Towards a New Economic Geography based Estimate of Cross-Hauling in Regional Supply and Use Tables

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Abstract. Regional supply, use and input-output tables are commonly estimated using nonsurvey techniques and are not constructed from survey data. However, these nonsurvey regionalization techniques do not take the possibility of exporting and importing the same type of products (cross-hauling) into account. Recently a new method was proposed to address this problem (Kronenberg, 2009). Although this method improves on earlier techniques as it makes cross-hauling possible, it is still subject to two major problems. These problems are the lack of an economic theoretical framework explaining the existence of cross-hauling, and the method is applicable to only one table independent from the others because the resulting regional tables would not add up to the national total. We therefore propose a new approach derived from the theoretical Dixit-Stiglitz-Krugman NEG model which is based on monopolistic competition and the love of variety. Its application is illustrated by the estimation of regional input-output tables for Europe (nuts 2) based on the European System of Accounts tables. Naturally, the new approach does not suffer from the underestimation of trade and the overestimation of regional input-output multipliers of earlier methods. The new method also gives insight in crucial parameters of the Dixit-Stiglitz-Krugman model such as the mark-up of regional trade transport costs.

Introduction

Supply, use and Input Output-Tables are commonly used as the main database for regional economic models such as regional Input-Output models or Spatial Computable General Equilibrium models. However, supply and use tables are not commonly made available at the regional level because the construction and collection of necessary data is too labour intensive and thereby too expensive. Regionalization methods based on nonsurvey methods requiring only little data became increasingly popular (Hewings 1985). There exists a variety of non-survey techniques aimed to construct regional use and supply tables by inferring the required information from other sources (see Tohmo, 2004 for an overview). A diffused approach consists into the disaggregation of national use and supply tables: the available data at regional level is used to split national data across regions, through a set of assumptions, for instance homogeneous technologies of national firms or homogenous export supply functions across regions.

More recently, nonsurvey methods are considered rather unreliable and systematically biased (Tohmo 2004). The main problem with nonsurvey methods is their failure to adequately take cross-hauling into account (Richardson 1985, Kronenberg 2009). Regionalization of the Supply and Use tables only determines the net trade balans between regions. Cross-hauling, trading apparently similar products back and forth between regions, is not determined after the regionalization procedure.

The aim of this paper is to suggest a methodology that estimates bilateral trade flows between a region and the rest of the country, starting from obtainable information on regional production, regional demand and the net trade balance that follows from a standard regionalization approach. Earlier methods proposed to address the cross-hauling problem (Kronenberg, 2009) were still subject to two major problems. These problems are the lack of an economic theoretical framework explaining the existence of cross-hauling, and the method is applicable to only one table independent from the others because the resulting regional tables would not add up to the national total.
We therefore propose an approach strongly embedded in economic theory. More specifically it makes use of the setup outlined by Dixit-Stiglitz monopolistic competition in which firms and consumers are located in different regions and transport costs are shaped as iceberg transport costs. The Dixit-Stiglitz-Krugman model first presented in Krugman (1991), allows for heterogeneous products implying variety, and is a theoretical economic (general equilibrium) model that allows for cross hauling of close substitutes.
The model we proposed, unlike other approaches to solve the cross-hauling problem, has also the advantage to be symmetric among regions. This means that if all regions in a country are inferred from a national table using our approach they will add up to the original national table including the cross-hauling which is also consistent with respect to the total volume of imports and exports between the regions within the country.

A theoretical model for cross-hauling

Our theoretical model for cross-hauling is based on the standard New Economic Geography model developed in Krugman (1991). A more recent overview of the model and its characteristics can be found in Glaeser (2008), Baldwin et al. (2003), and Fujita and Thisse (2002). To the core of the model and our approach is the familiar Dixit-Stiglitz (DS) demand function:

(1)
$$c_k = \frac{P_k^{-\sigma}}{\sum_k P_k^{1-\sigma}} E$$

Where c is the real consumption demand, P is the price of variety k, E is total expenditure. The nominal demand for the variety would therefore be

(2)
$$C_k = \frac{P_k^{1-\sigma}}{\sum_k P_k^{1-\sigma}} E$$

With two regions j and i, the nominal consumption of the generic variety k, in region j, depends on whether the variety k is produced locally (in j) or it is imported from region i.

