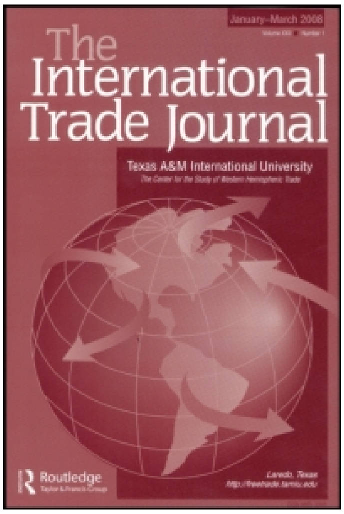

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A GRAVITY STUDY OF THE PROPOSED CHINA-ASEAN FREE TRADE AREA

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Benjamin A. Roberts

The proposed China-ASEAN Free Trade Area (CAFTA) has drawn much interest both at the regional and international level. This interest is justified given the recent surge in regional trade agreements. The implications the FTA will have for the less developed economies of Cambodia, Laos, Myanmar, and Vietnam (the CLMV economies) are of concern. How would trade between the integrating area and the rest of the world be affected? Will there be net trade creation or net trade diversion effects? What trading partners are likely to loose or gain following formation of the FTA in 2010? These are some of the issues that this article addresses by way of the Gravity Model of trade.

* * * * *

I. INTRODUCTION

The objective of this study is twofold. First, it attempts to test the suitability of the Gravity model to the proposed Regional Trade Area (RTA). Second, it seeks to find out if policy implications exist for both the proposed RTA governments and the Multilateral Trade System.

The underlying objectives of this study are important for three reasons. First, it helps to gauge the effects, if any, the

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proposed Free Trade Area will have on the multilateral trade system by way of trade creation and trade diversion and the possible effects on the economic welfare of the integrating and non-integrating members. Second, it addresses the issue of whether regional economic opportunities would result following the proposed economic integration and how these opportunities (or lack thereof) would affect the welfare of the economic units of the member countries. Third, it helps to give an insight into whether the proposed Free Trade Area (FTA) will have any effect on the economic geography of production, trade, and development within the proposed regional trade area.

The Gravity model has been widely used to evaluate the implications of already existing Free Trade Areas and to provide answers to varying objectives of interest. Within this study, the model is used to evaluate a Free Trade Area that is yet to come into existence.

It is claimed that the proposed Free Trade Area (CAFTA) will result in the creation of an economic region of 1.7 billion people with a GDP of US$2 trillion and a trade value of US$1.23 trillion (The SGV Review, 2001, p. 32). The size of the proposed RTA along with the important role played by China and some of the ASEAN economies in global trade makes this study imperative.

II. THE GRAVITY MODEL OF TRADE AND ECONOMIC INTEGRATION

The Gravity model, pioneered by Tinbergen (1962) and Linneman (1966), is renowned for its empirical robustness but has been used, in conjunction, to undertake ex ante analysis of RTAs. The works of Porojan (2000) and Carillo and Li (2002) are examples of such complementary analysis. The model is a bilateral trade model and in its most rudimentary form relates trade between two countries to their national incomes and the geographical distance between them. The Gravity model takes the functional form

$$(1) \qquad TF_{ij} = fn(GDP_i, GDP_j, GD_{ij}^{-1})$$

TF_{ij}: Trade flow between country i and country j
GD_{Ij}: Geographical distance between country i and country j

The crude form of the model shows that trade between two countries is directly related to the countries' national income and inversely related to the geographical distance between them (Carillo and Li, 2002). Though the model was developed in the early 1960s its application to the study of RTAs became popular following Krugman's (1991) study in which he posits that geography (proximity) plays a role in the decision to forming RTAs. He shows how proximity can lead to agglomeration of production to a given region and in the process biasing trade to that region by promoting a regional integrating area (RIA).

Despite its simplicity and intuitive nature, the Gravity model has come under heavy criticisms. Baldwin (1994) and Leamer (1994) criticized the model on grounds that it lacked a theoretical foundation. This criticism was, however, short-lived given the assumptions made by studies employing the model to show how proximity, among other explanatory variables, influence decisions on regional integration. Anderson (1979) settled the criticism of "theoretical foundation" when he underpinned the model with trade theory. Work done by Deardorff (1998), Eaton and Kortum (1997), and Helpman and Krugman (1985) derived the Gravity model from a Heckscher-Ohlin, Ricardian, and the "New International Trade Theory" framework, respectively. Carillo and Li (2002) also showed how a classification into differentiated and homogeneous product categories had different impacts on trade flows between and within the Latin American Integration

Association (LAIA), the Andean Community, and MERCUSOR; again dispelling of the "theoretical foundations" criticism.

