Is the WTO Mystery Really Solved?

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Abstract
The WTO's impact on bilateral trade remains puzzling due, in part, to previous studies' failure to simultaneously address three issues: inclusion of zero trade, proper controls for multilateral resistance, and proper membership definition. Addressing all fails to suggest a positive effect.

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1 Introduction

Ever since Rose (2004) found little evidence of the World Trade Organization's role in enhancing members' bilateral trade, a number of studies have employed the gravity model and attempted to solve this (p. 112) "interesting mystery." Unfortunately, all (to my knowledge) either estimate a theoretically inconsistent model by omitting controls for Anderson and van Wincoop's (2003) multilateral resistance variables, or risk a potential sample selection bias by dropping country-pairs with zero bilateral trade. While the estimates in Rose (2004) suffered from both, Tomz et al. (2007) fail to address either, but claim to have solved the mystery by redefining the set of GATT or WTO participants.[1] According to the authors, Rose's (2004) failure to capture the role of colonies, de facto members and provisional members as nonmember participants led to a downward bias in the estimated WTO coefficients. Using a new definition of participation, which includes both nonmember participants and formal members, they find positive and significant effects of WTO *participation*. Next, Subramanian and Wei (2007, p. 173) allude to "four asymmetries in the system" and consider the WTO to have done a "splendid" but "uneven" job in promoting trade. However, they exclude zero trade observations. More recently, Liu (2009) distinguishes between the WTO's roles at the intensive and extensive margins. While the former refers to promoting trade among existing trading partners, the latter involves encouraging new trading relationships. According to Liu (2009), the aforementioned studies underestimate the effects of membership by omitting the zero trade observations and thereby neglecting the extensive margin. While Liu (2009) finds a positive and significant effect of formal membership after including the zeros, the result remains questionable due to lack of proper controls for the theoretically motivated multilateral resistance terms. The remoteness proxy used is considered by Anderson and van Wincoop (2003, p. 170) to be "at odds with the theory."[2] Finally, Eicher and Henn (2011, p. 146) control for multilateral resistance and "search" for "WTO trade effects" by employing the participation definition. However, they neglect the extensive margin.

This paper contributes to the literature by estimating a theoretically consistent gravity model while avoiding the potential sample selection bias. In addition, sensitivity of the estimates to the two definitions of WTO membership - with and without the nonmember participants - is also analyzed. Using the data from Liu (2009) at five year intervals, the results are striking. In the full sample, the use of *neither* definition finds WTO countries to engage in significantly greater bilateral trade. Separate regressions for each decade, which also control for bilateral fixed effects, find membership to significantly promote trade

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[1] Henceforth, the acronym WTO is used to refer to the World Trade Organization and its predecessor, the General Agreement on Tariffs and Trade (GATT).

[2] By excluding the zero trade observations, using bilateral fixed effects, and estimating in levels, Liu (2009) also finds the WTO to be effective at the intensive margin. However, the levels model also relies on the remoteness proxy.

only upon using Tomz et al.'s (2007) participation definition during the 1950 to 1960 period. Hence, existing claims to have overturned Rose's (2004) findings appear tenuous. In fact, if the lack of a positive and significant WTO effect is indeed a mystery, then the prospect of solving it by estimating a gravity model seems unlikely once zero trade observations *and* controls for the multilateral resistance terms are included. Accordingly, Rose's (2007, p. 2025) desire to see the question addressed beyond the "confines of the gravity model" is timely.

The remainder of the paper is organized as follows. Section 2 describes the empirical methodology. Section 3 discusses the data. Section 4 presents the results, while Section 5 concludes.