(3) $$C_j^j = \frac{P_j^{1-\sigma}}{n_j P_j^{1-\sigma} + n_i (P_i T)^{1-\sigma}} E_j$$

(4) $$C_i^j = \frac{(P_i T)^{1-\sigma}}{n_j P_j^{1-\sigma} + n_i (P_i T)^{1-\sigma}} E_j$$

Where the superscript of C represents the region in which goods are consumed, n is number of varieties and T are transport costs. Since we are working with only two regions and we assume that the cost of shipping goods from i to j equals the cost of shipping from j to i, parameter T is not indexed. It is recalled that, in the Dixit-Stiglitz-Krugman model, transport costs are modelled as iceberg transport costs, meaning that T (with $T \geq 1$) is the number of goods that need to be produced in region i to deliver one unit in j. Optimizing behaviour of firms implies that a manufacturer in i will sell its product at price P_i in i and at price $P_i T$ in j. Naturally, the identical discussion holds for goods shipped from region j to region i. We also observe that the denominator, the price index, is different between regions.

We have now enough information to define exports and imports. Let X_j be exports of region j and let I_j be the imports in region j. Imports are nothing more than the consumption in region j of the generic variety produced in region i, times the number of varieties in i. The same reasoning can be applied to exports. We now can define them as

(5) $$I_j = \frac{(P_iT)^{1-\sigma}}{n_jP_j^{1-\sigma} + n_i(P_iT)^{1-\sigma}} E_j n_i \equiv X_i$$

(6) $$X_j = \frac{(P_jT)^{1-\sigma}}{n_iP_i^{1-\sigma} + n_j(P_jT)^{1-\sigma}} E_i n_j \equiv I_i$$

Moreover we also have by definition

(7) $$Z_j = I_j - X_j = X_i - I_i = -Z_i$$

(8) $$Y_j = E_j - I_j + X_j = E_j - Z_j$$

Where Z_j is the trade balance and Y_j is total output. In equations (5) and (6), it can be observed that total imports and exports depend on the parameters n_j and n_i, number of varieties (or firms) in region j or region i. To solve the equations, we link the number of varieties to the size of the economy.
Define Q_j the quantity of goods produced by a generic firm in j. We can split this quantity in $q1_j$ and $q2_j$, with $q1_j$ being the goods sold in the local market and $q2_j$ the goods exported to region i. It is important to highlight that, because of the structure of iceberg transport costs, this generic firm in j produces $q1_j + q2_j$T goods, but sells only $q1_j + q2_j$. It follows that

(9) $$y_j = (q1_j + q2_j)n_j$$

Where y_j is the total output expressed in quantities. For the purposes of this paper we want to express the relationship in (9) in nominal values

(10)
$$Y_j = [q1_jP_j + q2_j(P_jT)]n_j$$
$$Y_j = P_j(q1_j + q2_jT)n_j$$

In the Dixit-Stiglitz-Krugman model we have that maximizing behaviour of firms, in conjunction with the zero-profit condition in the long run, leads to

(11) $$q1_j + q2_j T = \frac{F(\sigma - 1)}{V}$$

Where F equals fixed costs and V equals variable costs. We now have everything is necessary to define the number of varieties in *j*

(12) $$n_j = \frac{Y_j}{\alpha P_j}$$

The parameter α is $F(\sigma\text{-}1)V^{-1}$. If the new expressions of number of varieties are plugged in (5) we obtain the following

(13) $$I_j = \left[\frac{(P_i T)^{1-\sigma}}{\left(\frac{Y_j}{\alpha P_j}\right) P_j^{1-\sigma} + \left(\frac{Y_i}{\alpha P_i}\right)(P_i T)^{1-\sigma}} \right] E_j \left(\frac{Y_i}{\alpha P_i}\right) \equiv X_i$$

Which simplifies in

(14) $$I_j = \frac{P_i^{-\sigma} T^{1-\sigma} E_j Y_i}{Y_j P_j^{-\sigma} + Y_i P_i^{-\sigma} T^{1-\sigma}} \equiv X_i$$

Utilizing the identical procedure from the point of view of region *i*, the result is

(15) $$X_j = \frac{P_j^{-\sigma} T^{1-\sigma} E_i Y_j}{Y_i P_i^{-\sigma} + Y_j P_j^{-\sigma} T^{1-\sigma}} \equiv I_i$$

The solution of the system

All the information available at this point on exports and imports are embodied into equations (7), (14) and (15). There are still three unknown in these equations, namely P_j, P_i and T.
Before showing how we proceed from here, allow us to adopt a slightly different notation, to make algebraic transformations easier to read. Let us define $t = T^{1-\sigma}$.
Now we take (14) and we multiply both sides of the equation by the denominator of the right hand side (RHS).

