Deriving Regional Input-Output Matrices to Assess Impacts in Small Portuguese Peripheral Regions

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Abstract

The central aim of this paper is to suggest a working methodology to derive Input Output tables at the regional level, particularly suitable for small peripheral regions. These economies are not very dense, and are heavily dependent on inter-regional and sometimes international imports, especially in some product categories such as manufacturing products. Thus, if one wishes to assess the impact on small regions of the indirect effects of policy interventions, or any other disturbances, there is the need to separate between those effects that are contained within the region and those spilling outside, i.e., diluting across other regions of the country or abroad.

This approach comprehends the adoption of a products taxonomy including three categories: regionally non-tradable products (type A), fully tradable products between regions and internationally (type B); and tradable products mainly with specific regions (type C). It follows that what critically matters to a small region are the types A and sometimes also C products - which have to be necessarily produced in the region or are subject to a limited inter-regional trade, amid a limited number of regions -, as in the other cases the effects are largely directed outside regional borders (spreading to other regions or even countries).

Our analysis is focused in small Portuguese peripheral regions (at the NUTS III level). The results of the complexity indicators calculated for these matrices confirm the reduced complexity of these economies, as well as the regional dependency on the types A and C products.

Keywords: Tradable and non-tradable goods, Input-Output, Small Regions, Regional Accounts, Complexity.

Topic: 1_Construction and adjustment of input-output tables.

1. Introduction

Economies, whether national or regional, are characterized by a complex network of interdependencies. When an economy of a region is hit by a (positive or negative) shock, it is not strictly an economic agent that is affected, but the entire regional economy. Let us assume a positive shock, e.g., a new investment project which involves an increase in the "Construction" activity in the region, for a certain period. In this case, not only the builders operating in the region arise as beneficiaries. These are involved in the first effect line, but the increase in the construction activity requires an increase in the production of various other materials: cement, metal products, bricks, ceramics of many different kinds; and services: engineering, architecture, etc.. Since materials and services consumed by the construction have to be produced, in turn, with other products, this second wave of production may occur in the region, or be satisfied by supply from other places: other regions or countries. Subsequently, the second wave is followed by a third, a fourth, and so on, which can also be met by local or imported production from other regions or countries.

Calculated under the input-output models, the stimuli of the local economy resulting from successive demand increments are usually known as *backward linkages*[1]. Apart from the inter-industry links described above, a positive shock in one region, like the one we are considering, also generates more income, largely distributed to resident households. This increased income allows higher consumption, which must be satisfied with more goods and services that, however, only in part will be produced within the region. Some of these consumer goods will be, for sure, imported, and these imports may be inter-regional or international.

In the language of input-output models, the first type of interdependence, relating the increased demand for raw materials and services as intermediate inputs, equates the *indirect effect* following the shock that the economy of the region was subject. The second type of effect, which involves the household income growth, corresponds to the *induced effect*. The point, however, is that either the indirect or induced effects following the shock, can be felt within the region, or go outside regional borders, spreading to other regions or even countries.

The central aim of this communication is to suggest a methodology that allows separating between the indirect effects that are contained within the region and those spilling outside, i.e., diluting across other regions of the country or abroad[2].

In the literature, several solutions have been proposed to deal with this problem. The more traditional (and often mentioned in textbooks) relies on the concept of location quotient - a measure of the weight of different products in the region according to their importance in the national economy - which is used itself as an indicator of the fraction to be met by domestic flows, for the demand increases following the initial shock. However, as shown in Sargento (2002), even giving examples, this is a mechanistic solution, which in many cases appears to be rough. Another alternative approach is to estimate, product by product, trade within the regions of a country, apart from international trade at the regional level, and then assume that whatever the use to which each product is designed, its imported fraction in a particular region is always the same (this proposal was originally formulated in Moses, 1955; see also Polenske, 1995).

The approach in this communication is different. Our proposal relies on the prior superior knowledge of the regions' economies, product by product and eventually broken down by destiny/use of this product considering a set of assumptions, with the aim of calibrating the input coefficients, of domestic flows type, associated with the production of the various products in those regions, calculated under the Input-Output models. In our opinion, this methodology is particularly suitable for applications in small regions. One reason is that for many products, particularly industrial products, our assumptions imply that the indirect effects are considered to reach the local economy in a very small scale. In fact these products are currently highly differentiated and have, in most cases, a non-significant transportation cost within a small country like Portugal.