2   Empirical Methodology

Gravity models are estimated in logs, with and without bilateral fixed effects. A theoretically consistent specification without bilateral fixed effects is given by

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\begin{aligned}
\ln\left(T_{ijt}\right) = & \ \beta_0 + \beta_1 both_{ijt} + \beta_2 one_{ijt} + \beta_3 \ln dist_{ij} + \beta_4 border_{ij} + \beta_5 landlock_{ij} \\
& + \beta_6 island_{ij} + \beta_7 comlang_{ij} + \beta_8 comrelig_{ij} + \beta_9 colony_{ij} + \beta_{10} colonizer_{ij} \\
& + \beta_{11} curcolony_{ijt} + \beta_{12} curcolonizer_{ijt} + \beta_{13} comcol_{ij} + \beta_{14} hostility_{ij} \\
& + \beta_{15} alliance_{ijt} + \beta_{16} CU_{ijt} + \beta_{17} RTA_{ijt} + \beta_{18} GSP_{ijt} + \beta_{19} GSP_{jit} \\
& + \theta_{it} + \theta_{jt} + \epsilon_{ij} + \eta_{ijt}.
\end{aligned}
\tag{1}
$$

Here, T_{ijt} is the real value of imports of country i from country j at time t; $both_{ijt}$ is a dummy variable taking the value one if both i and j are treated as WTO "members" at time t and zero otherwise; one_{ijt} is a dummy variable taking the value one if either i or j is considered to be a WTO "member" at time t and zero otherwise; $dist_{ij}$ is the distance between i and j; $border_{ij}$ is a binary variable assuming the value unity if i and j share a land border; $landlock_{ij}$ and $island_{ij}$ are ordered discrete variables depicting the number of landlocked countries (0,1, or 2) and the number of islands (0,1, or 2), respectively, in each country pair; $comlang_{ij}$ ($comrelig_{ij}$) is a dummy variable taking the value one if i and j share a common language (religion); $colony_{ij}$ ($colonizer_{ij}$) is a binary variable taking the value unity if i has ever been a colony (colonizer) of j; $curcolony_{ijt}$ ($curcolonizer_{ijt}$) is a dummy variable taking the value one if i is considered to be a colony (colonizer) of j at time t; $comcol_{ij}$ is a binary variable assuming the value unity if i and j were ever colonized by the same colonizer; $hostility_{ij}$ depicts the intensity of military conflict between i and j; $alliance_{ijt}$ is a dummy variable taking the value one if i and j were in a formal alliance at time t; CU_{ijt} (RTA_{ijt}) is a dummy variable taking the value one if i and j belong to the same currency union

(regional trade agreement) at time t and zero otherwise; GSP_{ijt} (GSP_{jit}) is a dummy variable taking the value 1 if i (j) offered preferences to j (i) under the Generalized System of Preferences at time t; and θ_{it} and θ_{jt} are the country-by-time dummies.[3] The bilateral time-varying and time-invariant unobservables are denoted by η_{ijt} and ϵ_{ij}, respectively. To facilitate comparison to prior studies, specifications replacing the country-by-time dummies with remoteness measures are also estimated.

Tomz et al.'s (2007, p. 2013) "benchmark specification" includes bilateral fixed effects. Liu (2009) also prefers including them on statistical grounds. The use of bilateral fixed effects controls for possible selection bias arising from time-invariant unobservables. Hence, gravity equations are also estimated with bilateral fixed effects. However, given the length of the sample period, it is unlikely that any relevant unobservables remain constant over the entire period. As such, regressions are estimated separately for each decade.

Finally, in order to include the zero trade observations, the dependent variable is considered to be $\ln(T_{ijt} + 1)$, as in Liu (2009). An alternative using $\ln\left(T_{ijt} + \sqrt[2]{T_{ijt}^2 + 1}\right)$ as the dependent variable is also tried (see, e.g., Kukenova and Monteiro, 2008). Since the two approaches yield very similar coefficient estimates, only the former are included.

3 Data

The majority of the data come from Liu (2009) for the years 1950 to 2000, at five year intervals. Since the data includes zero trade observations and more countries than used in Rose (2004), Subramanian and Wei (2007), or Tomz et al. (2007), it is considered to be relatively more complete by Liu (2009). However, unlike Liu (2009), here two definitions of WTO membership are considered. The first is the formal definition of WTO membership used in Liu (2009) (except for a few minor corrections made to his data). After the minor corrections, Czechoslovakia (for 1950, 1955, ..., 1990), Lebanon (for 1950), Liberia (for 1950), and Syria (for 1950) are treated as formal members. These changes rely on the sources listed in Liu (2009), and Tomz et al.'s (2007) accompanying datasets (available at http://www.stanford.edu/~tomz/pubs/pubs.shtml). The second definition is Tomz et al.'s (2007) participation-based definition. In addition, given the launch of a new WTO database on trade agreements in 2009 and some discrepancies in Liu's (2009) currency union variable, the trade agreement and currency union dummies have also been modified. Roy (2010) provides additional details.

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[3]The country-by-time dummies control for country-specific unobservables that vary over time but not across trading partners, as well as, the multilateral resistance terms (see, e.g., Subramanian and Wei, 2007). In this case, they also capture the impact of GDP, GDP per capita, area, and remoteness.

4 Results

Table 1 reports results from the full sample without bilateral fixed effects. While columns (a), (b), (c), and (d) present estimates that rely on measures of remoteness to control for multilateral resistance, the estimates in columns (e) and (f) are obtained after controlling for the multilateral resistance terms via country-by-time dummies. Since the atheoretical specification resembles Liu's (2009) log model, the corresponding regressions include (log) GDP, (log) GDP per capita, (log) area, and year dummies in addition to remoteness and the covariates listed in (1). While column (a) simply reproduces Liu's (2009) pooled cross-section log estimates, the estimates in column (b) are obtained from the data at five year intervals. Incorporating the corrections to the formal membership, currency union, and trade agreement dummies yields the estimates in column (c), which turn out to be very similar to the ones in columns (a) and (b). Thus, the results of the paper are not sensitive to the corrections or the use of data at five year intervals.

Next, unlike the estimates in columns (a), (b), or (c), the ones in column (d) utilize the participation definition of Tomz et al. (2007). A comparison of columns (c) and (d) leads to a surprising result. Contrary to the findings in Tomz et al. (2007), the use of *either* definition finds country-pairs with one or two WTO members to engage in significantly greater bilateral trade, relative to country-pairs with none. Hence, the inclusion of the zero trade observations appears to render any concern over the proper WTO definition unwarranted. However, before placing too much faith in these results, one needs to properly account for the multilateral resistance terms. Accordingly, the multilateral resistance terms are controlled for in columns (e) and (f). While the WTO dummies in column (e) correspond to formal membership, the participation definition is used for column (f). The results differ strikingly from those reported in columns (c) and (d). In the theoretically consistent model, the use of *neither* definition finds evidence in support of the WTO's trade promoting role. On an average, country-pairs with at least one WTO member engage in less bilateral trade. Interestingly, the finding is again insensitive to the definition of membership adopted although the estimates are statistically significant only when using the participation definition.

Table 2 reports gravity estimates after including the bilateral fixed effects, but separately for each decade (e.g., the 1950 to 1960 decade uses observations from 1950, 1955 and 1960). For brevity, only the coefficient estimates of the WTO dummies using both membership definitions are presented. While specification one (labelled Spec 1) omits the zero trade observations and the country-by-time fixed effects, specification two (labelled Spec 2) only includes the former. On the other hand, specification three (labelled Spec 3) controls for the multilateral resistance terms, but continues to omit the zeros. Finally, specification four (labelled Spec 4) represents a theoretically consistent model and includes the zeros.

For specifications corresponding to Spec 1 and Spec 2, the statistically significant estimates support the

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WTO's trade promoting role. On average, country-pairs with both WTO members are found to engage in more bilateral trade using either definition of membership. Although the 1960 to 1970 decade (Panel II), finds country-pairs with a single formal member to engage in less bilateral trade, such coefficients are considered to be less interesting by Rose (2004). Interestingly, the adoption of a theoretically consistent model is sufficient to question the findings corresponding to Spec 1 and Spec 2. According to the estimates from Spec 3, formal members are not found to engage in significantly different volumes of bilateral trade, in any of the decades. While there is some evidence of WTO *participants* engaging in significantly greater bilateral trade during the 1950s, 1960s, and 1980s, the estimates are still susceptible to sample selection bias due to exclusion of zero trade observations.

However, the estimates pertaining to Spec 4 - the preferred specification - are even more striking. Country-pairs with one or two formal members are never found to engage in significantly different volumes of bilateral trade. Even when Tomz et al.'s (2007) participation definition is used, the trade promoting role of the WTO is restricted to the 1950 to 1960 period. In fact, WTO *participants* are now found to engage in significantly less bilateral trade during the 1960s. Accordingly, by omitting the zero trade observations and controls for the multilateral resistance terms, existing claims to have explained Rose's (2004, p. 112) "negative result" are clearly tenuous.