(16) $$(Y_j P_j^{-\sigma} + Y_i P_i^{-\sigma} t) I_j = P_i^{-\sigma} E_j Y_i t$$

We rearrange and take the price ratio

(17) $$\left(\frac{P_j}{P_i}\right)^{-\sigma} = \frac{E_j Y_i t - I_j Y_i t}{I_j Y_j}$$

Again, it is possible to apply the same method on the export equation. Rearranging (15) we obtain

(18) $$\left(\frac{P_j}{P_i}\right)^{-\sigma} = \frac{X_j Y_i}{E_i Y_j t - X_j Y_j t}$$

Combining (17) and (18)

(19) $$\frac{X_j Y_i}{E_i Y_j t - X_j Y_j t} = \frac{E_j Y_i t - I_j Y_i t}{I_j Y_j}$$

(20) $$(X_j Y_i)(I_j Y_j) = (E_j Y_i t - I_j Y_i t)(E_i Y_j t - X_j Y_j t)$$

(21) $$X_j I_j = E_i E_j t^2 - E_i I_j t^2 + X_j I_j t^2 - E_j X_j t^2$$

Last step we have to comply is to use the definition of trade balance in (7) to express imports and exports as functions of transport costs. It is indifferent to proceed with respect to imports or exports. We start with exports. We plug in $I_j = Z_j + X_j$ into equation (21) to obtain

(22) $$X_j Z_j + X_j^2 = E_i E_j t^2 - E_i Z_j t^2 - E_i X_j t^2 + X_j Z_j t^2 + X_j^2 t^2 - E_j X_j t^2$$

Which rearranged is

(23) $$(1 - t^2) X_j^2 + (Z_j + E_i t^2 - Z_j t^2 + E_j t^2) X_j + (E_i Z_j t^2 - E_i E_j t^2) = 0$$

Then, we repeat for imports

(24) $$(1 - t^2) I_j^2 + (-Z_j + E_i t^2 + Z_j t^2 + E_j t^2) I_j + (-E_j Z_j t^2 - E_i E_j t^2) = 0$$

The determination of import and export flows

The whole set of transformations and rearrangements performed so far have conducted us to equations (23) and (24) which are the mirror images of each others. Our main task is to extract the values of imports and exports starting from the information we avail. A two-regions Dixit-Stiglitz/Krugman model has been set up, to show that, for the estimation of final flows of imports and exports, we do not need most variables and structural parameters of the model. Likely, during the transformations we simplified prices, number of firms, size of labour force, variable costs and fixed costs. The final specifications in (23) and (24) tell us that what we need is the demand in the two regions, the trade balance and the transport costs between them. The reader is reminded that, if we are performing a regionalization of the national supply and use tables, we possess the pieces of information required to have regional demand and trade balance. Consequently, to arrive to an estimate of interregional exports and imports we only need assumptions on $t=T^{1-\sigma}$.

There is a strong break point at this stage, since, depending on the assumptions we make, the model will take two completely different directions. The first branch is obtained by simply assuming that there are no transport costs between regions (T=1). By doing so, all t will drop out from (23) and (24) as well as the quadratic terms, leading the model to a simple and elegant solution, with trade flows that depend only on E_j, E_i and Z_j.

(25) $$X_j = \frac{E_i E_j - Z_j E_i}{E_j + E_i} \equiv I_i$$

It is worth noticing that positive export are observed if $E_j - Z_j > 0$. From equation (8), we observe that this happens when there exists a positive production. We can also rewrite

(26) $$X_j = \frac{E_i(E_j - Z_j)}{E_j + E_i} = \frac{E_i Y_j}{E_j + E_i} \equiv I_i$$

It is easy to verify that $X_j \equiv I_i$ and $I_j \equiv X_i$. This symmetry is reflected also on the condition for positive imports, which is $E_i + Z_j > 0$ or $E_i - Z_i > 0$.
The second branch of the model is defined when we assume positive transport costs (T>1). This second setting is theoretically more accurate, if transports costs are expected to be relevant for regional trade. On the other hand, the greater accuracy is paid with a loss of simplicity. The estimates of imports and exports now depend on the numeric values we attribute to T and σ. Moreover the objective variable (either X_j or I_j) appears with a quadratic term in our equation. Although for quadratic equations it is possible to derive the two analytical solutions, in this case the level of complexity of the symbolic expression of these solutions prevents to attribute a neat economic interpretation.

