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On the appropriate use of (input-output) coefficients to generate non-survey regional input-output tables: Implications for the determination of output multipliers

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On the appropriate use of (input-output) coefficients to generate non-survey regional input-output tables: Implications for the determination of output multipliers

Abstract:

Regional input-output (IO) tables are constructed as either scaled down versions of national tables or by means of surveys. In the first approach, commonly denoted as the non-survey method, location quotients (LQ) usually use employment structures to account for differences between nation and region. A LQ is designed to scale down national (input-output) coefficients to representative regional ones that are then used to derive regional multipliers. In this process there are two main approaches to define regional coefficients. The first one relies on national technological coefficients that show the use of inputs regardless of origin. In the second approach, regional coefficients are derived from national technical coefficients which allow distinguishing the source of origin of used intermediate inputs. Therefore, it is important to be aware of both the implicit effects of the design of LQ's and the implications of applying a LQ to a specific coefficient. There appears to be some persistent ambiguity in the regionalization literature about the proper application of LQ's. On the one hand, Jensen et al. (1979), in developing the GRIT regionalization method, favors reallocation of imports to create technological coefficients before applying LQ's. On the other hand, Flegg and Webber (1997, pp 801) apply their quotient to the technical coefficients: "*Whilst Hewings and Jensen's analysis is certainly helpful [...]. We are not convinced that it would be desirable to apply LQ's to the national technological coefficients.*" In this paper, it will be shown that it is inappropriate to apply LQ's on the basis of the technological coefficients: the resulting regional multipliers are likely to be overstated, since they generally fail to account for the absolute imports (leakages) required in the process of regional production. To illustrate our point, six regional tables are constructed by applying three different LQ's, on the basis of either technological or technical coefficients. Our findings indicate substantial discrepancies in the size of the regional multipliers, depending on the type of coefficients taken. Therefore, the issue deserves more attention in the regionalization literature and one should not remain content with current methods for non-survey regionalization.

1. Introduction

Even though regional input-output (IO) tables have been constructed for more than fifty years, regional economic analysis has experienced a revival in the end of the last, and the beginning of this, century. An interest in regional and rural development, combined with the emergence of more refined methods and availability of data, has spurred the creation of quantitative models based on regional, inter-regional and multi-regional input output tables (Oosterhaven and Polenske, 2009; Dissart, 2003; Madsen and Jensen-Butler, 2004, 2005). Regional IO tables have been used to study regional and rural development and to analyze specific sectors in a region. See Midmore and Harrison-Mayfield (1996) for an introduction to IO methods in relation to rural economic modeling and Mattas et al. (2008) for a recent regional application. For applications to specific sectors see for instance Hodges et al. (2006), Deller (2004), Eiser and Roberts (2002) or Sharma (1999). Furthermore the use of IO tables to assess the environmental impacts of different sectors and lifecycles of various products have re-accentuated their usefulness in economic analysis (Jones and Munday, 2007; Kratena, 2004; Suh, 2004).

There are many methods for constructing regional IO tables and even though the use of such methods and the analysis of regional tables in applied work are extensive there are still neglected issues regarding their construction. One of the most important problems is the way imports are dealt with; whether the regionalization builds on a table of coefficients showing technological flows or a table showing only domestic flows. An ad hoc approach seems to prevail, and two of the most influential regionalization techniques, the GRIT and the FLQ techniques, seem to favor different approaches as we will see below.

It is the purpose of this paper to discuss, explicitly, the difference between technological coefficients (tables of indirect allocation of imports) and technical/trade coefficients (tables of direct allocation of imports). We will investigate how the design of location quotients makes them suitable (or not) to be used together with either type of IO coefficient. After that we will construct six different regional IO tables for a Swedish region and derive multipliers from these tables to show how important this choice is. Survey tables are not available for Swedish regions so the analysis shows the large difference associated with different methods and coefficients but cannot draw on any wisdom of hindsight. There is a need for discussing the suitable use of location quotients and show the large impact that different methodological choices in regionalization have, not the least to better inform both scholars and practitioners of these aspects in relation to practical impact analyses. This is important since multipliers are often used for applied *ex ante* analyses as well as *ex post* evaluations. We conduct a numerical comparison between multipliers from different location quotients, and IO coefficients, to highlight the difference in multipliers associated with an actual regionalization which is undertaken for a Swedish region. It is apparent that there is a large difference in multipliers depending on which IO coefficient that is adjusted and what quotient is used. We briefly discuss potential adjustments or changes in location quotients to better reflect regional size and regional specialization¹. First of all we begin by introducing the concept of IO models, regionalization and the problem at hand. After that the concept of IO coefficients, the nature of imports and location quotients are

¹ Kronenberg (2004) for instance use trade data to capture and control for cross-hauling of heterogeneous products. The problem is that this method can only be applied to commodity-balance methods (CB) and to tables with technological coefficients, not to location quotient methods on trade coefficients. The final table will in that case report regional technological coefficients and cannot be used for regional economic analysis as the leakages associated with changes in final demand are not accounted for.

discussed more formally before we show the empirical implications for multipliers based on choices made at different stages in the regionalization process.

2. Background

The IO table is an accounting identity describing statically the linkages within an economy at a specified point in time. It records the various interdependencies between the industries in the economy and their consumption of intermediate goods and services. Furthermore, it also describes the final demand by households, government and other institutions including exports. Value added in each industry can be determined as well as the total production in the economy. The IO table is a fixed price equilibrium model utilizing the Leontief production function of fixed proportions. Important economic assumptions in this model are: (i) Fixed coefficients of production assuming a linear constant return to scale production function. (ii) Homogeneity in that each sector produces a product not produced by any other sector. (iii) No lack of capacity, this implies that the economy is assumed to immediately satisfy the need of extra production inputs.

