

Lugovskyy, Oleksandr; Skiba, Alexandre

**Working Paper**

## Effect of distance on trade under slope heterogeneity and cross-correlated effects

Economics Discussion Papers, No. 2014-30

**Provided in Cooperation with:**

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

*Suggested Citation:* Lugovskyy, Oleksandr; Skiba, Alexandre (2014) : Effect of distance on trade under slope heterogeneity and cross-correlated effects, Economics Discussion Papers, No. 2014-30, Kiel Institute for the World Economy (IfW), Kiel

This Version is available at:

<https://hdl.handle.net/10419/98833>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<http://creativecommons.org/licenses/by/3.0/>

**Discussion Paper**

No. 2014-30 | July 10, 2014 | <http://www.economics-ejournal.org/economics/discussionpapers/2014-30>

## **Effect of Distance on Trade under Slope Heterogeneity and Cross-Correlated Effects**

*Oleksandr Lugovskyy and Alexandre Skiba*

**Abstract**

The authors argue that endogeneity of transportation costs needs to be taken into account when estimating the effect of distance on trade. Otherwise, the estimates of the distance effect may be biased and inconsistent. Endogenous transportation can introduce slope heterogeneity and spatial correlation. Both issues can be accommodated with the help of Pesaran's cross-correlated effects mean-group (CCEMG) estimator. After applying this methodology, the authors uncover significant compression of the distance effect on trade starting from the middle of the 1990s. The trade-reducing effect of long distances becomes statistically indistinguishable from the effect of moderate distances. This compression is not present in the traditional fixed effects estimates. The authors hypothesize that such pattern may be reconciled by changes in shipping technology that disproportionately reduce transportation costs over long distances.

Published in Special Issue [Distance and Border Effects in Economics](#)

**JEL** F1 F6 R4

**Keywords** Gravity; distance effect; cross-correlated effects; mean group estimator; spatial correlation

**Authors**

*Oleksandr Lugovskyy*, University of Wisconsin - Eau Claire, Eau Claire, WI, USA

*Alexandre Skiba*, ✉ University of Wisconsin, Laramie, WY, USA, [askiba@uwyo.edu](mailto:askiba@uwyo.edu)

**Citation** Oleksandr Lugovskyy and Alexandre Skiba (2014). Effect of Distance on Trade under Slope Heterogeneity and Cross-Correlated Effects. Economics Discussion Papers, No 2014-30, Kiel Institute for the World Economy. <http://www.economics-ejournal.org/economics/discussionpapers/2014-30>

# 1 Introduction

Geographic distance significantly lowers volumes of trade between countries. While the exact reasons for this effect are not completely understood, it is commonly believed that distance lowers trade through the cost of transportation. The effect of distance on trade is commonly estimated using the gravity equation. Theoretical models of gravity, like the ones presented in Anderson and van Wincoop (2003), Chaney (2008), or Arkolakis et al. (2012), account for the effect of distance by assuming that geographic distance enters the model through the cost of transportation.<sup>1</sup> Consistent estimation of the distance effect on trade is most frequently done using a full set of importer and exporter fixed effects to allow for multi-lateral resistance to trade present in the above models. Fixed effects control for the multilateral resistance terms without the need to explicitly calculate them. Fixed effects estimators, however, are not necessarily consistent under slope heterogeneity and in the presence of spatial correlation. Pesaran (2006) proposed a CCEMG estimator that preserves consistency under slope heterogeneity and a wide range of possible cross-correlations. We argue that if distance affects trade through the cost of transportation, then slope heterogeneity and spatial cross-correlation are likely to exist in the gravity model. Consequently, Pesaran's CCEMG estimator could be used to obtain estimate consistently the effect of distance on trade.

One way to incorporate endogenous transportation sector is to explicitly include transportation sector into a structural model of trade and into the empirical specification. This is generally difficult to accomplish because international transportation involves multiple components including internal transportation, warehousing, loading and unloading in the ports or airports, and transportation between countries. Furthermore, the global trans-

---

<sup>1</sup>Notable exception is Chaney (2013) who offers explanation for gravity not based on the transportation cost of final goods but on the effect of distance on the formation of initial contacts between trading firms.

portation networks create a complex pattern of interdependence between multiple trade flows. An additional obstacle to such approach is data availability, the data on transportation costs and its components are not generally available. Instead, as an alternative to the structural treatment of the transportation cost, we suggest using estimation techniques that can produce consistent estimates of distance effect in the presence of the issues created by endogenous transportation sector.

