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Do Cohesion Funds foster regional trade integration? A structural gravity analysis for the EU regions.*

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Abstract

This paper uses a structural gravity model to explore the regional trade and welfare impact of the EU Cohesion Policy Transport Infrastructure Investment programme estimated using a novel data-set of the Generalised Transport Costs for the EU regions at the NUTS2 level. The results indicate that on average additional investment in transport infrastructure can increase NUTS2 total regional exports by 0.40% and regional real GDP by 1.13%. Central and Eastern European Regions enjoy the highest exports and GDP gains, while few Western European regions experience a negligible decrease in wages, which may occur as a result of factor price convergence.

JEL code: F13, F14, F15, R13
Keywords: structural gravity, trade policy, general equilibrium analysis.

1 Introduction

A growing body of literature explores the impact of trade-related policies on national economies. Surprisingly, similar assessment on regional level is much less common, despite the fact that there is much more trade taking place in short distances between regions compared to the level of trade between countries.

**The views and opinions expressed in this paper are the authors' and do not necessarily reflect those of the European Commission.*

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This study seeks to fill in this gap in the literature by carrying out a counterfactual analysis that sheds light on the regional trade and welfare effects arising from the European policies. To this end, we employ a modified version of the Structural Gravity model developed by Anderson *et al.* (2018) to simulate potential effects of a specific EU-wide policy. In particular, we focus on the current EU Cohesion program 2014-2020 and take the investments in road infrastructure of over 60 billion € as a policy-case study. We note, however, that the method used in this study is very flexible and can be adopted to derive trade and welfare effects in a wide range of national or international policy settings.

The contribution of this study is threefold. First, it provides an ex-ante evaluation of the impact of the European Cohesion Funds programme on trade, convergence and on territorial inequalities on regional level. Second, the analysis is implemented using the Poisson-pseudo-maximum-likelihood estimator (PPML) in a structural gravity set-up, which enables us to disentangle trade creation and trade diversion effects of the policy and estimate its long-run welfare implications. Finally, the study employs several novel regional EU data-sets to calibrate the model. The first dataset comes from Thissen *et al.* (2019) and contains the matrix of inter-regional trade flows for the 267 NUTS-2 EU regions for 2013. The second data-set is the matrix of inter-regional generalised transport costs (GTC). This GTC matrix is constructed by Persyn *et al.* (2020) and takes into account all distance and time-related economic costs for road freight transport among the 267 NUTS-2 EU regions. As a result it provides a nominal € measure of inter-regional transports costs. The third matrix takes use of the two previous datasets and converts the GTC matrix into a matrix of iceberg-type trade costs which is theoretically coherent with our structural gravity framework.

To carry out the counterfactual evaluation of the EU Cohesion Policy, we construct the GTC and iceberg-type trade cost matrix for a baseline and a counterfactual scenario. To this aim, we use the cost-benefit analysis described in Persyn *et al.* (2020) and estimate the effect of the transport infrastructure investment carried out under the cohesion framework on the inter-regional transport costs. That is, we estimate the potential reduction in transport costs once the EU road infrastructure network is improved thanks to the investment of the EU cohesion policy. This results in a counterfactual transport cost matrices that are used to carry out the evaluation of the policy effects.

The use of the baseline and counterfactual trade-cost matrices makes this study the first to estimate the impact of a EU-wide policy in a gravity set-up for the members of a single market with no internal trade barriers. Furthermore, we believe to be the first in using a structural gravity model to consider these issues at regional level.

Our results indicate that the effects of the reduction in transport costs due to the infrastructure investments differ significantly among regions. In particular, they reveal the highest gains for the Central and Eastern European Regions. For example, long-run trade gains for some of the Polish NUTS2 regions range between 5% to 10%, and the corresponding (real) GDP gains vary between 10% and 16%. The latter effect is associated mostly with the reduction in consumer prices after the policy implementation. Other regions that experience the highest trade and welfare effects are located in such countries as Estonia, Latvia, Lithuania, Czechia, Romania, and Hungary.

At the same time, most regions of Western Europe, characterised by *ex-ante* relatively advanced infrastructure, seem to benefit from spatial spillovers effects and experience small positive and, in some cases, negligible negative effects, as a result of the policy. For example, some regions of Germany, Netherlands and France, as well as a number of remote islands of Italy and Greece exhibit negative effects in terms of trade and welfare. We note, however, that such results are mostly conditioned by our assumption that most of the EU investment is channeled towards road improvement.

In an era in which the European policy debate is centered around the reduction of spatial inequalities with the a purpose of a more unified European single market, these results shed light on the effects of European regional and public policies.

2 Literature review

Our work builds on a growing body of literature that seeks to quantify counterfactual trade and welfare effects of trade liberalisation episodes. From a methodological viewpoint our analysis relies on gravity models - workhorse of empirical international trade literature for analysing determinants of bilateral trade flows. While being used to estimate bilateral trade data since the famous work of Tinbergen (1962), the use of gravity in the mainstream trade research is a relatively recent event. Despite some early work trying to relate empirical gravity to economic theory, the systematic use of gravity in empirical trade began much later. According to (Head and Mayer, 2014) the inclusion of gravity in a mainstream trade literature happened in three distinct steps: (i) when the economists realised a surprisingly large amount of missing trade; (ii) micro-founded gravity model studies pointed out the importance of multilateral resistance/fixed effects; (iii) convergence between gravity and heterogeneous firms literature.

In particular, the growing attention to gravity model began with the introduction of the idea of "missing trade" by Trefler (1995). And, despite the fact, that Trefler (1995) relied on home bias to explain the missing trade phenomenon, his work clearly highlighted the importance of understanding the nature of trade barriers as impediments to trade. Further, the importance of gravity models have been discussed by Leamer and Levinsohn (1995) and Krugman (1995) in a *Handbook of International Economics*. Krugman in particular was the first to offer an intuitive explanation to the multilateral resistance terms first derived by Anderson (1979) and further developed by Anderson and Van Wincoop (2003).

The first empirical evidence on the importance of borders in international trade was provided my McCallum (1995) who used previously unexplored data on Canadian inter-provincial trade flows and the trade between each Canadian province and US state to empirically evidence the role of national borders. In fact MacCallum's study was the first to highlight the importance of using gravity for estimating the effects of trade policies and gave an original push to the literature trying to understand the "border" puzzle. In fact, the study by Anderson and Van Wincoop (2003) is actually a solution to a puzzle exposed by McCallum (1995). Overall, with the arrival of studies by Eaton and Kortum (2002) and Anderson and Van Wincoop (2003) the standard criticism related to the absence of micro-foundations in the gravity model was finally disbanded. Later on, the study by Redding and Venables (2004) put forward the use of the exporter and importer fixed effects to capture the multilateral resistance terms described by Anderson and Van Wincoop (2003).

The final stage of gravity model development began with the publication of the seminal studies by Bernard *et al.* (2007), Mayer and Ottaviano (2007), and Chaney (2008). In particular, Bernard *et al.* (2007) discuss the challenges of traditional international trade models based on country and industry-level data and shift focus towards firm and product-level data. Furthermore, they use the transaction-level US data to explore firms' participation in international markets. The results of the study show that number of products as well as the number of export destinations is the cornerstone of understanding the role of distance on international trade. Mayer and Ottaviano (2007) provide further insights into the importance of firm export patterns for trade analysis. The authors highlight that changes in international trade are driven by both the *extensive* and *intensive* margins. The intensive margin refers to average exports, imports and FDI per firm, while extensive margin refers to the number of firms involved in these activities. The authors conclude that extensive margin is much more important, as most of the times the response of trade flows to changes in country fundamentals happens through this margin. Finally, a seminal study by 2008 uses structural gravity approach to further explore the role of trade barriers on the extensive and intensive margin of exports, while introducing firm heterogeneity in productivity and fixed costs of exporting. The author concludes that the impact of trade barriers is dampened and not magnified by the elasticity of substitution. At the same time, high elasticity of substitution translate productivity differences into large differences in size. In fact, the increase in size diminishes the impact of fixed costs on exports, as large firms can easily overcome them. And higher elasticity of substitution makes aggregate trade flows less sensitive to trade barriers.

The most recent papers closely related to our study include Anderson and Yotov (2016), who develop a sector Armington-style gravity model to estimate the welfare effects of free trade agreements (henceforth, FTAs) implemented since 1990s; a sector Ricardian-type models by Costinot *et al.* (2012) and Chor (2010); a sector input-output linkages gravity model based on Eaton and Kortum (2002) by Caliendo and Parro (2015), and a dynamic framework with asset accumulation (Olivero and Yotov, 2012; Anderson *et al.*, 2015; Eaton *et al.*, 2016). Finally, a study by Allen *et al.* (2020) derived the universal power of gravity by providing sufficient conditions for the existence and uniqueness of the trade equilibrium for a wide class of general equilibrium trade models.