Each flow between sectors in the nation is divided by the purchasing sector's total output to capture the relative requirement of different inputs in the production process. Let a_{ij} denote the coefficient of production inputs from sector i , which are involved in the production of sector j . Then, we can write $a_{ij} = Z_{ij}/X_j$, where Z_{ij} denotes the production input originating from sector i in the production of sector j and X_j denotes the total production of sector j . By collecting the coefficients into a matrix \mathbf{M} , we can express the vector of outputs as $\mathbf{X} = \mathbf{MX} + \mathbf{Y}$, where \mathbf{Y} is the vector of exogenous final demand. The formula $\Delta\mathbf{X} = (\mathbf{I} - \mathbf{M})^{-1}\Delta\mathbf{Y}$ expresses how a change in final demand ($\Delta\mathbf{Y}$) affects total output ($\Delta\mathbf{X}$) through backward linkages in the economy, which correspond to multipliers $(\mathbf{I} - \mathbf{M})^{-1}$. In the process of regionalisation these national requirement coefficients (\mathbf{M}) are adjusted to better reflect the region and to calculate (most often) regional multipliers based on a regional version of $(\mathbf{I} - \mathbf{M})^{-1}$. Together with regional output data (exogenous or derived) it is also possible to construct the actual transactions within the region. In the model outlined above, final demand (\mathbf{Y}) is exogenous and not part of the interrelated production system. Considering the wages earned by households, and their consumption of goods and services, it is questionable to treat this component of the economic system as exogenous in

impact analysis. Instead, the economic flows to and from households can be included in \mathbf{X} , thus making households endogenous to the model. This procedure is called *closing* the IO model with respect to the households. A model which disregards the induced effects of household earnings and consumption is referred to as *open*. Multipliers are known as either open or closed according to the type of model involved. If these multipliers are combined with knowledge about physical labour inputs in each industry, and the wages from the IO table, it is possible to compute employment and income multipliers (Miller and Blair, 2009).

Regional IO tables have typically been constructed as scaled-down versions of national counterparts (mechanical tables) or constructed on the basis of surveys; sometimes regional tables are based on borrowed coefficients from similar regions. Mechanical tables are usually based on location quotients (LQs) that use employment, or some other indicators (value added, total output, etc.), to account for differences between a nation and a region². Survey-based tables are in fact constructs of available exogenous data (surveys, trade flows and other statistics) but are believed to be more accurate, given the quality of the collected data (West, 1990; Hewings and Jensen, 1986). However, surveys are often referred to as expensive and time consuming (Flegg et al., 1995; West, 1980) and, therefore, there has been an increased interest in developing methods for producing non-survey tables. Earlier works includes Hewings (1971), Round (1978), Jensen et al. (1979), Isserman (1980) and Ralston et al. (1986).

Since then the non-survey work has evolved both in the creation of more refined location quotients and in the development of hybrid approaches³. Location quotients have been adjusted to take into consideration regional size and the relative size of selling and purchasing sectors (Flegg et al., 1995; Swanson et al., 1999; Jackson, 1998; Lahr, 2001b). It has been shown in comparisons with survey-based tables that simple or cross-industry location quotients often

² In the event that the regional row and column totals for all sectors are known from the start the RAS method could also be applied. For an introduction see Miller and Blair (2009) and for a recent clarification Dietzenbacher and Miller (2009).

³ The hybrid approach, usually personified by the GRIT method (Jensen et al., 1979) takes a mechanical table as its starting point but then update this table by means of all available superior data (West, 1980, 1990; Lahr, 1993, 2001a). The hybrid approach is often referred to as producing more accurate tables (Lahr, 1993; Oosterhaven and Polenske, 2009) but still this approach relies heavily upon the coefficients obtained by converting national coefficients through mechanical correction. Especially when the possibility for collecting superior data is limited or time and funds are scarce for doing so.

grossly overstate regional coefficients⁴. Today many regional tables are constructed based on an adjusted cross-industry employment location quotient (denoted FLQ) which has been tested and calibrated against regional survey tables (Flegg and Webber 2000; Tomho, 2004; Flegg and Tomho, 2008). This LQ has historically been questioned because it is based on a pragmatic approach which correct for regional size but does not take regional specialization or cross-hauling explicitly into consideration (Brand, 1997; McCann and Dewhurst, 1998, Kronenberg, 2004). Flegg and Webber (1997) also admit that even if systematic errors are removed, inaccuracies in individual cells are bound to remain and regional specialization will not be completely captured.

3. The neglected issue of technological and technical coefficients

A location quotient is used to scale down the national IO coefficients to regional trade coefficients. However, as two different conventions prevail as to how imports are dealt with in the transactions table, the application of a regional LQ to a national table can provide very different results. Technological coefficients show the use of intermediate inputs regardless of their origin whereas technical coefficients (in a national context) or trade coefficients (in a regional context) show the use of domestic or regional inputs respectively^{5,6}. This issue of technological and technical coefficients has been referred to as the sometimes neglected topic of regionalization (Hewings and Jensen, 1986) even though the problem was mentioned already by Hewings (1971). Many applications of the location quotients and the hybrid approaches do not discuss to what extent the location quotients that are used are designed to scale down either type of coefficient⁷.

There is a confusing distinction between how two of the most important contributions to regionalization methodology deals with this issue. Jensen et al. (1979), in their development of

⁴ However, this might be because these studies applies the location quotients on the national *technological* coefficients and then compares corresponding regional values with actual survey based regional *trade* coefficients.

⁵ Besides these coefficients, which are the division of total, national or regional requirements by column totals, it is possible for instance to divide requirements by row totals to determine the forward coefficients for intermediate use of each sectors output or commodity.

⁶ These coefficients will be thoroughly explained below.

⁷ Much of the regionalization literature today is either empirical studies or vindications of specific quotients or hybrid methods. In the field of multiplier analysis there seems to be a much more vivid debate concerning both the traditional multipliers and the so called supply driven (or Ghoshian) model (Roberts, 1994; Papadas and Dahl, 1999; Dietzenbacher, 2002, 2005; Oosterhaven and Stelder, 2002; de Mesnard 2002, 2007a, b; Oosterhaven, 2007; Gim and Kim, 2008).

the GRIT method, favors a reallocation of imports to create technological coefficients before the location quotients are applied. Flegg and Webber (1995, 1997) on the other hand reject this approach and apply their quotient (or what they define as an adjustment formulae) to the technical coefficients. In response to a critique by Brand (1997) towards their location quotient that it does not respect the convention they comment that “*whilst Hewings and Jensen’s analysis is certainly helpful [...]. We are not convinced that it would be desirable to apply LQs to the national technological coefficients*” (Flegg and Webber 1997, p. 801). The problem is accentuated when the FLQ is used as an integrated step of the GRIT: should one follow the initial recommendation or the adjustment formulae approach? This question is highly relevant as this is exactly the method outlined and used in several applied European research projects dealing with regional economic analysis (e.g. the CAPRI-RD project and the previous CARERA project⁸).