First issue that is likely to arise in the presence of endogenous transportation costs is slope heterogeneity. Slope heterogeneity in the context of gravity equation means that the effect of distance on trade varies over exporters or importers. To see that slope heterogeneity is a likely outcome of endogenous transportation it is sufficient to note that transportation technology differs across countries. These differences are important because trade is affected by distance-related trade costs, not by the distance itself. Disdier and Head (2008) express a similar idea in reference to “structural” heterogeneity. Pomfret and Sourdin (2010) for example shows that the quality of country’s institutions has a significant effect on international cost of transportation. Carrère et al. (2013) analyze the differences in the effect of distance on trade by the income level. Blonigen and Wilson (2008) document differences in the port efficiency across ports in various countries. Takahashi (2006) and Kleinert and Spies (2011) study adoption of better transportation technology. Hummels et al. (2009) focus on market power in international shipping and show that the routes with more competition and routes involving developed countries have lower shipping costs. Skiba (2013) shows that the unit cost of shipping depend on the route volumes.

Endogenous transportation can also contribute to the presence of spatial correlation in the form of cross-correlated effects. As we show in the next section, Pesaran’s model can be interpreted to allow for cross-correlated effects that combine importer-specific common

factors and exporter-specific factor loadings.<sup>2</sup> Endogenous transportation fits naturally into this representation because transportation costs are affected by the features of both importer's and exporter's transportation technology. For example, quality of port infrastructure is country-specific and therefore would affect all trading partners. Furthermore, a country with port infrastructure to handle large container ships is more likely to trade with other countries that have similar technology. The role of internal transportation infrastructure is similarly important because internal infrastructure of both importer and exporter affect transportation costs between countries. For example, Cosar and Demir (2014) estimate the effect of internal transportation network on international trade for Turkey.

This paper is related to several important streams of literature in international trade. First, this paper relates to the vast literature on the estimation of the gravity model. Specifically, we contribute to the literature on estimation of bilateral trade costs by pointing out a specific bias that can arise in the fixed effects estimation when the bilateral trade barrier, such as transportation costs, is endogenous. The CCEMG estimator can be applied to the estimation of other factors affecting bilateral trade costs, like preferential trade agreements or currency unions. Second, we contribute to the empirical literature estimating the effect of distance on trade volume. For a thorough discussion of the findings in this literature, see discussion in Disdier and Head (2008), who analyze estimates of the distance effects from 103 studies. Third, we contribute to the literature on determinants of non-zero trade flows and other violations of the OLS assumptions in gravity models. See for example Silva and Tenreyro (2006), Helpman et al. (2008) and Eaton et al. (2012).

CCEMG estimator has been applied in international trade notably by Bertoli and Fernández-Huertas Moraga (2013) and Serlenga and Shin (2007) . Bertoli and Fernández-

---

<sup>2</sup>We could make a similar argument for exporter-specific common factors and importer-specific factor loadings.

Huertas Moraga (2013) focus on multilateral resistance to migration. They argue that migration between origin and destination countries does not solely depend on the attractiveness of the latter, but also on the opportunities to migrate to other destinations. They derive a model with an error term that coincides with Pesaran’s multifactor error structure to justify the use of the cross-correlated effects estimator. Serlenga and Shin (2007) combine Hausman and Taylor (1981) and Pesaran (2006) techniques to develop cross-correlated common effect pooled estimation approach. Using this approach to estimate gravity equation, Serlenga and Shin (2007) discover that the conventional approach results in the estimated effect of total GDP being too large, and that the distance and common border dummies are no longer significant.

The rest of the paper is organized as follows: section 2 represents gravity model in terms of multifactor structure, section 3 presents results of empirical estimation and section 4 concludes.

## 2 Multifactor representation of gravity model.

In this section we represent empirical gravity equation using multifactor model that explicitly allows for slope heterogeneity and cross-correlated errors. This representation helps us motivate the application of the CCEMG estimator to obtain consistent and unbiased estimates of the effect of distance on trade. Following Pesaran (2006), let  $T_{ij}$  be the natural logarithm of the trade flow from country  $i$  to country  $j$  divided by the product of the two countries’ GDPs. Further, let  $i = 1, 2, \dots, N_I$  and  $j = 1, 2, \dots, N_J$ , where  $N_I$  and  $N_J$  are total numbers of exporters and importers respectively. We focus on the cross-sectional estimates of distance effects where the two dimensions of data are importers and exporters. Therefore the  $ij$  indexing is more appropriate than the traditional  $it$  index used in panel

models. Now suppose the following linear heterogeneous slope panel<sup>3</sup> data model:

$$T_{ij} = \alpha_i^\top d_j + \beta_i^\top x_{ij} + u_{ij}, \quad (1)$$

where  $d_j$  is a vector of observed common effects (including intercepts),  $x_{ij}$  is a  $j^{\text{th}}$   $k \times 1$  vector of observed gravity regressors for exporter  $i$  and importer  $j$ . The measures of distance are included among the regressors. The errors have the following multifactor structure:

