E C O N O M I C S   B U L L E T I N

HETEROGENEITY IN TRADE COSTS

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Abstract

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Key Words: trade costs, heterogeneity, distance, gravity equation.
JEL Classification: F10, F14, O52, R12.

1. INTRODUCTION

There is strong evidence on the impact of trade costs (TCs) on international trade (Anderson and van Wincoop, 2004, AvW henceforth) and on the location of production facilities. In the economic geography literature, pecuniary spillovers trigger a "circular causation" process leading to the endogenous formation of a richer industrial core and a poorer agricultural periphery (Krugman, 1991); agglomeration deepens as transportation costs decline. Other causes of agglomeration are cost and demand linkages (Venables, 1996) and innovation (Martin and Ottaviano, 2001). There is historical evidence that economic growth is associated with rapid urbanization, spatial disparities and rising income inequality (Kuznets, 1966). Spatial disparities are also evident today in fast growing emerging economies. The posited negative correlation between development and TCs is the natural extension of the core-periphery model when more cores and more peripheries are considered, that is when there is provincial heterogeneity.

To test our hypothesis, we proxy TCs with distance. In general, TCs rise with distance because of transportation costs. Consequently, close countries tend to trade more than distant countries. However, there is more than transportation in distance. Common language (Helliwell, 1999; Hutchinson, 2002), common colonial roots (Rauch 1999), shared religion (Kang and Fratianni, 2006), immigrant links to the home country (Gould, 1994; Head and Ries, 1998) or more generally ethnic networks (Rauch and Trindade, 2001), and similarity in economic development (Fratianni and Kang, 2006) are trade-enhancing characteristics that counteract transportation costs. Beyond culture, cross-border trade is influenced by institutions such as regional trade agreements (Carrère, 2006; Baier and Bergstrand, 2007) and common money (Rose, 2000; Rose and van Wincoop, 2001; Frankel and Rose, 2002). Last but not least, national borders are a big impediment to trade (McCallum, 1995; Helliwell, 1998; Anderson and van Wincoop, 2003; Chen, 2004). Using standard trade-enhancing factors to control cultural and institutional factors, we test our hypothesis with provincial export data from Italy. It is a country known for its North-South divide that goes back to the very beginning of the nation and persists to these days despite large government transfers to the South (Lutz, 1962; Bagnasco, 1977; Becattini, 2007). Because of high heterogeneity in economic development, Italy is a natural candidate for our purpose.

Our research strategy is to estimate gravity equations (GE) using bilateral trade between 103 Italian provinces and partner countries imposing the strong assumption that each province is distinctive only in its degree of economic development. The implication is that the elasticity of exports with respect to provincial TCs (simply, TC elasticity), our measure of TCs, is negatively related to provincial per-capita income, our synthetic measure of economic development. In Section II, we discuss the general form of GE in the presence of multilateral TCs. In Section III, we formulate the model. Section IV is devoted to data. Findings are analyzed in Section V. Conclusions are drawn in the last section.

2. THE GRAVITY EQUATION AND MULTILATERAL TRADE COSTS

In a well-known paper, McCallum (1995) applied a GE to 1988 exports and imports among ten Canadian provinces and thirty U.S. states and found that inter-provincial trade was approximately twenty times larger than trade between provinces and states; in essence, the US-Canadian border is very thick.

AvW (2003) criticized McCallum's findings mostly for ignoring multilateral TCs. They argue that general-equilibrium considerations dictate that trade flows from region i to region j depend, among other factors, not only on bilateral TCs but also on multilateral ones.[1] When multilateral costs rise relative to bilateral costs, trade flows rise between i and j. These authors derive the following operational GE (see their equation 13):

$$x_{ij} = \frac{y_i \cdot y_j}{y^W} \left(\frac{t_{ij}}{P_i \cdot P_j} \right)^{1-\sigma} , \qquad (1)$$

where x = exports from i to j, y = nominal income, t = bilateral TC factor, P = multilateral TC factor (i.e., consumer price index), σ = elasticity of substitution among goods, and i, j, and W indicate, respectively, exporter country, importer country and the world. Assuming that t_{ij} is a function of bilateral distance and one plus the tariff-equivalent bilateral border barrier, AvW estimate with nonlinear least squares a simultaneous system of equations on cross-section data. Their main result is that borders reduce trade in the range of 20 to 50 percent, that is much less than the border found by McCallum.

