and *OneinGW,* but that is not surprising. There were remaining issues with collinearity so we decided to drop *contig, comcol* and *comlang*, as well as continuing with the product of real GDP as a single variable rather than GDPs of countries separately.

Exogeneity and independence of observations

We assume the independent variables to not be correlated with the error term. If they are, endogeneity issues may arise and lead to biased and inconsistent estimates. The panel data design of our database takes care of this problem. Also, the observations are said to be independent from one another. That means that the trade flows between a pair of countries is independent from the trade flows between another pair of countries.

Equidispersion

Doing a PPML method means following a Poisson distribution. This means that the mean and the variance of the dependent variable should be equal. However, this is not a strong assumption because the model can still be robust with an overdispersion, where the variance is greater than the mean. Descriptive statistics show the variance being slightly greater than the mean. The results of the Goodness-Of-Fit test to check for overdispersion shows low results, indicating poor fit and overdispersion. This can be worrisome, however, given the advantages of the PPML model and the lack of better fit of other models, we will continue with the PPML model, being cautious of the outcome given the overdispersion.

Positivity of the dependent variable

As said in the introduction of the PPML section, this method is used mainly to observe count data. That naturally means that the dependent variable must be non-negative. We can assume this assumption cleared as trade flows – the dependent variable – cannot be negative.

PPML equation

Hereunder is the final equation used for the PPML regression to estimate the effects of membership in GATT/WTO on international trade:

$$X_{ijt} = \exp\big(\beta_1 \ln(gdp_{it} gdp_{jt}) + \beta_2 \ln \mathrm{Dist}_{ij} + \beta_3 contig_{ij} + \beta_4 coldep_{ijt} + \beta_5 fta_{ijt} + \beta_6 BothinGW_{ijt} + \beta_7 OneinGW_{IJT} + \chi_{it} + \lambda_{it} + \eta_{ij}\big) + u_{ijt}$$

Where i denotes the exporter, j denotes the importer, and t is time. The variables are defined as follows:

- X_{ijt} denotes trade flows between the exporting country i and the importing country j at time t,
- $Dist$ is the distance between i and j,
- gdp is the GDP for county i or j at time t in thousands of US dollars,
- $contig$ is a binary variable which is unity if country i and country j share a land border,
- $coldep$ is a binary variable which is unity if country i is a colony of j at time t and vice versa,
- fta is a binary variable which is unity if i and j both belong to the same regional trade agreement,
- $BothinGW_{ijt}$ is a binary variable which is unity if both i and j are GATT/WTO members at t,
- $OneinGW_{ijt}$ is a binary variable which is unity if either i or j is a GATT/WTO members at t,
- χ_{it} are exporter-time fixed effects,
- λ_{it} are importer-time fixed effects,
- η_{ij} are country-pair fixed effects and,
- u_{ijt} is the error term.

Data

For this study, we used the database Gravity from CEPII. This allowed me to analyse over two hundred and fifty countries from 1948 to 2021. This database was first used by Berthelon & Freund (2007), with the purpose being to provide a comprehensive overview of the Gravity model's application in international trade. Since its initial usage, the Gravity database has widened its utilization by allowing one to research about various domain of international trade, such as public policies, RTAs or even global economic changes.

We also created some variables such as the main variables of interest *BothinGW* and *OneinGW* that are dummy variables who are unity when countries i and j are members of the GATT/WTO and if only i or j is a member of the GATT/WTO respectively. In the dataset, dummies for membership in the EU, the GATT and the WTO already existed so we created variables that merged the results for GATT and WTO into one.

CEPII

Founded in 1978, CEPII is France's leading centre for research and expertise in international economics. Its acronym stands for "Centre d'études prospectives et d'information internationales". Through its impartial, in-depth analysis on global commerce, migration, macroeconomics, and finance, the centre contributes to the formulation of policy. Databases are also produced by CEPII and platform for debates are offered to private and public decision-maker, economists, academics, experts and so forth… CEPII proposes various databases that are grouped by theme: Gravitational Data, International Trade, Indicators and Macroeconomics.

The dataset for this study belongs to the Gravitational Data group and entitled "Gravity". It contains bilateral or unilateral data to estimate Gravity equations: trade flows, GDP, population, … For any pair of countries, of a sample of 252, from 1948 to 2021. The Gravity database is obtained by combining data from diverse sources; academic researchers or institutional sources. As for the variables, the database gathers Macroeconomic indicators (GDP, population, …), cultural indicators (language, religion, …), trade measures (RTA, membership to GATT/WTO/EU, …), geographical indicators (distance, borders, …) and bilateral flow, from three distinct sources : IMF, UN and BACI.

Variables

In this small section, we will go through the provenance of each variable used in our models and explain all these characteristics. We had all the data needed in the Gravity database from CEPII, so we had no need to merge data sets together.

First of all, for our dependent variable *trade*, we added *tradeflow_imf_o* and *tradeflow_imf_d*. Those variables indicate trade flows as reported by the exporter and the importer, respectively, in thousands of US dollars. *Tradeflow_imf_o* and *tradeflow_imf_d* are data provided from the IMF. Other similar variables existed to choose from that quantify trade: *tradeflow_baci*, *manuf_tradeflow_baci*, *tradeflow_comtrade_o* and *tradeflow_comtrade_d*. The first two are from CEPII' s BACI database and offers a variable that observe trade flow in thousands of US dollars (*tradeflow_baci*) and another that observe trade flow of manufactured goods in thousands of US dollars (*manuf_tradeflow_baci*). We did not choose to use the second one as

it targets only manufactured goods and therefore leaves out of the analysis a considerable amount of trade, such as primary goods. We also did not choose *tradeflow_baci* as the period of time on which they have been observed is much shorter (1996 to 2021) than the data from IMF (1948 to 2021). *Tradeflow_comtrade* variables are from the UN, they are organised the same way as the ones from IMF with a country of origin (exporter) and a country of destination (importer) in every pair of countries for every year. They had great time coverage, but we decided not to use them in the end.

Next, for the other dependent variable we used, *openness*, we divided the variable *trade* (sum of imports and exports) by the real GDP (multiplication of GDP from country of origin and destination). The main source for variables such as *gdp* – and *pop* (population) – is WDI, World Bank's Development Indicators.