(27) $$X_j = \frac{-(Z_j + E_i t^2 - Z_j t^2 + E_j t^2) \pm \sqrt{\begin{array}{c} Z_j^2 + 2Z_j E_i t^2 - 2Z_j^2 t^2 + 6E_j Z_j t^2 + \\ + E_i^2 t^4 - 2E_i Z_j t^4 - 2E_j E_i t^4 + Z_j^2 t^4 + \\ -6E_j Z_j t^4 + E_j^2 t^4 + 4E_j E_i t^2 \end{array}}}{2(1-t^2)} \equiv I_i$$

There is a clear trade-off between the two cases. If no transport costs are assumed, the model offers formulas for exports and imports that are easy to treat analytically. However, the presence of transport costs in the model is very appealing for international economics and regional sciences. A mathematical expression that relates exports, demand, production and transport costs can be used to estimate trade flows with a methodology that could work as an alternative to the largely diffused gravity models. Another immediate application of such relationship is that it offers, when data on imports and exports are available, ((a way to estimate transport costs, which, in turn, is a test for the validity of the model itself)). For all this reasons, the following paragraph will be dedicated to a brief analysis of equation (27).

Analysis of the export equation

It needs to be stressed that equation (27) is interesting because it gives an expression of exports that depends on transport costs and other variables that are generally available at the national statistical offices. Starting from the well accepted Dixit-Stiglitz-Krugman model, we were able to derive this relationship, without making further assumptions that could have moved away from the theory. The appealing points of this approach demand for a detailed analysis of equation (27), but, unfortunately, the relationship under exam is hardly tractable from an analytical point of view. It is, however, possible to discover the boundaries of the function and to observe some properties.
The first thing one should investigate is the number of solutions of the equation. We are dealing with an equation of degree two, with the typical form $ax^2+bx+c=0$. Equation (23) is re-reported to facilitate the comparison.

(23) $$(1-t^2)X_j^2+(Z_j+E_it^2-Z_jt^2+E_jt^2)X_j+(E_iZ_jt^2-E_iE_jt^2)=0$$

The solutions, with a not equal to zero, are well known: $x_{1\text{-}2}=(-b\pm(b^2\text{-}4ac)^{0.5})/2a$. Although it is not possible, before we attribute a numerical value to our variables, to know the exact size of *a, b* and *c,* we can use the information we avail to study what we should expect. Equation (15), repeated below, suggests that if either Y_j or E_i is equal to zero, then there will be no export at all.

(15) $$X_j=\frac{P_j^{-\sigma}T^{1-\sigma}E_iY_j}{Y_iP_i^{-\sigma}+Y_jP_j^{-\sigma}T^{1-\sigma}}\equiv I_i$$

We also do not want these two variables to be negative, so we can implement two conditions: Y_j>0 and E_i>0. Morover, t is always between zero and one, while domestic demand is expected to be non-negative. Under these conditions it can be demonstrated that the expression under the root in (27) is always positive, leading the model to have two solutions. Under the same conditions, we can prove that one of the solution is always negative, while the other is always positive. Naturally, the only solution that makes sense in economic terms is the positive one, which the following of the paragraph will focus on.

Now that it has been determined that there is always a positive solution, where is this expected to lie? The lower boundary has been already drawn: if Y_j=0 or E_i=0 there will be no export. As soon as we attribute to both even the smallest positive value, positive flows will be predicted. Where is the higher boundary? Also for this question there is an easy answer. The maximum amount of exports is reached in case the export flows are satisfying the entire foreign demand. This happen in case there is no foreign production (Y_i=0). Subsequently there will be no imports from that region and $X_j = E_i = Z_i = -Z_j$. This result is better observable starting from equation (15).