This issue is usually not explicitly dealt with and it is common to see authors follow the five-step procedure outlined in the GRIT, reallocate all imports or use a national technological table, with the result that multipliers for regions are much the same as national technological coefficients even for small nations and regions. For some application regional multipliers tend to be between 2 and 3 for really small regions, indicating that national technological coefficients were used within the GRIT approach and not adequately reduced. Sometimes it is also the case that authors describe that they have used a “modified GRIT” and perhaps this is where domestic coefficients have been used from the outset because the authors have realized that LQ’s were not able to model regional flows based on national technology (e.g. Johns and Leat, 1988).

3.1 IO Coefficients and the treatment of imports

A notation of coefficients at a national and regional level which follows Flegg and Webber (1997) is the following:

$$a_{ij}^n = ntc_{ij} - m_{ij}^n \quad (1)$$

$$a_{ij}^r = rtc_{ij} - m_{ij}^{ra} \quad (2)$$

$$a_{ij}^r = r_{ij} + m_{ij}^{rr} \quad (3)$$

$$r_{ij} = rtc_{ij} - m_{ij}^r \quad (4)$$

$$r_{ij} = a_{ij}^r - m_{ij}^{rr} \quad (5)$$

⁸ See Mattas et al. (2008) for the CARERA project and http://www.agp.uni-bonn.de/agpo/rsrch/capri-rd/capri-rd_e.htm for information about the CAPRI-RD.

The definitions of these coefficients are as follows:

ntc_{ij}	=	national technological coefficient
rtc_{ij}	=	regional technological coefficient
a_{ij}^n	=	national technical coefficient
a_{ij}^r	=	regional technical coefficient
r_{ij}	=	regional trade coefficient
m_{ij}^n	=	national import coefficient
m_{ij}^{ra}	=	regional imports from abroad
m_{ij}^{rr}	=	regional imports from other regions in the country
m_{ij}^r	=	total regional imports (abroad and other regions)

One confusing aspect of this notation is that national technical coefficients measure the flows net of all imports, whereas regional technical coefficients only measure flows net of international imports. However, a rule of thumb could then be that technical coefficients show flows net of international imports, both for nations and regions, whereas trade coefficients show the flows for regions net of all imports. Unfortunately, sometimes the notation “technical” and “technological” is used interchangeably and this is quite confusing. For instance Miller and Blair (2009, p 73) use the term “technical coefficients” for tables where imports have been allocated to the entries in the transactions matrix so that these coefficients show the technological relationships. Throughout this paper we will follow the notation outlined above.

As a principle however technological coefficients describe the production processes in the industries of the table regardless of the origin of intermediate goods used in production. Trade coefficients on the other hand describe the regional use of intermediate products as supplied from within the boundaries of the IO table. In theoretical terms, the choice is between a table of direct or indirect allocation of intermediate imports to production (West 1999). Indirect allocation means that imports of intermediate products which are used within the production process of national firms are allocated across the entries in the transactions table. That is imports of agricultural products are allocated across the agricultural row indicating the use of agricultural products as inputs to other industries. Direct allocation on the other hand allocates these imported products to an imports row directly beneath the transactions table, for a specific sector a cell in this row shows the total of imports of intermediate inputs from outside the geographical scope of

the IO table. While tables with indirect allocation provide tables *as if* intermediate purchases were all from within the boundaries of the table the direct allocation allows for an analysis of flows which are actually taking place between sectors within the geographical region.

One thing to be aware of when talking about imports in IO tables is the distinction between competitive and non-competitive imports. Competitive imports are imports of such commodities that are also produced within the country whereas non-competitive imports are such goods which have no counterpart in the national table. That is, some products are not produced in the country and might not even be classified in the national industry classification. Such commodities cannot be allocated to the transactions matrix even if the indirect approach is chosen and must even then be allocated directly to a row beneath the transactions table.

Economic analysis of indirect allocation tables (technological coefficients) will neglect the “leakage” of impacts as the economy adapts to a final demand change in one or more sectors. Therefore the approach has often been to produce a regional table with direct allocation of imports, practically accounting for imports of intermediate goods in a row outside (directly below) the intermediate transactions table. In other words, the regional tables have been constructed to show the proportion of intermediate inputs supplied by firms located within the region (Flegg and Webber, 1997, 2000). As mentioned by Flegg and Webber (1997) it is often the case that in applied work regional scientists do not explicitly talk about what type of IO coefficients they work with and what transactions table is used for a regionalization or an impact assessment; this means it is difficult for the reader to value the multipliers calculated for the region and compare to the nation or other regions. But the practitioner must make a choice when the national table is to be regionalized using some non-survey method. In this case the regional trade coefficients must be estimated based on either national technological or technical coefficients. Based on Hewings and Jensen (1986) the general problem of regionalization of IO tables can be depicted in the following way.

Define t_{ij}^n to be the proportion of requirements of commodity i supplied to production of commodity j from i produced within the nation. Hence the relationship is:

$$a_{ij}^n = t_{ij}^n \times ntc_{ij} \quad (6)$$

Then the purpose of the regionalization is to determine r_{ij} the regional trade coefficient. Based on the assumption of similar technology in the nation and the region this could be determined by:

$$r_{ij} = t_{ij}^r \times ntc_{ij} \quad (7)$$

Thus, the LQ approach has sometimes been described as to derive the regional trade coefficient from the national technological coefficient by means of estimating t_{ij}^r . As pointed out by Hewings and Jensen (1986) and West (1990) the relationship between the national technical coefficients and the regional trade coefficient is:

$$r_{ij} = \frac{t_{ij}^r}{t_{ij}^n} a_{ij}^n \quad (8)$$

Hence, if the location quotient is designed to estimate the t_{ij}^r it should be applied to the national technological coefficients (ntc_{ij}). If on the other hand the location quotient estimates the ratio between national and regional proportions of requirements it should be applied to the national technical coefficients (a_{ij}^n). A location quotient which is designed to estimate the ratio must also be allowed to exceed unity if sector i is over-represented in the region compared to the nation.

The influential work of Jensen et al. (1979), Hewings and Jensen (1986) and West (1980, 1990) have applied location quotients to national technological coefficients. The procedure in GRIT as it is outlined in Jensen et al. (1979) proposes the reallocation of the “imports row”, in an attempt to better reflect the technology of the nation. This reallocation produces a matrix as if all commodities in the economy were produced domestically. To understand the implications of this convention, we must examine the location quotients and determine how they perform vis-à-vis the national technological and technical coefficients. That is, are the quotients designed to estimate t_{ij}^r , $\frac{t_{ij}^r}{t_{ij}^n}$ or neither one?