The next strand of literature relevant for current study is related to the regional dimension of trade, and, in particular, inter-regional EU trade. Indeed, as mentioned earlier, most trade literature is centered around evaluating trade effects on national level, while, as shown by McCallum (1995) and Wei (1996), the amount of trade that happens within national borders surpasses the amount of trade that happens across countries. In fact, the study by McCallum (1995) based on US-Canada trade data confirms that national borders still exert a significant negative impact on trade. At the same time, given the value of exploring the welfare effects of trade on regional dimension, the literature on the topic remains scarce. The main reason for such scarcity of empirical studies is the lack of reliable regional trade data. Even in case of the European Union there are only a few studies estimating regional trade flows. The study by Llano *et al.* (2010) estimate exports from Spanish to European regions during the period 1995-2010 using the C-intereg database. Another study by Thissen *et al.* (2013) estimates inter - regional trade flows for a sample of 232 European regions for a period 2000 - 2010. Furthermore, a number of studies employed a C-intereg database to assess the effects on various policies and investments on inter-regional EU trade (Alamá-Sabater *et al.*, 2013, 2015; Márquez-Ramos, 2016; Gallego and Llano, 2014, 2015).

Finally, the two studies most closely related to our analysis from an institutional setting viewpoint are the ones by Dhingra *et al.* (2017) and Mayer *et al.* (2019). These studies explore trade-related welfare effects of the EU integration.

Dhingra *et al.* (2017) use a standard quantitative general equilibrium trade model with many countries, sectors and trade in intermediaries and calculate medium to long-run effects of Brexit, with a focus on trade and fiscal transfers. The authors simulate a number of counterfactual scenarios for the post-Brexit trade relationship between the EU and the UK, including the option for the UK to remain a part of the EU single market *a la* Norway (*'soft Brexit'*), and the UK trading with the EU under the World Trade Organisation rules (*'hard Brexit'*). Finally, when the dynamic effects of Brexit on productivity are taken into account the losses from any form of Brexit more than triple, partially through the decline in foreign investment.

At the same time, Mayer *et al.* (2019) quantify the effects of a much broader set of policy scenarios of the EU disintegration. The authors also disentangle the effects of various EU agreements and regional trade deals and estimate the changes in trade flows arising due to the specific steps of the EU integration process (Single market, Schengen, and the Euro). Furthermore, the simulation of the latter study are based on the estimates of the direct trade effects of the EU obtained using the latest available data and a structural gravity estimation method. At the same time, Dhingra *et al.* (2017) base their simulations on tariff-equivalent calculations of Non-Tariff-Barriers obtained from the literature.

Felbermayr *et al.* (2018) - another relevant study - estimates an industry-level gravity regression for 2000-2014. The authors collect bilateral tariff rates and add them to the regression in addition to the EU dummy. This approach provides them with their own estimate of trade elasticity, which is further used to calculate the tariff equivalent of the EU and potential trade gains associated with tariff cuts. Using this approach the authors find that most of the EU trade effects come from factors other than tariffs. Overall, the studies discussed above are complementary and, taken together, provide estimates for wide set of the EU disintegration scenarios on aggregate and sector level.

Our study builds upon this work and estimates the effect of the EU Cohesion policy taking into account not only sector, but also regional dimension.

3 Theoretical framework

Our empirical strategy follows the analysis presented in Anderson and Van Wincoop (2003), Anderson and Yotov (2016) and Yotov *et al.* (2016) *inter alia*. In particular, the model follows Anderson (1979) structural gravity model and assumes that consumers have constant elasticity of substitution preferences across varieties produced by n regions, with products being differentiated by the place of origin (Armington, 1969).

$$X_{ij} = \frac{Y_i E_j}{Y}\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \tag{1}$$

$$\Pi_i^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \frac{E_j}{Y} \tag{2}$$

$$P_j^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma} \frac{Y_i}{Y} \tag{3}$$

$$p_i = \left(\frac{Y_i}{Y}\right)^{\frac{1}{1-\sigma}} \frac{1}{\gamma_i \Pi_i} \tag{4}$$

$$E_i = \phi_i Y_i = \phi_i p_i Q_i \tag{5}$$

In this system of equations, X_{ij} denotes the expenditure on goods from origin i shipped to destination j at destination prices. E_j is the expenditure at destination j on goods shipped from all origins, and Y_i represents sales of goods from origin i at all destinations at their corresponding destination prices. $t\_ij \geq 1$ are transport costs of shipment of goods from i to j, expressed as an additive iceberg transport cost. $\sigma > 1$ is the elasticity of substitution among different varieties, and $\gamma_i > 0$ is the CES preferences parameter. P_j stands for the Inward Multilateral Resistance (IMR) term that aggregates the incidence of trade costs on consumers in each region; while Π_i is the Outward Multilateral Resistance (OMR) term that aggregates origin i outward costs relative to the destination price indexes and can be used to evaluate the incidence of trade costs on producers in each region[1].

In the system above Eq.1 - Eq.3 correspond to the structural gravity system derived in Anderson and Van Wincoop (2003). To offer a more thorough analysis of the general equilibrium links within the gravity framework Yotov *et al.* (2016) and Anderson *et al.* (2018) supplemented this system with Eq. 4 and 5. In particular, Eq.4 is derived from the market clearing condition that asserts that the value of output in region i should be equal to the total expenditure on this variety in all locations in the world, including the

[1] Please see Appendix B for a detailed discussion on the role of MR indexes

region itself, i.e. $Y_i = \sum_j X_{ij}$:

$$Y_i = \sum_j X_{ij} = \sum_j \left(\frac{\gamma_i p_i t_{ij}}{P_j}\right)^{(1-\sigma)} E_j = (\gamma_i p_i)^{(1-\sigma)} \sum_j \left(\frac{t_{ij}}{P_j}\right)^{(1-\sigma)} E_j \text{ for all } j$$

Substituting above for Eq.2 yields Eq.4:

$$\begin{aligned} \frac{Y_i}{Y} &= (\gamma_i p_i \Pi_i)^{(1-\sigma)} \\ p_i^{(1-\sigma)} &= \frac{Y_i}{Y} \frac{1}{(\gamma_i \Pi_i)^{(1-\sigma)}} \\ p_i &= \left(\frac{Y_i}{Y}\right)^{\frac{1}{1-\sigma}} \frac{1}{\gamma_i \Pi_i} \end{aligned} \tag{6}$$

Finally, Eq.5 links the value of output Y_i to the aggregate expenditure E_i, where $\phi_i > 1$ shows that region i runs a trade deficit, while $0 < \phi_i \leq 1$ reflects that region i runs a trade surplus. Especially in a regional context it is important to allow for the possibility of regions to run structural trade deficits.

The key parameter in the complete system of equations (Eq.1 - Eq.5) is t_{ij}. Any change in transport costs between two regions i and j triggers the full general equilibrium solution. In particular, changes in t_{ij} translates, first, into new levels of trade (Eq.1), leading to the partial equilibrium results. Once the policy is applied and transport costs decline, multilateral resistance terms (IMR and OMR) adapt conditionally to the new levels of trade flows and transport costs (Eq.2-Eq.3) which, in a second round modifies the factory-gate prices (Eq.4) through the OMR term. In a third round, these price levels impact on the expenditure equation (Eq.5) which now goes back to Eq.1 and modifies trade flows. This iterative process continues up to the point in which the difference between the new price levels and those in the baseline becomes insignificant (tend to zero). In other words, a change in any of the equations gives rise to a short-run equilibrium condition that, in a second step, converges into a full long-run equilibrium solution based on new levels of trade, prices and expenditure.

4 Empirical strategy

Our strategy relies on estimating two trade scenarios for the EU regions. On our baseline scenario, we take use of two individually estimated matrices, one for trade flows and another one for the iceberg transport costs. Both matrices are calculated for the actual EU transport network (Persyn *et al.*, 2020). Next, we estimate trade flows in a counterfactual scenario in which iceberg transport costs are reduced as a result of the implementation of the Transport Infrastructure Investment (TII) program as part of the EU Cohesion Policy 2014-2020. This transport policy shock is only put in practice for the EU regions following the guidelines of the EU Cohesion Policy. However, the trade and transport cost effects of such a policy might spill-over to other EU regions and impact the countries external to the EU. Therefore, in our empirical analysis we treat EU regions as part of the *treatment group* of our policy, whereas all extra-EU countries are treated as a *control group*.

In both scenarios, we follow the recent literature and estimate a gravity equation with importer and exporter fixed effects and dyadic trade frictions (Feenstra, 2015). Furthermore, we follow Silva and Tenreyro (2006) and use the PPML estimator that accounts for potential heteroskedasticity issues and takes advantage of the information conveyed by zero trade flows.