[1] The literature also mentions forward linkages, referring to the increased availability of products that can strength opportunities for other productive activities for which these products represent vital inputs in their own productive processes. See, among others, Miller and Blair (2009).

[2] The provisional results here presented are limited to the indirect effects. Although, the proposed methodology can be (and will be) extended to the induced effects, in future work.

Thus, in small regions, following a disturbance involving indirect effects on these products, they end up being massively imported from other regions or abroad. Our argument is that if one wants to analyse the indirect effects on a small region following a policy intervention, those that should be taken as certain are the effects on other types of products - particularly services - which have to be necessarily produced in the region itself or are subject to a limited inter-regional trade, amid a limited number of regions.

Another consequence of concentrating our interest to small regions is our preference for proposing uni-regional Input-Output models, in spite of a large multi-regional model. The advantage of the latter (the drawback is its complexity) is to incorporate *feedback* effects of a regional disruption affecting other regions and coming back to the original region due to demand increments for its production. Nevertheless, in what concerns to a small region such *feedback* effects are obviously far less relevant.

In this research paper we present the results of applying our methodology in two small NUTS III Portuguese regions: Cova da Beira and Pinhal Interior Sul. Both are regions in the interior centre of the country without contact or privileged access to the coast, having development indices below the national average.

In 2009, Cova da Beira had an estimated population of 90,387 inhabitants (0.9% of the country), and its GDP (provisional data for 2008) was only 0.6% of the Portuguese GDP. Historically it has been an important industrial region with a highly specialized segment on the textile and clothing sector, but the industry went into sharp decline in the last decades of the twentieth century. The installation of a University (now called University of Beira Interior - UBI), in the 1970s, however, facilitates this region conversion in favour of the services sector. In recent years was also installed in Cova da Beira a hospital with a supra-regional importance, which also created conditions for UBI to offer courses in Medicine. A significant part of the regional population lives in Covilhã, a city that is considered a medium-sized Portuguese urban centre.

In demographic terms Pinhal Interior Sul is the smallest NUTS III Portuguese region, with a population of only 40,106 inhabitants in 2009, i.e. less than 0.4% of the national total. This is a region of rugged orography, with no significant urban centre.

The population in 2009 was only of 21.1 inhabitants per km^2 (against 115.5 in the country). The population decline was very sharp throughout the twentieth century, having lost about 20% of its population since 1991. GDP is only 0.3% of the Portuguese total (2008 data), with a relevant contribution coming from electricity production (hydro and, more recently, wind). The forest products and processed wood also have importance in the regional economy.

Following this introduction, this communication is organized into three stages: a general presentation of the Input-Output Model (Section 2), a discussion on the problem(s) of the Input-Output regional tables derivation and, in general terms, on the solution(s) we are proposing (Section 3), followed by a brief presentation of some indicators, based on input-output matrices built by us, for the two NUTS III regions selected (Section 4). Section 5 concludes.