The AvW estimation procedure is rather cumbersome and other authors have sought simpler alternatives. Baier and Bergstrand (2007), using cross-section data, obtain virtually identical results with *bonus vetus* (good old) OLS using a first-order log-linear Taylor series expansion to approximate multilateral resistance with appropriate exogenous variables captured by country fixed effects (FE henceforth). Egger (2000) proposes for panel data a three-way FE: importer country, exporter country, and time. Baldwin and Taglioni (2006) take a broader look at the issue and identify three estimation errors with GEs, stemming primarily from multilateral trade factors. To each error the authors assign prizes in the form of Olympic medals. The bronze medal goes for using real GDPs, as opposed to nominal GDPs. The multilateral trade factors are not well identified and the model errors fail to be orthogonal to the regressors, with the consequence that the OLS estimator is asymptotically downward biased.[2] The silver medal, assigned for a more serious error, goes for employing two-way bilateral trade. Since the GE is a modified expenditure function with a market-clearing condition, the theory explains only one-way bilateral trade and not two-way trade. This error leads to an overestimate of bilateral trade and larger error variance, which is particularly severe in panel data. Finally, the gold medal goes for omitting altogether the multilateral resistance factor. Following Rose and van Wincoop (2001), Feenstra (2003), and Cheng and Wall (2003), Baldwin and Taglioni propose country dummies in cross-section data and country-pair FE in panel data to solve the gold medal error. However, country-pair dummies are time-invariant and consequently can only in part resolve the gold medal error; serial correlation remains. It should be added that pair dummies capture all FE, including distance elasticity, making it impossible to distinguish among parameters of various time-invariant variables.

The alternative is provided by Carrère (2006) who shows the merit of modelling pair dummies as random effects (RE henceforth). In sum, with pair RE we can estimate the impact of distance on trade and avoid receiving the gold medal.

[1] The immediate predecessor of Anderson and van Wincoop is Anderson (1979). Other theoretical foundations of GE are provided by Bergstrand (1985, 1989), Deardorff (1998), Helpman (1987), and Haveman and Hummels (2004).

[2] Other problems arise also from differences among price deflators (traded and non-traded goods) and price indices of traded goods.

3. GRAVITY EQUATION MODEL

Our strategy goes as follows. Distance elasticity is estimated directly for each of the 103 Italian provinces using a GE. In addition, border elasticity is estimated to be the same for those provinces that are adjacent to foreign countries. The sum of distance and border elasticities defines province-specific TC elasticity, which is then correlated with provincial per-capita income to see whether there is an inverse relationship between TCs and economic development. The other factors are common to all provinces.

Define TCs of the i^{th} Italian province to the j^{th} country as follows (for similar specification, see Carrère (2006)):

$$t_{ijt} = d_{ij}^{\rho_0} \cdot e^{[\rho_1 RTA_{jt} + \rho_2 InterRTA_{jt} + \rho_3 MONEY_{jt} + \rho_4 BORDER_{ij}]}, \qquad (2)$$

where d_{ij} is bilateral distance, *RTA* (*InterRTA*) is a dummy that assumes 1 when *i* and *j* belong to the same (different) regional trade agreement, *MONEY* and *BORDER* are dummies that assume 1 when *i* and *j* share the same money or a land border. Institutional and cultural factors such as common language, colonial relationships and immigrant links are irrelevant and have been omitted.[3] *RTA*, *InterRTA*, and *MONEY* are relevant but are common to all provinces; hence, we drop subscript *i*. *BORDER* is also relevant but affects only some Northern provinces; hence, subscript *i* has been retained while *t* has been dropped because this variable is time-invariant over the period. As to the signs of the coefficients, ρ_0 is positive and ρ_3 and ρ_4 are negative. The signs of ρ_1 and ρ_2, instead, depend on whether the RTA is trade creating or trade diverting. If the RTA is trade creating, both ρ_1 and ρ_2 are negative; if the RTA is trade diverting ρ_1 is negative but ρ_2 is positive (Carrère, 2006).

Substituting (2) in (1) we obtain a testable GE that is similar to AvW's (2003) equation 19:

$$\ln x_{ijt} = A + \ln y_{it} + \ln y_{jt} + (1-\sigma)\rho_0 \ln d_{ij} + \sum_{f=1}^{4} (1-\sigma)\rho_f Z_{f,ijt} + u_{ijt}, \qquad (3)$$

where $A = \ln\left(y_t^W P_{it}^{1-\sigma} P_{jt}^{1-\sigma}\right)$ is the multilateral TC factor and Z_f is the set of three TCs that are common to all provinces plus one TC that is common to Northern provinces adjacent to other countries (Z_1=*RTA*, Z_2=*InterRTA*, Z_3=*MONEY* and Z_4=*BORDER*). Province-sensitive distance elasticity $\beta_0 = (1-\sigma)\rho_0$ is negative since the elasticity of substitution σ is larger than unity; the four semi-elasticities $\beta_f = (1-\sigma)\rho_f$ are positive, except for $\beta_2 < 0$ when the RTA is trade diverting; $u_{ijt} = \mu_t + \varepsilon_{ijt}$, where μ_t is a year dummy and ε_{ijt} is an idiosyncratic error.