In particular, taking our gravity trade equation in Eq.1, gives us the following expression:

$$X_{ij} = exp[E_j + Y_i - Y + (1-\sigma)t_{ij} + (1-\sigma)\ln P_i - (1-\sigma)\Pi_j] + \epsilon_{ij} \tag{7}$$

Where ϵ_{ij} is an i.i.d. error term with $E(\epsilon|\mathbf{x}) = 0$. In Eq.7 all the terms except the t_{ij}, do not change between our baseline and counterfactual scenarios. Moreover, those terms concerning to the OMRs and the sales/output variables can be capture by means of an exporter fixed effect (π_j), whereas those related to the IMRs and the expenditure are controlled by an importer fixed effect (χ_j).

In the case of t_{ij}, it stands for the vector of trade-related costs that includes contiguity, language, common currency, border controls and icebergs transport costs. In the baseline scenario (t_{ij}^{BLN}) this vector can be presented as follows:

$$\begin{aligned}(1-\sigma)(t_{ij}^{BLN})^{(1-\sigma)} =& \beta_1 Cont_{ij} + \beta_2 Language_{ij} + \beta_3 Currency_{ij} + \\ & \beta_4 Border_{ij} + \beta_5 \ln \tau_{ij}^{BLN}\end{aligned} \tag{8}$$

Where τ_{ij} is the iceberg transport cost in the baseline estimated from Persyn *et al.* (2020), $Cont_{ij}$ is a contiguity dummy, $Language_{ij}$ and $Currency_{it}$ are dummy variables for common language and common currency respectively, and $Border_{ij}$ is a dummy variable that differentiates trade flows crossing the border between any pair ij of trading partners. On the contrary, in our counterfactual scenario (t_{ij}^{CFL}) is the only variable that changes once the transport policy shock is implemented such as:

$$(1-\sigma)(t_{ij}^{CFL})^{(1-\sigma)} = \beta_1 Cont_{ij} + \beta_2 Language_{ij} + \beta_3 Currency_{ij} + \beta_4 Border_{ij} + \beta_5 \ln \tau_{ij}^{CFL} \tag{9}$$

Therefore, our final version of the gravity model in both scenarios takes the form:

$$\ln X_{ij} = (1-\sigma)[\beta_1 \ln Cont_{ij} + \beta_2 Language_{ij} + \beta_3 Currency_{ij} + \beta_4 Border_{ij} + \beta_5 \tau_{ij}] + \pi_i + \chi_j + \epsilon_{ij} \tag{10}$$

Where now τ_{ij} changes depending on each trade scenario. Also note that Eq.10 is estimated with PPML estimator where X_{ij} enters in levels. To avoid perfect collinearity issues we follow Anderson *et al.* (2018) and drop one importer fixed effect. Furthermore, as discussed in Anderson *et al.* (2018), solving the system Eq.1 - Eq.3 requires normalisation with respect to one reference country/region which, in our case, becomes the USA. Hence, we deliberately normalise the multilateral resistance that corresponds to the dropped importer fixed effect (USA), $P_0^{\tilde{USA}} = 1$. Under such normalisation, the theoretical interpretation of the importer fixed effect $\tilde{\chi_0}$ is E_0; while the interpretation of all other fixed effects is computed relative to E_0. Finally, following Anas (1983); Fally (2015), the OMRs and IMRs can be recovered from the fixed effects when estimating Eq.9 using a poisson regression. Hence, we use the PPML estimator discussed above and follow the 3-step procedure developed by Anderson *et al.* (2018) to calculate the general equilibrium effects of the investment in transport infrastructure envisaged under the framework of the 2014-2020 EU Cohesion Policy. In brief, the Anderson *et al.* (2018) procedure proceeds in the following manner. First, we estimate the baseline gravity equation using the PPPML estimator with exporter, importer and pair fixed effects. The PPML estimator is chosen due to its appealing properties for gravity estimations. In the second step we re-estimate the model using the the new matrix of the Generalised Transport Costs imposed as a constraint in the PPML estimation. Using the obtained estimates, we construct the multilateral resistance terms and estimate the full GE gravity using the iteration procedure that repeats the estimation of the model updating the parameters until the increase in prices converges to zero.

5 Data

This analysis requires the compilation of three unique trade and transport costs data-sets. The first one relates to the estimation of inter-regional aggregate trade flows between EU regions and EU with OECD countries. The second data-set constitutes the cornerstone of our transport policy shock and accounts for a matrix of generalised transport costs between EU regions in our two considered scenarios. The third dataset converts the GTCs into iceberg ad-valorem transport costs between EU regions and OECD countries.

5.1 The Inter-regional Trade Flows Matrix

The empirical analysis presented in this study relies on three novel data-sets. The trade data-set is produced by JRC and PBL Netherlands and is based on the methodology by Thissen *et al.* (2019) that estimates a probabilistic trade flow matrix to construct the inter-regional trade flows for all 267 NUTS2 EU regions. The methodology is based on the 2013 national supply and use tables (SUTs) that contain an update of the information presented in the Eurostat SUTs and follow NACE Rev2 classification.[2] The tables account for the distribution of re-exports over origin and destination countries, and ensure the consistency of bilateral trade flows and top-down compatibility. The use of this information allows for the estimation of inter-regional and intra-regional trade flows for the year 2013. In the case of intra-regional flows, they are estimated as the difference between intra-regional production at the origin minus inter-regional flows to other destinations.

Furthermore, we complement the Eurostat SUTs tables with corresponding and equivalent tables for OECD countries. This process leads to the the estimation of coherent trade flows between the EU regions and OECD countries which in our analysis become external EU countries (i.e. the control group).

5.2 The Generalized Transport Costs Matrix

The generalised transport costs employed in this study come from Persyn *et al.* (2020), who use the concepts developed by for example Combes and Lafourcade (2005) and Zofío *et al.* (2014) to compute the average cost of transportation between and within all regions by identifying the cost-minimizing route (I) between large numbers of pairs of points sampled from a population density grid. Specifically, the GTC and takes the following

[2]The description of the NACE Rev2 classification can be found here: `https://ec.europa.eu/eurostat/ramon/index.cfm?TargetUrl=DSP_PUB_WELC`

definition:

$$GTC_{ij} = min_{I_{ij}}(DistC_{ij} + TimeC_{ij}) + Tax_i + Vignette_{ij} \quad (11)$$

Where $DistD_{ij}$ stands for distance related costs, $TimeC_{ij}$ does the same for time-related costs, Tax_i and $Vignette_{ij}$ account for vehicles taxes and EU road-pricing schemes (Eurovignettes) different from tolls.

The optimal routes are calculated upon all the costs related to distance (such as fuel, maintenance, tolls, ...) as well as the time (such as driver wages, insurance costs, ...) for a 40t heavy duty vehicle using the existing European road network. The approach controls for properties of the road network such as the curvature and slope, maximum speeds and the presence of roundabouts or traffic lights. These estimates rely on a large set of auxiliary data-sets, such as the Openstreetmap road network, Eurostat data on wages at the regional level, satellite observations on elevation etc.

The final GTC is a composite indicator in €/ km of moving a truck between two places. Then, it is aggregated to the region-to-region level. Therefore, any change in the GTC's components leads to a new level of GTC and, subsequently, a change in the overall GTC matrix for regions.

5.3 The Iceberg Transport Cost Matrix

The system of equations in Eq.1-5 considers transport costs as one the key variable. However, transport cost are usually proxied by different measures of transport costs even when most of the trade economic models refer to the concept of iceberg transport costs (τ). Our GTC matrix allows us to translate the nominal € measure of transport costs into an iceberg equivalent transport costs which also accounts for differences in the unit values when trading between i and j. To calculate these iceberg transport costs we use the following formula:

$$\tau_{ij} = \frac{F_{ij}(\frac{1}{L})GTC_{ij}}{V_{ij}} \quad (12)$$

Where F_{ij} is the flow of goods in tons between i and j; L is the average load (in tons) of trucks; GTC_{ij} is the corresponding GTC between i and j; and V_{ij} is the value of the goods traded between i and j.

The numerator expresses the total transport cost as a result of multiplying the trade flow in tonnes by the number of trucks required to ship one ton and by the cost of the trip for one truck. Expressing the total transport cost relative to the value of the trade flow gives the trade costs expressed in ad valorem terms (Hummels, 1999). Last, note that changes in the GTC trigger changes in τ. Nevertheless, the use of the iceberg transport cost over the GTC relies on the heterogeneous distribution of the tons-to-value ratio across regions and countries which are not properly captured with the GTC.

5.4 Counterfactual analysis: Change in the transport cost matrix

Using the cost-benefit approach described in Persyn *et al.* (2020) we estimate the reductions in transport costs induced by the upgrading of secondary and primary roads to highways. The number of highway kilometers constructed in each region is determined by the EU funds allocated to the road infrastructure investment in each region. The cost of improving a road is assumed to be 10 million EUR per km, and this amount is adjusted for differences in the price level of civil engineering works per country, the slope of the terrain, and the population density surrounding the road. The candidate roads for improvement are ranked by an estimate of the total economic gain from improving them. This benefit of improving the road is the saved generalised transport cost, aggregated over an estimate of the trucks that are using the road. To obtain the required estimate of the total traffic on each road segment, a simple gravity model is applied using the inter-regional data from Thissen *et al.* (2019).

