EXTENDED ABSTRACT

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Title:

European NUTS 2 regions: consistent Inter-regional Trade and Transport flows estimation

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Abstract: *(minimum1500 words)*

Economic development is interregional in nature, where physical and technological proximity determined by interregional and national cross-border interactions in trade, investments and knowledge are important determinants of economic growth. However, quantitative policy research analysing regional development in Europe such as proposed in the regional smart specialization strategy (McCann and Ortega-Argilés, 2011) has been hampered by data deficiencies. These data deficiencies are particularly severe on inter-regional trade relations that are central in regional economic modelling.

This study focuses therefore on a central part of multiregional input-output (IO) tables that are interlinked with trade in goods and services, within the same country as well as with regions in other Member States. Trade in goods and services will be derived from freight transport data and airline data on flights, and business travel data taking

transhipment locations into account. The methodology is centred on the probability of trade flows and was developed to fit the information available, without pre-imposing any geographical structure on the data. The method extends the approach proposed in Thissen et al. (2013) and is in line with 'parameter-free' universal methodologies as proposed by Simini et al. (2012). The new methodology makes it possible to analyses the importance of transhipment locations (hubs) in regional trade and link up actual transport costs to multiregional trade flows.

Introduction

Economic policy research in the EU analysing regional place-based development is seriously hampered by data deficiencies. This is particularly the case for the data and empirical evidence on interregional trade relations. The existing data on interregional trade are incomplete and based on data points which are far in the past. Therefore, interregional trade flows data needs to be estimated based on the state of the art methodology and developed in such a way that they can be subsequently used in transport, economic, econometric and spatial CGE analysis.

This study focuses on the construction of such interregional trade in goods and services of the regions, within the same country as well as with regions in other Member States. The estimation is based on a regionalisation of Supply and Use Tables explained in the next section. The production and consumption of goods and services in these European NUTS2 regions were subsequently interlinked using data on both freight transport (5 modes) for goods and business travel (3 modes) for services. The estimated transhipment locations and the number of transhipments are specific for every good on every trade link.

The Regionalization of Supply and Use Tables, not IO tables

We employed the approach known as the Commodity Balance (CB) method to regionalize the national accounts data. National supply and use tables were crossed with regional data on available data on value-added, regional investment, government demand and consumer demand (both with regional income as a proxy) from Eurostat (2014). Consistency of regional value-added, investment, government demand and consumer demand with the national account data was obtained by multiplying the national value according to the national accounts with the share of regions in the national totals. The structure of the national supply and use tables is assumed to give a good approximation for the regional tables. More formally, consumers are assumed to have homogenous preferences throughout the country concerned, homogenous government spending is assumed over the regions, and industries are assumed to use the same production technology, irrespective of their location within the country concerned.

The resulting regional supply and use tables are the basis for the estimation of the interregional trade flows. We use supply and use tables rather than Input-Output tables, because the focus is on the regionalization of both trade and regional technological coefficients (the use and supply of products by different economic actors). An input-output table is built around the assumption that every sector produces only one good. Therefore, depending on the type of IO table, either the sectors are not comparable over the nations and not comparable with regional sector statistics, or products are not comparable over nations and not comparable with trade statistics. Hence, a regionalisation of IO tables cannot make use of both regional sector statistics and regional trade statistics. As a consequence the regionalization of a complete supply and use framework is the only option available to us.

The regionalization of Trade flows

The central principle in our methodology inferring European regional trade flows from different sources of information is increasing data reliability by imposing consistency with available statistics. Regional trade flows need to be consistent with statistics on production and consumption per region, which, in turn, must be in line with national data on production and consumption. These regional flows must also be consistent with international trade statistics, on a national level. The amount of goods traded between regions should also be consistent with the amount of goods transported. Furthermore, international trade statistics also must be consistent with national data on production, consumption, imports and exports. Finally, trade statistics should be mutually consistent. That is, exports from a region or country A to a region or country B should equal the opposite flow of imports received by region or country B. All these consistency checks provide additional information and therefore add to the quality of the estimated trade flows.