2. The Input-Output Model structure

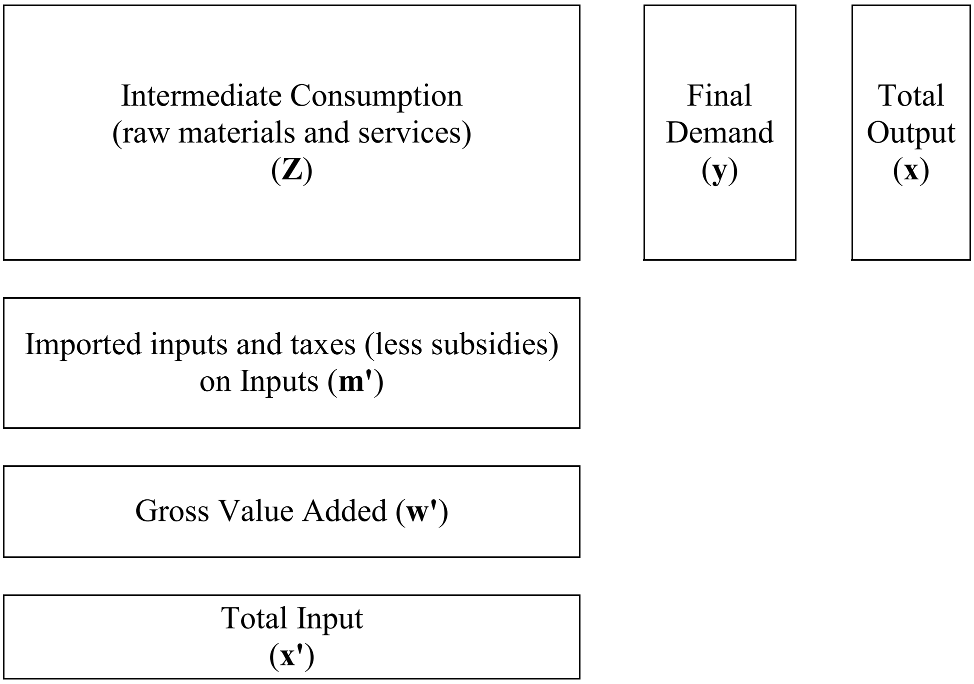
An Input-Output model is based on tables, which consist of rows and columns. Figure 1 represents the most common structure of this framework, and is used here in what we call the classical Leontief model. In Figure 1, **Z** is a square matrix and the remaining rectangles are column or row vectors, the latter being identified by the notation **'**. Matrix **Z** is the core of the Input-Output framework. Each entry z_{ij} of this matrix represents the amount of raw materials and services, i.e., the input i consumed in the production of product[3] or output j.

According to the structure presented in Diagram 1, each column can be understood as a product production's technology. The columns indicate the inputs used to produce each output, i.e., the intermediate inputs consumed in the production process, with respect to Z, or the primary inputs (labor, capital) whose remuneration is the value added, recorded in **w'**. On the other hand, lines represent the various products destinations, which can be purchased by other industries **(Z),** or going to final demand

[3] This communication assumes assumed that each industry produces only one product (or group of relatively homogeneous products). This is not a necessary hypothesis in an input-output framework (though it was in the first models, particularly in the pioneering work of Leontief), but will not be questioned here as the discussion concerning the secondary products treatment within the Input-Output models is beyond this paper's scope.

y, by way of consumption, investment and exports. The total of destinations for the output **x** is equal to the value of outputs produced, i.e. the total input **x'** (and this row vector is, as the notation indicates, the transpose of **x**).

Diagram 1 - The (Classic Leontief) Input-Output Model Structure



The essential issue to remember in this structure is that the **Z** matrix refers only to inputs produced in the region or country the model relates (domestic flows), since imported flows from other origins are included in the vector **m'**. Each **Z** matrix entry z_{ij} can thus be seen as the product of two factors:

$$z_{ij} = \psi_{ij} \,.\, (1 - \mu_{ij}) \quad \textbf{(1)}$$

being ψ_{ij} the input i "total flow" (i.e., it is irrelevant whether it is produced locally or imported) needed to produce the output j in the region being analyzed. μ_{ij} is the coefficient of imports of i, to be used in the production of j. $1 - \mu_{ij}$ is, therefore, the proportion of i that is locally produced.

Note that according to the structure shown in Figure 1 this is not the only type of input-output model that can be considered. There are other models based on total flows ψ_{ij} in place of domestic flows z_{ij}[4]. However, these models - despite their focus on total flows - do not avoid the basic problem this communication is concerned: separating demand for locally produced inputs from demand for inputs produced in other regions. For this reason the explanation of our problem is carried out considering exclusively the Input-Output classical Leontief model.

The production technology of a given product may be expressed in absolute figures - the cells of **Z, m'** and **w'** - but preferably in relative values. X_j is the total output of product j that one can observe in the j^{th} entry of the vector **x'**. The relative need of intermediate inputs (locally produced) is measured by what is defined as input coefficients. The input coefficient i used in production of j will be referred to as a_{ij}, where:

$$a_{ij} = {}^{z_{ij}}/_{x_j} \tag{2}$$

Note that in the *Input-Output* models literature a_{ij} is sometimes called the technical coefficient. Yet in this text it will express the total flows coefficient[5] α_{ij}, in which:

$$\alpha_{ij} = {}^{\psi_{ij}}/_{x_j} \tag{3}$$

Clearly, by (1) it comes:

$$a_{ij} = \alpha_{ij}.\,(1 - \mu_{ij}) \tag{4}$$

Let **A** be the matrix of input coefficients a_{ij}, calculated by (2) for each entry of matrix **Z**. Then the matrix equation **Zi** + **y** = **x**[6,] implicit in Figure 1, can be written[7]:

[4] Although less quoted in the literature, the Rectangular Input-Output Model constitutes a noteworthy alternative. For a description concerning this model structure see, e.g., Sargento (2009) and the classic Oosterhaven (1984) contribution.