Figure 2 shows the estimated reduction in transport costs due to the road transport investment in the context of the EU Cohesion Policy, by showing the percentage difference, for each region, in the harmonic regional-GVA weighted average of the transport cost of each region to all destinations, comparing the situation before and after the reduction due to infrastructure investment.

The results presented below report the difference in the predicted trade flows and corresponding welfare effects based on the gravity model that employs the original baseline transport cost estimates, and the predicted trade flows using the counterfactual transport cost estimates.

6 Trade integration: Results

This section computes trade and welfare GE effects of the TII envisaged under the EU Cohesion Policy 2014-2020. The spatial structure of the investment, presented in Figure 1, points to a distribution skewed towards the regions of Central and Eastern Europe. Indeed, many EU regions located in the new EU member states are characterised by a level of infrastructure significantly below the EU average. Hence, in line with the priorities of the EU Cohesion Policy, the TII investment is being distributed in a way that should bring these lagging regions closer to the EU average. This, in turn, should lead to a significant decrease in the transportation cost and increase productivity in those regions, making them better connected to the rest of the EU.

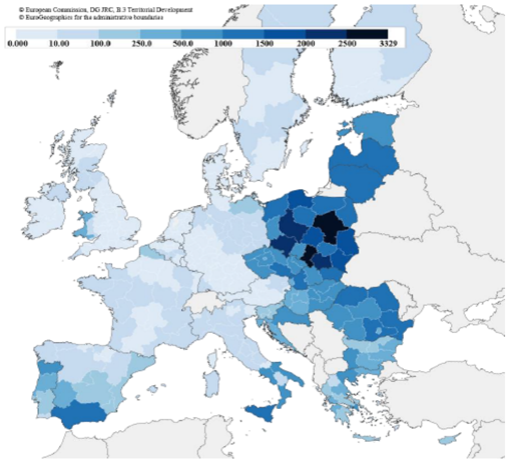

Figure 1: TII in the EU Cohesion Policy 2014-2020, Mln Euro

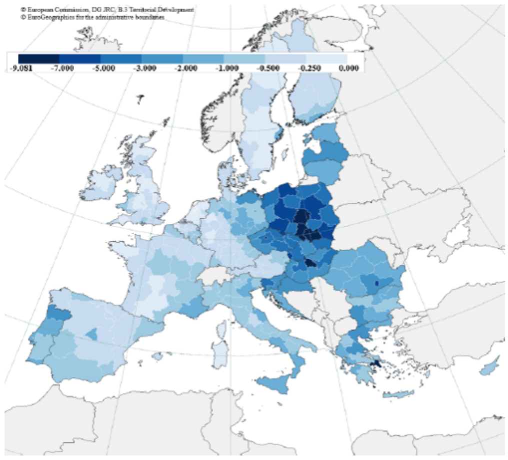

Figure 2: Change in the GTC due to the TII, %

The impact of transport infrastructure investment in our framework is modelled as a reduction in the GTCs among the 267 NUTS2 EU regions which then is translated into differences in the τ. Logically, the Central and Eastern-European regions experience the highest decline in GTCs following the TII (Figure 2). Next, we use the original and after-policy matrix of GTCs and employ Anderson *et al.* (2018) procedure to compute the general equilibrium effects of the European transport infrastructure programme.

The GTC's based on Persyn *et al.* (2020) contain only information for intra-EU region pairs. However, as regions and countries outside of the EU may include some important trading partners, the structural gravity model was estimated with these external countries included. In fact, the non-EU trading partners were used as a control group against which the trade and welfare effects of the TTI could be adequately measured.

For the transport costs to these non-EU trading partners, we first estimate a log-linear model explaining the GTC between European regions, depending on wages in origin and destination, and distance, and subsequently impute an approximate GTC for the third countries. Although this approximation will be quite crude, this is not highly relevant to the analysis, as we are not performing policy experiments on these trade links with imputed trade costs.

Our results are interesting and informative. First, we obtain large and heterogeneous conditional GE effects from the transport infrastructure investment program. We briefly

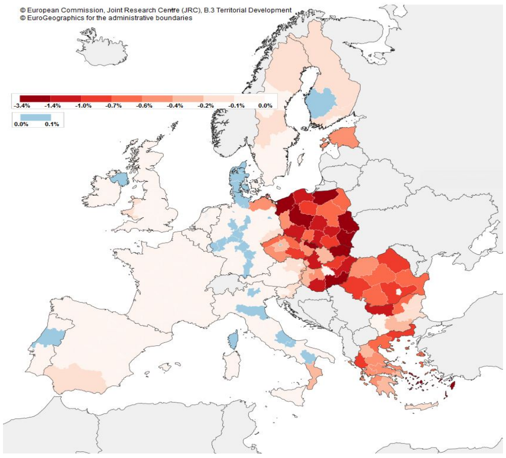

Figure 3: Changes in IMR, Full GE Results

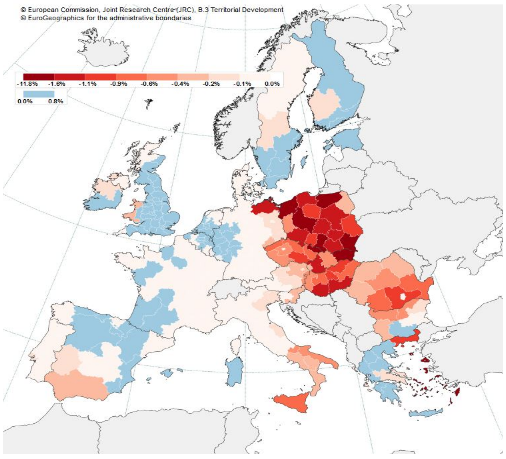

Figure 4: Changes in OMR, Full GE Results

analyse those, focusing on the conditional GE changes in total exports. The results of the conditional GE changes in exports by the NUTS2 region are given in column (1) of Appendix A. Several effects stand out. First of all, the estimated effects are quite large and show significant heterogeneity, ranging between -4.6% to 15.21%. Such sizeable heterogeneity is mainly driven by the regions' characteristics, such as size, geography and their initial trade openness and interconnectedness to the rest of the EU. For example, such countries as Latvia and Lithuania (both characterised by only one NUTS2 region due to their small size) experience the largest conditional positive effects on trade of around 15% and 12% respectively. Next, we proceed by analysing the full endowment GE effects of the transport infrastructure investment. In this case, the results with respect to exports and real GDP indicate that on average the NUTS2 EU regions will experience a rise in total exports of around 0.40% and a corresponding rise in real GDP of around 1.13%. However, significant inter-regional heterogeneity is still present. For example, the Moravian-Silesian Region in Czechia experiences a strong negative effect of the transport infrastructure investment on its exports (around 4%), accompanied by a strong positive effect on the long-run real GDP of around 7%. At the same time, Latvia shows the strongest increase in exports of over 15% in the full endowment GE scenario, followed by a strong positive effect on its long-run real GDP of around 8%. At the same time, Estonia exhibits a negligible increase in the long-run exports, which is accompanied by one of the highest increases in prices of around 36% and a relatively modest rise in real GDP of around 8%.

To shed more light on the underlying forces behind these heterogeneous estimates of the long-run trade and welfare effects we include some additional results of the full endowment GE scenario. In particular, columns (4) and (5) of Appendix A report the percentage changes in the inward (IMR) and outward (OMR) multilateral resistance terms, while column (3) reports the long-run changes in producer prices. We note that both IMR and OMR are only determined in relative terms due to the normalisation of the model needed to solve the MR system. Following the mainstream structural gravity literature we tried to choose region largely unaffected by the policy experiment as a reference point. To this end, we have chosen the IMR of the USA as a reference. Hence, the IMR change in the USA is equal to zero, while the MR changes in all other regions/countries should be interpreted relative to the effects of the transport infrastructure investment on American consumers. We find that, on average, additional transport infrastructure investment results in approximately equal IMR and OMR changes of around -0.6%. This result is different from the one of Anderson and Yotov (2010) who conclude that the incidence of trade costs on producers is much larger than the one on consumers. In our case, instead, the gains from the EU-wide investment in transport infrastructure are approximately equally divided among producers and consumers alike. The fall in the MR terms is accompanied by a rise in exports and GDP ranging between 0.5% - 1.2%. However, as can be seen in Figures 5 and 6, the results differ significantly across regions. For regions with small real GDP gains, such as regions in the UK, Spain Germany and France, we observe a decrease in the IMR and a corresponding increase in the OMR. This implies that the cost for the domestic producers in those regions to sell to international market increase, while domestic consumers' access to the world markets becomes easier, relative to the one of the US consumers. Overall, the increase in producers prices accompanied by a decrease in consumer prices results in medium positive GDP gains. At the same time, regions with high increase in real GDP exhibit larger fall in both IMRs and OMRs, accompanied by larger changes in prices.