Finally, we will go through the details of the conditioning variables used in the Gravity equation and conclude by explaining the creation of the two variables of interest, *BothinGW* and *OneinGW*. The conditioning variables are mainly from CEPII's GeoDist database. From this database, we find *contig*, that is a dummy and is unity if country of origin and destination share a border. There is also *comlang_off*, that is a dummy and is unity if country of origin and destination share a same language. The last variable from this database id *comcol*, which is dummy that is unity when countries of origin and destination share the same colonizer post 1945. *Col_dep* is from Head et al. (2010), and is a dummy variable that is unity if the pair of countries is currently in colonial or dependency relationship.

And then, we created the variable of interest *BothinGW* and *OneinGW* based on the dummy variables *wto* and *gatt*. We merged the two dummies – as *gatt* stopped showing observation after 1995 and *wto* did not have any before 1995 – in order to have one continuous variable. I, then, created a dummy that was unity when both countries within a pair were members of the GATT/WTO (that means the new dummy *gatt_wto* was equal to one for each country), *BothinGW*. *OneinGW* was created as well, being a dummy variable that is unity if one of the two countries in the pair is a member of the GATT/WTO (*gatt_wto* is equal to one for one of the two countries). The variable such as *gatt*, *wto*, *ue* and *fta_wto* were all obtained from the WTO.

Descriptive statistics

This section is expected to give the reader a better understanding of the state of the sample and the range of the dataset.

The final database contains 4.680.648 observations of trade flows for 252 countries over a period of time of about 75 years (from 1948 to 2021). Each country is importer and exporter in different pairs. Every country does not record their trade as well as others would, so as mentioned above, it is not always clear if values are missing or equal to zero. Table 4 gives more details on the statistics of our main variables.

Empirical findings

This section presents the findings of the methodology used to observe the effects of membership in GATT/WTO on trade. First, it will detail the estimations obtained doing an OLS regression analysis in the context of a Gravity model. Then, this section will go on to examine the results of the PPML methodology. Both models contain variations.

Gravity results

As a reminder, here is the Gravity equation used for this study:

$$\ln(trade_{ijt}) = \beta_0 + \beta_1 lnDist_{ij} + \beta_2 \ln(Y_i Y_j)_t + \beta_3 ln(\frac{Y_i Y_j}{Pop_i Pop_j})_t + \beta_4 comlang\_off_{ij} + \beta_5 contig_{ij} + \beta_9 comcol_{ij} + \beta_{10} col\_dep_{ijt} + \beta_{14} fta\_wto_{ijt} + \gamma_1 BothinGW_{ijt} + \gamma_2 OneinGW_{ijt} + \Sigma_t \varphi_t T_t + \varepsilon_{ijt}$$

A variation of this equation was estimated in the beginning of working on this subject, with the logarithm of "openness" as the dependent variable. Using the logarithm of *trade* for the dependent variable, gave slightly higher coefficient results. Here is the equation:

$$\ln(X_{ijt}) = \beta_0 + \beta_1 lnDist_{ij} + \beta_2 \ln(Y_i Y_j)_t + \beta_3 ln(\frac{Y_i Y_j}{Pop_i Pop_j})_t + \beta_4 Comlang\_off_{ij} + \beta_5 contig_{ij} + \beta_9 comcol_{ij} + \beta_{10} col\_dep_{ijt} + \beta_{14} fta\_wto_{ijt} + \gamma_1 BothinGW_{ijt} + \gamma_2 OneinGW_{ijt} + \Sigma_t \varphi_t T_t + \varepsilon_{ijt}$$

Table 1 contains benchmark OLS regression results with the logarithm of trade as dependent variable, and Table 2 contains benchmark OLS regression results with the logarithm of openness as the dependent variable.

In Table 1, the "Default" column is a regular OLS regression with no fixed effects or time effects. The model works relatively well as the R^2 is not low, 0.54, and every variable is statistically significant at the 1% level. This would mean that every variable of the model has an impact on trade. However, as in A. K. Rose (2003a)'s work, the results are surprising and unintuitive. Indeed, the coefficients for our variables of interest (when both countries are members and when one is, and the other is not) are high and negative: respectively -0.44 and -0.43. This means that when both countries of a trading pair are members of the GATT/WTO, contrary to if none of them are, their commerce decrease. Because our model is linear log, we have to consider the fact that the coefficients of the independent variables must be transformed as to obtain their real effect on trade. In the case of our default baseline results, when the pair of countries if entirely made of members, their trade decrease of approximately 35% ($e^{-0,44} - \approx -0,35$). And when only one country of the pair is a member of the institution, the trade should decrease of approximately 0.34 ($e^{-0,43} - \approx -0,34$). A. K. Rose (2003b), stated having found negative results with his first rough estimation, the results we got is in line with this statement.

Following these surprising results, we continued by controlling for the effects linked to time changes. We can see it did give a positive coefficient for $BothinGW$, but still a negative one for $OneinGW$. Now, membership of both countries impacts global trade by approximately 10%. This converge to A. K. Rose (2003a)'s results but are still a little lower than his. Adding country-pair fixed effects, the coefficient for $BothinGW$ and $OneinGW$ are both positive and significant and totally similar to Rose's. with their coefficient being 0.19 and 0.004 respectively, their impact on trade is an increase of approximately 20% and 0,4%. This means that when accounting for unobserved heterogeneity between different country pairs, we obtain a result that is positive and significant. The impact of the effect of membership can be interpreted differently according to who might read it. For A. K. Rose (2003a), the percentage he got of roughly 16% was not enough of an increase to affirm the GATT/WTO has had or still has an impact on trade. To others this number might seem high enough. Here the percentage is slightly higher, but we don't know if we can be absolute about its impact.

Also, one coefficient that may be surprising as well, is $coldep$'s. its coefficient is of about 1.04 with country-pair fixed effects. This means that when both countries are members and if the pair is currently in a colonial or dependency relationship, their trade increase of roughly 182%. It is probably because the link of theirs forces them to have more contact and to trade with each other.

Almost every variable, except for the dummy variable for the common land border, has decreased when applying country-pair fixed effects. However, the R^2 has increased and the number of observations has remained the same. In the end, we obtain roughly the same outcome as A. K. Rose (2003a)'s, but strictly data analysing speaking, we cannot deny an increase of trade when both countries of a pair are members of the GATT/WTO. Even though this increase might seem relatively small to some researchers.