Another criticism of the model regards mis-specification of the functional form (Hamilton and Winters, 1992; Polak, 1996). The importance of this concern has waned over the years because variables of economic size, trade distance, and GDP have become widely recognized as explanatory variables for trade flows. The model's log-linear specification, though highly restrictive as pointed out by Fik and Mulligan (1998), is only a problem under non-asymptotic conditions, especially in the least developing countries' context where trade data are hardly available. This dearth of statistical data is reminiscent of four of the eleven CAFTA economies in this study—Cambodia, Laos, Myanmar, and Vietnam. The number of groups and the resulting country-pairs makes the number of observations large enough to not worry about the problem of micronumerosity.

Issues of spatial dependence (caused by spatial aggregation and externalities) and heteroskedasticity (Anselin, 1998) are also of concern. Porojan (2000) pointed out that Spatial Econometrics technique can resolve the spatial dependence problem. The asymptotic nature of the sample along with the underlying provisions of the Central Limit Theorem makes the issue of spatial dependence and heteroskedasticity less of a concern (Gujarati, 1995).

Other criticisms relates to the argument by some, for example, Evenett and Keller (1998), that the success of the model depended on its assumption of increasing returns to scale production techniques outside of which the model becomes less robust. The application of the model by Carillo and Li (2002) under a differentiated and homogeneous product classification has proved otherwise.

III. CONCEPTUAL FRAMEWORK

Highly acclaimed for its simplicity, empirical robustness, and, until recently, theoretical foundations, the Gravity Model is first estimated to determine its suitability to the proposed Free Trade Area. Assessing the coefficient betas on the explanatory variables along with their statistical significance will provide insights to the two-fold study objective.

Unlike studies that invoke the provisions of the Central Limit Theorem, I undertake a more robust test for the presence of heteroskedasticity in the specified model. The inclusion of a distance indicator helps avoid potential mis-specification bias that might result from spatial effects. In the case of the estimated model, the distance indicator is specified in nautical miles since trade is mostly carried across maritime waters. Another reason for this specification is because of the limited road and rail infrastructure within ASEAN and between ASEAN and China.

In their study, Brulhart and Kelly (1999) weighted their remoteness indicator by trading partner's GNP. This GNP weighting resulted in higher remoteness value for economies with higher GNP values than economies with lower GNP values. To test the effect of this weighting I estimate two equations—in the first I use an absolute trade distance (Eq. (3)) and in the second I use a GDP weighted trade distance (Eq. (4))—in an attempt to discern the effect of the cost of trade distance on trade flows.

The estimation under Eq. (3) suffers from the shortcoming of the assumption that geographical distance is directly related to cost of trade distance. This assumption may not necessarily be true. The non-public nature of shipping costs—largely the result of the cartelized organization of containerized shipping—and the lack of credible data on transportation costs and tariff rates is partly reason for this assumption of a direct relationship between geographical distance and cost of trade distance.

Despite the underlying assumption and following in the practice of Brulhart and Kelly (1999), I specify a proximity indicator that weights the geographical distance between trading partners and the relative wealth of the individual CAFTA economies to the rest of the world.

$$PROX_i = DIST_{ij} \left| \frac{y_i}{Y_w} \right|$$

$PROX_i$: The proximity indicator for country i
$DIST_{ij}$: The nautical miles distance between country i and j and
$|\frac{y_i}{Y_w}|$: The relative wealth of country i to that of the world.

The direct application of GDP weights to the proximity indicator would seem to put too much emphasis on the importance of economic distance in bilateral trade flows. However, upon closer examination it would be realized that this practice is to measure the cost of trade distance in terms of the price paid for been economically distant from the rest of the world. This emphasis can, however, take away from one of the positive effects of globalization, that is, reduction in economic distance between trading partners. The fall in shipping costs, expressed as CIF/FOB ratios, highlights the eroding importance of economic distance. Blumenhagen (1981) estimated that about 11% of total import costs of developing countries consisted of freight costs. In 1996 UNCTAD estimated developing countries freight costs as a percentage of imports at 8.25%. This clearly is an indication that economic distance may not be as important as it was in the past. We will have the opportunity to assess if this is the case following analysis of the estimation results.