In summary, we note that additional transport infrastructure investment program implemented under the framework of the EU Cohesion policy leads to positive trade and welfare effects. The Central and Eastern European regions enjoying the highest exports and GDP gains, but individual effects vary significantly.

7 Concluding remarks

This paper provides first quantified evidence of the regional trade and welfare effects of the EU Cohesion policy. To the best of our knowledge this is the first study to

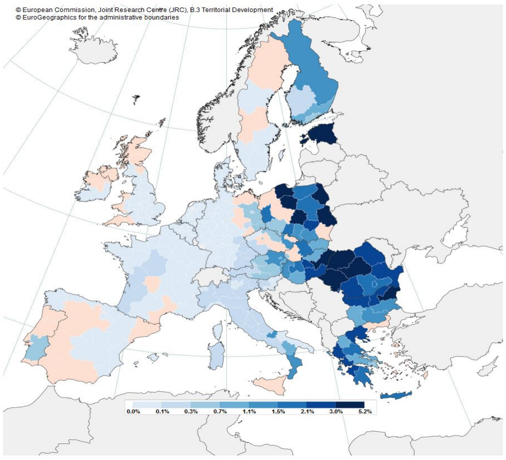

Figure 5: Changes in exports,
Full GE Results

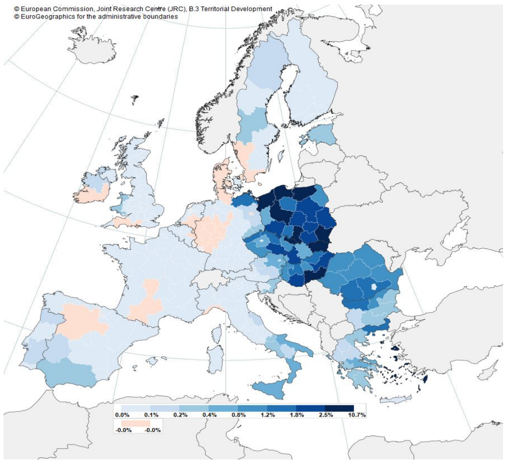

Figure 6: Changes in GDP,
Full GE Results

compute policy effects on regional level in a single market with no internal trade barriers. The exercise is made possible by using the baseline and counterfactual matrices of the generalised transport costs by Persyn *et al.* (2020) that include estimates of all distance and time-related economic costs for road freight transport among the 267 NUTS-2 EU regions. This, in turn, provides a nominal measure of inter-regional transports costs that we are using in our empirical exercise once we convert it into iceberg-type transport costs.

Our results confirm an overall positive effect of the EU cohesion policy on inter-regional trade and regional welfare indicators. In particular, our results indicate that an average increase in exports of a NUTS2 EU region will be around 0.40%, while an average policy-related increase in real regional GDP will be around 1.13%. At the same time, we note that our results reveal significant inter-regional heterogeneity. For example, numerous regions in countries *ex-ante* characterised by modern transport infrastructure, such as Germany, Belgium, Netherlands or France, as well as a number of small island of Italy and Greece, experience small negative long-run effects in both exports and real GDP. Such results are mainly driven by a rise in outward multilateral resistance terms (OMRs), which indicate increased costs of exports to international market for producers in these regions. Namely, the negative long-run effects for Greek and Italian islands appear as a result of the assumption that the bulk of the EU transport infrastructure investment is channelled towards road improvement. The impact of other types of transport infrastructure improvement would be interesting to consider from an academic and policy perspective. However, it is beyond the scope of this paper and is left for future research.

Furthermore, in some remote regions like Alentejo in Portugal or Aland in Finland, an increase in the outward multilateral resistance terms is accompanied by a smaller increase in the inward multilateral resistance terms (IMRs), which points to an increase in consumer prices in those places. Finally,the effect of the policy on extra-EU countries leads to a decline in their total export and real GDP. This is logical, as tighter integration among the EU regions that occurs as a result of the policy, makes them relatively less connected to the rest of the world and relatively more connected to each other.

One limitation of our analysis, is that it only captures the long-run static effects (i.e. the effects that arise once the estimated partial equilibrium trade effects have taken place). At the same time, our empirical setting does not allow us to explore the short-run effects on the EU-cohesion policy. Furthermore, our setting does not envisage any dynamic mechanism that would promote growth via increase in exports. Finally, the policy effects are explored for the aggregate trade flows only. Overall, the mainstream empirical trade literature suggests that all the omitted aspects mentioned above should increase trade and welfare gains from policies that promote trade integration.

Another critical aspect omitted in our analysis is related to the distributional effects. In particular, the model could be extended to include several types of production factors, such as, for example, skilled and unskilled labour, and allow the intensity of their use to vary across sectors. In this case, the EU Cohesion policy could potentially affect relative income, inequality and wage premium of higher-skilled workers. Until 2004, most economists dully assumed that differences in factor endowments across Europe were relatively small. However, due to the inclusion of a number of middle and lower income countries during the 2004 EU enlargement episode, this assumption might have to be revisited. In fact, several recently published papers tried to take this issue into account. For example, Costinot and Rodríguez-Clare (2014) introduced different skills in a structural gravity model similar to the one used in this study to find that, while inclusion of different skills accounts for distributional effects, such modification does not change the overall gains from trade (Mayer *et al.*, 2019). However, as the main goal of this study is to provide evidence on the regional trade and welfare effects of the EU cohesion policy we abstract from taking into account potential distributional effects of this policy leaving it for future research.

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Appendix A. Effects of Transport Infrastructure Investment

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
PT18	-0.25%	-0.27%	-0.65%	0.25%	0.76%	-0.90%
FI20	0.00%	0.25%	-0.36%	0.28%	0.42%	-0.64%
PT11	-0.60%	-0.58%	-0.59%	-0.18%	0.69%	-0.41%
ISL	-0.16%	-0.03%	-0.28%	0.09%	0.32%	-0.37%
ITF5	-0.04%	-0.07%	-0.36%	-0.04%	0.42%	-0.32%
SE12	-0.21%	-0.09%	-0.31%	0.00%	0.36%	-0.31%
PT30	0.00%	0.02%	-0.25%	0.05%	0.30%	-0.30%
FR21	-0.06%	-0.16%	-0.53%	-0.23%	0.62%	-0.30%
TUN	-0.37%	-0.25%	-0.27%	0.03%	0.31%	-0.30%
PT20	0.00%	0.03%	-0.25%	0.02%	0.29%	-0.27%
SE31	-0.10%	0.01%	-0.13%	0.12%	0.16%	-0.25%
BE24	-0.11%	-0.16%	-0.47%	-0.25%	0.55%	-0.22%
KHM	-0.18%	-0.11%	-0.19%	0.02%	0.22%	-0.21%
CRI	-0.39%	-0.29%	-0.21%	0.00%	0.25%	-0.21%
BE25	-0.14%	-0.18%	-0.47%	-0.26%	0.55%	-0.21%
NL22	-0.11%	-0.11%	-0.32%	-0.11%	0.38%	-0.21%
BRN	-0.04%	0.05%	-0.24%	-0.04%	0.28%	-0.20%
FR72	-0.05%	-0.15%	-0.34%	-0.14%	0.40%	-0.20%
NL33	-0.21%	-0.20%	-0.13%	0.06%	0.16%	-0.20%
FR83	-0.01%	-0.07%	-0.33%	-0.17%	0.38%	-0.16%
CHE	-0.86%	-0.74%	-0.19%	-0.03%	0.22%	-0.16%
ES30	-0.36%	-0.35%	-0.16%	0.00%	0.19%	-0.16%
NOR	-0.50%	-0.37%	-0.21%	-0.05%	0.24%	-0.16%
ISR	-0.52%	-0.45%	-0.14%	0.01%	0.17%	-0.15%
DE27	-0.03%	-0.12%	-0.35%	-0.21%	0.41%	-0.15%
DE14	-0.03%	-0.11%	-0.34%	-0.20%	0.39%	-0.14%
NL34	-0.03%	-0.01%	-0.17%	-0.03%	0.19%	-0.13%
ES63	0.00%	0.00%	-0.27%	-0.14%	0.32%	-0.13%
PT16	-0.10%	-0.17%	-0.14%	0.00%	0.16%	-0.13%
ITC1	-0.08%	-0.14%	-0.17%	-0.05%	0.20%	-0.13%
DE50	-0.02%	-0.07%	-0.33%	-0.20%	0.38%	-0.13%
SE11	-0.21%	-0.12%	-0.10%	0.02%	0.12%	-0.12%
NZL	-0.38%	-0.34%	-0.12%	0.00%	0.14%	-0.12%
VNM	-0.54%	-0.43%	-0.16%	-0.05%	0.19%	-0.12%