4. Location quotients

Mechanical regionalisation was initially conducted by some simple location quotient (SLQ) or cross-industry location quotient (CILQ), where sectors that are not large enough to support the

regional demand by other sectors are corrected (row wise for SLQ and cell by cell for the CILQ). Rounds (1978) criteria for what location quotients should consider determined the design of the simple- and cross industry- location quotients, these were:

- i. The size of the selling sector.
- ii. The size of the purchasing sector.
- iii. The size of the region.

Other aspects have been proposed since Round (1978), for instance (i) differences in import and export pattern between the region and the nation, (ii) differences in productivity and input efficiency between the region and the nation (for instance labor productivity), (iii) differences in the composition of inputs between the nation and the region (iv) the impact of regional size on the role of cross-hauling (trade of heterogeneous goods classified in the same sector of the IO) and (v) spatial market orientation for firms within the region compared to firms in general across the nation (see McCann and Dewhurst, 1998). So far these more refined criteria's have not been incorporated in applied work.

Location quotients are usually based on employment figures for the region vis-à-vis the nation but other data such as value added, output and wages has also been used. Defining RE_i and NE_i as labour in sector i in the region and nation respectively and TRE and TNE as total regional/national employment, the SLQ for sector i is the share of labour in sector i in the region divided by the share of labour for sector i in the nation:

$$SLQ_i = \frac{RE_i TNE}{NE_i TRE} \quad (9)$$

If the SLQ is larger or equal to one ($SLQ \geq 1$) the sector is assumed to be large enough to supply the demand by other sectors as well as household and other consumption in the region. The national coefficient (the one on which the quotients are applied) is then assumed to be correct and no regional adjustment is made. If however the SLQ is lower than one ($SLQ \leq 1$), the sector is believed to be smaller in the region than in the nation and hence cannot be assumed to supply intermediate inputs to all intermediate demand in the region. The procedure is then to adjust the national coefficients for all entries in row i :

$$r_{ij} = SLQ_i \times ntc_{ij} \quad \text{or} \quad r_{ij} = SLQ_i \times a_{ij}^n \quad (10/11)$$

The “residual”:

$$m_{ij}^r = (1 - SLQ_i) \times ntc_{ij} \quad \text{or} \quad m_{ij}^r = (1 - SLQ_i) \times a_{ij}^n \quad (12/13)$$

is the imports of products i as an intermediate input to production (from rest of the nation and rest of the world) which are recorded in the imports row of each sector using i . One obvious problem with such an approach is the assumption that labour is equally productive in the region and in the nation. Furthermore the SLQ as described above does only take the size of the selling sector and the size of the region into consideration. This has sometimes been criticised on the ground that what matters is the relative size of selling and purchasing sectors. Another approach that takes the relative size of selling and purchasing sectors into consideration, but not the size of the region, is the cross-industry location quotient (CILQ). This quotient is calculated to reflect the intra-industry dependencies and the size of each industry in relation to the sector they trade with in the nation relative to the region. The CILQ is defined as:

$$CILQ_{ij} = \frac{SLQ_i}{SLQ_j} = \frac{RE_i/NE_i}{RE_j/NE_j} \quad (14)$$

The application of the CILQ is the same as for the SLQ and the two quotients produce similar multiplier for most sectors of a region. A modification of this quotient has been discussed since it will produce values of 1 along the principal diagonal where $i = j$. This is of course only a problem working with gross tables⁹ and the solution proposed is to use the SLQ along the diagonal for all sectors.

To take both relative industrial size and regional size into consideration another regionalisation quotient has been proposed by Flegg et al. (1995), Flegg and Webber (1997) and Flegg and Webber (2000). This is the FLQ and it is calculated as:

$$FLQ_{ij} = CILQ_{ij} \times \lambda^* \quad (15)$$

⁹ “Gross tables” are regional tables where the elements on the principal diagonal of the national table are regionalized and remain in the table. It has been proposed that these values should be deleted in the process of regionalization, resulting in a “net table”, because these values could represent flows in the national table between regions rather than flows between firms or commodities in the same sector or commodity classification. This will probably depend both on the nature of each product, the way the national table is constructed and the aggregation level of the national and regional tables.

$$\lambda^* = [\log_2(1 + TRE/TNE)]^\delta \text{ and } 0 \leq \delta < 1 \quad (16)$$

$\log_2(X)$ is equivalent to $\ln X/\ln 2$ and represents a concave function between 0-1. δ will determine the actual shape of the relationship between λ^* and TRE/TNE and for values of $\delta < 1$ the function λ^* will increase, at a decreasing rate, as TRE/TNE approaches unity. In numerical test based on the UK (Flegg and Webber, 1997; Flegg and Webber 2000) and Finland (Tomho, 2004; Flegg and Tomho, 2008) it has been shown that $\delta = 0,3$ gives the best regional results in comparison with survey based tables. It should be emphasized that this correction for regional size is general for all cells of the IO table and that it does not capture regional specialization more than already done by the CILQ. The purpose of the correction is rather to scale down coefficient as it is postulated that a negative relationship exists between regional size and self sufficiency. However, working with national technical coefficients it becomes evident that location quotient should be allowed to correct coefficients both upwards and downwards. This was tested by Flegg and Webber (2000) after observing that 50 percent of the regional coefficients were above the national (UK) in the Scottish survey table. However their specialization-augmented adjustment formula (AFLQ) was not able to capture these coefficients. Hence they reject regional specialization as the driving force behind this observation. Differences in labour productivity or technology could be other explanations. Perhaps another formula that better reflects specialization would capture the coefficients better.

5. How do quotients perform when applied to technological or technical coefficients?

5.1 Technological coefficients

If a location quotient is designed in terms of national and regional employment it is, in one respect, capable of capturing differences in industrial structures between a specific region and the nation. If a sector is large in the region this should be reflected by the employment in that sector and this should reflect the possibility of that sector to provide inputs to other sectors of the region. What location quotients in their present form cannot capture is the national and international import patterns of a region. Let us see why. Consider the following location quotient:

$$CILQ_{ij} = \frac{SLQ_i}{SLQ_j} = \frac{RE_i/NE_i}{RE_j/NE_j} \quad (17)$$

What we have to realize is that this quotient have different “units” in relation to different IO coefficients in its numerator and denominator¹⁰. Remember that the numerator shows employment in a sector that *supplies* intermediate inputs whereas the denominator shows a sector that *uses* intermediate inputs. The national/regional worker in sector i produce a national/regional quantity of good i whereas the national/regional worker in sector j uses both domestic/regional and imported i in their production process. We will see that such a quotient is very “similar” to the principle behind a trade coefficient in its numerator and the principle behind a technological coefficient in its denominator. Consider first the numerator.