Table 1: Baseline results OLS regression

Variables	Default	With year effects	With country-pair fixed effects
Both in GATT/WTO	-0.44*** (0.009)	0.1*** (0.033)	0.19*** (0.29)
One in GATT/WTO	-0.43*** (0.009)	-0.11*** (0.031)	0.004 (0.03)
Log Distance	-1.04*** (0.003)	-0.99*** (0.017)	-0.25 (0.25)
Log real GDP	0.89*** (0.001)	0.96*** (0.005)	0.4*** (0.021)
Log real GDP p/c	-0.22*** (0.001)	0.05*** (0.007)	0.09*** (0.026)
Common Language	0.59*** (0.008)	0.61*** (0.038)	Omitted
Land Border	0.6*** (0.017)	0.69*** (0.088)	1.08*** (0.406)

Common Colonizer	0.11*** (0.01)	0.83*** (0.054)	Omitted
Colonize each other	3.92*** (0.082)	2.48*** (0.367)	1.04*** (0.195)
Regional FTA	0.58*** (0.009)	0.78*** (0.034)	0.34*** (0.022)
Observations	713,203	713,203	713,203
R^2	0.54	0.64	0.8

P < 0.01 ***, p < 0.05 **, p < 0.1 ***

Regressand: log real trade.

OLS with year effects (2) and country-pair fixed effects (3).

Robust standard errors (clustering by country-pairs) in parentheses.

Stata: own computation

In the appendix, table 2 shows the results of the same OLS regression with its variations but with the logarithm of openness (sum of imports and exports divided by real GDP) replacing the logarithm of real trade (sum of imports and exports). The outcome is almost identically the same, expect for the logarithm of real GDP that is now negative and has the coefficient of 0.59 (with country-pair fixed effects). The other coefficients and the number of observations are the same as the ones from the first regression, but the R^2 are lower.

Also, the Table 5 from the appendix represents a cross-sectional analysis at a five-year interval of the variables of interests, when the two countries of a pair are members, and when only one of them is. There, we can clearly see that the effect of membership in GATT/WTO has drastically decreased from 1950. This can mean that the high and significant expected results were more probable to get before than currently.

PPML results

As a reminder, here is the equation used for the PPML regression:

$$X_{ijt} = \exp\big(\beta_1 \ln(gdp_{it}gdp_{jt}) + \beta_2 \ln \mathrm{Dist}_{ij} + \beta_3 contig_{ij} + \beta_4 coldep_{ijt} + \beta_5 fta_{ijt} + \beta_6 BothinGW_{ijt} + \beta_7 OneinGW_{ijt} + \chi_{it} + \lambda_{it} + \eta_{ij}\big) + u_{ijt}$$

Table 3 contains the results of the PPML regression with, country-pair fixed effects in column (1), exporter-time and importer-time fixed effects in column (2), and all three fixed effects in column (3). The dependent variable is the sum of imports and exports within a pair of countries.

In the first column, accounting only for potentially unobserved heterogeneity between pairs of countries with the country-pair fixed effects, the coefficients of the variables of interest are positive and statistically significant with a higher value than from the Gravity OLS estimation. This time, every variable is significant at the 1% level except for the logarithm of distance and the dummy variable of the common land border that are significant at the 10% level. The model

seems to fit well with high pseudo-R^2 for every variation of the regression, each time with a pseudo-R^2 higher than 90%. The results are not really similar to Esteve-Pérez et al. (2018)'s, which is surprising but can be explained by the fact that their variables of interest included the currency unions, which ours does not, and the fact that their model was computed at a five-year interval while ours is at a yearly interval. The coefficient of the variable of interest, when both countries of a pair are members in the GATT/WTP is 0.41 and when only one is a member is 0.33. this means that when both countries of a pair are a part of the GATT/WTO their trade increases of about 50% ($e^{0.41} - 1 \approx 0.507$). This time, the model is an exponential one, so that means that to interpret the coefficient of each variable we have to transform them in order to obtain their real effect. With only country-pair fixed effects, the effect of membership in the GATT/WTO of both countries or only one in the pair, are 50% and 39% respectively ($e^{0.41} - 1 \approx 0.507$, $e^{0.33} - 1 \approx 0.391$). in other words, when both countries of a commerce exchange are a part of the GATT/WTO, their trade should increase of about half of what it would be if they were not members.

In the second column, we accounted for unobserved heterogeneity specific for exporters and importers over time with exporter-time and importer-time fixed effects. This specification gave us the lowest coefficient for $BothinGW$ and $OneinGW$ with 0.01 and -0.1. These equal an increase of 1% of trade when both countries are members and a decrease of 9%. These results are not like Esteve-Pérez et al. (2018)'s except maybe for the first column of his second table which exhibits slightly smaller coefficients than ours but still negative. The pseudo-R^2 is also slightly smaller than in the first column but still above the 90% level. Unfortunately, the coefficients of the variables of interest are not significant at all.

Lastly, when controlling for all three types of unobserved heterogeneity and multilateral resistance terms we get the highest coefficients meaning the highest positive effect on trade. The impact of when two countries of a pair are members in the GATT/WTO is an increase of approximately 44% of their trade. When only one nation of the pair is a member, the increase of trade is about 46%. This outcome has even more significance and a higher coefficient than the ones in Esteve-Pérez et al. (2018) and Larch et al. (2017). It can, perhaps, be explained by the change of covariates or the different time period observed. This time, the coefficients of the variables of interest are significant at a 10% level for $BothinGW$ and at the 1% level for $OneinGW$. For the rest of the covariates, only the coefficient of the logarithm of distance is not significant and $coldep$ is significant at a 11% level, every other coefficient is significant.

All in all, the coefficients increased with the number of fixed effects as well as the value of the pseudo-R^2. The number of observations remained quite the same for all three of the regressions.

Table 3: PPML estimations results

Variables	(1)	(2)	(3)
Log of real GDP	0.61*** (0.02)	Omitted	Omitted
Log of distance	-0.73* (0.27)	-0.67*** (0.02)	-0.14 (0.13)
Common land border	0.54* (0.27)	0.56*** (0.07)	0.34*** (0.13)
Colonize each other	0.51*** (0.1)	1.28*** (0.33)	0.16 (0.09)
Regional FTA	0.16*** (0.04)	0.43*** (0.05)	0.13*** (0.02)

Both in GATT/WTO	0.41*** (0.09)	0.01 (0.3)	0.37** (0.21)
One in GATT/WTO	0.33*** (0.12)	-0.1 (0.15)	0.38*** (0.14)
Observations	1,004,192	1,004,139	1,004,139
Pseudo R^2	0.96	0.94	0.97

Regressand: real trade.