[5] Indeed, it is the total flows coefficient – α_{ij} – that expresses the relationship between the technical input i and the output j. In technical terms, the production of j requires a certain amount of i, being irrelevant (in technological terms) if i is produced locally, or imported. Concerning solely the domestic flows, beyond the technical relation, the input coefficients a_{ij}, reveal the local source of production.

[6] **i** vector is a column vector consisting of 1s, which multiplied by **Z** sums this matrix each line cells.

$$\mathbf{A.x} + \mathbf{y} = \mathbf{x} \quad (5)$$

Solving (5) in order to **x** gives:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}.\ \mathbf{y} = \mathbf{B}.\ \mathbf{y} \quad (6)$$

Matrix **B** = $(\mathbf{I} - \mathbf{A})^{-1}$ is known in the literature as the Leontief Inverse. This array consists on a set of operators, which if multiplied by the (constant) final demands vector **y,** would allow to calculate the directly and indirectly required productions of **x**, so that **y** can be made available to the economy. These operators are called the "Leontief multipliers".

The idea is that the final demand **y** is the ultimate economic activity justification. **Y** is the consumption, investment, or exports that the economic agents in the region want to accomplish. Note that in the simplest version of the Input-Output model, **y** should also equate the disruption that the economy might suffer. However, given the inter-industrial relations (i.e., the products are produced with other products), **X** is what is needed to produce **y**. In the classical Leontief model, in which this paper is based, **x** is only the *locally produced* output needed for a given regional final demand **y**. If there is a shock in **y,** the consequent **x** variation measures the direct and indirect effects of this disturbance occurred solely within the region under analysis.

Besides the direct and indirect effects, it can also be interesting to consider the induced effects. To this end, **A** matrix in (5) must be expanded into **A***, which differs from **A** to include an additional line comprising the coefficients that equate the income effects that each production process have on the families, and a column with the coefficients of these families consumption, induced by that income. These coefficients are total income consumption ratios, and in the classic Leontief model they refer only to

[7] The best way to confirm is from the matrix equation (5) and perform algebraic operations there suggested, given that:

$$\mathbf{A} = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \quad \mathbf{x} = \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} \quad \mathbf{y} = \begin{bmatrix} y_1 \\ \vdots \\ y_n \end{bmatrix}$$

n is the number of sectors considered. We then have:

$$\begin{matrix} a_{11}x_1 + \ldots + a_{1n}x_n + y_1 = x_1 & & z_{11} + \ldots + z_{1n} + y_1 = x_1 \\ \ldots & \Leftrightarrow & \ldots \\ a_{n1}x_1 + \ldots + a_{nn}x_n + y_n = x_n & & z_{n1} + \ldots + z_{nn} + y_n = x_n \end{matrix}$$

what is the same as **Z.i** + **y** = **x**.

the consumption of products that are produced in the region, i.e., purged of goods and services imported from other regions or countries. The coefficients of $\mathbf{B^*} = (\mathbf{I} - \mathbf{A^*})^{-1}$ are Leontief multipliers (sometimes said to type II), which express the direct, indirect and induced effects generated within a region, reflected in the regional production **x**, of a particular disturbance that hit this region's final demand vector **y**[8].

3. Building an Input-Output Model for a region

In their structure, uniregional Input-Output Models are not different from national models and the configuration described in Figure 1 is well suited to a conventional Leontief model type, at a regional level. The main issue is that for regions, especially small ones, input-output tables, with an official or semi-official nature, already constructed are not usually available, in opposition to what typically happens concerning countries. In Portugal, for example, the Department of Prospective and Planning (DPP) of the Ministry of Environment and Spatial Planning (Dias, 2008) published - last year for 2005 - a national input-output table following the Figure 1 generic structure. When tables are not provided with this exact configuration there are, in the official National Accounts, comparable tables that can be appropriated by alternative national Input-Output models, which can be adapted into tables as in Figure 1, subject to some simplifying assumptions.