5 Conclusion

Rose (2004) found little evidence of the WTO's role in promoting trade. Although a number of subsequent studies claim to have solved this mystery, none has simultaneously addressed the issue of zero trade while controlling for the multilateral resistance terms. Upon doing so, this paper arrives at striking results. Formal membership in the WTO is never found to increase bilateral trade. Once bilateral fixed effects are employed, country-pairs with one or two WTO members are found to engage in significantly greater bilateral trade only upon using Tomz et al.'s (2007) participation definition for the 1950 to 1960 period. Accordingly, existing claims to have solved Rose's (2004, p. 112) "interesting mystery" are clearly tenuous.

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Table 1. Full sample estimates without bilateral fixed effects

	Omitting Country-by-Time Dummies				Country-by-Time Dummies	
	(a)	(b)	(c)	(d)	(e)	(f)
Both	2.08 *	2.048 *	1.879 *	1.476 *	-1.625	-11.654 *
	(0.06)	(0.038)	(0.038)	(0.048)	(2.820)	(3.991)
One	0.97 *	0.973 *	0.915 *	0.926 *	-1.312	-5.675 *
	(0.05)	(0.032)	(0.032)	(0.048)	(1.410)	(1.996)
Log distance	-2.08 *	-2.051 *	-2.018 *	-2.013 *	-2.200 *	-2.202 *
	(0.04)	(0.021)	(0.022)	(0.022)	(0.016)	(0.016)
Border	1.13 *	1.237 *	1.239 *	1.182 *	1.049 *	1.082 *
	(0.18)	(0.099)	(0.100)	(0.100)	(0.078)	(0.078)
Number landlocked	-0.45 *	-0.432 *	-0.458 *	-0.420 *	-0.373	-0.316
	(0.04)	(0.023)	(0.023)	(0.023)	(0.896)	(0.897)
Number islands	0.24 *	0.241 *	0.274 *	0.203 *	-5.572	-0.618
	(0.05)	(0.026)	(0.026)	(0.027)	(4.879)	(4.850)
Common language	0.30 *	0.266 *	0.304 *	0.312 *	0.594 *	0.607 *
	(0.08)	(0.044)	(0.044)	(0.044)	(0.039)	(0.039)
Common religion	0.45 *	0.498 *	0.472 *	0.535 *	0.282 *	0.295 *
	(0.04)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Colony	2.84 *	2.840 *	2.566 *	2.624 *	2.203 *	2.233 *
	(0.21)	(0.121)	(0.121)	(0.122)	(0.147)	(0.147)
Colonizer	3.43 *	3.466 *	3.427 *	3.482 *	2.232 *	2.261 *
	(0.24)	(0.134)	(0.133)	(0.133)	(0.147)	(0.147)
Current colony	-1.10	-0.784 ‡	-0.307	-0.515	-1.041 *	-1.207 *
	(0.67)	(0.422)	(0.431)	(0.429)	(0.259)	(0.259)
Current colonizer	-0.47	-0.192	0.199	-0.011	-0.213	-0.376
	(0.68)	(0.419)	(0.423)	(0.421)	(0.260)	(0.260)
Common colonizer	1.12 *	1.096 *	1.206 *	1.201 *	1.404 *	1.408 *
	(0.07)	(0.037)	(0.037)	(0.037)	(0.035)	(0.035)
Hostility	-1.48 *	-1.435 *	-1.380 *	-1.418 *	-1.507 *	-1.545 *
	(0.39)	(0.180)	(0.182)	(0.182)	(0.111)	(0.111)
Alliance	1.10 *	1.142 *	1.119 *	1.264 *	0.958 *	1.043 *
	(0.09)	(0.052)	(0.052)	(0.052)	(0.051)	(0.051)
CU	1.55 *	1.535 *	0.547 *	0.559 *	0.914 *	0.953 *
	(0.15)	(0.087)	(0.086)	(0.086)	(0.071)	(0.071)
RTA	1.27 *	1.247 *	1.536 *	1.614 *	1.288 *	1.339 *
	(0.07)	(0.050)	(0.038)	(0.038)	(0.040)	(0.040)
GSP (ij)	2.84 *	2.799 *	2.520 *	2.560 *	2.271 *	2.254 *
	(0.07)	(0.047)	(0.047)	(0.047)	(0.071)	(0.072)
GSP (ji)	3.10 *	3.025 *	2.737 *	2.774 *	1.889 *	1.872 *
	(0.06)	(0.044)	(0.044)	(0.044)	(0.071)	(0.071)
N (Both = 1)		74863	76220	148571	76220	148571
N (One = 1)		126728	127548	100316	127548	100316
N	**1184525**	**244569**	**244569**	**244569**	**268911**	**268911**