$$u_{ij} = \gamma_i^\top f_j + \epsilon_{ij}, \quad (2)$$

where  $f_j$  is a vector of unobserved effects common to all exporters  $i$  trading with the importer  $j$ ,  $\gamma_i$  is exporter-specific factor loading, and  $\epsilon_{ij}$  is the individual-specific error assumed to be distributed independently of  $(d_j, x_{ij})$ . Note that Pesaran (2006) also permits the unobserved factors  $f_j$  to correlate with  $(d_j, x_{ij})$  by adopting the following general model for the individual-specific regressors:

$$x_{ij} = A_i^\top d_j + \Gamma_i^\top f_j + v_{ij}, \quad (3)$$

where  $A_i$  and  $\Gamma_i$  are  $n \times k$  and  $m \times k$  factor loading matrices with fixed components and  $v_{ij}$  are the specific components of  $x_{ij}$  distributed independently of the common effects and across  $i$ , but assumed to follow general covariance stationary processes. See Pesaran (2006) for a more detailed description of the model and assumptions.

Notice that the model simplifies to a simple fixed effects specification, similar to Baltagi (2008), if the multifactor structure is dropped and beta is assumed to be identical for each exporter  $j$ . However, such assumptions may introduce bias or inconsistency. First note,

---

<sup>3</sup>We use the term “panel” even though one of the dimensions is not “time” but rather a set of countries.

that in equation (1),  $\beta$  has a subscript  $i$ , which indicates that each exporter is allowed to have its own parameter estimates. In other words, CCEMG permits countries to have different distance and contiguity effects. Ignoring the slope heterogeneity (as done by the fixed effects estimator) will likely result in biased estimates of the  $\beta$ . That is  $\hat{\beta}_{FE}$  estimator will not equal the expected value of the true  $\beta$ , but will rather be arbitrarily weighted and biased away from the true  $\beta$ . Following a setup similar to Juhl and Lugovskyy (2014) note that

$$\hat{\beta} = \sum_{i=1}^N \omega_i \hat{\beta}_i \quad (4)$$

where  $\omega_i$  is a weight is given by:

$$\omega_i = \left( \sum_{j=1}^N X_j^\top M_0 X_j \right)^{-1} \left( X_i^\top M_0 X_i \right), \quad (5)$$

while

$$M_0 = I_{N_J} - \frac{\iota_{N_J} \iota_{N_J}^\top}{N_J}, \quad (6)$$

is a matrix that de-means each group by subtracting exporter means from every variable. Hence,  $\hat{\beta}_{FE}$  is a weighted average of OLS coefficients for each exporter. However, this weighting is acceptable only in the case when  $\beta_i = \beta \quad \forall i$ , otherwise the groups with the highest intra-exporter variation  $X_i^\top M_0 X_i$  will be assigned the most weight. Since in practice exporter variances are rarely estimated, it is plausible to assume that in the presence of slope heterogeneity the fixed effect estimator produces parameter estimates that are biased (with the direction and magnitude of the bias unknown) and potentially even inconsistent. In other words,  $\hat{\beta}_{FE}$  estimator is not the expected value of the true  $\beta$ , but



rather arbitrarily weighted and biased away from the true  $\beta$ . Second, CCEMG allows for cross-sectional dependence, which if left unaccounted for, can lead to inefficiency (and therefore invalid inference) and in some cases inconsistency. The CCEMG estimator incorporates the possibility of individual (country) dependence by inducing the cross-sectional dependence, time-variant unobservables with heterogeneous impact across panel members as laid out in equations (1)-(3). As noted in Eberhardt (2011),  $\beta_i$  is unidentified if the regressor contains  $f_j$  (note that  $f_j$  are correlated with  $x_{ij}$ ). This is addressed by CCEMG in the following way. First, for each  $N_J$ , CCEMG procedure calculates  $\bar{T}_{.j} = \frac{1}{N_I} \sum_{i=1}^{N_I} T_{ij}$  and  $\bar{x}_{.j} = \frac{1}{N_I} \sum_{i=1}^{N_I} x_{ij}$ . Then, for each  $N_I$ , the following equation is estimated:

$$T_{ij} = \beta x_{ij} + \rho_1 \bar{T}_{.j} + \rho_2 \bar{x}_{.j} + w_{ij},$$

and finally the averages of the  $\hat{\beta}$ 's are calculated to obtain the CCEMG estimates. The cross-correlated effects are therefore "filtered out" when Pesaran's technique is used. While the FE estimator accounts for neither cross-importer correlated effects nor slope heterogeneity and can provide inconsistent parameter estimates.