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
DEF0	-0.05%	-0.09%	-0.31%	-0.19%	0.36%	-0.12%
ITG1	-0.35%	-0.35%	-0.19%	-0.07%	0.22%	-0.12%
HKG	-0.78%	-0.70%	-0.11%	0.00%	0.13%	-0.11%
COL	-0.71%	-0.59%	-0.14%	-0.03%	0.17%	-0.11%
ES12	-0.06%	-0.05%	-0.15%	-0.04%	0.17%	-0.11%
CHL	-0.64%	-0.57%	-0.13%	-0.02%	0.15%	-0.11%
PHL	-0.45%	-0.43%	-0.10%	0.00%	0.12%	-0.10%
ARG	-0.61%	-0.48%	-0.19%	-0.09%	0.22%	-0.10%
FR51	-0.07%	-0.16%	-0.29%	-0.20%	0.34%	-0.10%
TUR	-1.42%	-1.25%	-0.10%	0.00%	0.12%	-0.09%
ZAF	-0.66%	-0.58%	-0.11%	-0.01%	0.12%	-0.09%
SAU	-0.36%	-0.20%	-0.24%	-0.15%	0.28%	-0.09%
THA	-0.56%	-0.48%	-0.15%	-0.06%	0.18%	-0.09%
ITI4	-0.10%	-0.13%	-0.20%	-0.11%	0.23%	-0.09%
UKD7	-0.08%	-0.06%	-0.18%	-0.09%	0.21%	-0.08%
DEA4	-0.03%	-0.10%	-0.31%	-0.22%	0.36%	-0.08%
ES24	-0.03%	-0.03%	-0.18%	-0.10%	0.21%	-0.08%
MYS	-0.39%	-0.34%	-0.14%	-0.06%	0.17%	-0.08%
TWN	-0.65%	-0.57%	-0.15%	-0.07%	0.17%	-0.08%
SGP	-0.54%	-0.48%	-0.14%	-0.06%	0.16%	-0.08%
RUS	-0.74%	-0.57%	-0.19%	-0.12%	0.23%	-0.08%
AUS	-0.84%	-0.72%	-0.13%	-0.05%	0.15%	-0.08%
ES52	-0.07%	-0.06%	-0.19%	-0.12%	0.22%	-0.07%
DE26	-0.01%	-0.08%	-0.26%	-0.19%	0.30%	-0.07%
CAN	-0.69%	-0.60%	-0.10%	-0.04%	0.12%	-0.07%
IDN	-0.87%	-0.72%	-0.16%	-0.09%	0.19%	-0.07%
DEA3	-0.02%	-0.10%	-0.26%	-0.20%	0.31%	-0.06%
KOR	-0.94%	-0.83%	-0.13%	-0.07%	0.15%	-0.06%
ITC4	-0.08%	-0.13%	-0.23%	-0.17%	0.27%	-0.06%
UKD6	-0.07%	-0.05%	-0.14%	-0.08%	0.16%	-0.06%
ITC3	-0.01%	-0.05%	-0.12%	-0.06%	0.14%	-0.06%
UKE3	-0.01%	0.02%	-0.12%	-0.06%	0.14%	-0.06%
MEX	-0.82%	-0.70%	-0.11%	-0.06%	0.13%	-0.06%
ITH3	-0.05%	-0.09%	-0.50%	-0.44%	0.58%	-0.05%

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
IND	-1.10%	-1.01%	-0.06%	-0.01%	0.07%	-0.05%
BRA	-0.76%	-0.67%	-0.16%	-0.11%	0.18%	-0.05%
UKI1	-0.05%	0.00%	-0.18%	-0.14%	0.21%	-0.05%
UKK4	-0.01%	0.03%	-0.11%	-0.06%	0.12%	-0.05%
ITH5	-0.04%	-0.11%	-0.20%	-0.16%	0.24%	-0.04%
ES22	-0.01%	-0.02%	-0.09%	-0.05%	0.11%	-0.04%
FR82	-0.04%	-0.12%	-0.22%	-0.18%	0.26%	-0.04%
JPN	-0.83%	-0.71%	-0.14%	-0.10%	0.16%	-0.04%
FR81	-0.02%	-0.12%	-0.22%	-0.18%	0.25%	-0.04%
CHN	-0.77%	-0.63%	-0.16%	-0.13%	0.19%	-0.03%
UKL2	0.00%	0.01%	-0.09%	-0.06%	0.10%	-0.03%
DK04	-0.03%	0.08%	0.21%	0.24%	-0.25%	-0.03%
USA	-1.39%	-1.34%	-0.02%	0.00%	0.03%	-0.02%
ES21	-0.02%	-0.01%	-0.12%	-0.10%	0.14%	-0.02%
DE21	-0.02%	-0.05%	-0.26%	-0.25%	0.31%	-0.02%
ES13	0.00%	0.00%	-0.06%	-0.05%	0.07%	-0.01%
AT34	0.00%	0.11%	-0.07%	-0.07%	0.09%	-0.01%
FR30	-0.01%	-0.08%	-0.27%	-0.27%	0.32%	-0.01%
ES62	0.00%	0.00%	-0.12%	-0.12%	0.14%	0.00%
UKE2	0.00%	0.03%	-0.09%	-0.08%	0.10%	0.00%
FR22	0.00%	-0.12%	-0.29%	-0.29%	0.34%	0.00%
FR52	0.00%	-0.09%	-0.19%	-0.19%	0.22%	0.00%
DEA5	0.00%	-0.07%	-0.22%	-0.23%	0.26%	0.00%
BE22	0.00%	-0.05%	-0.28%	-0.28%	0.33%	0.00%
IE02	0.01%	0.04%	-0.15%	-0.15%	0.17%	0.00%
BE35	0.00%	-0.04%	-0.26%	-0.27%	0.31%	0.01%
AT32	0.00%	0.13%	-0.17%	-0.17%	0.19%	0.01%
UKH1	0.00%	0.04%	-0.16%	-0.17%	0.19%	0.01%
DK05	0.01%	0.15%	0.05%	0.04%	-0.06%	0.01%
UKJ4	0.00%	0.05%	-0.15%	-0.16%	0.17%	0.01%
FR23	0.00%	-0.10%	-0.19%	-0.20%	0.22%	0.01%
DK03	0.01%	0.15%	-0.05%	-0.07%	0.06%	0.01%
FR62	0.01%	-0.08%	-0.30%	-0.32%	0.35%	0.01%
ES41	0.01%	-0.01%	-0.16%	-0.18%	0.19%	0.02%

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
IE01	0.01%	0.05%	0.02%	0.00%	-0.02%	0.02%
UKJ1	0.01%	0.06%	-0.13%	-0.15%	0.15%	0.02%
UKF2	0.01%	0.04%	-0.09%	-0.11%	0.10%	0.02%
UKD3	0.01%	0.02%	-0.12%	-0.14%	0.14%	0.02%
UKK1	0.01%	0.06%	-0.11%	-0.13%	0.12%	0.03%
UKC1	0.01%	0.04%	-0.10%	-0.13%	0.12%	0.03%
NL23	0.01%	-0.01%	-0.04%	-0.08%	0.05%	0.03%
UKN0	0.02%	0.07%	-0.10%	-0.13%	0.11%	0.04%
ES11	0.02%	0.03%	-0.22%	-0.26%	0.26%	0.04%
UKF3	0.01%	0.04%	-0.10%	-0.13%	0.11%	0.04%
DEA2	0.03%	-0.03%	-0.23%	-0.27%	0.27%	0.04%
UKG2	0.01%	0.03%	-0.02%	-0.06%	0.02%	0.04%
PT17	0.08%	0.07%	-0.19%	-0.23%	0.22%	0.04%
ES42	0.01%	0.00%	-0.27%	-0.31%	0.31%	0.05%
ES64	0.00%	0.03%	-0.14%	-0.19%	0.17%	0.05%
BE32	0.01%	-0.07%	-0.24%	-0.29%	0.28%	0.05%
UKK3	0.00%	0.04%	-0.10%	-0.15%	0.12%	0.05%
BE23	0.04%	-0.05%	-0.21%	-0.26%	0.24%	0.05%
SE32	0.01%	0.10%	0.07%	0.02%	-0.08%	0.05%
DE93	0.01%	-0.05%	-0.13%	-0.19%	0.15%	0.06%
UKM5	0.01%	0.07%	-0.17%	-0.23%	0.20%	0.06%
DE94	0.02%	-0.04%	-0.17%	-0.22%	0.19%	0.06%
FR43	0.01%	-0.08%	-0.16%	-0.22%	0.19%	0.06%
FR63	0.01%	-0.10%	-0.13%	-0.18%	0.15%	0.06%
ITI2	0.03%	-0.01%	-0.15%	-0.21%	0.18%	0.06%
ES23	0.01%	0.01%	0.03%	-0.03%	-0.04%	0.07%
UKE4	0.03%	0.06%	-0.14%	-0.21%	0.16%	0.07%
DE12	0.03%	-0.04%	-0.20%	-0.27%	0.23%	0.07%
DE11	0.07%	0.01%	-0.23%	-0.30%	0.26%	0.08%
DE60	0.05%	0.00%	-0.09%	-0.17%	0.10%	0.08%
FR53	0.03%	-0.06%	-0.23%	-0.31%	0.26%	0.08%
NL21	0.04%	0.07%	-0.34%	-0.42%	0.39%	0.08%
SE33	0.03%	0.14%	-0.15%	-0.23%	0.17%	0.08%
DE92	0.03%	-0.02%	-0.26%	-0.35%	0.30%	0.09%