RE_i/NE_i shows how many people work in sector i in the region relative to the nation. This sector will use a mix of domestic and imported inputs to produce a certain amount of output, and this is national or regional output of i which can be used by other firms in the nation or region. The number of employees working in sector i tells us nothing about how much of this same product is imported to the nation or the region, even if a small number of persons are employed in the selling sector, the total use $r_{ij} + m_{ij}^r$, can be high for a buying sector j . Hence the relationship between regional and national employment in this sector and the way it relates to relative employment levels in other sectors (i.e. if this sector is relatively large or small in the region) will be in the form of trade coefficients, what the sector supplies from within the region. Let us consider the denominator.

RE_j/NE_j shows how many people that are employed in sector j in the region in relation to the nation. These persons use regionally or nationally produced intermediate inputs as well as imported goods to produce output j . The number of persons employed in j tells us nothing about how much of the sectors inputs that are used from within the nation or region and how much is imported. Hence the number of persons employed in sector j reflects *both* the use of domestic and imported intermediate goods. How much of sector j that is actually in a region, that is RE_j/NE_j , relative to how much there is of a supplying sector (say i) gives us no information towards how a technological coefficient should be scaled down to reflect intraregional trade and imports. Certainly as long as the relation between two sectors are not the same in a region as in the nation,

¹⁰ This controversy between the design of location quotients and coefficients was actually mentioned, but not pursued further, in Flegg and Webber (1997) in their response to Brands (1997) critique.

and the selling sector is relatively less represented, the LQ approach will scale down the national technological coefficient. But it would seem as though the scaling down will not be to a regional trade coefficient but rather something in between a regional technological and trade coefficient. In the extreme case where the region is a scaled-down one-to-one version of the nation the CILQ will simply tell the researcher to accept national technological coefficients and make no adjustments for imports. We could emphasize the argument by a simple example. Assume we take as our starting position a national table of technological coefficients. To be able to analyze regional effects of changes in final demand we want to produce a regional table of trade coefficients.¹¹ We construct our location quotients based on for instance the CILQ. For many selling sectors in this example region the relative size compared to the purchasing sectors are equal or larger compared to the nation. The effect of this is that the CILQ between these sectors is above or equal to one. Hence, we accept the national technological coefficients as the regional trade coefficient. As an example consider,

$$CILQ_{ij} = \frac{RE_i/NE_i}{RE_j/NE_j} = \frac{50/500}{70/700} = 1 \quad (18)$$

In this case the location quotient indicates we should accept the coefficient. The implication of this is that we have accepted the technological coefficient for the purchasing sector, even though the sector at a national level might have been heavily dependent on imports. That is, if the choice was made to start from a table of technology the national *technological* coefficient is accepted as the regional *trade* coefficient. For the cells where the purchasing sector is relatively large in the region we will correct the coefficients and allow for some imports, but this will be arbitrary. Hence, trade coefficients in the regional IO table will be inflated by national imports. That is, in an attempt to reflect input technologies in a better way we have underestimated imports and hence multipliers calculated from such a table will be overestimated.¹² Hence, there seem to be a discrepancy between that one should use technological coefficients to start with and what location quotients can actually do when it comes to scaling down these coefficients. Furthermore, it may actually seem as though coefficients have been scaled down, but in fact a large fraction of

¹¹ Remember that this has been the traditional role of location quotients (Flegg and Webber, 1997, 2000).

¹² The FLQ will produce the same table as the CILQ in the “first round”. Then this will be scaled down due to the assumption that size is negatively related to self sufficiency, but this has nothing to do with the location quotients capturing anything to do with regional and sector specific import structures.

international trade is still incorporated as bias in the regional trade coefficients. Let us now turn to the technical coefficients.

5.2 Technical coefficients

The second question to answer from section 3 is if the SLQ, CILQ or FLQ are in fact appropriate estimates of $\frac{t_{ij}^r}{t_{ij}^n}$ or if they are at least appropriate adjustment formulas for technical coefficients. It should be clear that the $CILQ_{ij} = SLQ_i / SLQ_j$ does not directly correspond to $\frac{t_{ij}^r}{t_{ij}^n}$ and that, even though t_{ij}^n is readily available in the countries where a domestic transactions table is also produced, the problem is still the regional import proportions (t_{ij}^r). Flegg and Webber (1997) believe that it is more suitable to try and find the differences in the abilities of the selling sectors to fulfill the needs of the purchasing sectors at a national and regional level. This is a pragmatic approach rather than to try and estimate the exact quotient which would evidently be as difficult as to define a LQ to be applied to the technological coefficients (corresponding to t_{ij}^r). If a suitable way to account for differences in the proportions of national and regional import propensities could be found, this measure could then act as a short-cut adjustment formula to mimic $\frac{t_{ij}^r}{t_{ij}^n}$. That is, we are interested in differences in individual relationships between sectors at a national and regional level. Are these differences reflected in the ratios of the LQ's, for instance the CILQ?

To some extent they are. Going back to the difference between the numerator and denominator in the CILQ the fact that the numerator is related to trade coefficients makes this type of LQ's suitable for corrections of trade coefficients in the "row to column" type corrections that regionalization employs. In mechanical correction of this type we explicitly consider the possibility of the supplying sector to deliver inputs to the purchasing sectors. And as this possibility should be reflected by the regional output relative to the total need of the purchasing sector the LQ can capture this aspect of regional coefficients. Even if we assume the same technology between the nation and the region, if a purchasing sector uses more imports at the regional level, this would be reflected in a lower employment share for the corresponding selling sector. If we are interested in differences between the nation and the region when it comes to