We modify general specification (3) replacing distance on the right-hand side with the interaction of distance with provincial dummies as follows:

$$\ln x_{ijt} = A + \ln y_{it} + \ln y_{jt} + \sum_{i=1}^{I} \beta_{0,i}\delta(i) \ln d_{ij} + \sum_{f=1}^{4} \beta_f Z_{f,ijt} + u_{ijt}, \qquad (4)$$

where *I* is the number of provinces and *δ(i)* is a province dummy. Province-specific TC elasticities are:

[3] Italian, as the majority's language, is only spoken in Italy. Catholicism is the prevalent religion. Colonial relationships with former colonies Libya, Somalia and Eritrea were too short lived to be of any relevance. Emigrants' relationships are primarily with the home country. Furthermore, these relationships have diminished over time and are captured in our model by country fixed effects.

$$\beta_{S,i} = \beta_{0,i} + \beta_{4,i} * \overline{BORDER}_{ij} , \quad (5)$$

where $\overline{BORDER}_{ij}$ is the frequency of common-land border trade in total trade of province ***i***. Mean-adjusted $\beta_{S,i}$ are then regressed on average per-capita income of province *i*, Y_i/N_i, to see whether they are an increasing function of economic development:

$$\beta_{S,i} - \overline{\beta}_{S,i} = a + b \cdot \frac{Y_i}{N_i} \quad (6)$$

$$b > 0 . \quad \text{(HYP)}$$

Our methodology is closer to the "*bonus vetus OLS*" of Baier and Bergrstrand than to the nonlinear least square estimation of AvW. However, we avoid receiving any medals in the Baldwin-Taglioni mistake race. With respect to the gold medal, we control for multilateral resistance using (a) two-way FE, (b) province-country pair RE and (c) combined procedure of two-way FE and province-country pair RE. In each case we add year dummies.

Method (a) is a two-way FE including importer country and year dummies. Egger (2000) proposes a three-way FE model, where the third FE is the exporter country dummy. We cannot implement a three-way FE model because the provincial FE are collinear with the interacting variable between distance and province. Method (b) applies specific effects to province-country pairs but not to individual exporter and importer countries. We use RE to model pair specific effects to avoid their collinearity with distance (Carrère 2006). In the last method, we combine (a) and (b). Our method (c) encompasses all time-invariant multilateral resistance factors. Method (b) captures the bulk of specific effects, and thus is less consistent than (c). Both (b) and (c) are based on the assumption that province-country pairs behave randomly and thus permit us to estimate distance coefficients for each of the 103 Italian provinces. Method (a) controls only for importer country FE; it is better than a pure OLS since the latter fails to control for all specific effects (Egger 2000). Moreover, we avoid also the silver medal because our dependent variable are exports and not two-way trade flows. Finally, we avoid the bronze medal because we employ nominal GDP instead of real GDP.

We test our hypothesis using estimated distance coefficients as dependent variable. We eliminate potential systematic biases by taking mean-adjusted values of the estimated coefficients. But we cannot avoid heteroskedasticity that is present in equation (6). Saxonhouse (1976) suggests to substitute (6) in (4) and to employ a feasible generalized least squares estimator on the resulting equation. Unfortunately, we cannot implement his procedure because of the strong correlation that exists between provincial per-capita income and provincial income.[4] This correlation increases the size of the standard errors and yields inefficient estimates of equation (6). Nonetheless, we are able to control for heteroskedasticity in equation (6) either by applying robust standard errors or a bootstrap method.

4. DATA

Our dataset consists of 130,321 observations covering 103 Italian provinces and 188 countries over the period 1995-2004. The data come from different sources. Annual exports by province and country are from the Italian National Institute of Statistics (ISTAT); they include all bilateral flows in excess of one euro recorded by custom offices. As already mentioned, we avoid the silver medal in the mistake race by considering only exports. On the other hand, we cannot avoid magnifying the

[4] Population is relatively stable in the Italian provinces over the sample period.

effects of vertical specialization (Hummels, Ishii and Yi, 2001). A bias is generated by re-exporting, which occurs when part of the intermediate production process is localized abroad. In these instances, export data overestimate the true but unknown value of exports (AvW, 2004). We eliminate sector "Ships and aircrafts, etc." because it lacks a specific destination and exports to politically undefined areas (e.g., Antarctica) or remote parts of a country (e.g., Denmark's Greenland). ISTAT is also the source of provincial population and income, the latter measured as the sum of value added in agriculture, industry and service except the public sector and financial services.

Country income and population come from the World Development Indicators 2007 (WDI) of the World Bank. We lose some records in merging the two datasets because of the mismatching between ISTAT export destination and WDI country definition (e.g., Timor-Leste). We lose records because income is not reported for some countries (e.g., Brunei and Cuba). These inevitable trimmings, however, are of little consequence for the final research outcome. Variable d_{ij} is measured as the kilometric geodesic distance between province *i*'s capital and country *j*'s capital. [5]

Data on provincial latitude and longitude are provided by the official sites of each province; data on capitals' latitude and longitude are from the *World Factbook* of the Central Intelligence Agency.

As to institutional factors, we define 11 separate RTAs, with year of entry and exit of each member.[6] Italy is a member of the European Union and when a province trades with a country that is a member of another RTA, the *InterRTA* dummy is equal to one. Information on common money, the euro, comes from the European Commission.