### 3 Empirics

In this section we compare fixed effects and CCEMG estimates of the distance effect on trade. The CCEMG methodology precludes the use of both importer and exporter fixed effects simultaneously because the coefficients are estimated separately for each exporter across importers, or for each importer across exporters. Therefore, we separately control for exporter- and importer-specific effects using the fixed effects and CCEMG specifications. Specification with the exporter exporter effects is given as:

$$\ln T_{ij} = \beta_1 \ln D_{ij} + \beta_2 \ln \left( \frac{\text{GDP}_j}{\text{POP}_j} \right) + \beta_3 C_{ij} + \beta_4 \ln R_j + u_{ij}, \quad (7)$$

where  $i$  indexes exporters and  $j$  indexes importers ;  $T_{ij}$  is calculated to restrict coefficients on the exporter and importer GDP to one as

$$T_{ij} = \frac{\text{Trade}_{ij}}{\text{GDP}_i \times \text{GDP}_j};$$

GDP and POP are correspondingly the GDP and population; R is remoteness, calculated as the GDP-weighted average of distances between countries as in Wei (1996); C is the contiguity dummy that equals one if countries  $i$  and  $j$  share a border;  $D_{ij}$  is a measure of distance. We measure distance in two different ways: first, as the natural logarithm of geographic distance; and second, as four intervals 1-4,000km, 4,000-7,800km, 7,800-14,000km, and >14,000 as in Baldwin and Harrigan (2011). The base interval is the shortest interval (1-4,000km). For the fixed effects estimation we assume that the error term in the above equation (7) is given by  $u_{ij} = \alpha_i + \epsilon_{ij}$  and for the CCEMG estimation the error term  $u_{ij}$  is defined in equation (2).

Note that the continuous measure of distance and intervals each offer distinct advantages. Estimating the effects of distance intervals does not produce a single “distance elasticity” of trade but instead allows a more flexible representation of the distance effect. Comparison of the estimated coefficients across the two measures is not always straightforward, a point presented in detail by Buch et al. (2004). Intuitively, if the effects of distance for all intervals increased by 10% the elasticity estimate would not necessarily change. In other words, distance elasticity measures how fast the volumes of trade decline with distance, but not necessarily what is the average level of that decline.

Since we cannot account for both importer and exporter effects simultaneously in CCEMG estimation, and since one could make a similar argument for slope heterogeneity and cross-correlation across exporter or importers, we also estimate the following equation with importer effects, instead of the exporter effects.

$$\ln T_{ij} = \beta_1 \ln D_{ij} + \beta_2 \ln \left( \frac{\text{GDP}_i}{\text{POP}_i} \right) + \beta_3 C_{ij} + \beta_4 \ln R_i + u_{ij}. \quad (8)$$

For the fixed effects estimation we assume that  $u_{ij} = \alpha_j + \epsilon_{ij}$ , and for the CCEMG estimation the error term  $u_{ij}$  is defined similarly to equation (2) with  $i$  and  $j$  interchanged.

We estimate equations (7) and (8) using gravity data publicly available from CEPII and described in Head et al. (2010). The data contain trade flows, GDPs, populations, distances, and common border variables for the period of 1980-2004. We keep only observations where trade volume is at least \$10,000. Estimating sample includes exporters with at least 50 destinations.<sup>4</sup> The estimates are obtained using `xtmg` procedure described in Eberhardt (2011). The base category is the bilateral distance interval that is less than 4,000km. The results of estimation for 1990 and 2004 are presented in Tables 1 and 2. In both tables, column (1) presents estimates of gravity equation with full sets of importer and exporter fixed effects. Columns (2) and (3) present estimates of equation (7) and columns (4) and (5) represent estimates of equation (8). Panels A and B differ with respect to the measure of distance.

CCEMG distance elasticities in columns (4) and (5) of Panel A are larger in absolute values than the fixed effects elasticities in columns (2) and (3) suggesting that trade is more elastic with respect to distance than the fixed effects estimators imply. The coefficients on distance intervals in Panel B show the effect of increasing distance relative to the base

---

<sup>4</sup>The results are qualitatively similar for other thresholds but the annual estimates become more volatile for the smaller thresholds because the CCEMG estimates are calculated as averages and are affected by outliers.