PPML with country-pair fixed effects (1), importer-time and exporter-time fixed effects (2) and all three high dimensional fixed effects (3).

Robust standard errors (clustering by country-pairs) in parentheses.

Stata: Own computation

Robustness checks

In order to test whether our results depend on the specifications of these models or if they are robust to others as well, we will conduct several tests to check their robustness.

Five-year interval

The small effect obtained (in particular with the Gravity OLS regression), can potentially be explained by the effect of *phase-in.* That is that the effect of membership in the GATT/WTO on trade may not be visible the year the country joined but in the next few years. Mainly because of the implementation of some liberalisation measures and the change of trading habits. Cheng & Wall (2005) have recommended to use a several year interval rather than a yearly interval. This has since become general practice in the domain of RTAs (Bergstrand et al., 2015). We will therefore redo the OLS regression and the PPML estimation at a five-year interval to control for *phase-in* effects. As we can see in the Table 8, the five-year interval does not change any variables coefficient as far as the PPML estimation is concerned. However, the results of the OLS regression are slightly different. The coefficient of the main variable of interest $BothinGW$ has increased a little as well as the R^2. The effect's increase is negligible and, since it is the only change of coefficient worth mentioning, we can conclude that the potential effect of *phase-in* is really small.

Lags

As discussed above, the effect of membership may be greater if we take into consideration the time it takes for countries to adjust to the new measures and therefore the time it takes to see a significant change in trade. Including lags can be another way to capture *the delayed* effects. Baier & Bergstrand (2007), suggested adding lagged explanatory variables to the model. Until now, we counted the exact year countries became members in the GATT/WTO as the moment their trade should increase or change. However, as we recognise there may be a delayed effect, countries cannot change their economical behaviour drastically overnight, so lagging both variables of interest $BothinGW$ and $OneinGW$ may allow one to see a different outcome. The table 9 contains column (1) to remind the baseline results of the OLS regression and the PPML estimation, both with country-pair fixed effects, and column (2) with one lag for both variables

of interest. It seems that, when observing the outcome of the OLS regressions, the delayed effect of membership for both countries of a pair is similar to the immediate effect and remains significant. It does not counter the findings from the previous section, when analysing the *phase-in* effect. As for the PPML estimations, it looks like when adding a lagged variable, their delayed effect is of less value and statistically insignificant. Adding those lagged variables enabled us to see that at the very best, the increase of trade increases a little bit more with the delayed of membership, or at the very worse it nullifies it.

Also, the columns (3) of the table are to check for reverse causality with an added lead to the membership variables. If the coefficients are significant, that would mean trade influencing the decision of being a member of the GATT/WTO is a possibility. As we can see, the coefficients of the lead variables are significant which could mean that the level may influence the decision to be a member of the GATT/WTO, which could itself increase international trade.

Testing for change of independent variables

It may be interesting to see how the coefficients of our OLS regression and PPML estimation react to a change of conditioning variables. If the coefficients vary after a change of variables, that means the results were very reliant on those conditioning variables. In Table 6, we see the results of the linear regression and PPML estimation without conditioning variables/covariates and with other added. Table 6 depicts the outcome of a change of independent variables with less in column (2) and more in column (3), column (1) being the baseline results. We observe that the R^2 remains the same when dummies are removed or added for both, the OLS regression and the PPML estimation. For the OLS regression, it does not seem like the change of variables has any impact on the coefficients. $OneinGW$ stays insignificant whether dummies are added or removed and the same goes for the logarithm of distance. Other than that, the coefficient of all variables stays significant and relatively the same. This means that the model is not heavily reliant on the conditioning variables. We can also assume the model is stable as it does not change even when the omitted variables are included or removed. As for the PPML estimation, adding dummies does not necessarily have an impact because the added variables are not significant or are omitted, but removing the covariates produces insignificant results compared to the regular estimation. This can be explained by the already small number of covariates in the default regression, therefore diminishing these variables would lead to an unstable model. We can assume the results of the baseline estimations to provide the most reliable results.

Testing for sub samples

Last test to verify the robustness of the models is a sub sample analysis with industrialized and developing countries. The effect of membership may be greater for a specific type of country. The assumption that the institution was designed to favour developing countries was supported by Tomz et al. (2005), while the opposite was by Subramanian & Wei (2003). Here, we will simplify the method used to determine the status of countries (developed or developing countries). The World Bank uses the GNI (Gross National Income) per capita to determine the classification of countries and has set $13,845 as the upper limit for developing countries. Another limit they set is $4,466 as the upper limit for lower-middle income economies. We will use it as proxy. We will use the GDP per capita at a threshold of $4,466 as

the upper limit for developing countries. In table 7, we observe the difference of outcome when using a full sample (1), only developed countries (2) and only developing countries (3) the latter two as determined by the threshold mentioned above. In table 7, we observe that the effect of membership when both countries of a pair are members is higher when they both are developing countries. Not only is the value of the coefficient higher but it is also statistically significant. This only goes for the OLS regression, as we observe the opposite for the PPML estimation. The coefficient of the variables of interest became lower when observing only developing countries or developed countries than the full sample. The coefficient also became insignificant. This definitely means that the effects of the GATT/WTO vary or are sensitive to the population observed.

Limitations

Even though our models verified several assumptions and survived robustness checks, they also suffer from some limitations.

Indeed, as we saw in the model assumptions sections some were not totally verified and therefore limit the credibility and efficiency of our model's results.

First, the RESET test depicted in Table 11 shows statistically significant results, implying that our Gravity model may be misspecified. The problem may come from potential reverse causality found during the robustness checks. Indeed, the level of trade of one country may influence the decision of becoming a member or not. The fact that the zero conditional mean assumption is not necessarily verified could lead to biased and inconsistent estimators. It could also imply endogeneity issues that cannot be accounted for with fixed effects.

Second, we were not able to reject the hypothesis of serial correlation in the residuals and, therefore, our model may present positive autocorrelation. The immediate implication is that the standard errors of our estimated coefficients may be biased. In other words, autocorrelation can provide inefficient estimators and biased estimates that can lead to a misinterpretation of the results. The violation of the same assumption can also imply the presence of heteroscedasticity. This means that the residuals are not constant overtime and across all independent variables. Again, heteroscedasticity leads to biased standard errors and inefficiency of the estimators.

Finally, the lack of data recorded from smaller countries definitely play a part in the results. We can wonder if there were more observations on their part, how it would have impacted the outcome of the estimations. When doing the sub samples robustness checks, the analysis of developed versus developing countries came out insignificant, but one wonders what the results may have been if there were more observations and whether or not these results are insignificant due to the lack of data.