import propensities, this should be reflected in the relative size of the sectors relative to the country. However, other aspects which we would like to incorporate into regional coefficients cannot be dealt with completely by this approach. When the location quotient is applied to the technical coefficient the cross-hauling of products at a national level has only been taken into consideration to some extent for the region (cross-hauling at the national level will be imports and exports) as this is captured by the technical coefficients which only show domestic flows. When we allow some sectors in the nation to purchase imports of a product which is also produced within the nation, we allow for cross-hauling. What is not captured, however, is the fact that a greater import penetration together with a greater trade in heterogeneous products might sustain a high regional employment in the selling sector as well. That is, if the selling sector exports products to other regions the employment level in that sector can be sustained. This might lead to an over-estimation of the regional trade coefficient between the two sectors in a situation where products are heterogeneous. That is, an increase in cross-hauling, at the regional level, might not be captured. This problem will be larger the more aggregated the regional IO table. What we also have to assume is that the purchasing sector does not change the proportion of imports relative to local/national use for some other reason, for instance this could be the case if industries within the same classification are not actually the same (due to product differentiation, scale etc.). Disregarding this aspect of heterogeneity it would seem that the potential problems of applying a location quotient is lower for the technical coefficients. Take for instance the situation where the sectors have the same relative employment shares in the region as in the nation. The national technical coefficient will be accepted for the region instead of the technological and we will at least allow for some imports.

6. Regionalization and numerical example

To be able to show how quotients perform when applied to technological or technical coefficients we have performed a regionalization. Six different tables have been constructed to see how the multipliers differ when the regionalization starts from either the technological or technical coefficients. To show the difference between different regionalization techniques we regionalize using SLQ, CILQ and FLQ. As the FLQ has proven to produce reasonable multipliers both in Scotland and Finland based on $\delta = 0,3$ we use this calibration for the FLQ. All the tables produced are depicted in figure1 and the table derived using technical coefficients and FLQ is

shown in an aggregated format in appendix A (i.e. the table associated with “F: output multipliers”) together with its multipliers in appendix B.

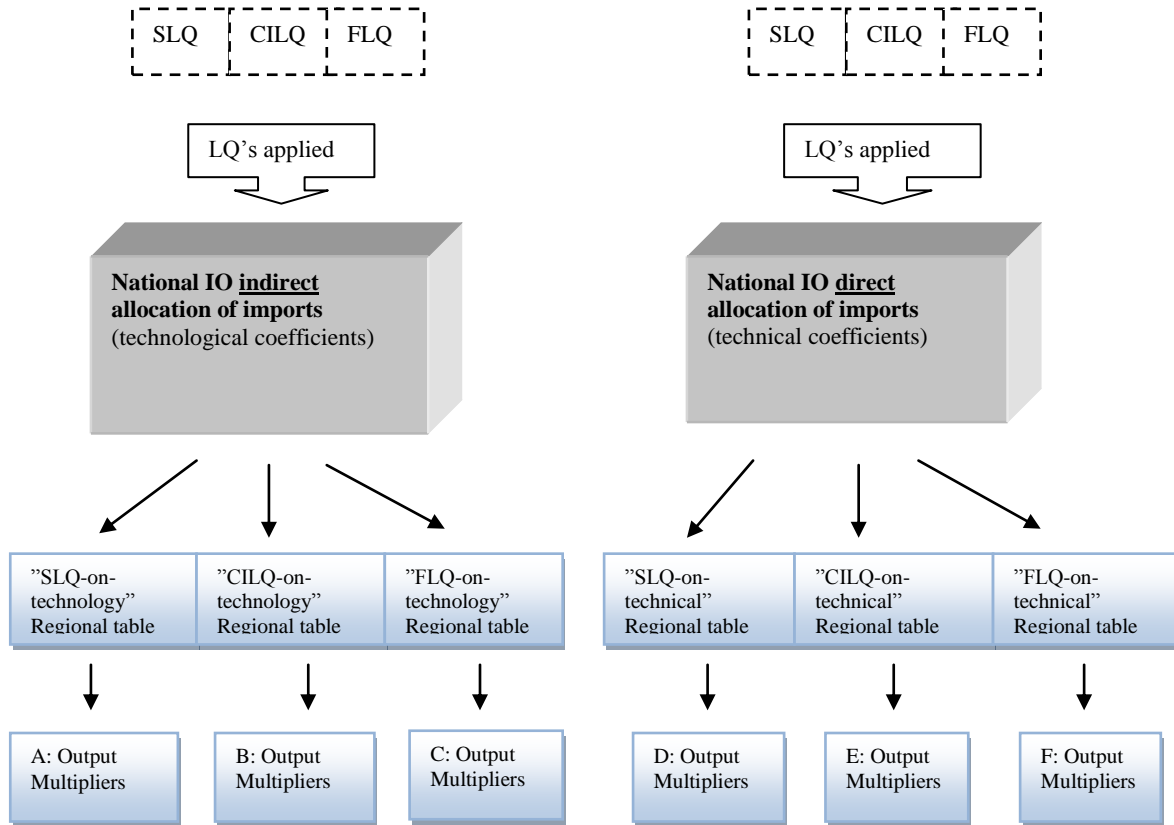


Figure 1: The tables produced to compare multipliers from regionalization procedures.

In this regionalization the Swedish IO table for 2005 has been used. The 2005 table was the most recent table available. The table is symmetric, of commodity-commodity class, and is derived from national Use and Make matrices by means of industry technology assumptions¹³. The industries and commodities are divided into 59 accounts¹⁴ using the standard SNI2002 classifications. The national technological table can be broken down into one IO table recording only domestic flows, or transactions, and one IO table recording only international trade. The

¹³ ITA makes the assumption that an industry produces its mix of outputs by using inputs in the same proportion across them all. The alternative is the commodity technology assumption (CTA) which assumes that all industries producing a commodity do so by using the same input structure. The problem with using CTA is that it sometimes yields negative IO coefficients.

¹⁴ Due to confidentiality, data restrictions and lack of activity the national IO (MAKE and USE) can be effectively defined as consisting of 50 industries and 50 commodities.

region for which the national table has been regionalized is Östergötland which is a NUTS III region in the south-eastern part of Sweden. In figure 2 the difference in multipliers based on the SLQ, CILQ and FLQ are shown. The multipliers from the technological coefficients are substantially larger than the multipliers from the technical coefficients. On average multipliers from the technological coefficients, that have been regionalized, are 21 percent higher for the SLQ. Notice how the gap increase for the manufacturing industries that use a substantial amount of imported intermediate products in their production processes. Multipliers for these sectors seem to diverge more than multipliers for primary and service sectors. We see a similar picture in the multipliers from the CILQ regionalization and many multipliers are still more than 50 percent higher if they are calculated based on regionalized technological coefficients. If the FLQ is applied we see in figure 2 that the difference between the two models is reduced. This is because the FLQ have a tendency to reduce, in absolute terms, larger coefficients more than small coefficients. Because of this the multipliers from a technological coefficient table will not deviate as much in this case. Still, multipliers from the regionalized technological coefficients are on average 12 percent higher and some deviate as much as 30 and 40 percent.