interval. For example, based on the estimates of column (3) in Panel B of Table 1, country pairs with bilateral distance in the 4,000-7,800km interval trade  $(1 - \exp(-1.399)) = 75.3\%$  less than the countries located within 1-4,000km from each other. Similarly, countries located within 4,000-7,800km interval trade  $(1 - \exp(-2.074)) = 87.4\%$  less than country pairs within the first distance interval. Panel B shows that the CCEMG estimates of the effects of distance intervals are generally smaller in absolute value than the fixed effects estimates. There is no contradiction between this difference and the difference between fixed effects and CCEMG estimates in Panel A. This is because the distance elasticity of trade does not take into account the level of the effect of distance on trade. That is, a proportionate increase in trade over all distances can leave elasticity unchanged. This point was made by Buch et al. (2004). In other words, taken together evidence from Panels A and B suggests that according to the CCEMG estimates, distance has a weaker negative overall effect on the level of trade at all distance levels, but trade volumes drop more precipitously with distance.<sup>5</sup>

An interesting and novel finding emerges when we consider the effect of distance intervals on trade over time. Figures 1 and 2 represent changes in the effect of distance intervals over time. Figure 1 plots coefficients like the ones shown for 1990 and 2004 in columns (2) and (3) of Panel B in Tables 1 and 2, while Figure 2 plots coefficients shown in columns (4) and (5) of Tables 1 and 2. There is no substantial difference over time in the fixed effect estimators. There is, however, a clear pattern in the change of the CCEMG estimates of the distance effect. There is a significant compression of the distance effect starting from the middle of 1990s. After 1995 the effect of the second (4,000-7,800km) interval continues to hover around historical average around  $-1.3$  and  $-1.6$  but the effect

---

<sup>5</sup>Unfortunately, we cannot distinguish how much of the difference between the specification with double fixed effects, shown in column (1), and CCEMG estimates, shown in columns (3) and (5), is due to mismeasurement of the multilateral resistance term.

of the next two intervals (7,800-14,000km and >14,000km) becomes weaker and practically indistinguishable from one another.<sup>6</sup> This suggest a significant compression of the effect of distance starting with the second half of the 1990s.

Such pattern of compression means that especially long distances become less of a barrier to trade over time. This is true about the absolute magnitude and also about the magnitude relative to the effect of shorter distances on trade. If the effect of distance works through transportation costs, such compression can be a result of change in transportation technology where the cost of shipping declines disproportionately more for the long distances. One example of such technological change can be the increase in the size of container ships. A larger container ship does not only lower the average cost of shipping a container but also lowers the cost of shipping cargo over longer distances. Change in the transportation technology obviously is not the only explanation for the observed pattern of changing effect of distance, but its one consistent with the view that distance affects trade volume through transportation costs.

## 4 Conclusions

The results of this paper provide an additional argument for the importance of better understanding of the effect of distance on trade. We show that estimates of distance effect based on the CCEMG methodology are substantially different from the traditional fixed effects estimators of distance effect on trade. Based on the estimates with distance intervals, we document a significant compression of the distance effect on trade volume starting from the middle of the 1990s. An increase in distance between an importer and an exporter from 1-4,000km to 4,000-7,800km reduces trade at consistent levels during the

---

<sup>6</sup>We cannot reject the null of no difference in effects. In order to test this hypothesis we re-estimate the coefficients of CCEMG specifications with the 7,800-14,000km to evaluate statistical significance of the dummy for >14,000km interval.

period of 1980-2004, but the effects of the two longer distance intervals (7,800-14,000km and >14,000km) become weaker and virtually indistinguishable starting from the middle of the 1990s. One important caveat to our finding is that the CCEMG methodology is not directly comparable to the double fixed effects estimators because coefficients are estimated for each exporter (importer) separately and therefore importer (exporter) fixed effects would be collinear with distance. Our results should not be interpreted as evidence of the role of transportation in determining the distance effect. We are merely suggesting that such possibility exists and therefore needs to be acknowledged and accounted for in estimation.

## References

- Anderson, J. E. and van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93(1):170–192.
- Arkolakis, C., Costinot, A., and Rodriguez-Clare, A. (2012). New trade models, same old gains? *American Economic Review*, 102(1):94–130.
- Baldwin, R. and Harrigan, J. (2011). Zeros, quality, and space: Trade theory and trade evidence. *American Economic Journal: Microeconomics*, 3(2):60–88.
- Baltagi, B. H. (2008). *Econometric Analysis of Panel Data*. Wiley.
- Bertoli, S. and Fernández-Huertas Moraga, J. (2013). Multilateral resistance to migration. *Journal of Development Economics*, 102:79–100.
- Blonigen, B. A. and Wilson, W. W. (2008). Port Efficiency and Trade Flows. *Review of International Economics*, 16(1):21–36.
- Buch, C. M., Kleinert, J., and Toubal, F. (2004). The distance puzzle: on the interpretation of the distance coefficient in gravity equations. *Economics Letters*, 83(3):293–298.
- Carrère, C., de Melo, J., and Wilson, J. (2013). The Distance Puzzle And Low-Income Countries: An Update. *Journal of Economic Surveys*, 27(4):717–742.
- Chaney, T. (2008). Distorted gravity: The intensive and extensive margins of international trade. *American Economic Review*, 98(4):1707–21.
- Chaney, T. (2013). The gravity equation in international trade: An explanation. Working Paper 19285, National Bureau of Economic Research.

