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Do We Really Need Domestic Trade Flows to Evaluate the Impact of Trade Agreements? A Comment.

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Abstract

Campos et al. (2021) (Economics Letters) show that including domestic trade flows in the gravity model is important for estimating the effect of trade agreements (TAs), regardless of how these flows are measured. Without domestic trade flows, TA effects are small, negative, and statistically insignificant. The opposite holds once domestic flows are included. Using the Campos et al. (2021) data, we show that their results are caused by the big size difference between international trade and domestic trade flows in combination with the Poisson Pseudo Maximum Likelihood (PPML) estimator. We find that the TA variable is not statistically significant in the Campos et al. (2021) data.

JEL Classification Codes: F14, F15

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1 Introduction

Over the last decades, the structural gravity model has become the empirical work-horse model to estimate the effects of trade barriers and trade liberalization efforts on trade flows, as well as calculate their welfare consequences. A novel trend has been to include domestic trade flows in the structural gravity model. Yotov (2022) lists 15 (!) reasons, both theoretical and empirical, for their inclusion.

In contrast to international trade flows, domestic trade flows are not commonly recorded. Theoretically, the domestic or intra-national trade flows are defined as the part of goods and services produced in a country or region that are devoted to domestic consumption, i.e., domestic production minus domestic exports abroad. Three methods are commonly used to approximate domestic trade flows. They vary depending on whether GDP, gross output or input-output tables are used for the calculation of domestic trade. Campos et al. (2021) compare the gravity estimation results for all three domestic trade measures and find that the estimated effect of trade agreements (TA) is very similar.

Another, surprising result in Campos et al. (2021) is that the inclusion of domestic trade flows appears necessary in order to obtain a positive and statistically significant estimate of the TA effect. If excluded, the estimated effect is negative and statistically insignificant. In stark contrast and theoretically not surprising, simulation results by Matschke and Rojas Rodríguez (2025) indicate that to estimate the impact of an international trade policy (e.g. TA) variable, a gravity model with just international trade flows yields estimates that are just as good as when domestic trade flows are included. Moreover, the results with GDP-based domestic trade flows appear biased in the simulation exercise.

In this note, we review the results of Campos et al. (2021) and investigate why the inclusion of domestic trade flows changes their TA effect estimate. Moreover, we answer the question whether the pure international trade or the domestic trade-inclusive estimate measures the TA effect more accurately.

2 The data set of Campos et al. (2021)

Campos et al. (2021) use a standard triple-index gravity data set (exporter, importer, period) for the years 1995 to 2011 which they augment with trade agreement data from the Baier-Bergstrand EIA data base and tariffs from the World Bank WDI data base. Domestic trade flows are calculated in three different ways, namely based on GDP, based on gross outputs (TIVA) and directly derived from input-output tables (WIOD). The authors then calculate domestic trade flows as: 1) difference between a country's GDP and its exports (GDP-based method); 2) difference between a country's gross output / total output value and its exports (gross output-based method in a narrow sense); and 3) the sum of gross output sold by domestic industries to domestic final consumers and domestic industries (input-output-based method, gross output-based method in a wider sense). Further details

can be found in Campos et al. (2021). The authors thankfully provided their data set to us so that we were able to analyze it independently. Not shown in Campos et al. (2021), but calculated here, are the summary statistics, displayed separately for domestic and international trade flows (Table A1). The international trade flows are on average much smaller in size than the domestic trade flows. Of the domestic trade flows, the GDP-based ones are by far the largest, whereas the other two domestic trade flow versions are relatively similar. The inclusion of services in GDP, but not in gross output, explains the higher GDP-based domestic trade flows in Campos et al. (2021).