IV. MODEL SPECIFICATION

I specify a Gravity model that builds on the conventional Tinbergen (1962) and Linneman (1966) bilateral trade model. Unlike some Gravity studies, I do not seek to prove whether trade flows are indeed affected by geographical distance, economic size, or incomes. These intricacies have already been settled.

The specified model takes the functional form:

$$
\begin{aligned}
(3) \qquad \log TF_{ij} = {} & \beta_0 + \beta_1 \log(GDP_i) + \beta_2 \log(GDP_j) \\
& + \beta_3 \log(pcGDP_i) + \beta_4 \log(pcGDP_j) \\
& + \beta_5 \log(pcGDP\,diff_{ij}) \\
& + \beta_6 \log(int\ er\_cafta\_dist) + +\varepsilon_{ij}
\end{aligned}
$$

TF_{ij} (trade flows) represents total trade values (imports + exports) between country i and j and are expressed in thousands of current U.S. dollars. The GDP and per capita GDP variables are stated in thousands of current[1] U.S. dollars. The GDP and per capita GDP coefficients are expected to have a positive sign because of the direct relationship between trade, economic size, and income. The coefficient betas on economic size (β_1 and β_2) and the coefficient betas on per capita income levels (β_3 and β_4) are likely to be statistically significant given the summative attribute of the dependent variable.

The per capita GDP difference ($pcGDP\,diff_{ij}$) between countries i and j, expressed in absolute terms, is intended to test for the Linder Hypothesis. That is, that countries with similar levels of income per capita will exhibit similar tastes, produce similar but differentiated products and trade more amongst themselves. A negative sign on the per capita GDP difference variable will support the hypothesis. There is an implicit policy implication from this hypothesis for the economies of China and ASEAN.

The $Inter\_Cafta\_dist_{ij}$ variable captures the trade distance in nautical miles between the trading country pairs. Like Endoh

[1] Linneman (1996) showed that the use of nominal GDP as opposed to Real GDP only had a small effect on the estimated betas.

(1999) I use actual transport distance between trading countries. The expected sign on the trade distance coefficient is negative given the inverse relationship between trade and distance.

In an attempt to capture the implications of costs of trade distance, I re-estimate the Gravity model with the geographical distance variable replaced by the proximity variable in Eq. (4). Though some models estimate a single equation using both trade distance and a proxy for cost of trade distance, I do not follow in this practice since this could lead to an over specified model with potential bias in the coefficients.

$$\begin{aligned} \text{(4)} \qquad \log TF_{ij} = {} & \beta_0 + \beta_1 \log(GDP_i) + \beta_2 \log(GDP_j) \\ & + \beta_3 \log(pcGDP_i) + \beta_4 \log(pcGDP_j) \\ & + \beta_5 \log(pcGDP\,diff_{ij}) \\ & + \beta_6 \log(PROX_i) + \varepsilon_{ij} \end{aligned}$$

All the six explanatory and the dependent variables are expressed in log form and hence their coefficient interpretation is one of constant elasticity. Unlike Endoh (1999), I do not explicitly estimate for trade creation effects. Rather, there is an implicit assumption that trade creation will occur; this is not an unrealistic assumption given the empirical evidence on trade creation following the formation of Free Trade Areas.

The estimation method is that of Ordinary Least Squares (OLS). Preliminary data analysis is employed to ensure that OLS is appropriate for estimating the model. The correlation matrix reveals variable independence but a moderately strong positive relationship between trade flow and GDP. The results of the analysis meet the Classical Linear Regression Model assumptions making OLS a good estimation method.

An underlying assumption is held with respect to the levels of dependent variables that are partly reported between trading pairs. This assumption is premised on the IMF methodology of using a cif/fob ratio of 1.10 to proxy a country's trade partners' export or import value in a given period. Assume that Singapore trades with Laos and Singapore reports its trade flows to and from Laos and assume Laos does not report either of its trade flows to Singapore. Using Singapore's reported import value from Laos and dividing it by the ratio 1.10 will give us Laos's export value to Singapore. This methodology was used in calculating some of the trade flow data for Cambodia, Laos, Myanmar, and Vietnam and also for the trade flows between Singapore and Indonesia for 1996–2000 (with Indonesia not reporting its trade flows to and from Singapore). This extrapolation assumes that trade costs comprise only of insurance and freight and sums up to 10% of trade value.

V. DATA USED IN ESTIMATING THE MODEL

Data on GDP for China and the ASEAN economies, except Brunei, were obtained from the World Economic Outlook database. Data on GDP and per capita GDP for Brunei were obtained from the ASEAN Surveillance Coordinating Unit (ASCU) (*www.aseansec.org/macroeconomic/gdpPercapita.html*). Per capita GDP for the rest were obtained from the World Bank Development Database through the WDI data query (*http://dvdata.worldbank.org/data-query*). GDP and population queries used for calculating per capita GDP were only available for 1997–2000. Since the model estimates trade flows from 1996–2000, 1996 per capita GDP figures from the World Economic Outlook database query were used. All GDP figures are in thousands of U.S. dollars and both GDP and per capita GDP figures are stated in nominal terms.

Data on trading distance between the CAFTA economies are between major cities. The cities used are Beijing (China), Singapore (Singapore), Kuala Lumpur (Malaysia), Bangkok (Thailand), Jakarta (Indonesia), Manila (Philippines), Bandar Seri Begawan (Brunei), Phnom Penh (Cambodia), Vientiane (Laos), Rangoon (Myanmar), and Hanoi (Vietnam). The inter trade distance data is stated in nautical miles and was obtained from the Great Circle Distance between Cities database (*www.wcrl.ars.usda.gov/cec/java/lat-long.htm*).

Data on the dependent variable, stated in nominal U.S. dollars, were compiled from the *Direction of Trade Statistics Yearbooks 2000* (IMF) and *2001* (IMF). Some country pair trade data were completely lacking and were recorded as missing values in the IMF trade statistics yearbook. Such data, as pointed out by the Fund, could be indicative of a lack of statistical data, a zero value reported, or trade data with less than half a significant digit. Missing trade flow data were treated as zero values.[2]

As pointed out by Brulhart and Kelly (1999) these zero trade values under asymptotic conditions should not affect the point estimates significantly. Baldwin (1994) cited this point as to why OLS has become the norm for estimating Gravity equations. In Brulhart and Kelly (1999) the number of missing observations represented less than 3% of their observations (15 out of 552) making the estimation method used less of an issue. In this study, missing values accounted for 12% of the observations but the asymptotic data set renders the missing values trivial.

VI. ESTIMATION RESULTS

Concerns of heteroskedasticity in the Gravity model, especially that of the unknown form remains a problem. To address

[2]Observations with zero values are undefined in the log specification of the Gravity Model. Therefore the data set used in estimating the model is truncated involving 482 observations out of a possible 500 observations.

this concern, the model is first estimated using OLS with the error terms subjected to the Breusch-Pagan test under which I test the null hypothesis of homoskedastic constant error terms.[3]

The regression equation is estimated using 1996–2000 cross-sectional data for the 11 CAFTA economies with 10 country-pairs and 550 observations. Noted for its empirical success, the estimated Gravity model manifests a good fit with an adjusted R-square of 68 percent for both Eqs. (3) and (4). Standard error of the regression equals to approximately 60 percent of the standard deviation and about one-eighth the mean of the dependent variable in both equations. This good fit is in line with the objective of determining the suitability of the model to the proposed free trade area.

Tables I and II give the regression results for both Eqs. (3) and (4)—hereafter referred to as the Base and Modified models. As indicated on both tables all of the explanatory variables have the expected signs. The coefficient on the per capita GDP difference variable supports the Linder Hypothesis. However, both coefficients on the per capita GDP difference variable in the estimation output for the Base and Modified models are insignificant. The coefficients on GDP and Per Capita GDP are statistically significant at the 1% level for both estimated equations.