The methodology is based on the demonstrated methodology in Thissen et al. (2013), revise to improve upon the validity and the quality of the estimate by incorporating the estimation of transport flows into the estimation of the trade flows. The methodology is based on the distribution of probabilities of transport flows between regions that are described in the next subsection. These probabilities are subsequently used to estimate transhipment locations, specific number of transhipment per good and the amount of goods and services traded between regions.

In our proposed new methodology we determined the trade between nuts2 regions given data on freight transport and regionalized supply and use tables for the European NUTS2 regions. The methodology was based on linear and non-linear optimization techniques. The methodology consists of two independent steps. In the first step we determine the probability matrices of trade between regions using 0, 1, 2, up to 5 transhipment locations. In the second step these probability matrices are used to estimate the trade between the regions where we minimize the estimate for value per ton shipped in a country, and the differences in observed and predicted transport flows, and observed and predicted ton goods loaded and unloaded in a region. We describe below the two basic steps in the new methodology in more detail.

Distribution Probabilities

In order to calculate all possible trade destination possibilities for different number of transhipment transport of the goods we need a basic probability matrix. This probability matrix is derived from origin-destination transport matrices by dividing the amount of goods transported by a region to another region by the total amount of this good being transported.

In mathematical terms we therefore have the probability matrix $\chi_{\tau,p,r,s}$ derived from the freight matrix $F_{p,r,s}$ as follows.

$$\chi_{0,p,r,s} = \frac{F_{p,r,s}}{\sum_{s'} F_{p,r,s'}} \quad (0.1)$$

Using this information we can determine the probability of trade using one or multiple transhipment locations by multiplying the appropriate probability matrices for non-transhipment trade. We apply several logical conditions on transhipments such as that goods that leave a region do not return to the same region and goods that leave a country do not return to the country they were produced. In a similar way we can determine exactly how many goods are likely to leave a transhipment location for every route taken. Since we also have the bi-regional distance matrices between the regions we can also determine the amount of kilometres these goods have been transported.

Using the $\xi_{r,s}$ Distance matrix in km from region r to region s we can determine the following associated distance $\zeta_{0,p,r,r}$ with the non-transhipment trade.

(0.2)
$$\begin{aligned}\zeta_{0,p,r,r} &= \sum_{s} \chi_{0,p,r,s}\xi_{r,s}\\ \psi_{0,p,r,r} &= 1\end{aligned}$$

Using this information we can determine the probability of trade using one or multiple transhipment locations. The following set of equations determines the needed probabilities and distances.

(0.3)
$$\begin{aligned}\chi_{1,p,r,s} &= \sum_{r'|r'\neq r,r'\neq s} \chi_{0,p,r,r'}\chi_{0,p,r',s}\\ \zeta_{0,p,r,r'} &= \sum_{s|r'\neq r,r'\neq s} \chi_{0,p,r,r'}\chi_{0,p,r',s}\xi_{r,s}\\ \psi_{0,p,r,r'} &= \sum_{s|r'\neq r,r'\neq s} \chi_{0,p,r,r'}\chi_{0,p,r',s} = \chi_{0,p,r,r'}\end{aligned}$$

There is one more condition on r' that is left out of the above equation. This condition is that if r' is in a different country than r, then r is also in a different country than s. In a comparable way all parameters for the different number of transhipment trade is determined.

We also need the probabilities of a good leaving a region for every transhipment route. We also need the kilometres of these good leaving that region. These probabilities can be easily calculated from the probabilities of transhipment summing up in different points of the transport chain.

Trade assignment Model

Given production, consumption from the regionalized supply and use tables and multi-country trade from the national supply and use tables, we used quadratic and nonlinear programming to minimize the distance of the predicted trade flows based on the calculated probabilities and the trade flows determined in the trade assignment. Moreover, we will also minimize the distance to the observed Eurostat information on value per ton for every good, goods loaded in every region, the goods unloaded in every region, and the ton kilometres of goods leaving a region.