This (relative) data abundance is not verified when we face a region. It is true that in Portugal there have been some studies by public agencies or individual researchers, which have derived regional Input-Output Tables[9], but at least in recent years these tables have been limited to NUTS II regions and the case of small regions, where the lack of data is more problematic, has been avoided. Moreover, these regional tables have not been constructed with statistical information from scratch (except for some exceptional products and flows), being instead derived from the corresponding national tables using significant assumptions.

[8] See Ramos and Sargento (2010) for a more detailed and pedagogical clarification of the Input-Output model (at the national and regional levels). For a comprehensive explanation, using mathematical language intensively, see the classic manual (recently reprinted) Miller and Blair (2009).

[9] The Input-Output model from DPP has itself an extension to the NUTS II regional level. See Dias and Lopes (2009). Other attempts to produce input-output type regional tables were CCRN / MPAT (1995) for the North Region, Sargento (2002) for the Centre Region, CIDER / CCRAlgarve (2001) for the Algarve and ISEG / CIRIUS (2004) for the Azores.

In fact, the input-output regional tables' derivation procedure from national tables does not happen exclusively in Portugal, being the rule in many other countries in the world[10]. This communication does not oppose, instead praises this approach, which seems the only viable - and affordable - if we want to study the economic interdependence within a region. Our main goal is to discuss and propose appropriate assumptions to assist this operation and explore their validity in the production of input-output tables for small areas. Our two target regions are, as already stated above, the hinterland Portuguese Cova da Beira and Pinhal Interior Sul.

The most common simplifying assumption, used in the course of derivation of regional input-output models, is the assumption of equal technologies – i.e., the same technical coefficients in the region and the entire national economy. In this communication, it is not our aim to discuss the goodness and/or reasonableness of this hypothesis[11], but only to stress that it can be adopted for α_{ij} type technical coefficients, as in (3), i.e. for total flows, but never directly to the a_{ij} type input coefficients, as in (2), i.e. for domestic flows. In fact, it may be acceptable that the production of product j make use of these inputs in different regions, and therefore also in the national arena, but the percentage by which products are produced domestically ($1 - \mu_{ij}$) is expected to be much higher in the country than in its constituent regions, and also much higher in large regions than in small ones. Indeed, even if one assumes that the proportion of imported goods from abroad is equal in different regions, and consequently in the country[12], in the regions the inter-regional imports should also be taken into account[13], which adds to the international trade and therefore reduce, sometimes considerably, the regional input coefficients calculated as in (4).

The idea for this study is that for a region R, equation (4) can be broken down into:

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[10] See, e.g., Lahr (1993); Hulu and Hewings (1993), Eding *et al.* (1997) and Shchwarm *et al.* (2006).

[11] Ramos and Sargento (2010) list some conditions that make this hypothesis more reasonable, thus minimizing the potential simplification bias.

[12] This simplification hypothesis may not be considered in Portugal, since there is some statistical information on international imports by regions, which can be used.

[13] The international empirical evidence on this matter, especially the one from the few countries that produce official statistics on inter-regional trade, is that the inter-regional trade is much more intense than international trade, which is restrained by a "border effect". This argumentation pioneering reference is McCallum (1995).

$$a^{R}_{ij} = \alpha_{ij}.\,(1 - \mu^{IN}_{ij} - \mu^{IR}_{ij}) \quad (7)$$

where μ^{IN}_{ij} is the proportion of input *i* used in producing *j* imported from other countries, and μ^{IR}_{ij} is the equivalent proportion of imports of *i*, used in the *j* production process, coming from other national regions. μ^{IN}_{ij} for the regions is known or can be easily estimated from national data. It is accepted that the technical coefficient defined in terms of total flows α_{ij}, be assumed equal in the region and in the country. Our attention is therefore directed to μ^{IR}_{ij}. The idea is to carry out a calibration process based on two main steps:

- Initially a fine analysis is carried out, product by product, taking into account the characteristics of each region *I*, the different inputs *i* used in production of different outputs *j,* and other destinations given to *i;* a typology for products *i* is adopted (which in some cases may vary depending on the destination of *i* - sector *j* or another - or the region under consideration); the classification adopted for *i* determines the methodology to reduce the regional input coefficients a^{R}_{ij}, subtracting them the inter-regional imports; the calculation procedure is similar with regard to households final consumption expenditures.
- On a second step, starting from the a^{R}_{ij} coefficients, and being known, from the official Regional Accounts[14], the various sectors productions, it is possible to determine, in absolute terms, the products demands met locally; demands related to consumer spending from other institutional sectors and investment are exogenously estimated; the difference between the production of each product by region and corresponding local demand is assumed equal to exports from the region; being known (or in some cases estimated) international exports, inter-regional exports are obtained by differences; the second phase, itself, consists on a product by product analysis of exports and inter-regional imports from different regions, and the final value assigned to μ^{IR}_{ij} (and to a^{R}_{ij}) is the result of adjustments arising from the inconsistencies detected with this analysis.

[14] Actually, the NUTS III Portuguese Regional Accounts only give information on the gross value added by industry. Outputs are estimated by us, assuming that the gross value added coefficients (W_i/X_i) are equal in the country and regions.

The results presented in this communication, which have a provisional nature, are fundamentally the outcome of implementing the first stage of the calibration process described above, since the second stage is still incomplete. In this first stage, products *i* can be included in one of two extreme categories, which have a simple solution for the coefficients:

- type A products are regionally non-tradable, i.e., products that must be produced in the same region where they are consumed, and consequently are not imported from other regions, nor from other countries; for these products it is assumed that $\mu_{ij}^{IR}= 0$, and as μ_{ij}^{IN} is also zero (or assumes a residual value, known *a priori*), it comes that a_{ij}^{R} = (or ≅) a_{ij};
- type B products are fully tradable, international and inter-regionally, i.e., products that move between regions at no (or non significant) cost, namely within a small country like Portugal; in this case an additional demand tends to be mostly satisfied by imports, since there is no valid reason to justify any regional preference; in this situation our proposal is that the weight of local sourcing is supposed equal to the region output weight of that product in the national total[15]. Note that for small regions this solution leads to $a_{ij} \cong 0$ for most products and their uses, and therefore little local impacts involving these products.

Our belief is that in small regions a significant number of products fall into one of these two extreme types, A or B, and so there is a simple solution for determining the corresponding entries in the construction of regional input coefficients **A** matrix. Indeed, from the 56 products with non-zero production in the input-output Portuguese matrix, 38 in Cova da Beira and 41 in Pinhal Interior Sul were considered as either A or B. The type A products include the "Construction", "Retail Services", "Public Administration", "Education" and some personal services. Type B products are mainly industrial products and some products not produced in some regions. There are however exceptions to this binary classification. Some products fall into an intermediate category:

[15] That is, $a_{ij}^{R} = \beta_i\, a_{ij}\, (1-\mu_{ij}^{IN})$ where $\beta_i = {x_i^R}/{x_i^N}$, and *R* notes the region, and *N* the country.

- type C products are regionally tradable between specific regions, sometimes nearby regions, in other cases regions that for some special reason assume a special role. In the first condition are included products with significant shipping costs, or other restriction to their mobility between distant regions (typically these products are only occasionally internationally traded, i.e., these products are largely produced in the region in which they are consumed, but may be partly imported from neighboring regions).

Other interesting situation leading to the classification of some products such as type C, is what we call "headquarters effect". Indeed, some services demand is locally manifested, but it is met by nationwide companies that, for reasons of internal organization, have a significant part of their business located in the national headquarters (sometimes also in *off-shores),* or on regional headquarters that does not have to necessarily be located in small regions. Although this is essentially local demand, production occurs partially in other regions, which is equivalent to import from these regions, a fraction of the total product output.

Products classified as type C, although limited in number either in Cova da Beira and Pinhal Interior Sul, still have an economically significant weight, exceeding 40% of GVA in each of these regions. Good examples of type C products, which admit a "headquarter effect", are "financial intermediation" and "Post and Telecommunications" activities. Although distinct (as most of the corresponding companies are not nationwide), other sector where there is a significant activity concentration in large urban centers of the Portuguese coast is a very important one, namely due its inter-industry relationship with the rest of the economy: the sector of "Other services provided mainly to companies". In this case, we have decided for an approach similar to that of products with "headquarters-effect." Other examples of type C products are the ones of "Agriculture" and "Wholesale Trade".