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
ITF2	0.00%	-0.04%	-0.02%	-0.12%	0.02%	0.09%
FR10	0.29%	0.20%	-0.23%	-0.33%	0.27%	0.10%
FR71	0.13%	0.04%	-0.20%	-0.30%	0.23%	0.10%
DEB3	0.03%	-0.02%	-0.15%	-0.25%	0.18%	0.10%
DEA1	0.09%	0.03%	-0.15%	-0.26%	0.18%	0.11%
FR61	0.08%	-0.01%	-0.22%	-0.33%	0.26%	0.11%
DE13	0.04%	-0.01%	-0.07%	-0.18%	0.08%	0.11%
NL12	0.03%	0.06%	-0.05%	-0.17%	0.06%	0.12%
FR24	0.04%	-0.07%	-0.22%	-0.34%	0.26%	0.12%
BE21	0.13%	0.07%	-0.17%	-0.28%	0.19%	0.12%
DE24	0.02%	-0.02%	-0.16%	-0.29%	0.18%	0.13%
NL32	0.15%	0.16%	-0.11%	-0.24%	0.12%	0.13%
DEB1	0.02%	-0.04%	-0.09%	-0.23%	0.11%	0.14%
SE22	0.11%	0.26%	-0.03%	-0.17%	0.04%	0.14%
DE73	0.02%	-0.04%	-0.10%	-0.24%	0.12%	0.14%
FR42	0.06%	-0.02%	-0.18%	-0.32%	0.21%	0.14%
DE22	0.03%	-0.02%	-0.08%	-0.22%	0.09%	0.14%
DE91	0.03%	-0.02%	-0.06%	-0.20%	0.07%	0.14%
DEG0	0.04%	-0.01%	-0.09%	-0.23%	0.10%	0.15%
UKH2	0.05%	0.08%	0.09%	-0.05%	-0.11%	0.15%
ES51	0.30%	0.28%	-0.04%	-0.19%	0.05%	0.15%
NL42	0.07%	0.09%	-0.06%	-0.22%	0.07%	0.16%
UKC2	0.05%	0.09%	0.08%	-0.09%	-0.09%	0.16%
ES53	0.07%	0.10%	0.24%	0.07%	-0.28%	0.17%
DEE0	0.05%	0.01%	-0.12%	-0.28%	0.14%	0.17%
ITH4	0.12%	0.07%	-0.06%	-0.23%	0.08%	0.17%
FR26	0.04%	-0.07%	-0.13%	-0.30%	0.15%	0.17%
NL31	0.07%	0.08%	-0.23%	-0.40%	0.27%	0.17%
DED4	0.03%	0.00%	-0.12%	-0.30%	0.14%	0.17%
DE71	0.14%	0.09%	-0.08%	-0.25%	0.09%	0.18%
ES70	0.14%	0.16%	-0.09%	-0.27%	0.11%	0.18%
DED2	-0.04%	-0.06%	-0.13%	-0.31%	0.15%	0.18%
UKI2	0.15%	0.17%	0.05%	-0.14%	-0.05%	0.18%
DE25	0.04%	-0.03%	-0.14%	-0.33%	0.16%	0.18%

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
ITH1	0.10%	0.03%	0.11%	-0.08%	-0.13%	0.19%
FR25	0.06%	-0.03%	-0.16%	-0.36%	0.19%	0.20%
ITI1	0.17%	0.12%	-0.09%	-0.29%	0.11%	0.20%
BE31	0.05%	-0.01%	-0.12%	-0.33%	0.13%	0.21%
DED5	0.04%	0.01%	-0.07%	-0.29%	0.08%	0.22%
ES61	-0.13%	-0.12%	-0.01%	-0.23%	0.01%	0.22%
NL13	0.05%	0.09%	0.20%	-0.02%	-0.23%	0.22%
DEB2	0.02%	-0.04%	-0.03%	-0.25%	0.04%	0.22%
UKH3	0.07%	0.11%	0.16%	-0.06%	-0.19%	0.22%
ITF4	0.06%	0.03%	-0.14%	-0.37%	0.16%	0.23%
UKD1	0.02%	0.07%	0.18%	-0.04%	-0.22%	0.23%
UKD4	0.04%	0.06%	0.12%	-0.12%	-0.13%	0.23%
SE21	0.10%	0.21%	0.19%	-0.05%	-0.23%	0.24%
UKL1	-0.10%	-0.06%	0.04%	-0.22%	-0.04%	0.25%
DEC0	0.06%	0.01%	0.00%	-0.25%	0.00%	0.25%
UKM3	0.13%	0.19%	0.10%	-0.16%	-0.12%	0.26%
BE33	0.13%	0.08%	-0.03%	-0.29%	0.03%	0.26%
DE72	0.04%	-0.02%	0.03%	-0.24%	-0.04%	0.27%
ITG2	0.08%	0.07%	-0.01%	-0.29%	0.01%	0.27%
ITC2	0.01%	-0.04%	-0.21%	-0.48%	0.24%	0.27%
UKG3	0.13%	0.16%	0.15%	-0.13%	-0.18%	0.28%
UKG1	0.06%	0.09%	0.15%	-0.13%	-0.18%	0.28%
NL41	0.24%	0.25%	-0.01%	-0.29%	0.01%	0.28%
ITI3	0.16%	0.11%	-0.07%	-0.36%	0.09%	0.28%
AT21	0.08%	0.20%	0.06%	-0.23%	-0.07%	0.29%
UKJ2	0.17%	0.20%	0.16%	-0.15%	-0.19%	0.31%
UKJ3	0.11%	0.15%	0.16%	-0.15%	-0.18%	0.31%
ITF3	0.16%	0.13%	-0.11%	-0.42%	0.13%	0.31%
AT33	0.12%	0.22%	0.10%	-0.21%	-0.11%	0.31%
UKF1	0.08%	0.09%	0.15%	-0.16%	-0.17%	0.31%
ITH2	0.16%	0.09%	-0.12%	-0.43%	0.14%	0.31%
UKK2	0.08%	0.12%	0.18%	-0.14%	-0.21%	0.32%
UKM6	0.03%	0.09%	0.23%	-0.09%	-0.27%	0.32%
UKE1	0.06%	0.09%	0.17%	-0.16%	-0.20%	0.33%

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
MT00	0.07%	0.17%	0.10%	-0.22%	-0.12%	0.33%
BE10	0.24%	0.20%	0.04%	-0.30%	-0.04%	0.33%
DE80	0.06%	0.03%	0.02%	-0.33%	-0.03%	0.35%
UKM2	0.17%	0.22%	0.26%	-0.11%	-0.30%	0.37%
ITF1	0.07%	0.03%	-0.18%	-0.56%	0.21%	0.38%
FR41	0.18%	0.10%	-0.17%	-0.56%	0.20%	0.39%
DE23	0.06%	0.00%	-0.10%	-0.49%	0.12%	0.39%
DK01	0.64%	0.76%	0.16%	-0.23%	-0.19%	0.39%
BE34	0.05%	0.03%	0.10%	-0.29%	-0.11%	0.39%
AT31	0.31%	0.47%	0.28%	-0.18%	-0.32%	0.45%
AT22	0.25%	0.42%	0.27%	-0.20%	-0.31%	0.46%
LU00	0.79%	0.94%	-0.11%	-0.59%	0.13%	0.49%
FI1D	0.31%	0.63%	-0.05%	-0.53%	0.05%	0.49%
DE40	0.20%	0.18%	0.03%	-0.46%	-0.04%	0.49%
SE23	0.49%	0.57%	0.61%	0.11%	-0.71%	0.50%
DE30	0.32%	0.30%	0.03%	-0.50%	-0.03%	0.53%
NL11	0.21%	0.26%	0.08%	-0.47%	-0.09%	0.54%
ITF6	-0.14%	-0.17%	0.28%	-0.28%	-0.33%	0.56%
PT15	0.20%	0.22%	-0.02%	-0.64%	0.02%	0.62%
SI02	0.22%	0.35%	0.24%	-0.40%	-0.28%	0.64%
DK02	0.50%	0.65%	-0.11%	-0.76%	0.12%	0.65%
EL42	-0.42%	-0.27%	0.45%	-0.21%	-0.53%	0.66%
SI01	0.35%	0.50%	0.22%	-0.46%	-0.26%	0.68%
AT11	0.03%	0.23%	0.35%	-0.37%	-0.41%	0.73%
CY00	0.53%	0.62%	0.03%	-0.77%	-0.04%	0.81%
ES43	0.08%	0.10%	0.60%	-0.26%	-0.70%	0.86%
AT13	0.91%	1.07%	0.43%	-0.43%	-0.51%	0.86%
CZ01	1.00%	1.60%	0.49%	-0.44%	-0.57%	0.93%
EL21	0.14%	0.32%	0.18%	-0.85%	-0.21%	1.03%
EL30	1.59%	1.73%	0.29%	-0.76%	-0.33%	1.04%
FI19	1.30%	1.55%	0.99%	-0.11%	-1.16%	1.10%
EL22	0.04%	0.20%	0.71%	-0.44%	-0.83%	1.15%
AT12	0.79%	0.96%	0.80%	-0.36%	-0.94%	1.16%
EL12	0.43%	0.60%	-0.05%	-1.21%	0.06%	1.16%