As indicated by the coefficient on the trade distance variable (Base model), trade distance remains a hindrance to trade. Globalization, despite its benefits, has not reduced the importance of physical distance. This view is supported by the 1% significance level on the coefficient on trade distance. This is not

[3] F-statistics and probability values are significant at the 1% significance level for both Eqs. (3) and (4). Both equations are estimated under White's Heteroskedastic Robust Error Terms. As Wooldridge (2000) argued heteroskedastic robust procedures result in valid t, F, and LM statistics even within the presence of heteroskedasticity. This is true at least in asymptotic samples.

Table I
Regression Results for Eq. (3)

Explanatory Variable	Coefficient Betas	t-Statistic*
$\log GDP_i$	0.919	22.480
$\log GDP_j$	0.911	22.115
$\log pcGDP_i$	0.286	4.546
$\log pcGDP_j$	0.235	3.739
$\log pcGDP diff$	−0.021	−0.348
$\log InterCaftaDist_{ij}$	−1.246	−10.673
Const	−14.707	−12.418

Number of Observations: 482;
Adj. $R^2 = 0.68$;
SE of Regression $= 1.455$.

*Heteroskedasticity-consistent t-values (White adjusted).

All coefficients are significant at the 1% significance level with the exception of per capita GDP difference.

Table II
Regression Results for Eq. (4)

Explanatory Variable	Coefficient Betas	t-Statistic*
$\log GDP_i$	2.158	16.089
$\log GDP_j$	0.910	22.087
$\log pcGDP_i$	0.288	4.577
$\log pcGDP_j$	0.236	3.756
$\log pcGDP diff$	−0.022	−0.359
$\log PROX_i$	−1.240	−10.644
Const	−27.513	−20.950

Number of Observations: 482;
Adj. $R^2 = 0.68$;
SE of Regression $= 1.456$.

*Heteroskedasticity-consistent t-values (White adjusted).

All coefficients are significant at the 1% significance level with the exception of per capita GDP difference.

to further an argument that globalization has not improved upon costs associated with distance since it has by way of improved communication, breakdown in cultural barriers, and facilitation of financial transactions. However, distance remains a barrier to trade even though technological innovations continue to spark reductions in transport costs.

The cost of trade distance coefficient (PROX) in the Modified model surprisingly has an almost similar coefficient elasticity as that of trade distance in the Base model and it is also significant at 1%. Looking at the regression results in Tables I and II, we find that though the coefficient on trade distance in the Base model is identically the same as that of the cost of trade distance under the Modified model, the intercept parameter under the Base model is almost half (−15) the intercept parameter under the Modified model (−28). The almost double magnitude in the Modified model's intercept term—a parameter that captures the consequential welfare effects on autarkic states—means a lower welfare consequence under the Base model than under the Modified model.

The implication from the above results is that whilst both geographical distance and the cost of trade distance have statistically significant effects on trade flows, it is the cost of trade distance rather than trade distance that is likely to pose the greatest challenge to an autarkic economy. Assume two countries, i and j, living in autarky with x nautical miles between them. Suppose i and j engage in trade by overcoming the geographical distance (improvement in infrastructural and navigational systems) between them, i and j would benefit less since they would register lesser welfare improvements given the lower negative elasticity on the intercept term in the Base model. If i and j had lived in autarky because of the costs of trade distance (non-navigable waters) then overcoming these costs would bear relatively greater welfare gains given the higher negative elasticity value on the intercept parameter in the Modified model. Cost of trade distance is therefore more of a formidable hindrance to trade than trade distance in terms of welfare effects.

VII. POLICY IMPLICATIONS

One of the two underlying objectives of this article was to help find out if there are policy implications for both the proposed FTA and the Multilateral Trade System. As evidenced in the regression results (though insignificant) the coefficient on per capita GDP differences ($pcGDP\,diff_{ij}$) had the expected sign thus lending support to the Linder Hypothesis. It is plausible to hint that the insignificance of the coefficient testing for the Linder Hypothesis is due to the aggregated nature of the trade flows used in this study given that the Hypothesis has been strongly supported by studies modeling differentiated and product specific trade flows (McPherson et al., 2001). In this study, the insignificance of the coefficient testing for the Linder Hypothesis supports the position that CAFTA does not have similar demand patterns and therefore their manufacturing sectors are less likely to produce differentiated goods destined for each others market. This dissimilarity in demand patterns is supported by the World Bank's classification of China, Cambodia, Laos, Myanmar, and Vietnam as Low Income economies; Indonesia, Thailand, and Philippines as Low Middle Income economies; Malaysia as a Middle Income economy; and Singapore and Brunei as High Income economies. The inherent policy implication for CAFTA is to strive to narrow the income gap between the aspiring members in an attempt to take full advantage of the benefits of integration.