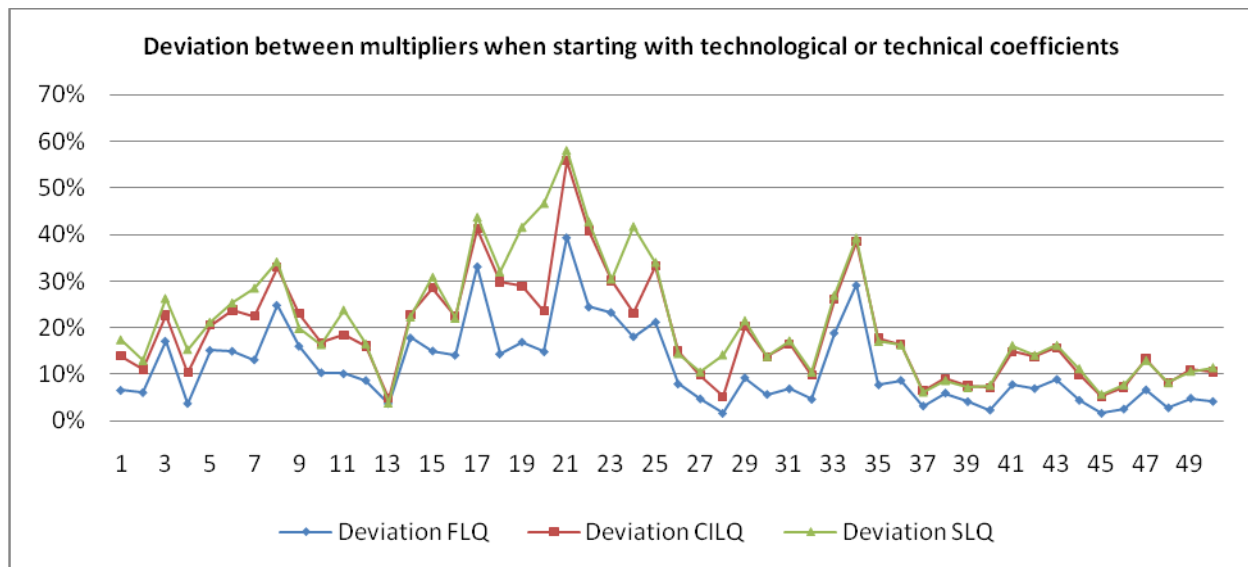


Figure 2. Comparison of the percentage deviation between multipliers from tables produced by SLQ, CILQ and FLQ starting from national technological or technical coefficients.

To better understand the implication of using either one of these six approaches in applied work we present the multipliers for one of the sectors in the regional IO table in figure 3. Sector 01 is

agriculture, hunting and related services and multipliers for this sector range between 1.30 and 2.01 for the various coefficients and quotients. It is apparent, in coherence with figure 2, that the difference becomes smaller if the FLQ is used rather than SLQ or CILQ.

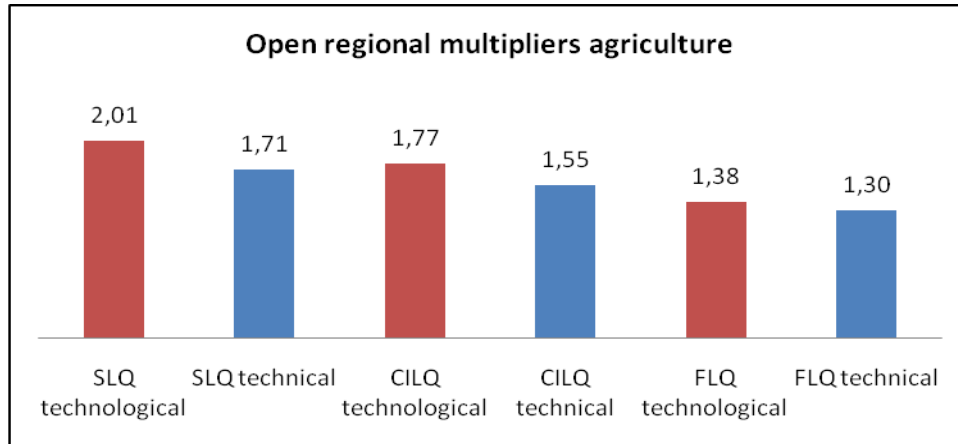


Figure 3. Comparison of open regional multipliers for the agricultural sector based on the starting point of the regionalization and the choice of location quotient.

7. Conclusions

This paper has investigated the somewhat neglected difference between technological and technical coefficients in the process of regionalization of input-output tables. It might be a perception that the difference in multipliers is not that large even if quotients are applied to the technological coefficients. In fact, in the conversion of coefficients into multipliers, the traditional tool for IO analysis, it is evident that the difference is profound. When a national IO table is regionalized by a non-survey location quotient method, it makes a great difference what coefficient the location quotients are applied to. It has been argued that if the target is a regional table of trade coefficients, it is not possible to apply any one of the currently available location quotients to a table where imports have been re-allocated. Such tables are often denoted indirect allocation tables and they show a table as if all intermediate products were supplied from within the nation. It has sometimes been argued that is essential to start from such a table to capture the technology of the production process, but apparently this will overestimate regional multipliers. This is because there is a problem with how the location quotients are constructed in relation to technological coefficients. In many cases national technological coefficients will be accepted as regional trade coefficients. Starting from a table of technical coefficients, or a table of direct

allocation of imports, is probably more suitable. This also have some drawbacks, the most serious one being that national import patterns are implicitly transferred to the region. If the selling sector is not large enough to supply intermediate inputs within the region these national patterns are augmented with more imports.

The problem identified in this paper is certainly more important for small open economies, where imports constitute a larger proportion of intermediate imports, and when the regionalization is conducted for a region that is small relative to the country. If imports are small at a national level, and the region is large in comparison to the country, the impact of starting from a table of indirect allocation will be smaller. However the problem will differ substantially for sectors of the regional table and even for nations with limited aggregate import the issue may well arise for certain sectors.