- Cosar, A. K. and Demir, B. (2014). Domestic Road Infrastructure and International Trade: Evidence from Turkey. Koç University-TUSIAD Economic Research Forum Working Papers 1406, Koc University-TUSIAD Economic Research Forum.
- Disdier, A.-C. and Head, K. (2008). The puzzling persistence of the distance effect on bilateral trade. *The Review of Economics and Statistics*, 90(1):37–48.
- Eaton, J., Kortum, S. S., and Sotelo, S. (2012). International Trade: Linking Micro and Macro. NBER Working Papers 17864, National Bureau of Economic Research, Inc.
- Eberhardt, M. (2011). Xtmg: Stata module to estimate panel time series models with heterogeneous slopes. Statistical Software Components, Boston College Department of Economics.
- Hausman, J. A. and Taylor, W. E. (1981). Panel Data and Unobservable Individual Effects. *Journal of Econometrics*, 16.
- Head, K., Mayer, T., and Ries, J. (2010). The erosion of colonial trade linkages after independence. *Journal of International Economics*, 81(1):1–14.
- Helpman, E., Melitz, M., and Rubinstein, Y. (2008). Estimating Trade Flows: Trading Partners and Trading Volumes. *The Quarterly Journal of Economics*, 123(2):441–487.
- Hummels, D., Lugovskyy, V., and Skiba, A. (2009). The trade reducing effects of market power in international shipping. *Journal of Development Economics*, 89(1):84–97.
- Juhl, T. P. and Lugovskyy, O. V. (2014). A test for slope heterogeneity. *Econometric Reviews*, Forthcoming.
- Kleinert, J. and Spies, J. (2011). Endogenous Transport Costs in International Trade. IAW Discussion Papers 74, Institut für Angewandte Wirtschaftsforschung (IAW).



- Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74(4):967–1012.
- Pomfret, R. and Sourdin, P. (2010). Why do trade costs vary? *Review of World Economics*, 146(4):709–730.
- Serlenga, L. and Shin, Y. (2007). Gravity models of intra-eu trade: application of the ccept-ht estimation in heterogeneous panels with unobserved common time-specific factors. *Journal of applied econometrics*, 22(2):361–381.
- Silva, J. M. C. S. and Tenreyro, S. (2006). The Log of Gravity. *The Review of Economics and Statistics*, 88(4):641–658.
- Skiba, A. (2013). Regional Economies of Scale and Regional Welfare. Technical report, University of Wyoming, Mimeo.
- Takahashi, T. (2006). Economic geography and endogenous determination of transport technology. *Journal of Urban Economics*, 60(3):498–518.
- Wei, S.-J. (1996). Intra-national versus international trade: How stubborn are nations in global integration? Working Paper 5531, National Bureau of Economic Research.

Table 1. Effect of distance on trade.  
(comparison table for 1990)

Specification	(1) Double FE	(2) Exporter- FE	(3) Exporter- CCEMG	(4) Importer- FE	(5) Importer- CCEMG
Panel A					
Distance, log	-1.558 (0.071)**	-1.570 (0.077)**	-1.941 (0.088)**	-1.445 (0.028)**	-1.792 (0.059)**
Contiguity	0.149 (0.170)	0.118 (0.197)	-0.161 (0.120)	0.242 (0.143)+	0.011 (0.109)
GDP per capita		-0.016 (0.026)	0.002 (0.029)	0.365 (0.015)**	-0.010 (0.023)
Remoteness		1.275 (0.202)**	-0.476 (0.279)+	1.414 (0.099)**	0.037 (0.171)
$R^2$	0.49	0.34		0.33	
<i>N.obs</i>	5,526	7,927	7,927	7,446	7,446
Panel B					
Distance interval:					
4,000-7,800km	-1.708 (0.105)**	-1.626 (0.109)**	-1.399 (0.128)**	-1.698 (0.066)**	-1.581 (0.133)**
7,800-14,000km	-2.416 (0.129)**	-2.449 (0.128)**	-2.074 (0.191)**	-2.144 (0.064)**	-2.275 (0.155)**
>14,000km	-3.263 (0.173)**	-3.163 (0.173)**	-2.203 (0.332)**	-2.752 (0.096)**	-2.696 (0.238)**
Contiguity	1.438 (0.177)**	1.391 (0.219)**	0.979 (0.139)**	1.496 (0.148)**	0.992 (0.133)**
GDP per capita		-0.003 (0.029)	0.002 (0.033)	0.358 (0.016)**	0.005 (0.030)
Remoteness		1.007 (0.191)**	-0.520 (0.356)	1.078 (0.107)**	-0.268 (0.236)
$R^2$	0.38	0.24		0.23	
<i>N.obs</i>	5,526	7,927	7,927	7,446	7,446