Notes: (a) reproduces Liu's (2009) full sample pooled cross-section log results; (b) uses the same specification, but at five-year intervals;
(c) uses the same specification but incorporates corrections to CU, RTA, and the formal membership dummies; (d) relies on the same specification
but uses the participation definition; (e) includes the country-by-time dummies but uses the formal membership definition; (f) includes the
country-by-time dummies but uses the participation definition. Robust standard errors are reported in (a)-(d), while usual standard errors are reported in
(e)-(f). Although (a)-(d) include (log) GDP, (log) GDP per capita, (log) area, remoteness, and year dummies, the coefficient estimates are not reported.
‡ p<0.10, † p<0.05, * p<0.01.

Table 2. Estimates for each decade with bilateral fixed effects

	Formal membership definition				Participation definition			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
I. 1950-1960								
Both	0.251 *	0.345	-0.194	-1.414	0.038	0.789 *	2.125 *	3.585 *
	(0.084)	(0.214)	(0.429)	(0.942)	(0.076)	(0.186)	(0.300)	(1.343)
One	0.219 *	0.423 *	-0.012	-0.442	0.087	0.676 *	1.097 *	2.083 *
	(0.063)	(0.100)	(0.223)	(0.471)	(0.060)	(0.147)	(0.144)	(0.678)
II. 1960-1970								
Both	-0.024	1.072 *	-2.883 ‡	1.119	0.138 ‡	0.333 ‡	1.043 †	-3.598 *
	(0.053)	(0.120)	(1.628)	(1.526)	(0.082)	(0.172)	(0.487)	(1.038)
One	-0.102 †	0.231 *	-1.542 ‡	0.191	0.033	0.200	0.474 ‡	-1.813 *
	(0.046)	(0.077)	(0.815)	(0.767)	(0.074)	(0.140)	(0.246)	(0.535)
III. 1970-1980								
Both	0.065	2.095 *	-2.694 *	0.627	0.076	2.861 *	-1.406	-2.767
	(0.110)	(0.269)	(0.952)	(1.487)	(0.126)	(0.279)	(0.903)	(2.082)
One	0.112	1.004 *	-1.287 *	0.351	0.055	1.634 *	-0.720	-1.242
	(0.091)	(0.199)	(0.482)	(0.757)	(0.111)	(0.243)	(0.464)	(1.055)
IV. 1980-1990								
Both	0.307 *	1.488 *	1.228	3.066	0.491 *	1.232 *	1.773 †	2.008
	(0.089)	(0.183)	(1.613)	(2.497)	(0.149)	(0.311)	(0.756)	(1.727)
One	0.169 †	0.660 *	0.637	1.513	0.235 ‡	0.784 *	0.936 †	1.302
	(0.077)	(0.144)	(0.804)	(1.258)	(0.139)	(0.277)	(0.396)	(0.887)
V. 1990-2000								
Both	-0.018	0.151	-0.023	-0.694	0.203 †	0.079	-1.036	-1.753
	(0.088)	(0.124)	(1.510)	(1.395)	(0.101)	(0.158)	(0.901)	(1.650)
One	-0.029	0.142	-0.110	-0.415	0.082	-0.044	-0.599	-0.988
	(0.082)	(0.107)	(0.758)	(0.704)	(0.094)	(0.149)	(0.459)	(0.838)

Notes: Spec 1 omits the country-by-time dummies and zero trade observations; Spec 2 only includes the zeros; Spec 3 only includes the country-by-time dummies;
Spec 4 includes both. Standard errors in parentheses are robust to clustering by country-pair. ‡ $p<0.10$, † $p<0.05$, * $p<0.01$.