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
EL25	-0.53%	-0.35%	0.22%	-0.98%	-0.25%	1.20%
HRV	0.42%	0.58%	0.50%	-0.74%	-0.58%	1.24%
EL14	0.30%	0.45%	0.44%	-0.93%	-0.51%	1.37%
EL43	0.29%	0.44%	0.75%	-0.80%	-0.87%	1.54%
EL23	0.18%	0.37%	0.60%	-0.96%	-0.70%	1.56%
RO32	3.23%	3.78%	0.80%	-0.82%	-0.94%	1.62%
EL13	0.23%	0.38%	0.59%	-1.12%	-0.69%	1.71%
EL41	-0.43%	-0.28%	0.70%	-1.03%	-0.82%	1.74%
BG41	1.64%	1.85%	0.69%	-1.07%	-0.80%	1.76%
EL24	-0.06%	0.11%	0.83%	-0.94%	-0.97%	1.77%
BG42	0.51%	0.74%	0.64%	-1.14%	-0.75%	1.78%
CZ02	0.54%	1.27%	1.05%	-0.77%	-1.23%	1.82%
SK01	0.78%	1.41%	0.78%	-1.12%	-0.91%	1.90%
EL11	-0.38%	-0.25%	0.88%	-1.06%	-1.02%	1.94%
BG31	0.14%	0.42%	0.72%	-1.24%	-0.84%	1.96%
BG34	0.25%	0.51%	0.82%	-1.16%	-0.96%	1.98%
FI1B	3.46%	3.77%	0.77%	-1.38%	-0.90%	2.15%
FI1C	1.07%	1.38%	1.43%	-0.81%	-1.67%	2.24%
HU22	0.38%	0.83%	0.71%	-1.54%	-0.83%	2.26%
RO42	0.70%	1.35%	1.08%	-1.21%	-1.26%	2.29%
CZ04	-1.09%	-0.50%	1.20%	-1.32%	-1.41%	2.53%
HU23	-0.37%	0.10%	1.19%	-1.35%	-1.39%	2.54%
CZ03	0.55%	1.18%	1.32%	-1.48%	-1.54%	2.80%
CZ05	-0.26%	0.49%	1.53%	-1.44%	-1.79%	2.97%
BG33	1.13%	1.38%	1.56%	-1.42%	-1.82%	2.99%
HU10	1.83%	2.39%	1.25%	-1.78%	-1.46%	3.03%
SK03	-0.04%	0.79%	1.34%	-1.90%	-1.56%	3.24%
HU21	0.98%	1.52%	1.47%	-1.93%	-1.72%	3.40%
RO41	-0.15%	0.44%	1.62%	-1.89%	-1.89%	3.51%
RO11	1.27%	1.83%	2.04%	-1.56%	-2.38%	3.60%
RO31	-1.16%	-0.47%	1.69%	-1.93%	-1.97%	3.62%
RO12	0.23%	0.98%	1.85%	-1.83%	-2.16%	3.68%
BG32	0.30%	0.55%	1.91%	-1.82%	-2.23%	3.73%

Reg.	Cond GE. Δ % Exp	Δ % Exports	Δ % price	Full Δ % IMR	Endowment Δ %OMR	GE Δ % RGDP
CZ06	0.33%	1.08%	2.03%	-1.91%	-2.37%	3.94%
HU33	0.63%	1.21%	1.86%	-2.22%	-2.17%	4.08%
HU31	-0.61%	-0.08%	1.90%	-2.21%	-2.22%	4.11%
RO21	0.82%	1.51%	2.14%	-2.20%	-2.49%	4.34%
SK02	-2.93%	-2.46%	2.10%	-2.40%	-2.45%	4.49%
RO22	-0.29%	0.38%	2.45%	-2.67%	-2.85%	5.12%
HU32	0.81%	1.34%	2.52%	-2.81%	-2.94%	5.34%
PL42	1.92%	4.12%	2.56%	-3.05%	-2.99%	5.62%
CZ07	-0.09%	0.69%	3.22%	-2.45%	-3.75%	5.67%
PL43	1.51%	3.70%	2.84%	-3.86%	-3.32%	6.71%
CZ08	-4.60%	-3.95%	3.39%	-3.43%	-3.96%	6.82%
PL41	-1.00%	1.49%	2.99%	-3.85%	-3.48%	6.84%
SK04	-2.29%	-1.84%	3.70%	-3.50%	-4.32%	7.20%
PL51	-1.21%	0.93%	3.33%	-3.87%	-3.89%	7.21%
EE00	0.00%	0.09%	36.23%	28.46%	-42.10%	7.75%
LT00	15.21%	15.43%	4.54%	-3.24%	-5.30%	7.79%
LV00	11.69%	11.92%	2.94%	-5.34%	-3.43%	8.28%
PL52	0.92%	3.81%	4.24%	-4.05%	-4.94%	8.29%
PL33	0.94%	4.16%	4.10%	-4.64%	-4.78%	8.74%
PL32	-3.93%	-1.53%	4.64%	-4.13%	-5.41%	8.77%
PL34	1.76%	4.39%	4.35%	-5.11%	-5.07%	9.46%
PL12	3.98%	6.42%	4.87%	-5.10%	-5.68%	9.98%
PL61	1.28%	4.00%	5.18%	-5.26%	-6.05%	10.45%
PL31	1.47%	3.94%	5.43%	-5.57%	-6.33%	11.01%
PL21	0.71%	3.44%	5.26%	-5.79%	-6.13%	11.05%
PL63	3.50%	5.73%	5.27%	-6.15%	-6.15%	11.43%
PL62	1.18%	3.74%	7.20%	-7.65%	-8.39%	14.86%
PL11	5.11%	7.93%	6.55%	-8.49%	-7.64%	15.06%
PL22	10.04%	12.31%	7.88%	-8.22%	-9.19%	16.12%

Appendix B. Multilateral Resistances

First defined by Anderson and Van Wincoop (2003), multilateral resistance (MR) terms are at the centre of the general equilibrium (GE) trade policy analysis. The intuitive interpretation of the multilateral resistance indexes is that the more remote the two trading partners are from the rest of the world the more they trade with each other. Based on this intuition MR terms are often referred to as *remoteness indexes*. Defined formally in Eq.2 and Eq.3, the MR indexes are theory consistent aggregates of the total trade costs to the country/region level (Anderson *et al.*, 2018). The main advantage of the MR terms is their ability to transform an *NxN* system of bilateral links in the gravity model into a *2xN* dimensional series of country-specific indexes. Namely, this property of MRs makes them particularly appealing for structural estimation and policy analysis.

In the framework of GE structural gravity analysis the MR terms represent the GE trade cost terms. In other words, the MRs will capture the fact that a change in trade cost will not only entail a change in bilateral trade flows between the EU regions (i.e. direct partial effects) but will also result in: (i) additional (i.e. general equilibrium) effects for the involved regions (treated group); and (ii) will also affect other non-EU regions; with (iii) possible feedback effects for the affected EU-regions. In fact Anderson and Van Wincoop (2003), highlight the importance of GE effects of the MR terms for the appropriate account of the impact of a change in trade costs on trade between any two trading partners. The main point being that, as mentioned above, the trade between two regions/countries depends not only on the their direct bilateral trade costs, but also on the trade costs between them and the rest of the world. In other words, in case of the reduction of trade costs between two regions the GE effect will result in the lower MRs between the affected regions and higher MRs between the affected regions and the rest of the world. As a result, the treated regions become more integrated while becoming more isolated from the rest of the world.

Next important property of the MR terms is that they can decompose the aggregate effect of the changes in trade costs into the impact of the aforementioned changes on consumers and producers in each region/country in the world.

In summary, the MRs carry appealing properties from both structural estimation and policy perspective. Specifically, from a policy perspective, the MR terms are seen as informative indexes that summarise the GE effect of changes in trade costs, while they can also be used to aggregate and decompose the effects of said changes on consumers and producers not only in affected regions, but also in the rest of the world.

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