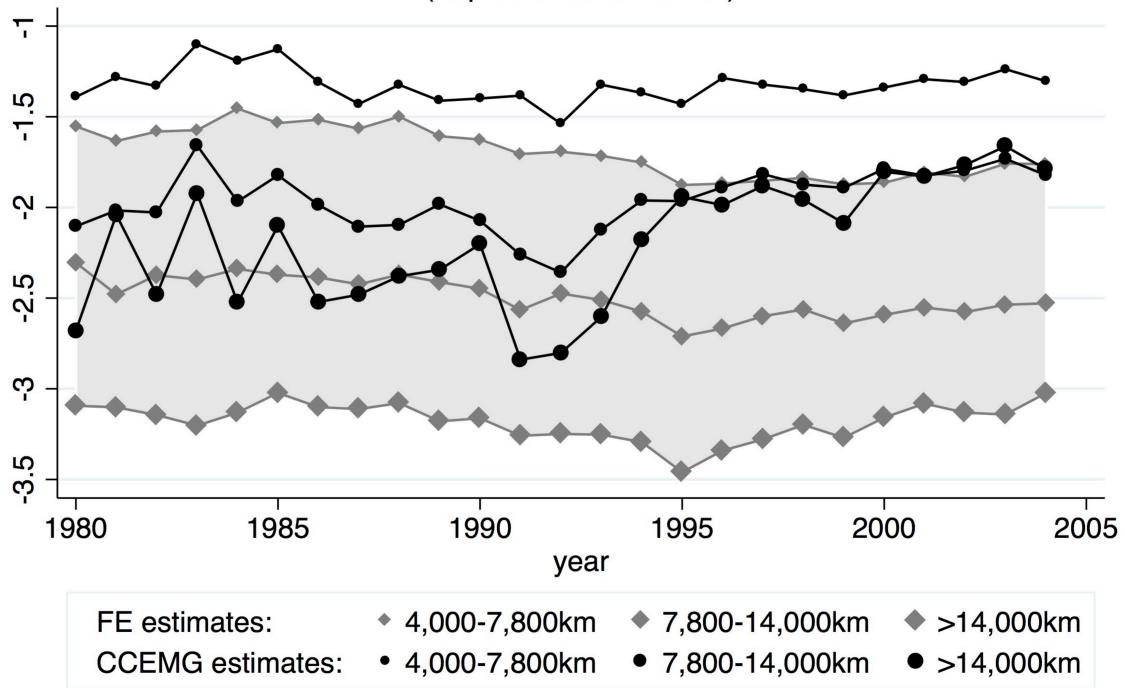
Notes: Standard errors are shown below the coefficients. Significance levels denoted by +, \*, \*\* correspond to 10%, 5%, and 1%. Dependent variable is the natural logarithm of trade scaled by the product of importer and exporter GDPs. Reference category is distance below 4000km. GDP per capita and Remoteness are in logarithms. Remoteness is the GDP-share weighted distance to trading partners. GDP per capita and Remoteness corresponds to the importer in the specifications with the exporter fixed effects and to the exporter in the specification with the importer fixed effects.

Table 2. Effect of distance on trade.  
(comparison table for 2004)

Specification	(1) Double FE	(2) Exporter- FE	(3) Exporter- CCEMG	(4) Importer- FE	(5) Importer- CCEMG
Panel A					
Distance, log	-1.669 (0.054)**	-1.652 (0.060)**	-1.803 (0.074)**	-1.476 (0.021)**	-1.754 (0.055)**
Contiguity	0.919 (0.131)**	0.745 (0.132)**	0.429 (0.097)**	1.030 (0.098)**	0.518 (0.095)**
GDP per capita		-0.090 (0.021)**	-0.011 (0.019)	0.257 (0.010)**	-0.032 (0.018)+
Remoteness		1.312 (0.155)**	-0.604 (0.196)**	1.717 (0.069)**	-0.003 (0.157)
$R^2$	0.48	0.37		0.30	
$N.obs$	15,637	16,157	16,157	16,793	16,793
Panel B					
Distance interval:					
4,000-7,800km	-1.857 (0.085)**	-1.760 (0.090)**	-1.304 (0.091)**	-1.719 (0.041)**	-1.404 (0.076)**
7,800-14,000km	-2.560 (0.097)**	-2.529 (0.111)**	-1.822 (0.127)**	-2.215 (0.043)**	-1.784 (0.110)**
>14,000km	-3.059 (0.122)**	-3.024 (0.144)**	-1.789 (0.197)**	-2.539 (0.069)**	-1.482 (0.209)**
Contiguity	2.459 (0.135)**	2.272 (0.138)**	1.769 (0.118)**	2.388 (0.097)**	1.725 (0.119)**
GDP per capita		-0.098 (0.023)**	0.022 (0.021)	0.237 (0.010)**	-0.028 (0.022)
Remoteness		0.822 (0.166)**	-0.341 (0.266)	1.187 (0.074)**	0.079 (0.240)
$R^2$	0.40	0.29		0.23	
$N.obs$	15,637	16,157	16,157	16,793	16,793