(15) $$X_j=\frac{P_j^{-\sigma}T^{1-\sigma}E_iY_j}{Y_iP_i^{-\sigma}+P_j^{-\sigma}T^{1-\sigma}Y_j}=E_i\equiv I_i$$

So far we described two obvious, but necessary, limit cases. First, if the production is entirely concentrated in the foreign region there will be no exports from home. Second, if the production is concentrated home, the exports will equal the foreign demand. Next, it is worth studying a third limit case: when the two regions are identical. This option is particularly convenient because it simplifies drastically the export function. In fact, with two identical regions we have that $E_j = E_i$ and $Z_j = 0$. Equation (23) becomes

(29) $$(1-t^2)X_j^2+(2E_it^2)X_j+(E_it^2)=0$$

With the usual solution algorithm, we have

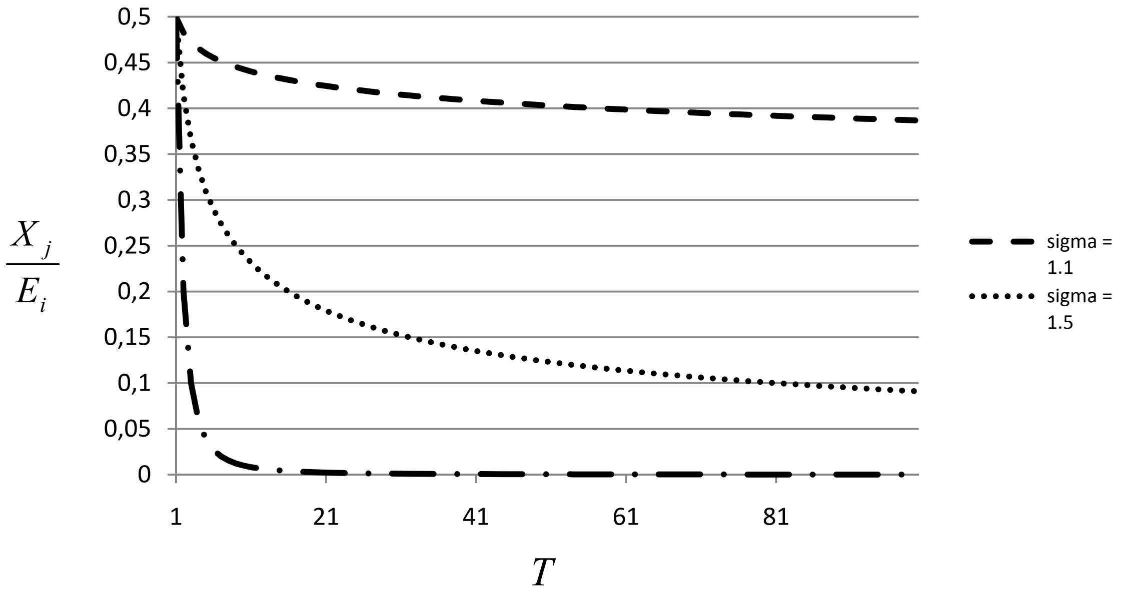
(30) $$X_j = \frac{-2E_i t^2 \pm \sqrt{4E_i^2 t^2}}{2(1-t^2)} \equiv I_i$$

Only the positive solution is taken

(31) $$X_j = \frac{2E_i(t-t^2)}{2(1-t^2)} = \frac{2E_i(1-t)t}{2(1-t)(1+t)} \equiv I_i$$

(32) $$X_j = E_i \frac{t}{(1+t)} \equiv I_i$$

It is highlighted that, since t varies between 0 and 1, $t/(1+t)$ lies between 0 and 0.5. We can interpret this parameter as a percentage. Transport costs are determining what part of the demand is satisfied by imports from the other region. In case there are no transport costs, the answer is exactly half. In the following graph we can visualize the relationship between exports and transport costs T (with $T = t^{1/(1-\sigma)}$).



As expected, the percentage of foreign demand satisfied by interregional trade is in indirect relationship with transport costs. The lower limit is 0.5, which indicates that, with no transport costs, consumers spend their money equally between the varieties of the two regions. When transport costs go to infinitive, X_j/E_i goes to zero. We also notice that three graphs have been drawn for three different numerical values of sigma. It is clear that for higher sigma, the responsiveness of consumers to transport costs increases. This is not surprising. When the elasticity increases, the varieties become more and more substitute to each others. The price becomes more relevant to the consumer and a rise of transport costs leads to a stronger shift towards local goods.

Unlikely, the same type of analysis cannot be replicated for regions of different sizes, due to the difficulties to treat the function (27) with the tools of analysis. The best option we have is to explore the function numerically, which means studying a function in $R^4 \rightarrow R$, if we make assumptions on T and sigma together, and a function in $R^5 \rightarrow R$ if we want to see the effects separately.