Table I presents descriptive statistics of our dataset. Average provincial income is \$11.3 billion (Panel A) vs. an average country income of \$168.3 billion (Panel B)[7]; 15.5 percent of Italian provinces have a common land border with foreign countries; 7.1 percent of provincial trade flows go to members of the European Union; 3.2 percent to countries that share the same currency (the euro); and 28 percent to countries affiliated with other RTAs. Panel C gives descriptive statistics in relation to aggregate provincial exports. Average incomes rise in Panel C because of the higher frequency of high-income areas, which tend to export more than low-income areas. The same occurs for the number of trade relations among RTA members as a proportion of maximum bilateral relations and for the share of common money countries. The incidence of common border loses relative to other institutional factors. Average distance is 5,231 km. Average provincial exports are \$19.5 billion. There is no selection bias because ISTAT reports all export values. Figure 1 shows that provincial exports have a profile consistent with a log-normal distribution. In the GE the normality of the dependent variable is critical because the estimations are basically OLS.

5. FINDINGS

Table II presents the results from GE estimations. Our panel estimates use a cluster correction for the province-country pair and robust standard errors. The former reduces potential pair serial correlation and the latter corrects for potential heteroschedasticity. Table III shows some statistical tests on the three methods. Under method (a), the likelihood ratio test reveals that the importer country FE provide significant explanatory power. The restriction that time FE are zero is rejected.

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[5] The applied formula is:

$$d_{ij} = r \cdot a\cos\left(\sin\left(\frac{\pi \cdot lat_i}{180}\right)\cdot\sin\left(\frac{\pi \cdot lat_j}{180}\right)+\cos\left(\frac{\pi \cdot lat_i}{180}\right)\cdot\cos\left(\frac{\pi \cdot lat_j}{180}\right)\cdot\cos\left(\frac{\pi \cdot lon_j}{180}\right)-\cos\left(\frac{\pi \cdot lon_i}{180}\right)\right),$$

where the average earth radius *r* is 6,371 km, *acos(x)* is the radian value of the arc-cosine of *x*, *i* is the province, *j* is the country, and *lat* and *lon* indicate respectively latitude and longitude. The maximum error between real and geodesic distance is less than 20 km.

[6] They are European Union, U.S-IS, NAFTA, CARICOM, PATCRA, ANZCERTA, CACM, MECOSUR, ASEAN, SPARTECA, and ANDEAN; see Oh (2006).

[7] The range from \$1.3 to \$154.8 billion for provinces and from \$ 0.041 to \$11,711.8 billion for country income (with respective standard deviations of \$15.8 and \$812.5 billion) indicates high income variability.

These findings are in line with Egger's (2000) results and are consistent with the two-way FE model. Under (b) and (c), we assume RE on province-country pairs. The Hausman (1978) specification tests to discriminate between FE and RE failed because of the high number of groups (16,629) in our sample. Instead, we relied on the Breusch-Pagan Lagrange Multiplier (1979, BPLM for short) tests, which reject the null hypothesis of zero-variance implied by the FE model in favor of the alternative RE model under both methods (see Table II). In other words, BPLM tests do not reject our assumption of province-country pair RE.

Provincial and country income elasticities have the expected signs and are statistically significant even if they are individually different from one, a result that is in contrast with theory but accords with much of the empirical literature; see table II. The *RTA* semi-elasticity is statistically positive in two out of the three methods but the size is very sensitive to the methodology.[8] The negative *InterRTA* semi-elasticity in two out of the three methods suggests trade diversion, but the size, like for the *RTA* coefficient, is very sensitive to the chosen methodology. The *MONEY* semi-elasticity is statistically positive but of low economic impact.[9] The *BORDER* semi-elasticity is statistically positive, stable through the different methods, and economically relevant.[10] The 103 distance elasticities interacting with provinces are all negative and statistically very significant, individually as well as jointly. The average distance elasticity is -1.268 under method (a), -1.037 under method (b), and -1.388 under method (c). Variability across provinces is high, ranging from a minimum of -1.738 for Cosenza, in the South, under method (c) to a maximum of -0.840 for Vercelli, in the North, under method (b). Clearly, there is more than transportation costs in distance. Finally, the regressions explain a great portion of the export variance and confirm the empirical robustness of the GE also at a highly (geographical) disaggregated level.

The impact of TCs on exports is the sum of distance, *BORDER*, *RTA*, *InterRTA*, and *MONEY* elasticities, with the last three being common to all Italian provinces. In our model, this impact for the northern province of Vercelli, using method (b), is the sum of its own distance elasticity, -0.840, its own *BORDER* elasticity, 0.0008, and the three common (to all provinces) elasticities that add up to 0.0565; that is, -0.7828. For the southern province of Cosenza, TC elasticity, using method (c), is the sum of its own distance elasticity, -1.738, plus the three common elasticities that add up to -0.2163; that is, -1.9543.[11] Naturally, in comparing provinces, the common TCs drop out and one is left with the sum of distance and border elasticities. Distance elasticity accounts, on average, for about 99 percent of province-specific TCs.

To test our main hypothesis, we regress mean-adjusted provincial TC elasticities on average provincial per-capita income. Estimated results are shown in Table IV. We correct for heteroskedasticity in equation (6) either with (i) robust standard errors or (ii) a bootstrap method. For the latter, we tried 100, 1,000, and 10,000 replications. We report only results from 1,000 replications. Standard errors are virtually the same under both (i) and (ii).

We show scatter plots in the [$\beta_{S,i}$ - $\overline{\beta}_{S,i}$, Y_i/N_i] space and fitted lines for each of the three methods in Figure 2. The fitted lines are positive and statistically very significant: provinces with lower (i.e., more negative) than average TC elasticities, such as Cosenza, are associated with lower per-capita income, while provinces with higher (i.e., less negative) than average TC elasticities,

[8] We recall that method (a) uses country fixed effects, method (b) country pair random effects, and method (c) country fixed effects and country pair random effects. All methods use year dummies.

[9] For example, the exponent of 0.061 (the estimated MONEY coefficient under method (c)) is 1.06, suggesting that common money raises exports by 6 percent. The effects of common money on trade reported by Rose (2000), Rose and van Wincoop (2001), and Frankel and Rose (2002) are much higher. There is a considerable controversy on this subject.

[10] For example, the exponent of 0.507 (the estimated BORDER coefficient under method (c)) means that a common border raises exports by 66 percent.

[11] For Cosenza, BORDER is zero and the RTA coefficient is not statistically different from zero.

such as Vercelli, are associated with higher per-capita income.[12] In essence, developing provinces face higher TCs than developed provinces.

In sum, the evidence supports our hypothesis that TCs and economic development are inversely related in Italy. Development patterns appear to be consistent with the main implications of agglomeration theory: developed and richer provinces occur more frequently in the industrial North than in the still developing South. These patterns are shown visually in Figure 3, where Italian provinces are coded according to the values of the estimated provincial TC elasticities. With few exceptions, provinces in the "First Italy" (North-West) and "Third Italy" (North-East and parts of the Center) face lower TCs than provinces in the developing South; these results are consistent with the message of the literature on heterogeneous regional economic development.

6. CONCLUSIONS

The key result of the paper is that economic development is associated with lower trade costs. Using different methods to control for multilateral resistance, we apply a gravity equation to exports from 103 Italian provinces to 188 countries over the period 1995-2004. In each method, we fail to reject our hypothesis that trade costs are inversely related to economic development. We have measured the impact of trade costs on exports as the sum of two province-specific elasticities, distance and border, and three other elasticities –*RTA*, *InterRTA*, and *MONEY*– that are common to all Italian provinces.

We contribute to the economic literature in two way: (i) we verify the robustness of the gravity equation for bilateral trade at the provincial level; (ii) we find trade costs to be heterogeneous within a country. In the future, we plan to explore possible asymmetries in "common" trade costs, the conjecture being that the effects of the European Union and of the euro are felt differently across Italian provinces.

[12] While the slope coefficients of the graphs appear low (ranging from 0.0194 to 0.0223), it should be remembered that we correlate a pure number like elasticity with a level variable like per-capita income.

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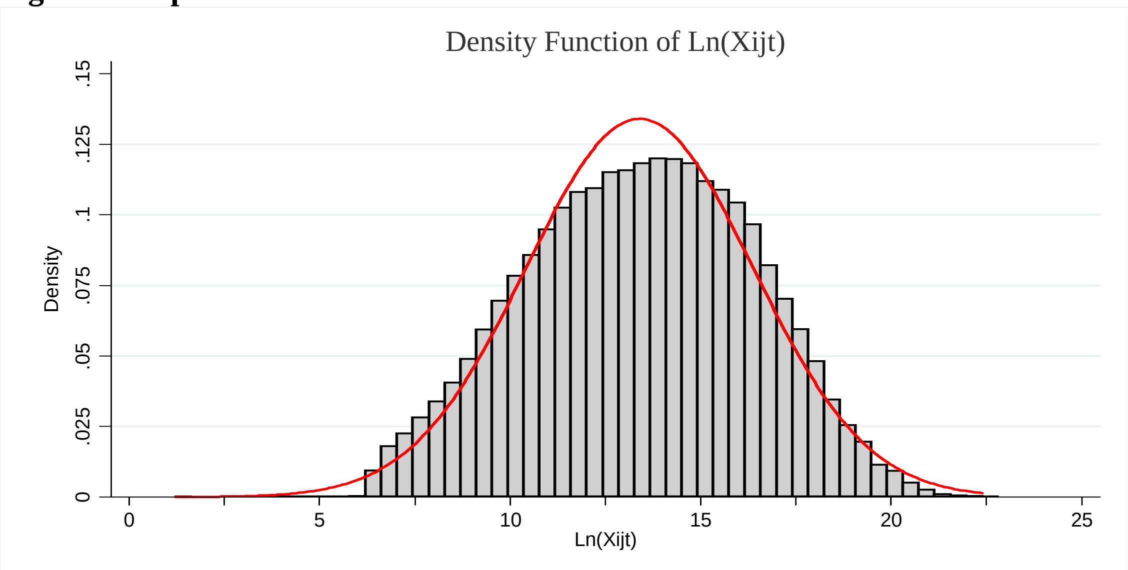
Table I: Descriptive Statistics (millions of US dollars for *Exports*, Y_i and Y_j)