All in all, the limitations mentioned above about the specification of the model used for this study may shed a new light on the results, but that is why it is important for them to be kept in mind when interpretating the outcome of this analysis.

Conclusion

The effect of membership in a trade organisation remains ambiguous as it depends on the method used. When accounting for unobserved heterogeneity, the traditional Gravity approach provides positive and statistically significant effects, with estimated effect of about 20% increase of trade when both countries of a commerce exchange are a part of the GATT/WTO.

The results of the Gravity model match A. K. Rose (2003a)'s findings that were of about a 16% increase. He considered this as not sufficient enough to unapologetically state that the GATT/WTO improves greatly international trade. He also thinks that extraneous factors may have been the reason for this little increase like the decrease of trade rates, and the development of globalisation that facilitates commerce as a whole. These are not delirious remarks and are relevant. Also, when analysing the cross-sectional analysis, we observe that the mean effect of membership has relatively remained the same which, if we take out the extraneous potential effects mentioned above, could mean that the real effect has diminished.

On the other hand, the results of the PPML estimation are also similar with the initial researchers' ones, Esteve-Pérez et al. (2018). We found that membership of both countries of a commerce exchange, when adding country-pair, importer-year and exporter-year fixed effects, had a positive and statistically significant effect on trade with an increase of about 68%. It is even more than what Esteve-Pérez et al. (2018) found, an increase of 43%. The same reasoning stands with this method and the previous one, that other factors may have impacted the effect, but we cannot deny a positive and significant impact.

Alternatively, the debate about the application of the institution to a specific population is somewhat irrelevant in this study as the results when analysing the effect on sub samples are not significant. The effect of membership on only developed countries is less than on the full sample for both methods. It even gives negative coefficient for the OLS regression. And the effect on only developing countries gives very slightly higher results (coefficient of 0.24 rather than 0.19) for the OLS regressions and continues to give smaller coefficients with the PPML estimation. In this case, the value of effect does not seem to have something to do with the population observed.

In the end, this work allowed to bring forward another opinion on the matter of membership to the GATT/WTO with findings that assure there is a positive and significant impact on trade but not necessarily groundbreaking.

It is worth mentioning that this study has some econometric limitations and must be read, and the results must be interpreted knowingly.

Appendices

Table 2: Baseline results OLS regression

Variables	Default	With year fixed effects	With country-pair fixed effects
Both in GATT/WTO	-0.44*** (0.009)	0.1*** (0.033)	0.19*** (0.29)
One in GATT/WTO	-0.43*** (0.009)	-0.11*** (0.031)	0.004 (0.03)
Log Distance	-1.04*** (0.003)	-0.99*** (0.017)	-0.25 (0.25)
Log real GDP	-0.1*** (0.001)	-0.03*** (0.005)	-0.59*** (0.021)
Log real GDP p/c	-0.22*** (0.001)	0.05*** (0.007)	0.09*** (0.026)
Common Language	0.59*** (0.008)	0.61*** (0.038)	Omitted
Land Border	0.6*** (0.017)	0.69*** (0.088)	1.08*** (0.406)
Common Colonizer	0.11*** (0.01)	0.83*** (0.054)	Omitted
Colonize each other	3.92*** (0.082)	2.48*** (0.367)	1.04*** (0.195)
Regional FTA	0.58*** (0.009)	0.78*** (0.034)	0.34*** (0.022)
Observations	713,203	713,203	713,203
R^2	0.27	0.43	0.68

P < 0.01 ***, p < 0.05 **, p < 0.1 *

Regressand: log of openness (Imports + exports divided by real GDP).

OLS with year effects (2) and country-pair fixed effects (3).

Robust standard errors (clustering by country-pairs) in parentheses.

Stata: own computation

Table 4: summary statistics

Variables	Observations	Mean	Variance	Min.	Max.
Log of real trade	791,321	8.97	3.59	-6.21	20.74
Log of openness	1,004,886	-26.16	3.13	-44,61	-13.7
Trade	1,123,977	639,826.1	7,879,615	0.001	1.02e+09
Log of distance	3,611,260	8.84	0.78	0.69	9.9
Log of real GDP	1,958,602	32.03	3.84	18.55	47.45
Log of real GDP p/c	1,939,996	15.3	2.78	6.82	24.21
Common language	3,308,848	0.19	0.39	0	1
Common Land border	3,611,478	0.01	0.01	0	1
Common colonizer	3,308,848	0.12	0.1	0	1
Colonize each other	3,611,034	0.002	0.05	0	1
Regional FTA	3,611,478	0.03	0.19	0	1
Both in GATT/WTO	4,680,648	0.18	0.38	0	1
One in GATT/WTO	4,680,648	0.38	0.48	0	1

Stata: own computation

Table 5: Cross-sectional analysis

	Both in GATT/WTO	One in GATT/WTO
1950	1.67	0.73
	(0.12)	(0.11)
1955	1.87	0.9
	(0.11)	(0.1)
1960	2.39	1.16
	(0.1)	(0.09)
1965	1.26	0.75
	(0.1)	(0.1)
1970	1.63	0.9
	(0.12)	(0.12)
1975	1.54	0.9
	(0.13)	(0.14)
1980	1.21	0.6
	(0.14)	(0.14)
1985	1.59	0.79
	(0.11)	(0.11)
1990	1.85	0.44
	(0.14)	(0.15)
1995	0.92	0.0008
	(0.12)	(0.12)
2000	1.19	-0.08
	(0.09)	(0.09)
2005	1.73	-0.01
	(0.08)	(0.08)
2010	2.34	0.24
	(0.08)	(0.07)
2015	2.46	-0.1
	(0.07)	(0.07)
2020	2.73	-0.05
	(0.07)	(0.07)