The simulation we performed revealed no surprise: exports are increasing in foreign demand E_i and local production Y_j, while they are decreasing in transport costs and elasticity. Local demand E_j also decreases total exports. This is not in contradiction with the home market effect of the Krugman model, because, in our setup, demand and production are exogenous. The labour force is also exogenous and immobile. Hence, if local demand exogenously increases, but the local production stays the same, firms in the region will move part of their sells to the local market.

The responsiveness of exports to foreign demand E_i depends on the level of transport costs T and level of sigma. When these last two parameters are high enough, a variation of E_i will have an little effect on export. When, instead, transport costs are low, local firms will respond strongly to foreign demand. With respect to local demand E_j the converse is true: in case of high transport costs, firms are more willing to substitute exports to supply the local market.

(33)
$$X_j = E_i \frac{t}{(1+t)} \equiv I_i$$

The empirical estimation of Cross-hauling in European nuts2 regions

The theoretical model built in this paper, relates production, consumption, internal trade balance, elasticity of substitution and transport costs with internal trade. With respect to production, consumption and internal trade balance, those are quantities that can typically be extracted with nonsurvey regionalization techniques. In case one obtains estimates of the elasticity of substitution between varieties and of transport costs, cross-hauling can be simply be computed. As mentioned before, these estimates are consistent with each other. The possibility of computing is given by the fact that the model with only two regions has an analytical solution.

In our case we have 19 national supply and use tables for the year 2000 which are publicly available from Eurostat. Using data from ERP Cambridge econometrics these tables have been regionalized with respect to250 nuts 2 regions. In order to focus on our approach of cross-hauling we will not discuss the details of the standard regionalization of the table. The standard regionalization gives us supply and use tables for all nuts2 regions without cross-hauling, thus only with a net trade balance. Moreover, from the national tables we derive the total transport margins *TM* for every distinguished. We are now set to determine the cross-hauling for our regions by minimizing the following objective function for every product group:

$$Min \quad Z = \sum_c \left[TM_c - \sum_{j,c} (\tau_c - 1) X_{j,c} \right]^2$$

$$s.t.$$

(34) $$(1-t_c^2)X_{j,c}^2 + (Z_{j,c} + E_{i,c}t_c^2 - Z_{j,c}t_c^2 + E_{j,c}t_c^2)X_{j,c} + (E_{i,c}Z_{j,c}t_c^2 - E_{i,c}E_{j,c}t_c^2) = 0\,,$$

$$\tau_c = 1 + \ln\left[1 + \gamma \bullet dist_{j,c}\right]$$

$$t = (\tau_c)^{1-\sigma}$$

Where τ_c is the iceberg transport costs markup for country *c,* $dist_{j,c}$ is the distance from region *j* to the average of the other regions in the country, and γ is a parameter in the cost function.

However, before presenting our results we first need an indicator for cross-hauling. Following Kronenberg we define the degree of cross-hauling (*CH*) as

(34) $$CH = \frac{X_j + I_j + \left|I_j - X_j\right|}{X_j + I_j},$$

Where I_j are the imports in region *j*, $X_j + I_j$ is the total volume of trade (*VT*) and $I_j - X_j \equiv Z_j$ is the net trade balance.

Since exports or imports cannot be negative by definition, the degree of cross-hauling lies between zero (no cross-hauling) and one (maximum cross-hauling).

In Table 1 we present our estimation results of the degree of cross-hauling in European nuts2 regions assuming a substitution elasticity σ equal to 1.5. For matters of space we present only the average values of all regions in the different countries for the aggregates of agricultural and industrial products. We also present to total volume of trade and the markup next to the degree of crosshauling.

Table 1: Cross-hauling in nuts 2 regions in different countries (substitution elasticity is 1.5)

	Industry			Agriculture		
	CH	VT	Markup	CH	VT	Markup
Austria	0,892	127313	0,021	0,792	11953	0,012
Belgium	0,848	177722	0,008	0,764	15360	0,005
Czech Republic	0,913	57737	0,016	0,832	7797	0,009
Germany	0,338	266179	0,028		26422	0,017
Denmark	0,886	40288	0,010	0,104	4102	0,006
Spain	0,460	195584	0,054	0,691	64053	0,033
Finland	0,935	65186	0,038	0,658	8805	0,023
France	0,679	345550	0,040	0,826	137037	0,024
Greece		12826	0,032		6641	0,019
Hungary	0,856	38402	0,017	0,746	8216	0,010
Ireland	0,571	11839	0,014	0,562	5170	0,008
Italy	0,834	1169973	0,041		14353	0,024
Netherlands	0,886	218500	0,011	0,013	6033	0,007
Norway	0,850	81854	0,043		3356	0,026
Poland	0,936	159636	0,028	0,894	36681	0,016
Portugal	0,887	76263	0,022	0,625	13187	0,013
Sweden	0,837	88331	0,044	0,013	4836	0,026
Slovakia	0,915	13120	0,016	0,909	3297	0,009
United Kingdom	0,652	395343	0,025	0,067	22295	0,015