[Insert Table A1]

3 Investigating the results of Campos et al. (2021)

We want to investigate whether the inclusion of domestic trade flows is necessary to correctly estimate the impact of the TA variable or, on the contrary, whether it can bias the coefficient estimate. We concentrate on the results with just the TA variable and without any globalization trend or tariff variable, i.e. the simplest of the Campos et al. (2021) specifications that delivers the major results. In their Table 2, Campos et al. (2021, p. 3) conclude that when pair, importer-time and exporter-time fixed effects are used, the estimate for the TA coefficient is small, negative and statistically insignificant.¹ Once the domestic trade flows are included, the estimates become high, positive and statistically significant at the 1% level. The estimate for the TA coefficient then implies about 33% more bilateral trade. Since a positive impact of trade agreements is the expected outcome, Campos et al. (2021) from then on always use domestic trade flows in their estimation equation. The replication of their baseline results is shown in row 1 of Table A2.² The difference between the estimates with and without domestic trade flows appears surprising because the regression includes pair fixed effects and the TA variable always equals 0 for all domestic trade observations. Our a priori expectation would have been that the domestic trade inclusion should not influence the TA coefficient estimate, but the opposite is the case.

To investigate this puzzle, we first replace the pair fixed effects with a dummy variable for domestic trade (row 2 of Table A2). In all regressions, the TA coefficient dramatically increases and is statistically significant at the 1% level. Whereas in column 1, the comparison is between country pairs with and without TA between them, the comparison in columns 2 to 4 is between international trade observations with a TA on the one hand and international trade observations without a TA and domestic trade observations on the other hand. Compared with the much lower

¹Other authors have reported the opposite findings for similar specifications (Baier and Bergstrand, 2007; Didier and Koenig, 2019; Larch et al., 2019; Lavallée and Lochar, 2019; El Dahrawy Sanchez-Albornoz and Timini, 2021).

²The full estimation results for all estimations reported in Table A2 can be found in the online appendix in Tables A1 to A6.

estimates in row 1 (with pair fixed effects), this suggests that trade agreements are typically signed between countries that are already close trading partners.³

In row 3 of Table A2, we add to the previous specification standard gravity variables, namely common border (*CB*), same official language (*CLang*), log of geographical distance (distinguishing between international and intra-national distance) and former colonial ties (*Col45*).⁴ Interestingly, the TA coefficient in the international trade sample is small and insignificant, similar to the original estimate in row 1. The estimates for the domestic trade inclusive data change compared to row 1: for the gross output-based domestic flows (TIVA and WIOD), the estimates are now also small and insignificant. The GDP-based data, however, deliver a negative and statistically significant estimate. The use of standard gravity variables does not approximate the results with pair fixed effects (row 1 of Table A2).

Conjecturing that the sheer size of domestic trade flows (compare Table A1) may explain the surprising results, we now rescale the domestic trade flows by multiplying them with the ratio of average international to domestic trade flows. This way, the domestic trade flow evolution over time is preserved, but they are shrunk in size to match the international flows. We include the full set of fixed effects (pair, importer-time, exporter-time) as in row 1 and report the results in row 4 of Table A2. The estimates in column 1 are of course identical, but for the domestic trade flow inclusive data, all TA estimates change to small and statistically insignificant. In row 5 of Table A2, we re-estimate the models using OLS. For this specification, we logarithmize all original trade flows observations and estimate the model with all fixed effects. The sample size decreases somewhat because of zero trade observations. Also in this specification, the TA coefficient is small and statistically insignificant.

Lastly, we re-estimate the models with ratios as dependent variable, namely the import and expenditure shares.⁵ This transformation should reduce the size impact of domestic flows and also the dispersion, similarly to the log transformation. The results of these PPML estimations in row 6 of Table A2⁶ also yield a small and

³This is one of the endogeneity concerns related to the trade policy variables, which is also why pair fixed effects are included as a recommended method to control for this issue (Baier and Bergstrand, 2007). Regarding the variation in the TA variable, it proves to be more diverse than initially expected. Out of a total of 41,769 observations, 26,095 refer to country pairs for which the TA variable remains constant over time: 14,518 observations pertain to pairs without an agreement throughout the entire period, while 11,577 relate to pairs already covered by an agreement. The remaining 15,674 observations correspond to pairs that either entered into or terminated a trade agreement during the sample period.

⁴See the full results in Table A3 of the online appendix.

⁵We calculate each importer's total annual imports by summing all its imports from all trade partners in the sample. For each of the three domestic trade flows used, we obtain the expenditure by adding the corresponding domestic trade flow to the total imports. When domestic flows are absent from the regression, we divide the trade flows by the importer's total imports of the corresponding year; when present, we divide them by the corresponding expenditure specific to each domestic flow source, importer and year.

⁶According to Head and Mayer (2014) and Sotelo (2019), using the PPML method to estimate the gravity model in shares is equivalent to using the Multinomial Pseudo Maximum Likelihood

statistically insignificant TA coefficient.

We thus conclude that the dramatic difference between the TA estimate for the international and domestic trade-inclusive data sets is caused by a combination of pair fixed effects that absorb much of the trade flow variation, the sheer size of the domestic trade flows that exceed international trade flows by a factor of 230 to 420 and the non-linear PPML estimation method. Dropping pair-fixed effects leads to high positive and statistically significant estimates, that become small and typically statistically insignificant when standard pair-dependent gravity variables are added. But even when pair fixed effects are included, the TA estimates become small and insignificant throughout if the domestic trade flows are rescaled to match their international counterparts or if PPML is replaced by OLS or MPML.

A technical explanation is beyond the scope of this note. However, it appears obvious that since PPML estimation method uses the level trade flows as dependent variable and estimates the gravity model in its multiplicative form, the very large domestic trade flows are more influential than would be the case for the linear OLS model with log trade flows as dependent variable. In the score function, the residuals of the domestic observations are potentially big and the estimated coefficients are thus adjusted to mainly fit the domestic trade observations.⁷ If the domestic trade flows (for which $TA=0$) increase less over time than the international trade flows with TA, this could explain the big positive TA estimate. However, from a policy perspective, the interesting comparison is between international trade flows with and without a TA, and this effect seems small and insignificant in the used data set.

4 Conclusion

The inclusion of domestic trade flows in gravity models is important when estimating effects that differ between international and domestic trade flows. In a simulation exercise, Matschke and Rojas Rodríguez (2025) conclude that the inclusion of domestic trade is not necessary for estimating trade agreement (TA) effects and may even bias the results if domestic trade is mismeasured. In contrast, Campos et al. (2021) find positive and statistically significant effects of trade agreements only once domestic trade flows are included, an apparent puzzle. Using the data of Campos et al. (2021), we show that the combination of pair fixed effects, big size differences between international and domestic trade flows and non-linear estimation methods such as Poisson Pseudo Maximum Likelihood explain their surprising finding. Moreover, we conclude that the TA effect in the Campos et al. (2021) data set is most likely absolutely small and statistically not distinguishable from zero.

(MPML) estimator (Gourieroux et al., 1984).

⁷The difference in the weights assigned by each estimator to the observations also explains the differences between the PPML and MPML estimates (Sotelo, 2019).

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Appendix

Table A1: Data Summary

	Mean	SD	Min	Max	N
TA (BB)	0.475	0.50	0.00	1.00	41,769
Int X	2,039.778	9,321.24	0.00	328,417.69	41,106
Dom X GDP	855,445.124	1,924,470.58	1,807.33	14,398,194.00	663
Dom X PROD	498,273.819	1,116,517.26	1,049.70	12,517,777.00	663
Dom X WIOD	475,009.823	1,091,970.55	934.83	11,795,303.00	663

Table A2: Trade Agreement Coefficient Estimates

TA coefficient	(1) Int. Trade	(2) GDP	(3) TIVA	(4) WIOD
PPML, pair FE	-0.0107 (0.0437)	0.292*** (0.0917)	0.280*** (0.0784)	0.294*** (0.0806)
PPML, no pair FE	1.568*** (0.206)	0.867*** (0.151)	1.006*** (0.171)	1.051*** (0.185)
PPML, pair gravity var.	0.0893 (0.0962)	-0.187** (0.0778)	-0.0480 (0.124)	-0.0715 (0.122)
PPML, scaled dom. trade	-0.0107 (0.0437)	-0.00234 (0.0429)	0.00451 (0.0432)	0.00572 (0.0429)
OLS, pair FE	0.0423 (0.0422)	0.0570 (0.0389)	0.0603 (0.0390)	0.0631 (0.0391)
MPML, pair FE	-0.0661 (0.0895)	0.0354 (0.0599)	0.0350 (0.0631)	0.0469 (0.0649)

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Online Appendix

Table A1: PPML Estimation with Pair, Exporter-Time and Importer-Time FE

VARIABLES	(1) Int. Trade	(2) GDP	(3) TIVA	(4) WIOD
TA (BB)	-0.0107 (0.0437)	0.292*** (0.0917)	0.280*** (0.0784)	0.294*** (0.0806)
Observations	40,919	41,582	41,582	41,582
R-squared	0.997	1	1	1

Table A2: PPML Estimation with Exporter-Time and Importer-Time FE, domestic trade dummy

VARIABLES	(1) Int. Trade	(2) GDP	(3) TIVA	(4) WIOD
TA (BB)	1.568*** (0.206)	0.867*** (0.151)	1.006*** (0.171)	1.051*** (0.185)
DB		5.453*** (0.205)	4.925*** (0.234)	4.860*** (0.234)
Observations	41,106	41,769	41,769	41,769
R-squared	0.791	0.998	0.995	0.995

Table A3: PPML Estimation with Exporter-Time and Importer-Time FE, Pair-Dependent Variables

VARIABLES	(1) Int. Trade	(2) GDP	(3) TIVA	(4) WIOD
TA (BB)	0.0893 (0.0962)	-0.187** (0.0778)	-0.0480 (0.124)	-0.0715 (0.122)
DB		2.657*** (0.506)	1.651** (0.812)	0.856 (0.861)
CB	0.349*** (0.0906)	0.317*** (0.100)	0.342*** (0.121)	0.348*** (0.117)
ln(Int Dist)	-0.798*** (0.0612)	-0.888*** (0.0629)	-0.843*** (0.0786)	-0.857*** (0.0806)
ln(Dom Dist)		-0.991*** (0.0865)	-0.810*** (0.119)	-0.694*** (0.121)
C Lang	0.113 (0.143)	0.0548 (0.0868)	0.318*** (0.110)	0.380*** (0.104)
Col 45	-0.246 (0.393)	0.200 (0.247)	0.0766 (0.253)	-0.00817 (0.255)
Observations	41,106	41,769	41,769	41,769
R-squared	0.925	0.999	0.997	0.997

Table A4: PPML Estimation with Scaled Domestic Trade Flows

VARIABLES	(1) Int. Trade	(2) GDP	(3) TIVA	(4) WIOD
TA (BB)	-0.0107 (0.0437)	-0.00234 (0.0429)	0.00451 (0.0432)	0.00572 (0.0429)
Observations	40,919	41,582	41,582	41,582
R-squared	0.997	0.997	0.997	0.997

Table A5: OLS Estimation with Pair, Exporter-Time and Importer-Time FE

	(1)	(2)	(3)	(4)
VARIABLES	Int. Trade	GDP	TIVA	WIOD
TA (BB)	0.0423 (0.0422)	0.0570 (0.0389)	0.0603 (0.0390)	0.0631 (0.0391)
Observations	40,457	41,120	41,120	41,120
R-squared	0.975	0.977	0.977	0.977

Table A6: MPML Estimation with Pair, Exporter-Time and Importer-Time FE

	(1)	(2)	(3)	(4)
VARIABLES	Int. Trade	GDP	TIVA	WIOD
TA (BB)	-0.0661 (0.0895)	0.0354 (0.0599)	0.0350 (0.0631)	0.0469 (0.0649)
Observations	40,919	41,582	41,582	41,582
R-squared	0.976	0.996	0.994	0.993