	Mean	Median	Stand.Dev.	Min	Max
Panel A (N=103)					
Y_i	11,315.7	6,967.2	15,809.2	1,284.0	154,822.0
BORDER	0.155	0	0.362	0	1
Panel B (N=188)					
Y_j	168,332.7	8,089.5	812,480.3	40.8	11,711,833.7
RTA	0.071	0	0.257	0	1
Inter-RTA	0.280	0	0.449	0	1
MONEY	0.032	0	0.176	0	1
BORDER	0.022	0	0.147	0	1
Panel C (N=130,321)					
Exports	19.5	0.7	108.9	$3x10^{-6}$	5,238.2
Y_i	13,135.2	7,848.3	17,968,2	1,284.0	154,821.9
Y_j	238,517.9	18,672.6	965,930.3	40.8	11,711,833.7
Distance	5,231	4,444	3,862	69	18,932
RTA	0.104	0	0.305	0	1
Inter-RTA	0.232	0	0.422	0	1
MONEY	0.050	0	0.218	0	1
BORDER	0.001	0	0.036	0	1

Note: Panel A: statistics on provinces (i=103, j=1, t=10); Panel B: statistics on countries (i=1, j=188, t=10); Panel C: statistics on province-country (i=103, j=188, t=10).

Figure 1: Export distribution



Note: 130,321 observations. I=103, J=188, T=10.

Table II: Distance interacting with Provinces. Period 1995-2004 (N=130,321)

COEFFICIENT	(a)	(b)	(c)	COEFFICIENT	(a)	(b)	(c)
Year Dummies	Yes	Yes	Yes	d*Massa-Carrara	-1.082	-0.877	-1.214
Constant	-29.29	-31.79	-28.97	d*Matera	-1.310	-1.068	-1.424
$\ln(Y_i)$	1.465	1.364	1.457	d*Messina	-1.521	-1.256	-1.621
$\ln(Y_j)$	0.785	0.929	0.831	d*Milano	-1.235	-0.990	-1.368
BORDER	0.583	0.760	0.507	d*Modena	-1.093	-0.875	-1.229
RTA	1.083	0.166	-1.219	d*Napoli	-1.312	-1.077	-1.442
inter-RTA	-0.480	0.155	-0.399	d*Novara	-1.128	-0.918	-1.263
MONEY	0.061	0.065	0.061	d*Nuoro	-1.567	-1.297	-1.660
d*Agrigento	-1.628	-1.370	-1.731	d*Oristano	-1.510	-1.204	-1.569
d*Alessandria	-1.148	-0.936	-1.281	d*Padova	-1.158	-0.937	-1.291
d*Ancona	-1.147	-0.940	-1.287	d*Palermo	-1.541	-1.280	-1.643
d*Aosta	-1.327	-1.095	-1.440	d*Parma	-1.121	-0.910	-1.256
d*Arezzo	-1.142	-0.930	-1.274	d*Pavia	-1.153	-0.939	-1.286
d*Ascoli-Piceno	-1.179	-0.969	-1.316	d*Perugia	-1.279	-1.058	-1.408
d*Asti	-1.175	-0.957	-1.297	d*Pesaro	-1.146	-0.929	-1.275
d*Avellino	-1.296	-1.063	-1.411	d*Pescara	-1.275	-1.053	-1.398
d*Bari	-1.366	-1.135	-1.494	d*Piacenza	-1.117	-0.907	-1.248
d*Belluno	-1.135	-0.931	-1.275	d*Pisa	-1.183	-0.965	-1.312
d*Benevento	-1.547	-1.258	-1.621	d*Pistoia	-1.132	-0.922	-1.261
d*Bergamo	-1.167	-0.948	-1.306	d*Pordenone	-1.098	-0.886	-1.230
d*Biella	-1.159	-0.956	-1.296	d*Potenza	-1.390	-1.151	-1.504