The degree of cross-hauling among European regions is high in Table 1 which emphasizes the large error that is being made if cross-hauling is not taken into account. The variation in the degree of cross-hauling among regions in different European countries is also quite substantial. This may be caused by specific regional production patterns, but may also be caused by large differences in transport margins in the original country tables. For instance, very low overall transport costs cause cross-hauling to become zero in some countries. The reason is that cross-hauling increases the total volume of trade which is given the estimate for γ leading to transport costs which are too high compared to the data in the national table.

In a second step we analyse the sensitivity of the results for our assumption regarding the substitution elasticity between product varieties of 1.5. We therefore also estimate the degree of cross-hauling with a very high substitution elasticity of 5. The resulting degree of cross-hauling is presented in Table 2. The degree of cross-hauling becomes lower when the substitution elasticity increases. This is what is theoretically expected. However, the differences are very small. The reason is that in our estimation procedure the total transport costs are given. Smaller trade volumes due to a higher substitution elasticity will therefore cause the transport markup to increase because otherwise total transport costs are not conform the given costs from the national tables. However, higher transport markups will cause an even further decline in trade volumes. The degree of cross-hauling changes therefore only marginally with a change in the assumed substitution elasticity making the estimation very robust.

Table 2: Cross-hauling in nuts 2 regions in different countries (substitution elasticity is 5)

	Industry			Agriculture		
	CH	VT	Markup	CH	VT	Markup
Austria	0,890	125320	0,021	0,791	11896	0,012
Belgium	0,847	176746	0,008	0,763	15325	0,005
Czech Republic	0,912	57107	0,016	0,831	7762	0,009
Germany	0,335	265115	0,028		26422	0,017
Denmark	0,885	39680	0,011	0,103	4095	0,006
Spain	0,451	192155	0,055	0,690	63733	0,033
Finland	0,933	62821	0,039	0,654	8701	0,023
France	0,671	337493	0,040	0,825	136248	0,024
Greece		12826	0,032		6641	0,019
Hungary	0,854	37896	0,017	0,745	8176	0,010
Ireland	0,565	11692	0,014	0,561	5156	0,008
Italy	0,831	1149283	0,041		14353	0,025
Netherlands	0,885	216875	0,011	0,013	6033	0,007
Norway	0,845	79479	0,043		3356	0,026
Poland	0,936	157533	0,028	0,893	36502	0,016
Portugal	0,884	74789	0,022	0,621	13065	0,013
Sweden	0,834	87138	0,044	0,015	4848	0,026
Slovakia	0,913	12870	0,016	0,908	3273	0,009
United Kingdom	0,647	390702	0,025	0,067	22291	0,015

Conclusions

In this paper we presented a new approach to determine the degree of cross-hauling from a regionalization of the supply and use tables. This approach addresses two problems with existing methods: The lack of a theoretical economic foundation for the existence of cross-hauling and an approach that is consistent with respect to the regionalization of *all* regions in a country. Our approach is derived from the sound theoretical Dixit-Stiglitz-Krugman NEG model based on monopolistic competition. It is based on a spatial general equilibrium model and therefore automatically consistent with respect to the estimation of cross-hauling in all regions in a country.

The proposed methodology is illustrated by a regionalization of 19 national European supply and use tables into 250 regional tables. We found that there is a substantial degree of cross-hauling in European nuts2 regions. We also showed that the estimation method is robust with respect to the assumption regarding the degree of substitution among product varieties.

Naturally, the new approach does not suffer from the underestimation of trade and the overestimation of regional input-output multipliers of earlier methods. The new method also gives insight in crucial parameters of the Dixit-Stiglitz-Krugman model such as the mark-up of regional trade transport costs, while it also gives more reliable estimates for regional trade which is crucial for spatial economic research.

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