Stata: own computation

Table 6: OLS and PPML estimations with change of independent variables

Variables	OLS			PPML		
	Default	Less dummies	More dummies	Default	Less dummies	More dummies
Log of real GDP	0.4***	0.48***	0.40***	Omitted	Omitted	Omitted
	(0.02)	(0.003)	(0.02)			
Log of distance	-0.25	-0.22	-0.25	-0.14	-0.17	-0.14
	(0.25)	(0.25)	(0.25)	(0.13)	(0.14)	(0.13)
Log of real GDP p/c	0.09***		0.09***			
	(0.02)		(0.02)			
Common language	Omitted		Omitted			
Common land border	1.08***		1.08***	0.34***		0.34***
	(0.4)		(0.4)	(0.13)		(0.13)
Common colonizer	Omitted		Omitted			
Colonize each other	1.04***		1.04***	0.16		0.16
	(0.19)		(0.19)	(0.09)		(0.09)
Now Same colonizer			1.32***			-0.22
			(0.28)			(0.25)
Ever colony (col45)			Omitted			Omitted
Change of legal origin			Omitted			Omitted
Regional FTA	0.34***	0.35***	0.34***	0.13***	0.06	0.13***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)
Both in GATT/WTO	0.19***	0.19***	0.19***	0.37*	0.11	0.37*
	(0.02)	(0.02)	(0.02)	(0.21)	(0.26)	(0.21)
One in GATT/WTO	0.004	0.007	0.007	0.38***	0.18	0.38***
	(0.03)	(0.03)	(0.03)	(0.14)	(0.18)	(0.14)
Observations	713,203	720,524	713,203	1,004,139	1,004,321	999,489
(pseudo) R^2	0.80	0.80	0.80	0.97	0.97	0.97

$p < 0.01$***, $p < 0.05$ **, $p < 0.1$ *

Regressand: log of trade for the OLS regression and trade for the PPML estimation

Country-pair fixed effects for all OLS regressions

Country-pair, importer-timer and exporter-time fixed effects for all PPML estimations

Robust standard errors (clustering by country-pairs) in parentheses.

Stata: own computation

Table 7: OLS and PPML estimation with full sample and sub samples

Variables	OLS			PPML		
	Full sample	Developed countries	Developing countries	Full sample	Developed countries	Developing countries
Log of real GDP	0.4***	0.55***	0.53***	Omitted	Omitted	Omitted
	(0.02)	(0.04)	(0.03)			
Log of distance	-0.25	-0.37	0.003	-0.14	Omitted	0.1
	(0.25)	(1.05)	(0.22)	(0.13)		(0.13)
Log of real GDP p/c	0.09***	-0.08*	-0.03			
	(0.02)	(0.05)	(0.04)			
Common language	Omitted	Omitted	Omitted			
Common land border	1.08***	0.35***	1.98***	0.34***	0.11**	1.04*
	(0.4)	(0.1)	(0.43)	(0.13)	(0.05)	(0.54)
Common colonizer	Omitted	Omitted	Omitted			
Colonize each other	1.04***	0.48	0.35***	0.16	0.03	0.54***
	(0.19)	(0.61)	(0.08)	(0.09)	(0.08)	(0.1)
Regional FTA	0.34***	0.08***	0.55***	0.13***	0.05**	0.1***
	(0.02)	(0.02)	(0.06)	(0.02)	(0.02)	(0.03)
Both in GATT/WTO	0.19***	-0.07	0.23***	0.37*	0.12	0.2
	(0.02)	(0.05)	(0.04)	(0.21)	(0.32)	(0.23)
One in GATT/WTO	0.004	-0.08	0.09*	0.38***	0.47	0.1
	(0.03)	(0.05)	(0.04)	(0.14)	(0.3)	(0.13)
Observations	713,203	174,241	207,197	1,004,139	209,418	346,800
(pseudo) R^2	0.80	0.86	0.75	0.97	0.98	0.95

$p < 0.01$***, $p < 0.05$ **, $p < 0.1$ *

Regressand: log of trade for the OLS regression and trade for the PPML estimation

Country-pair fixed effects for all OLS regressions

Country-pair, importer-timer and exporter-time fixed effects for all PPML estimations

Robust standard errors (clustering by country-pairs) in parentheses.

Stata: own computation

Table 8: OLS and PPML estimation with a yearly interval and a 5-year interval

Variables	OLS		PPML	
	Default	5-year interval	Default	5-year interval
Log of real GDP	0.4***	0.32***	Omitted	Omitted
	(0.02)	(0.02)		
Log of distance	-0.25	-0.39	-0.14	-0.14
	(0.25)	(0.28)	(0.13)	(0.13)
Log of real GDP p/c	0.09***	0.15***		
	(0.02)	(0.02)		
Common language	Omitted	Omitted		
Common land border	1.08***	1.26**	0.34***	0.34***
	(0.4)	(0.53)	(0.13)	(0.13)
Common colonizer	Omitted	Omitted		
Colonize each other	1.04***	1.35***	0.16	0.16
	(0.19)	(0.23)	(0.09)	(0.09)
Regional FTA	0.34***	0.43***	0.13***	0.13***
	(0.02)	(0.02)	(0.02)	(0.02)
Both in GATT/WTO	0.19	0.23***	0.37*	0.37*
	(0.02)	(0.04)	(0.22)	(0.21)
One in GATT/WTO	0.004	0.03	0.38***	0.38***
	(0.03)	(0.04)	(0.14)	(0.14)
Observations	713,203	115,104	1,004,139	1,004,139
(pseudo) R^2	0.80	0.90	0.97	0.97

$p < 0.01$***, $p < 0.05$ **, $p < 0.1$ *

Regressand: log of trade for the OLS regression and trade for the PPML estimation

Country-pair fixed effects for all OLS regressions

Country-pair, importer-timer and exporter-time fixed effects for all PPML estimations

Robust standard errors (clustering by country-pairs) in parentheses.

Stata: own computation

Table 9: OLS and PPML estimation with lagged memberships

	OLS			PPML		
Variables	Default	Lag	Lead	Default	Lag	Lead
Log of real GDP	0.4***	0.39***	0.39***	0.61***	0.56***	0.56***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.007)	(0.007)
Log of distance	-.25	-0.28	-0.28	-0.73*	-0.75***	-0.75***
	(0.25)	(0.26)	(0.26)	(0.23)	(0.24)	(0.25)
Log of real GDP p/c	0.09***	0.09***	0.09***			
	(0.02)	(0.02)	(0.02)			
Common language	Omitted	Omitted	Omitted			
Common land border	1.08***	1.17***	1.17***	0.54*	0.53*	0.53*
	(0.4)	(0.45)	(0.45)	(0.29)	(0.30)	(0.3)
Common colonizer	Omitted	Omitted	Omitted			
Colonize each other	1.04***	0.98***	0.97***	0.51***	0.49***	0.48***
	(0.19)	(0.19)	(0.19)	(0.11)	(0.11)	(0.11)
Regional FTA	0.34***	0.36***	0.36***	0.16***	0.12***	0.12***
	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)
Both in GATT/WTO	0.19***	0.07*	0.13***	0.41***	0.30***	0.18**
	(0.02)	(0.03)	(0.03)	(0.08)	(0.06)	(0.07)
One in GATT/WTO	0.004	0.1**	-0.01	0.33***	0.28***	0.07
	(0.03)	(0.04)	(0.04)	(0.11)	(0.08)	(0.12)
$BothinGW_{ijt-1}$		0.18***			0.07	
		(0.03)			(0.06)	
$OneinGW_{ijt-1}$		0.004			-0.07	
		(0.03)			(0.09)	
$BothinGW_{ijt+1}$			0.11***			0.19***
			(0.04)			(0.07)
$OneinGW_{ijt+1}$			0.13***			0.15*
			(0.04)			(0.08)
Observations	713,203	420,549	420,549	1,004,192	576,809	576,809
(pseudo) R^2	0.80	0.87	0.87	0.96	0.98	0.98