In mathematical terms we therefore have the following model. Let us have regions r, s, countries l, k and products p. Production and Trade are classified according to number of $\tau[0,\ldots,4]$ transhipment locations used. Notice that to solve the model it can be solved for all products separately since they are not dependent on each other.

The NLP Model

(0.4) *Minimize* $$Z=\sum_{l,k}\left(\sum_{\tau,p,r\in l,s\in k}\left(\nu_{\tau,p,r,s}-\nu_{p,l,k}\right)^2\right)+\frac{1}{\bar{G}_{p,s}}\sum_{p,s}\left(\bar{G}_{p,s}-G_{p,s}\right)^2$$

Subject to

(0.5) $$X_{p,r}=\sum_{\tau,s}\nu_{\tau,p,r,s}Q_{\tau,p,r}\chi_{\tau,p,r,s}$$

(0.6) $$C_{p,s}=\sum_{\tau,r}\nu_{\tau,p,r,s}Q_{\tau,p,r}\chi_{\tau,p,r,s}$$

(0.7) $$T_{p,l,k}=\sum_{\tau,r\in l,s\in k}\nu_{\tau,p,r,s}Q_{\tau,p,r}\chi_{\tau,p,r,s}$$

(0.8) $$\bar{U}_{p,s}=\sum_{\tau,r}Q_{\tau,p,r}\chi_{\tau,p,r,s}+\sum_{\tau,r\neq s}Q_{\tau,p,r}\psi_{\tau,p,r,s}$$

(0.9) $$\bar{N}_{p,r}=\sum_{\tau,s}Q_{\tau,p,r}\psi_{\tau,p,r,s}$$

(0.10) $$G_{p,s}=\sum_{\tau,r}Q_{\tau,p,r}\psi_{\tau,p,r,s}\zeta_{\tau,p,r,s}$$

(0.11) $$Q_{0,p,r}\geq Q_{1,p,r}\geq Q_{2,p,r}\geq Q_{3,p,r}\geq Q_{4,p,r}$$

List of Exogenous Variables and parameters needed for probabilities

$F_{p,r,s}$ Freight of product p from region r to region s in tons

$\xi_{r,s}$ Distance matrix in km from region r to region s

$X_{p,r}$ Total production of product p in region r in values

$C_{p,r}$ Consumption of product p in region r in values

$\chi_{\tau,p,r,s}$ Probability matrix of trade of product p from region r to region s that is going to be traded using τ transhipment locations

$\psi_{\tau,p,r,s}$ Probability matrix of trade of product p from region r that will be transhipped in region s and that is using τ transhipment locations

$\zeta_{\tau,p,r,s}$ Distance matrix in km of trade of product p from region r that is using τ transhipment locations and is leaving transhipment region s

$T_{p,l,k}$ Country trade of product p from country l to country k

$\bar{U}_{p,r}$ Data on Goods unloaded in region r (tons)

$\bar{N}_{p,r}$ Data on Goods loaded in region r (tons)

$\bar{G}_{p,r}$ Data on Ton kilometres of goods leaving region r

Endogenous positive Variables

$Q_{\tau,p,r}$ Production of product p in region r in tons that is going to be traded using τ transhipment locations

$v_{p,r}$ Value per ton

$G_{p,r}$ Ton kilometres of goods leaving region r (tons)

Conclusions

The end result are regional trade matrices that are not only consistent with the regional supply and use tables, but also with the main European transport data taking multimodal transport (5 modes) with endogenously determined transhipment locations into account. This makes it possible to analyses the importance of transhipment locations (hubs) in regional trade and link up actual transport costs to multiregional trade flows.

The new methodology gives a better trade estimate now more detailed information transported goods is being used. This will strengthen the validity of the trade dataset and extend the use of the data beyond the field of economics (i.e. transport and logistics).

The goods trade estimates are more detailed due to improved quality of micro data on freight transport and the improved data on regional business travel will results in better services trade estimates. Moreover, improved estimation of the amount of cross-hauling will be achieved by integrating this in the estimation methodology.

References

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JEL codes: