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Frankel and Romer revisited

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FRANKEL AND ROMER REVISITED

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Highlights

- Frankel and Romer's (FR) instrument establishing a causal relationship between trade and growth is not robust to time, sample and estimation technique.
- Trade and geography are less correlated in recent years.
- The FR instrument may have picked up the direct effect of geography on income levels.

Abstract

Frankel and Romer (1999) proposed an instrument variable for trade intensity to robustly assess the causal impact of international trade on standards of living. The instrument is based on OLS estimates of the gravity equation and has been widely used in the literature. In this note I show that the instrument is unrelated to income in the mid-2000s. Re-estimating the gravity equation using PPML, I show that the resulting instrument is strongly related to GDP per capita, but weakly correlated with trade, suggesting that what is captured may be a direct link between geography and income.

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1. Introduction

The article "Does Trade Cause Growth" by Frankel and Romer (1999), hereafter FR, has been cited 5636 times and counting.[1] It proposes an instrument for trade to robustly assess the causal impact of international trade on standards of living, an issue that had been fraught with identification and endogeneity problems.

The FR instrument is constructed from the fitted values of a gravity regression estimated on cross-section data for overall merchandise trade among 63 countries in 1985 using ordinary least squares (OLS). To avoid the endogeneity problem, bilateral trade was regressed on dyadic geographical characteristics only. The instrument explained about 36% of bilateral trade and was strongly correlated with trade intensity.

Recent research has revealed three major deficiencies with the standard OLS gravity regressions. First, most countries do not trade with all other countries. Therefore, the underlying model must account for zero trade flows (Chaney 2008) and gravity regressions could suffer from sample selection bias if zero trade flows are omitted. Second, bilateral trade between two countries not only depends on the characteristics of the two countries, but also on market conditions in and trade costs with all other countries. Bilateral trade costs must therefore be assessed relative to trade costs with all other trading partners, or so-called multilateral resistance terms (Anderson and van Wincoop, 2003). Failing this may result in omitted variable bias. Third, bilateral trade data are typically characterized by heteroscedasticity, which leads to inefficient elasticity estimates in log-linear OLS. Santos Silva and Tenreyro (2006) showed that estimating the gravity model using Poisson pseudo maximum likelihood (PPML) solves the heteroscedasticity problem, allows for the inclusion of zero trade flows and can accommodate multilateral resistance, for instance by including exporter and importer fixed effects. In this note I explore to what extent the FR instrument is still valid in the light of these new insights.

The rest of the paper is organised as follows: Section 2 first replicates the FR methodology for a more recent year, 2005, to asses to what extent changes in technology and trade costs have affected the instrument. Second, it re-estimates the instrument using PPML. The resulting alternative instrument is related to GDP per capita in section 3, while section 4 concludes.

2. Replicating Frankel and Romer and robustness checks

FR estimated the following specification of the gravity model:

$$\ln\left(\tau_{ij}/GDP_i\right) = a_0 + a_1 lnD_{ij} + a_2 lnN_i + a_3 lnA_i + a_4 lnN_j + a_5 lnA_j + a_6\left(L_i + L_j\right) + a_7 B_{ij} + a_8 B_{ij} lnD_{ij} + a_9 B_{ij} lnN_i + a_{10} B_{ij} lnA_i + a_{11} B_{ij} lnN_j + a_{12} B_{ij} lnA_j + a_{13} B_{ij}\left(L_i + L_j\right) + \varepsilon_{ij} \quad (1)$$

The dependent variable is bilateral trade (exports plus imports) between countries *i* and *j* relative to GDP in country *i*, D_{ij} represents distance between the trading partners, N denotes population, A land area, B_{ij} is a dummy reflecting whether or not a country pair shares a common land border and L signify whether or not a country is land-locked. FR estimated this equation on a cross-section of 63 countries in 1985.

To test whether the instrument is still valid, I make three changes. First, I use a more recent year, 2005, which is a normal year before the financial crisis led to major upheavals in international trade.[2] As

[1] According to Google Scholar accessed 12.02.2018.

[2] I also estimated the regression for other years during the 2000s and the results are similar.

far as possible the FR sample is used, but West Germany is replaced by unified Germany and Yugoslavia with the countries that emerged after the country broke up. Iran has been subject to sanctions and political unrest during the past decade and was dropped, while Russia and Vietnam, which have emerged as significant trading nations in recent years, were added. This sample is labelled FR adj. The second change I make is extending the sample to all countries for which information on trade and the control variables is available. It does not solve the omitted variable problem, but at least the parameter estimates are based on a larger sample with a higher explanatory power.[3] Third, I re-run all the regressions using the PPML estimator. The results are presented in Table 1.

[3] Country-fixed effects would capture all country-specific variables, including income, and would render the instrument unsuitable.

Table 1. Gravity regressions FR and 2005

	OLS			PPML		
	FR	FR adj.	Full sample	FR adj.	FR adj. with zero	Full sample with zero
Ln distance	-0.85***	-0.892***	-1.504***	-0.681***	-0.447***	-0.722***
	(0.04)	(0.042)	(0.026)	(0.042)	(0.043)	(0.029)
Ln population (country i)	-0.24***	0.155***	0.180***	0.034	0.022	-0.089***
	(0.03)	(0.030)	(0.017)	(0.034)	(0.035)	(0.034)
Ln area (country i)	-0.12***	-0.174***	-0.089***	-0.157***	-0.150***	0.012
	(0.02)	(0.022)	(0.013)	(0.029)	(0.030)	(0.025)
Ln population (country j)	0.61***	0.812***	1.202***	0.660***	0.632***	0.790***
	(0.03)	(0.030)	(0.016)	(0.035)	(0.034)	(0.025)
Ln area (country j)	-0.19***	-0.315***	-0.272***	-0.193***	-0.159***	-0.134***
	(0.02)	(0.022)	(0.013)	(0.038)	(0.039)	(0.033)
Landlocked	-0.36***	-0.911***	-1.144***	-0.426***	-0.365***	-0.574***
	(0.08)	(0.089)	(0.037)	(0.129)	(0.131)	(0.064)
Border	5.10***	5.935**	5.493***	3.503*	5.388***	3.768***
	(1.78)	(2.961)	(1.808)	(1.927)	(1.939)	(1.205)
Border* ln distance	0.15	0.615*	0.561**	0.416*	0.182	0.248
	(0.30)	(0.332)	(0.226)	(0.237)	(0.237)	(0.154)
Border* ln population i	-0.29	-0.501**	-0.427***	-0.400***	-0.388***	-0.124
	(0.18)	(0.220)	(0.123)	(0.122)	(0.123)	(0.086)
Border*ln area i	-0.06	0.068	0.036	0.084	0.077	-0.036
	(0.15)	(0.185)	(0.125)	(0.108)	(0.109)	(0.077)
Border ln population j	-0.14	-0.148	-0.309**	0.092	0.12	-0.224***
	(0.18)	(0.224)	(0.127)	(0.146)	(0.146)	(0.086)
Border ln area j	-0.07	0.061	0.213*	-0.122	-0.156	0.126
	(0.15)	(0.184)	(0.124)	(0.127)	(0.127)	(0.121)
Border* landlocked	0.33	0.704*	0.775***	0.142	0.081	0.507***
	(0.33)	(0.397)	(0.201)	(0.214)	(0.215)	(0.129)
Constant	-6.38***	-8.315***	-12.609***	-6.222***	-8.108***	-9.408***
	(0.42)	(0.621)	(0.328)	(0.649)	(0.682)	(0.466)
N	3220	3536	20466	3537	3599	25872
R^2 /Pseudo R^2	0.36	0.32	0.39	0.15	0.14	0.20

Note: Standard errors are reported in parentheses. The standard errors are clustered on country pairs in the PPML regressions. ***, **, and * signify statistical significance at 1%, 5% and 10% level respectively. Trade data are from UN Comtrade, area and populations from the World Development Indicators and the other gravity variables from CEPII.

The first column reproduces Table 1 in FR. My OLS estimates of equation (1) for 2005 are reported in columns 2 and 3. The results are qualitatively similar to FR, although the result for the full sample raises the absolute value of the coefficient on distance substantially. The PPML regression results are reported in

columns 4 to 6.[4] They turn out not to be very sensitive to whether or not zero trade flows are included. As in previous research (e.g. Santos Silva and Tenreyro, 2006) the parameter estimates tend to be smaller in absolute value in the PPML regressions compared to OLS. Finally, we observe that geography explains only half as much of the variation in trade intensity when using PPML.

3. Do the instruments establish a causal relationship between trade and GDP per capita?

Following FR I create country-specific instruments for trade shares, aggregating predicted bilateral trade shares over trading partners for each country. Four instruments are created using the predicted trade shares from i) OLS regressions using the adjusted FR sample; ii) OLS regressions using the full sample; iii) PPML regressions using the FR sample; and iv) PPML regressions using the full sample. The correlations between the instruments and the actual trade flows are reported in Table 2.

Table 2. Correlation between instruments and actual trade

	Actual
Instrument OLS FR sample	0.230***
Instrument OLS full sample	0.271***
Instrument PPML FR sample	0.306***
Instrument PPML full sample	0.355***

Note: The reported correlations are the Pearson correlation coefficients. *** signifies statistical significance at a 1% level.

FR reported a correlation coefficient of 0.62 between their instrument and actual trade share. My constructed trade share using the same methodology for 2005 turns out a much lower correlation coefficient, suggesting that geography is less important for trade in the 2000s compared to the 1980s. The correlation improves when expanding the sample and when using the PPML estimator, which, as noted, corrects for heteroscedasticity and a possible sample selection bias. Following FR, I finally regressed the log of GDP per capita on actual trade shares or the instruments, controlling for population and area as follows:

$$lnY_i = a + bT_i + c_1 lnN_i + c_2 lnA_i + u_i \quad (2)$$

Where Y represents GDP per capita and T is exports plus imports over GDP. The results are reported in Table 3.

[4] The left-hand side of the PPML regression is τ_{ij}/GDP_i and the right hand side is the exponential of the right hand side of equation (1).

Table 3. Trade share and GDP per capita, 2005, with instruments

	Actual trade share	Instrument, OLS		Instrument PPML	
		FR sample	full sample	FR sample	full sample
Ln population	0.105	0.058	0.083	0.049	0.066
	(0.107)	(0.179)	(0.132)	(0.200)	(0.161)
Ln area	-0.159*	0.110	-0.079	0.040	-0.020
	(0.083)	(0.232)	(0.129)	(0.198)	(0.133)
Trade share	0.832**	5.201	2.886	5.966	4.419***
	(0.420)	(6.154)	(2.550)	(3.664)	(1.443)
Constant	7.996***	4.154	6.190***	3.481	4.842**
	(1.148)	(5.458)	(2.390)	(3.373)	(1.655)
N	147	147	147	147	147
Adjusted R^2	0.049				
Prob>chi^2		0.4224	0.1052	0.2668	0.0117

Note: Standard errors are reported in parentheses. ***, **, and * signify statistical significance at 1%, 5% and 10% level respectively. The instrument regressions are run using standard 2SLS with robust standard errors.

Population, area and trade share are poor predictors of income level as indicated by the overall fit of the regressions. Interestingly, the instrument for trade intensity suggested by FR estimated on 2005 data is not significantly related to GDP per capita. However, the instrument estimated using PPML on the full sample depicts a statistically significant relationship to GDP per capita with a somewhat higher coefficient compared to FR.

4. Concluding remarks

This note has revisited the instrument variable approach proposed by Frankel and Romer (1999) for establishing a causal relationship between trade and growth. The FR instrument is found to be sensitive to the time period, the sample and the estimation technique applied. In its original form, it is no longer significantly related to GDP per capita. However, although a re-estimation using the PPML technique yields an instrument that is weakly correlated with actual trade intensity, it is significantly and positively related to GDP per capita. A possible explanation is that geography, as picked up by the instrument, has a direct impact on income levels (Gallup et al., 1999; Dell et al., 2014) and that gains from trade may not be proportional to trade volumes (Markusen and Venables, 1998).

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