By classifying products according to this typology, and adopting specific criteria associated with different product types, we manage to reduce the a_{ij} input coefficients for each product i - in some cases differing destinations j -, estimating a_{ij}^{R} for each region R, or what is the same, estimating the μ_{ij}^{IR} linked to a_{ij}^{R} by (4'). Known the a_{ij}^R, equation (6) can then be derived for *R* and the corresponding Leontief multipliers deducted. These reveal the direct and indirect effects, confined to the region's economy following a shock in the regional final demand **y.** The same methodology can be pursued concerning the **A*** extended matrix, leading to Leontief multipliers (**B***) which also incorporate the additional induced effects (confined to the region in question as well).

4. Some Results

The methodology described above allowed building (on a draft version) input-output matrices for two Portuguese small regions: Cova da Beira and Pinhal Interior Sul. For sake of space restrictions, we do not transcribe here these matrices, or their Leontief inverses. Instead we just point out some of their key characteristics. A significant one, already expected in small regions, respects the low density of economic interdepence recorded in these spaces. Indeed, at the outset, it is observed that while for the 59 sectors included in Portuguese national economy input-output table, there are only three groups of homogeneous products with zero output[16], in the Cova da Beira, the group of products with zero output amount to 13, and in Pinhal Interior Sul stand at 19. Table 1 includes a set of "complexity" indicators to illustrate the aforementioned inter-industry relationships low density within these small region's economies[17]. Among these indicators we emphasize the "**A** Percentage of nonzero coefficients"[18]**,** which is 61.4% for Portugal as a whole, but merely 27.8% in Cova da Beira and 19.6% in Pinhal Interior Sul matrices, respectively. Also, the "Average output multiplier", i.e., the average of **B** Leontief multipliers, is considerably lower in these small regions than for Portugal.

Table 1 - Some Complexity indicators calculated based on Input-Output tables for Portugal, Cova da Beira and Pinhal Interior Sul

[16] 10 - Mining of coal and lignite; extraction of peat; 11 - Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying; 12 - Mining of uranium and thorium ores.
[17] For a literature review on the various indexes of economic complexity as intersectoral connectedness see Lopes *et al.,* 2008.
[18] In the calculation of this indicator, we considered equal to 0 all coefficients less than 0.1×10^{-5}.

This reduced complexity of regional economies reflects the modest magnitude of indirect effects confined to the region, subsequent to an eventual final demand change in these regions. What happens, of course, is that given the high dependence of these regions on inter-regional imports, a very significant impact of the local final demand change escapes to the rest of the country, instead of affecting the regional economy itself. This happens particularly in type B products, i.e., for which there are not a preference for locally produced products and the region depends massively on inter-regional imports, even though, in some cases, the region might have a relatively significant production of some of these products.

Table 2 shows us the goods for which the largest totals were obtained by adding up each line of multipliers in the Leontief inverse matrices **B,** considering the country and the two regions matrices. These products are commonly referred to as "Base Products", and are those most affected, positively or negatively, by any regional economy transversal disturbance.

Table 2 - Main “Base Products” in Portugal, Cova da Beira and Pinhal Interior Sul

Considering that modern economies are based on services, the sector corresponding to "Other services provided mainly to Business” represents the typical base product. This is true in Portugal and that status is maintained in our two small regions. But this indicator value for the Portuguese economy (7.08) is considerably greater than for these small regions (2.77 in Cova da Beira and 2.48 in Pinhal Interior Sul), and only slightly surpassing the value of the regions indicator in "Construction ", which was considered as a type A product. The difference is that in "Construction" any change in its demand, direct or indirect, must be met locally, while in "Other Services provided mainly to Business" (a type C product), a significant total demand proportion is met by inter-regional imports, from large urban areas in the littoral. Another curious result is that "Electricity" - a type B product - which is, at the country level, a base product, does not appear in Table 2 columns for these two regions. This happens even in Pinhal Interior Sul which is, in relative terms, an important "electricity" producer. The reason is that when the Pinhal Interior Sul economy expands (or contracts) there is no reason to think that the indirect effects on electricity production are local effects.

Instead, the increase (or decrease) on electricity demand in these regions should be filled by national domestic production of that product as a whole.