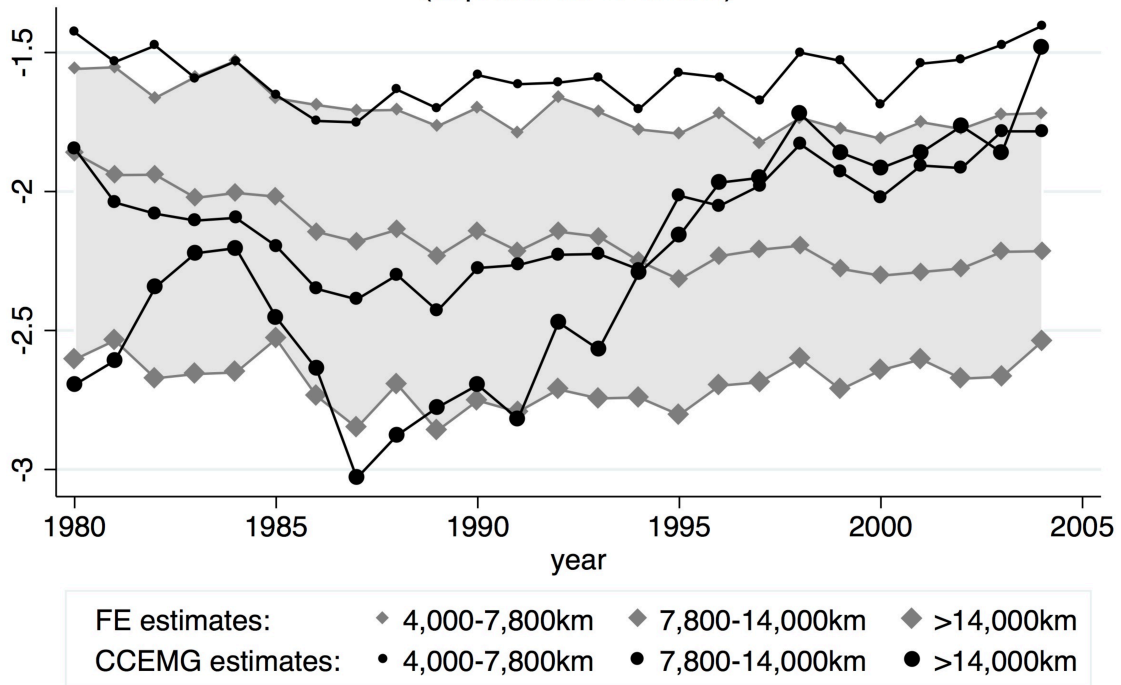
Notes: Standard errors are shown below the coefficients. Significance levels denoted by +, \*, \*\* correspond to 10%, 5%, and 1%. Dependent variable is the natural logarithm of trade scaled by the product of importer and exporter GDPs. Reference category is distance below 4000km. GDP per capita and Remoteness are in logarithms. Remoteness is the GDP-share weighted distance to trading partners. GDP per capita and Remoteness corresponds to the importer in the specifications with the exporter fixed effects and to the exporter in the specification with the importer fixed effects.

Figure 1. Effect of distance intervals on trade  
(exporter fixed effects)



Notes: We keep only observations with at least \$10,000 in trade. Estimating sample includes exporters with at least 50 destinations. The base category is the bilateral distance interval that is less than 4,000km.

Figure 2. Effect of distance intervals on trade  
(importer fixed effects)



Notes: We keep only observations with at least \$10,000 in trade. Estimating sample includes exporters with at least 50 destinations. The base category is the bilateral distance interval that is less than 4,000km.

Please note:

You are most sincerely encouraged to participate in the open assessment of this discussion paper. You can do so by either recommending the paper or by posting your comments.

Please go to:

<http://www.economics-ejournal.org/economics/discussionpapers/2014-30>

The Editor