One disadvantage of the traditional location quotient approach is the fact that location quotients are not allowed to be above one. Hence, in a region where a large supplier is situated, it is not possible to increase the regional use of these intermediate products above the coefficient for the nation. One proposition in the literature has been that when CILQ is above unity, the trading coefficients should be allowed to shift up. This was tested for in the Scottish regional IO table by Flegg and Webber 1997. They find that although 50 percent of Scottish regional trading coefficients are in fact above the UK trading coefficients (in a survey table), their adjusted AFLQ, where upward adjustment was allowed, performs worse than the FLQ¹⁵. It is apparent that for some sectors where regional coefficients are in fact higher than the nation, this is not reflected in the regional employment figures. At the same time trade in heterogeneous products, that is, cross-hauling, might imply that high regional employment figures does not correspond to high regional coefficients. This makes the adjustment for regional specialization more complex and not manageable within the traditional location quotient framework.

¹⁵ A test for Östergötland reveals that 32 percent of the FLQ's are above unity, even after we have adjusted the location quotient for regional size, that is after multiplying by λ^* . This does not mean that the corresponding coefficients should be adjusted upwards. FLQ's might be high because of export oriented (national and domestic) production.

Furthermore, it should be noted that neither one of the more popular location quotients deal intentionally with (i) Differences in import and export pattern between the region and the nation, (ii) Differences in productivity and input efficiency between the region and the nation (for instance labor productivity), (iii) Differences in the composition of inputs between the nation and the region, (iv) The impact of regional size on the role of cross-hauling (trade of heterogeneous goods within the same sector classification) or (v) Spatial market orientation for firms within the region compared to firms in general across the nation (McCann and Dewhurst, 1998). Finding new ways of integrating these aspects of regional specialization into location quotients, or adjustment formulas, should be prioritized work in regionalization theory. Cell by cell corrections for regional specialization or specific trading patterns should be the goal, but requires more data on a regional scale than what is currently generally available. Hybrid approaches are a promising method for improving regionalization but as superior data is often difficult to obtain they need to be, first of all, built around a mechanical table that do not overestimate regional coefficients.

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Appendix A: Aggregated IO table for Östergötland (Swedish NUTS III region) based on FLQ and national technical coefficients.

Sectors	1	2	3	4	5	6	7	8	Total Intermediate sales	Final demand	Output
1 Agriculture	0,0	0,6	664,0	6,6	33,6	23,2	5,9	19,5	753,3	1566,5	2319,7
2 Other primary production	1,5	0,2	2,0	496,6	5,5	12,2	1,3	0,2	519,5	905,6	1425,1
3 Food products	80,2	0,1	0,0	18,2	33,3	205,3	80,3	6,3	423,8	4846,2	5270,0
4 Secondary production	97,1	38,0	138,3	2876,4	372,3	2091,7	705,3	141,1	6460,1	73576,8	80036,9
5 Trade	49,9	10,7	51,5	925,7	0,0	438,3	161,0	85,9	1723,1	12527,6	14250,8
6 Services	34,7	36,2	238,6	3264,4	1218,0	3728,2	1789,2	410,9	10720,2	43522,5	54242,6
7 Public administration	9,1	2,1	10,4	161,8	36,0	321,7	337,2	44,5	922,9	28255,1	29178,0
8 Other services	1,5	0,8	3,1	101,9	32,8	236,2	54,1	5,7	436,2	4340,5	4776,7
Total intermediate consumption	273,9	88,7	1107,9	7851,8	1731,4	7056,9	3134,3	714,1			
Compensation of Households	398,9	243,7	902,0	16616,1	5688,9	13550,5	15241,5	1901,3			
Imports	1233,6	190,2	2661,4	46684,4	4388,9	19107,4	8363,5	1544,9			
Other Final Payments	413,3	902,5	598,7	8884,7	2441,5	14527,8	2438,6	616,4			
Output	2319,7	1425,1	5270,0	80036,9	14250,8	54242,6	29178,0	4776,7			

Appendix B (next page): Open output multipliers for the disaggregated IO model for Östergötland (Swedish NUTS III region) based on FLQ and national technical coefficients.

Sector	Open Output Multiplier	
1	Agriculture, hunting and related services	1,30
2	Forestry, logging and related services	1,16
3	Fishing products; services incidental of fishing	1,31
4	Coal and lignite; peat; Crude petroleum and natural gas	1,24
5	Metal ores; Other mining and quarrying products	1,38
6	Food products and beverages	1,46
7	Textiles	1,13
8	Wearing apparel; furs	1,35
9	Leather and leather products	1,42
10	Wood and products of wood and cork (except furniture)	1,52
11	Pulp, paper and paper products	1,23
12	Printed matter and recorded media	1,44
13	Coke, refined petroleum products and nuclear fuels	1,06
14	Chemicals, chemical products and man-made fibres	1,31
15	Rubber and plastic products	1,15
16	Other non-metallic mineral products	1,34
17	Basic metals	1,26
18	Fabricated metal products, except machinery and equipment	1,27
19	Machinery and equipment n.e.c.	1,16
20	Office machinery and computers	1,05
21	Radio, television and communication equipment and apparatus;	1,20
22	Medical, precision and optical instruments, watches and clocks	1,20
23	Motor vehicles, trailers and semi-trailers	1,42
24	Other transport equipment	1,13
25	Furniture; other manufactured goods n.e.c.	1,32
26	Secondary raw materials	1,25
27	Electrical energy, gas, steam and hot water	1,17
28	Collected and purified water, distribution services of water	1,05
29	Construction work	1,18
30	Wholesale trade and commission trade services	1,17
31	Hotel and restaurant services	1,26
32	Land transport; transport via pipeline services	1,31
33	Water transport services	1,44
34	Air transport services	1,44
35	Supporting and auxiliary transport services; travel agency services	1,28
36	Post and telecommunication services	1,36
37	Financial intermediation services, except insurance and pension funding services	1,20
38	Insurance and pension funding services, except compulsory social security services	1,12
39	Services auxiliary to financial intermediation	1,38
40	Real estate services	1,22
41	Renting services of machinery and equipment	1,19
42	Computer and related services	1,26
43	Other business services Research and development services	1,26
44	Public administration and defence services; compulsory social security services	1,20
45	Education services	1,13
46	Health and social work services	1,10
47	Sewage and refuse disposal services, sanitation and similar services	1,33
48	Membership organisation services n.e.c.	1,14
49	Recreational, cultural and sporting services	1,33
50	Other services	1,11