Table 3 shows the effect of a 1% variation in household's final consumption on the economies of both regions[19], in comparison with the country. This disturbance differs from the previous one in that the increased demand is not the same for all the products, instead positively discriminates those that are highly consumed. Moreover, not all variation in final demand corresponds to domestic production, i.e., some is allegedly imported. This imported parcel is obviously greater in the regions, given the possibility of inter-regional imports.

Table 3 - Main Products directly and indirectly consumed by households (effect of 1% variation in household's final consumption expenditure) in Portugal, Cova da Beira and Pinhal Interior Sul

The figures show, in the two regions, two type A products as those that most benefit the regional economy following demand expansion as assumed: "Real Estate Business "and "Retail Trade". At country level, the "Real Estate Business" also has a leading position, given its weight in household consumption, namely due to the inclusion of the value (partially inputted) of the housing services inherent in the enjoyment of the dwellings, either rented or used by the owners. However, despite the weight of trade margins on consumption, "Retail Trade" is overtaken by other products that do not appear in Table 3 at the regional level, e.g., "Other Services Provided mainly to Business" and "Food and Beverages". What happens is that each region demand for these products is partially driven to other regions output and has, therefore, smaller local impacts, both direct and indirect.

5. Endnote

This presentation is not an ended job. It is an initial contribution from a research project in progress: the DEMOSPIN. What is proposed is a working methodology to derive input-output tables at the regional level, starting from the corresponding national framework. It is argued that the proposed methodology is particularly suitable for small regions. These economies are not very dense, and are heavily dependent on inter-regional and sometimes international imports, especially in some product categories such as manufacturing products. If one wishes to assess the impact on small regions of the indirect effects of policy interventions, or any other disturbances, what should be taken for granted are the consequences of the existence in these regions of non-tradable products, even within regions or, in other cases, products that might be tradable between regions, but predominantly only with certain specific regions.

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[19] In absolute terms, i.e., 10^6 euros. Therefore the impacts at the country level are much larger than at the regional ground.

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Tables:

Table 1

Indicators	Portugal	Cova da Beira	Pinhal Interior Sul
Percentage of intermediate transactions in total production	38,760	15,604	14,998
Average (partial) output multiplier	0,029	0,021	0,019
Percentage of nonzero coefficients in A	61,448	27,774	19,579
Total intermediate consumption sector coefficients average	0,365	0,118	0,091
Determinant of the Leontief inverse matrix	157,716	4,017	2,881

Some Complexity indicators calculated based on Input-Output tables
for Portugal, Cova da Beira and Pinhal Interior Sul

Table 2

Portugal		Cova da Beira		Pinhal Interior Sul	
(74) Other Services provided mainly to Business	7,08	(74) Other Services provided mainly to Business	2,77	(74) Other Services provided mainly to Business	2,48
(40) Electricity	3,84	(45) Construction	2,32	(45) Construction	2,15
(51) Wholesale trade	2,93	(64) Post and telecommunications	1,78	(64) Post and telecommunications	1,69
(65) Financial Interm. Services	2,82	(65) Financial Interm. Services	1,55	(65) Financial Interm. Services	1,55
(64) Post and telecommunications	2,44	(51) Wholesale trade	1,61	(51) Wholesale trade	1,54

Main “Base Products” in Portugal, Cova da Beira and Pinhal Interior Sul

Table 3

Portugal		Cova da Beira		Pinhal Interior Sul	
(70) Real Estate Activities	110,8	(70) Real Estate activities	2,77	(70) Real Estate Activities	0,24
(74) Other Serv. prov. mainly to. Business	92,82	(52) Retail Trade	2,32	(52) Retail Trade	0,18
(51) Food and Beverage Products	87,64	(50) Trade and Motor Vehicles Maintenance	1,78	(50) Trade and Motor Vehicles Maintenance	0,09
(52) Retail Trade	80,04	(64) Post and Telecommunications	1,55	(64) Post and Telecommunications	0,08
(51) Wholesale Trade	72,10	(55) Accommodation and Restaurants	0,21	(55) Accommodation and Restaurants	0,07

Main Products directly and indirectly consumed by households
(effect of 1% variation in household's final consumption expenditure)
in Portugal, Cova da Beira and Pinhal Interior Sul