p < 0.01***, p < 0.05 **, p < 0.1 *

Regressand: log of trade for the OLS regression and trade for the PPML estimation

Country-pair fixed effects for all OLS regressions and PPML estimations

Robust standard errors (clustering by country-pairs) in parentheses.

Stata: own computation

Table 10.1: Correlation matrix

	Log of trade	Log of distance	Log of GDP	Log of GDP p/c	Comon language	Common border
Log of trade	1.000					
Log of distance	-0.2006	1.000				
Log of GDP	0.6561	0.1443	1.000			
Log of GDP p/c	0.3070	0.0512	0.5991	1.000		
Common language	-0.0281	-0.1579	-0.2107	-0.1279	1.000	
Common border	0.1382	-0.3939	-0.0420	-0.1120	0.1413	1.000
Common colonizer	-0.1036	-0.1453	-0.2547	-0.1509	0.3546	0.0829
Colonize each other	0.0224	0.0107	-0.0213	0.0051	0.0650	-0.0063
Regional FTA	0.2240	-0.3908	0.1250	0.2620	0.0613	0.1552
Both in GATT/WTO	0.1544	0.0812	0.2691	0.2031	-0.0013	-0.0217
One in GATT/WTO	-0.1179	-0.0228	-0.1444	-0.0881	-0.0594	-0.0307

Stata: Own computation

Table 10.2: Correlation matrix

	Common colonizer	Colonize each other	Regional FTA	Both in GATT/WTO	One in GATT/WTO
Log of trade					
Log of distance					
Log of GDP					
Log of GDP p/c					
Common language					
Common border					
Common colonizer	1.000				
Colonize each other	-0.0108	1.000			
Regional FTA	0.0727	0.0179	1.000		
Both in GATT/WTO	0.0297	-0.0374	0.1272	1.000	
One in GATT/WTO	-0.0695	0.0367	-0.0938	-0.7747	1.000

Stata: Own computation

Table 11: RESET test.

Fitted value form	Coefficient	P-value
$Fitted\ values^2$	0.7579	0.00
$Fitted\ values^3$	-0.0220	0.00

Stata: Own computation

Table 12.1: Correlation matrix PPML

	Trade	Log of GDP (importer)	Log of GDP (exporter)	Log of distance	Common language
Trade	1.000				
Log of GDP (importer)	0.1340	1.000			
Log of GDP (exporter)	0.1324	-0.0654	1.000		
Log of distance	-0.0732	0.0525	0.0852	1.000	
Common language	0.0105	-0.1282	-0.1401	-0.1548	1.000
Common border	0.1166	-0.0097	-0.0226	-0.3827	0.1326
Common colonizer	-0.0204	-0.1633	-0.1724	-0.1144	0.3788
Regional FTA	0.1092	0.1081	0.0933	-0.3641	0.0646
Both in GATT/WTO	0.0531	0.2074	0.1784	0.0631	-0.0094
One in GATT/WTO	-0.0326	-0.0928	-0.1022	-0.0016	-0.0640

Stata: Own computation

Table 12.2: Correlation matrix PPML

	Common border	Common colonizer	Regional FTA	Both in GATT/WTO	One in GATT/WTO
Trade					
Log of GDP (importer)					
Log of GDP (exporter)					
Log of distance					
Common language					
Common border	1.000				
Common colonizer	0.0707	1.000			
Regional FTA	0.1501	0.0637	1.000		
Both in GATT/WTO	-0.0160	0.0369	0.1319	1.000	
One in GATT/WTO	-0.0317	-0.0659	-0.0954	-0.7498	1.000

Stata: Own computation

Table 13: Regression of squared residuals on our independent variables (Breusch-Pagan Test)

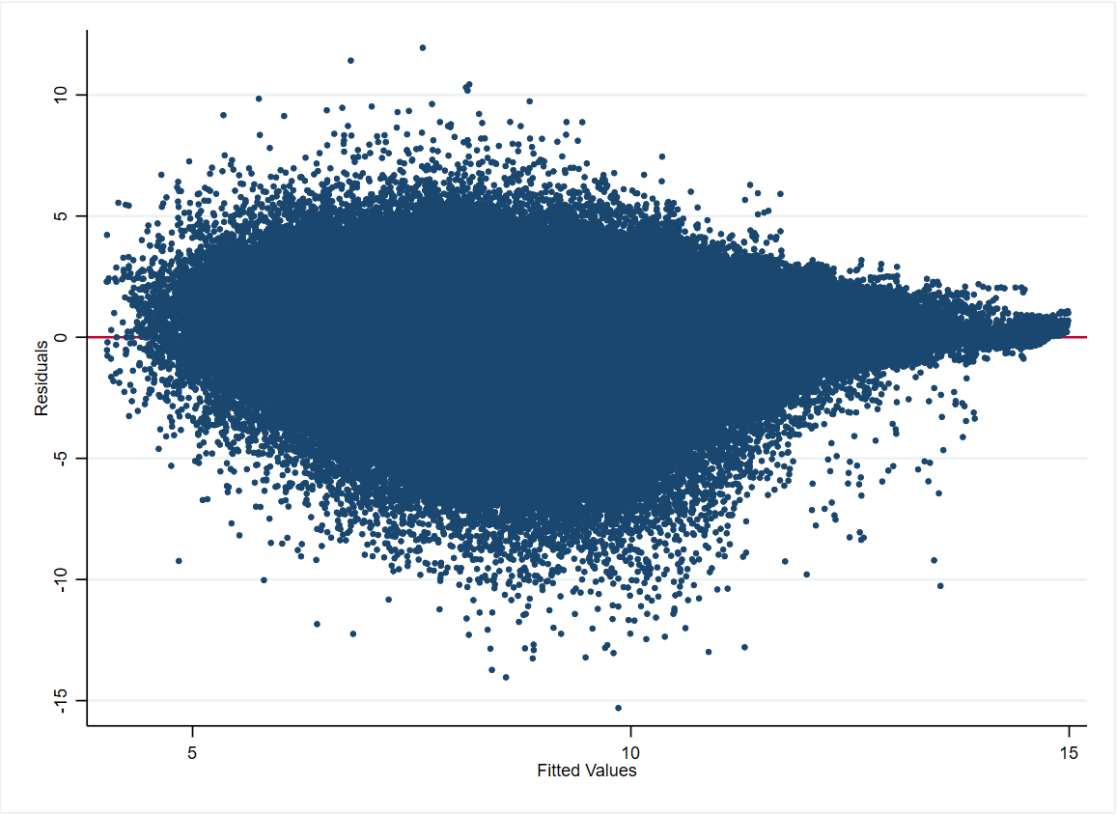
Variables	Coefficients
Log of distance	0.38*** (0.008)
Log of real GDP	-0.24*** (0.002)
Log of real GDP per capita	0.14*** (0.003)
Common language	-0.26*** (0.01)
Common border	0.12*** (0.04)
Common colonizer	0.28*** (0.02)
Colonize each other	-1.94*** (0.18)
Regional FTA	-0.48*** (0.02)
Both in GATT/WTO	-0.35*** (0.02)
One in GATT/WTO	0.23*** (0.02)