d*Bologna	-1.164	-0.939	-1.296	d*Prato	-1.076	-0.876	-1.218
d*Bolzano	-1.404	-1.175	-1.529	d*Ragusa	-1.522	-1.269	-1.629
d*Brescia	-1.207	-0.987	-1.345	d*Ravenna	-1.159	-0.950	-1.294
d*Brindisi	-1.355	-1.109	-1.464	d*Reggio-Calabria	-1.551	-1.293	-1.648
d*Cagliari	-1.373	-1.126	-1.492	d*Reggio-Emilia	-1.077	-0.860	-1.210
d*Caltanisetta	-1.444	-1.185	-1.545	d*Rieti	-1.271	-1.016	-1.361
d*Campobasso	-1.341	-1.101	-1.449	d*Rimini	-1.236	-1.017	-1.363
d*Caserta	-1.292	-1.063	-1.415	d*Roma	-1.427	-1.181	-1.555
d*Catania	-1.463	-1.217	-1.574	d*Rovigo	-1.193	-0.968	-1.312
d*Catanzaro	-1.595	-1.311	-1.672	d*Salerno	-1.222	-0.998	-1.352
d*Chieti	-1.201	-0.977	-1.324	d*Sassari	-1.478	-1.239	-1.596
d*Como	-1.136	-0.921	-1.271	d*Savona	-1.284	-1.046	-1.397
d*Cosenza	-1.647	-1.373	-1.738	d*Siena	-1.131	-0.914	-1.254
d*Cremona	-1.186	-0.972	-1.319	d*Siracusa	-1.189	-0.952	-1.305
d*Crotone	-1.477	-1.218	-1.569	d*Sondrio	-1.269	-1.036	-1.386
d*Cuneo	-1.177	-0.959	-1.309	d*Taranto	-1.365	-1.123	-1.485
d*Enna	-1.525	-1.257	-1.617	d*Teramo	-1.164	-0.951	-1.293
d*Ferrara	-1.182	-0.965	-1.311	d*Terni	-1.217	-0.994	-1.338
d*Firenze	-1.222	-1.000	-1.356	d*Torino	-1.277	-1.049	-1.415
d*Foggia	-1.533	-1.272	-1.630	d*Trapani	-1.416	-1.168	-1.522
d*Forlì	-1.160	-0.946	-1.293	d*Trento	-1.277	-1.059	-1.409
d*Frosinone	-1.240	-1.009	-1.357	d*Treviso	-1.139	-0.915	-1.271
d*Genova	-1.251	-1.025	-1.382	d*Trieste	-1.204	-0.978	-1.326
d*Gorizia	-1.148	-0.930	-1.271	d*Udine	-1.196	-0.984	-1.335
d*Grosseto	-1.348	-1.093	-1.443	d*Varese	-1.132	-0.910	-1.264
d*Imperia	-1.352	-1.119	-1.468	d*Venezia	-1.229	-1.008	-1.363
d*Isernia	-1.121	-0.906	-1.250	d*Verbania	-1.280	-1.062	-1.406
d*LaSpezia	-1.220	-0.997	-1.339	d*Vercelli	-1.051	-0.840	-1.177
d*L'Aquila	-1.319	-1.082	-1.433	d*Verona	-1.176	-0.953	-1.307
d*Latina	-1.194	-0.973	-1.324	d*Vibo-Valentia	-1.488	-1.199	-1.550
d*Lecce	-1.386	-1.149	-1.502	d*Vicenza	-1.133	-0.910	-1.266
d*Lecco	-1.160	-0.950	-1.294	d*Viterbo	-1.289	-1.054	-1.400
d*Livorno	-1.235	-1.005	-1.354	Observations	130,321	130,321	130,321
d*Lodi	-1.222	-1.000	-1.345	Number of pair		16,629	16,629
d*Lucca	-1.135	-0.912	-1.258	R^2	0.776	0.724	0.774
d*Macerata	-1.167	-0.963	-1.307	F-test	480.4	76,148	129,281
d*Mantova	-1.130	-0.917	-1.264	Prob>F	0	0	0