The other policy implication regards the trade distance variable. In the estimated model distance is specified in nautical miles rather than land distance given the poor transport infrastructure within ASEAN and between ASEAN and China. Given the statistical significance of the coefficients of this variable, it is evident that trade between CAFTA will increase following a comprehensive development of the land transport infrastructure, especially among the least developed ASEAN economies and between ASEAN and China. This infrastructural development will lead to a reduction in the economic distance between the integrating countries. The approximate unitary value of the distance variable means that a Free Trade Agreement that reduces trade costs by 5% would lead to a resulting increase in intra CAFTA trade of 5%. This trade creation estimate, though laudable, should not have consequential effects on the global trading system.

That the proposed China-ASEAN FTA never underwent WTO consultation is reason for concern. The fact that all of CAFTA have the United States as one of their major trading partner means that the United States is at a possible risk of suffering a trade diversion should the proposed integration become a reality. This could perhaps be one of the reasons for the recent signing of the United States-Singapore FTA (USSFTA) and the other FTA proposals by Japan, India, and CER currently under consultation with ASEAN.

An urgent and real problem facing CAFTA is that of the welfare of the less prosperous ASEAN economies of Cambodia, Laos, Myanmar, and Vietnam. As the regression results indicate, the coefficient testing the Linder Hypothesis, though supported, was not significant. This insignificance necessitates revisiting one of the outlined reasons as to why the twofold objectives of this study are deemed important—that is, giving an insight as to whether the proposed FTA will have any effect on the economic geography of production, trade, and development within CAFTA.

If the coefficient testing for the Linder Hypothesis is to be significant, China and ASEAN would have to ensure convergence on their per capita income levels. For this to eventually happen, the equalization of factor prices will have to take place. Overtime therefore, one is likely to find a relocation of economic activity from the more prosperous economies of CAFTA to the lesser prosperous economies where factor prices are likely to be lower. This eventual convergence would, however, require the presence of strong institutions, an educated labour force, transparent bureaucracies, and synonymous trade and competition policies in all the CAFTA economies, especially the lesser prosperous economies of Cambodia, Laos, Myanmar, and Vietnam. That the proposed FTA maintains improving the welfare of its economic units as one of its prime objectives means that overtime we are likely to see a shift in the economic geography of production with greater development in the lesser prosperous member countries.

VIII. CONCLUSION

The objective of this study was two-fold. First, the results of the Gravity model exhibited a good fit in explaining trade flows within CAFTA. Regarding the second objective, the results of the model proved that the CAFTA economies would have to map out policies and strategies to bring about convergence in their income levels should maximum benefits be expected from the proposed Free Trade Area. This implication is derived from the Linder Hypothesis which holds that countries with similar demand patterns and therefore similar per capita income levels are likely to trade more with each other.

On the Multilateral Trading environment however, the model revealed a rather insignificant effect in terms of the potential trade creation that could result from the integration. Though trade diversion effects were not explicitly modelled for, the resulting unitary elasticity on the cost of trade distance variable gives a good indication of the inconsequential effect CAFTA would have on global trade by way of trade diversion.

In terms of policy implications the results of the model shows that the more developed CAFTA economies—Singapore, Malaysia, Thailand, and China—have a crucial role to play if integration is to benefit the less-developed economies of Cambodia, Laos, Myanmar, and Vietnam. Potential economic development opportunities exist for these lesser developed economies but this potential is not automatic and conscious effort would have to be made by the governments of the integrating area to ensure realisation of this potential. Differences in demand patterns would have to be alleviated and in the process the integrating area could achieve equalisation in factor prices. It is anticipated that attempts to achieve equalization in factor prices will ultimately have an effect on the economic geography of production and trade within the sub-region.

Despite the good fit exhibited by the model, some caution has to be exercised in the normative interpretation of the results, especially that pertaining to the cost of trade distance. This caution is warranted given the rather crude function used to proxy the cost of trade distance. This limitation, largely because of the lack of good data on trade transport cost, leaves unfilled a gap in the Gravity literature.

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