P<0.01***, p<0.05**, p<0.1*

Standard errors in parentheses

Stata: Own computation

Figure 1: Scatterplot of the residuals from the OLS regression



Stata: Own computation

Trading entities in the sample

Afghanistan	East Germany	Malawi	Saudi Arabia
Albania	Ecuador	Malaysia + Singapore	Senegal
Algeria	Egypt	Maldives	Serbia
American Samoa	El Salvador	Mali	Serbia and Montenegro
Andorra	Equatorial Guinea	Malta	Seychelles
Angola	Eritrea	Marshall Islands	Sierra Leone
Anguilla	Estonia	Martinique	Singapore
Antigua and Barbuda	Eswatini	Mauritania	Sint Marteen
Argentina	Ethiopia + Eritrea	Mauritius	Slovakia
Armenia	Falkland Islands	Mayotte	Slovenia
Aruba	Faroe Islands	Mexico	Solomon Islands
Australia	Fiji	Micronesia	Somalia
Austria	Finland	Moldova	South Africa
Azerbaijan	France	Monaco	South Korea
Bahamas	French Guiana	Mongolia	South Sudan
Bahrain	French Polynesia	Montenegro	South Yemen
Bangladesh	Gabon	Montserrat	Spain
Barbados	Gambia	Morocco	Sri Lanka
Belarus	Georgia	Mozambique	Sudan + South Sudan
Belgium	West Germany	Myanmar	Suriname
Belize	Ghana	Namibia	Sweden
Benin	Gibraltar	Nauru	Switzerland
Bermuda	Greece	Nepal	Syria
Bhutan	Greenland	Netherlands	Taiwan
Bolivia	Grenada	Netherlands Antilles + Aruba	Tajikistan
Bonaire, Sint Eustatius and Saba	Guadeloupe	New Caledonia	Tanzania
Bosnia and Herzegovina	Guam	New Zealand	Thailand
Botswana	Guatemala	Nicaragua	Timor-Leste
Brazil	Guinea	Niger	Togo
British Indian Ocean Territory	Guinea-Bissau	Nigeria	Tokelau
British Virgin Islands	Guyana	Niue	Tonga
Brunei	Haiti	Norfolk Island	Trinidad and Tobago
Bulgaria	Holy See	North Korea	Tunisia
Burkina Faso	Honduras	North Macedonia	Turkey
Burundi	Hong Kong	North Vietnam	Turkmenistan
Cambodia	Hungary	Northern Mariana Islands	Turks and Caicos Islands
Cameroon	Iceland	Norway	Tuvalu
Canada	India	Oman	USSR
Cape Verde	Indonesia + Timor-Leste	Pakistan + Bangladesh	Uganda
Cayman Islands	Iran	Palau	Ukraine
Central African Republic	Iraq	Palestine	United Arab Emirates
Chad	Ireland	Panama	United Kingdom

Chile	Israel	Papua New Guinea	United States of America
China	Italy	Paraguay	Uruguay
Christmas Islands	Jamaica	Peru	Uzbekistan
Cocos (Keeling) Islands	Japan	Philippines	Vanuatu
Colombia	Jordan	Pitcairn Islands	Venezuela
Comoros	Kazakhstan	Poland	South Vietnam
Congo, Democratic Rep. Of the	Kenya	Portugal	Wallis and Futuna
Congo, Rep. Of the	Kiribati	Puerto Rico	Western Sahara
Cook Islands	Kuwait	Qatar	North Yemen
Costa Rica	Kyrgyzstan	Reunion	Yugoslavia
Cote d'Ivoire	Laos	Romania	Zambia
Croatia	Latvia	Russia	Zimbabwe
Cuba	Lebanon	Rwanda	Netherlands Antilles
Curacao	Lesotho	Saint Helena	Pakistan
Cyprus	Liberia	Saint Kitts and Nevis	Ethiopia
Czech Republic	Libya	Saint Lucia	Malaysia
Czechoslovakia	Liechtenstein	Saint Pierre and Miquelon	Sudan
Denmark	Lithuania	Saint Vincent and the Grenadines	Indonesia
Djibouti	Luxembourg	Samoa	Germany
Dominica	Macao	San Marino	Yemen
Dominican Republic	Madagascar	Sao Tome and Principe	Vietnam

Source: Gravity database documentation CEPII

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Executive summary

A general consensus among economists is that the WTO institution (formerly known as the GATT) has a significant and positive impact on international trade. However, as of the early 2000s, this statement was never truly empirically proven right. That is until Andrew K. Rose sparked the debate with a paper affirming the institution did not, in fact, have any effect on global trade. Since then, many economists have contributed to analyse and obtain the real effect of the WTO. Using a different database with a larger observed period of time and varied methods, this study will also aim at analysing this matter. The outcome seems positive and significant and in line with what other have found before.

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