NOTE: Robust standard errors: no-asterisk p<0.01; * p<0.05; ** p<0.1; *** p>0.1. Cluster correction on pairs. See text for (a), (b), (c) methods.

Table III: Some statistical tests on method (a), (b), and (c).

Test	Statistic	Degree of Freedom	P-value
	Method (a)		
LR-T[d] χ^2	435.60	9	0.00000
LR-M[e] χ^2	26,776.00	186	0.00000
	Method (b)		
BPLM Test[f]	135,176.00	1	0.00000
	Method (c)		
BPLM Test[f]	85,015.00	1	0.00000

(a): time FE and importer country FE.
(b): time FE and province-country pair RE.
(c): time FE, importer country FE, and province-country pair RE.
(d): Likelihood ratio test: importer country FE.
(e): Likelihood ratio test: time FE.
(f): Breusch-Pagan Lagrange Multiplier test for RE.

Figure 2: Relative distance elasticity and per capita provincial income

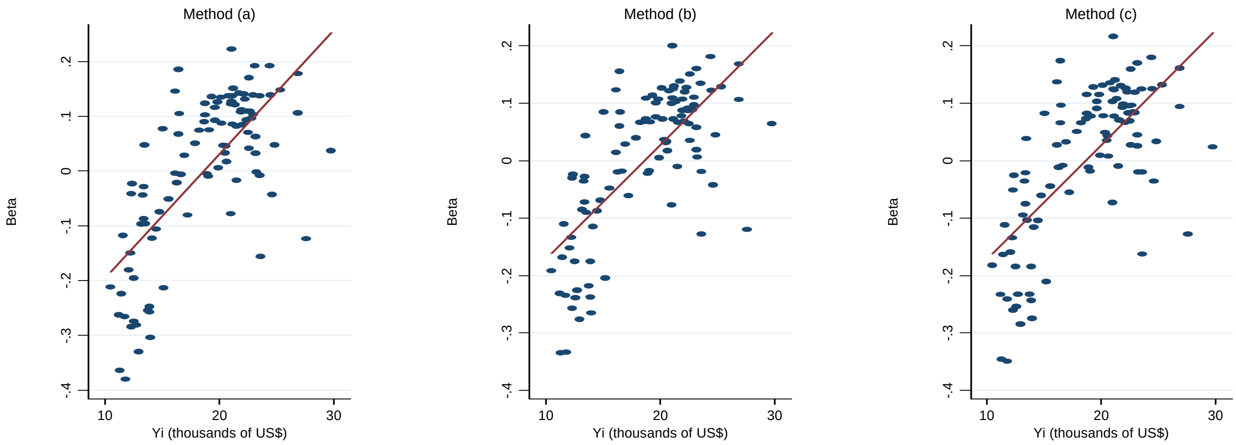
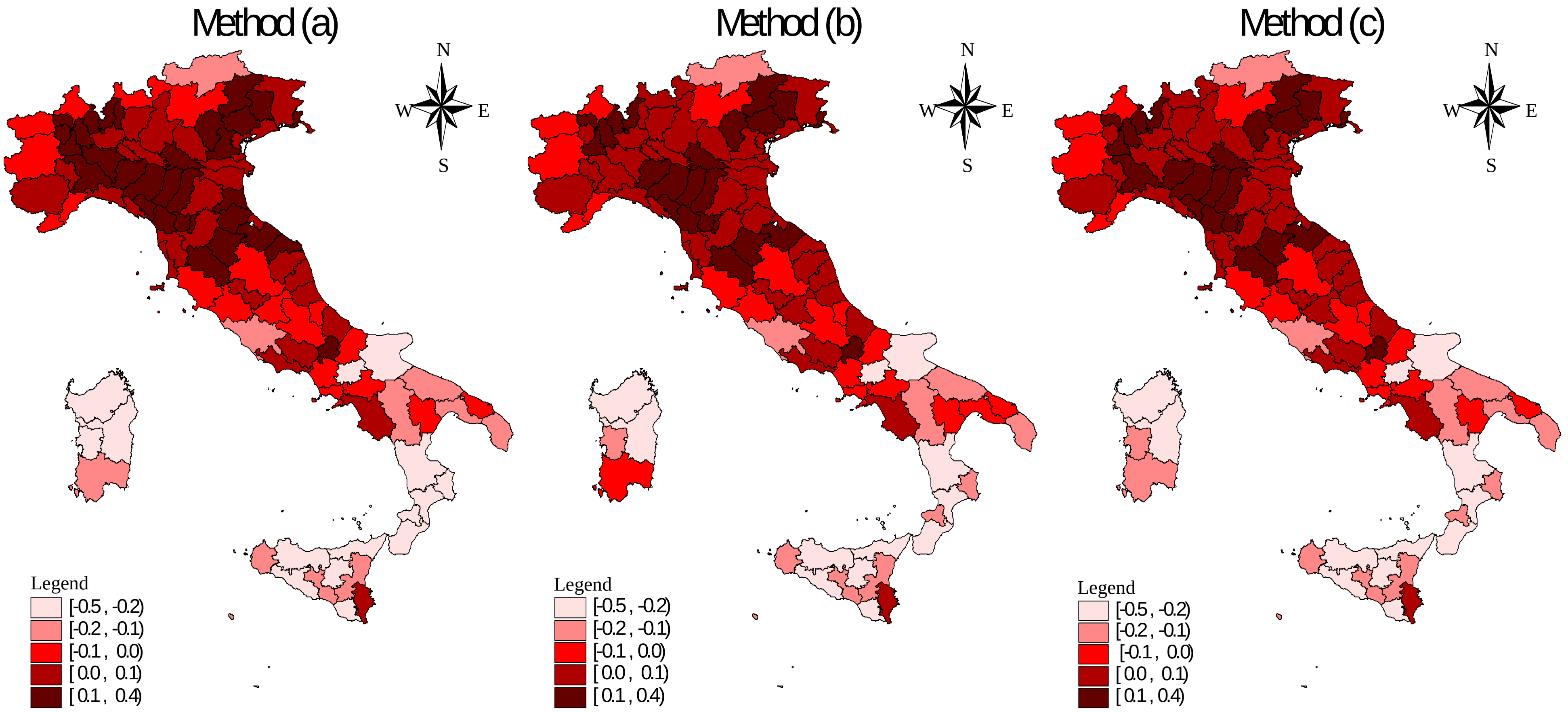


Table IV: Relationship between TC elasticities and average provincial per-capita income.

COEFFICIENT	Robust Standard Errors			Bootstrap Method with 1,000 replications		
	(a)	(b)	(c)	(a)	(b)	(c)
Constant	-0.417	-0.362	-0.369	-0.417	-0.362	-0.369
	(0.054)	(0.047)	(0.050)	(0.052)	(0.048)	(0.051)
Y_i/N_i	0.0223	0.0194	0.0197	0.0223	0.0194	0.0197
	(0.0028)	(0.0025)	(0.0026)	(0.0027)	(0.0025)	(0.0027)
Observations	103	103	103	103	103	103
R^2	0.486	0.478	0.459	0.486	0.478	0.459

NOTE: Y_i/N_i is the average over period 1995-2004. Robust standard errors in parentheses in columns 1-3; standard errors from bootstrap method with 1,000 replications in columns 3-5 (similar results with 100 and 10,000 replications): no-asterisk p<0.01; * p<0.05; ** p<0.1; *** p>0.1. See text for methods (a), (b), and (c).

Figure 3: Map of distance elasticities of 103 Italian provinces.



Note: Colors in the maps represent mean-adjusted provincial distance elasticities; see text for methods (a), (b), and (c); first and last ranges in the legend are larger than other ranges because they include extreme values.