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The performance of non-survey techniques for constructing sub-territorial input-output tables*

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Abstract. This study is a contribution to the ongoing debate on the performance of various non-survey techniques for constructing sub-territorial input-output tables. Three aspects of the behaviour of the methods are analysed: performances in reproducing 'true' input coefficients, variability of error, and direction of bias. The analysis uses real data and in particular the world input-output table. The most important aspect that emerges from the analysis is that even though simple location quotient (SLQ) has been identified as one of the most robust methods, its performance drops when confronted with Input Output Tables characterized by a high percentage of technical coefficients close to zero. Also the cross industry location quotient (CILQ), the semi logarithmic location quotient (RLQ), the symmetric cross industry location quotient (SCILQ) methods behave in a similar way. On the contrary, the performance of the methods the Flegg location quotient (FLQ) for $\delta = 0.2$ and the Augmented Flegg location quotient (AFLQ) for $0.2 \leq \delta \leq 0.3$ are not affected by this situation.

JEL classification: C67, O18, R15

Key words: Non-survey methods, cross-regional methods, regional input-output tables, location quotient

1 Introduction

Since it was first developed, the input-output table (IOT) has been one of the main tools used to analyse the economic structure of a country and the relations between the economic sectors. The original applications of the IOT were made generally at a nation-wide level, but the interest in extending the IOT to a sub-territorial level (for example a regional level, which is one of the most widespread extensions) is now a major issue in regional sciences because corresponding sub-territorial data are often unavailable.

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In general, the construction of an IOT at a sub-territorial (or sub area) level can be carried out in three different ways: survey, semi survey, and non-survey methods (Kowalewski 2015).

Unfortunately, the costs and time required to construct a sub-territorial IOT directly with survey or semi survey methods are often prohibitive. An alternative approach consists in the application of non-survey or indirect methods (Oosterhaven and Polenske 2009).

The latter, which use existing data, have attracted the attention of researchers and practitioners because they can save time and resources, and because the techniques can be easily implemented.

The goal of these approaches is to adapt the IOT of a bigger geographic area to a sub-territorial level. In particular, the goal of indirect methods is to estimate the sub area input coefficients by multiplying the area input coefficient with some adjustment coefficients. Generally, these re-proportioning coefficients coincide with the location quotient (LQ) index.

The purpose of the LQ is to quantify how specialized is a particular industry or economic sector in a territorial area (for example a region) compared to a larger geographic area (such as a nation). If the LQ index is greater than one, the regional economic sector is more specialized compared to the national ones. The opposite holds if the LQ index is less than one.

Various location quotient methods have been suggested in the literature (Miller and Blair 2009). Among them, the following appear frequently: the simple location quotient (SLQ), the cross industry location quotient (CILQ), the semi logarithmic location quotient (RLQ), the symmetric cross industry location quotient (SCILQ), the Flegg location quotient (FLQ), and the augmented Flegg location quotient (AFLQ).

In general, these methods are based on the assumptions that both the sub geographic area and the reference area have the same productive technologies, and that sub area input coefficients (the amount of an input necessary for producing one unit of gross production) differ from those of the reference in the extent to which goods and services are imported from other territorial areas.

There is already a large and growing body of literature on the strengths and weaknesses of these methods. In most cases, the accuracy of different location quotient methods is evaluated. See for example: Bonfiglio and Chelli (2008), Flegg and Webber (1997, 2000), Flegg and Tohmo (2013), Harrigan et al. (1980), Lehtonen and Tykkyläinen (2014), Morrissey (2016), Morrison and Smith (1974), Oosterhaven and Cardeñoso (2011), Rickman (2003), Round (1978), Schaffer and Chu (1969), and Tohmo (2004).

Although the literature is rich with empirical investigation, the issue concerning the best method with which to regionalize a national IOT is still unresolved because there is no consensus on the best techniques. See for example Lehtonen and Tykkyläinen (2012).

The objective of this study is to make a further contribution to evaluating the accuracy of the above-mentioned non-survey techniques in constructing sub-territorial area input-output tables. The survey uses real data, taken from the World Input-Output Database (see URL: http://www.wiot.org). The database covers 27 European countries, 13 other major countries in the world and the rest of world for the period from 1995 to 2011. More and detailed technical information on the construction of the world input output table (WIOT) can be found in Dietzenbacher et al. (2013) and Timmer (2012). The world input-output table used in this analysis is built at current prices with a classification for 35 industries (economic sectors), and, compared to the national IOT, it provides a more detailed description of the interdependence of industries (economic sectors) between countries.

In this inquiry, the WIOT is treated like the IOT of a reference territorial area with countries acting as sub territorial areas.

The rest of the paper is structured as follows. The next section presents the regionalization techniques considered in the investigation. Section 3 explains the data used in the analysis and the results obtained. Finally, Section 4 concludes the paper.

2 Review of methods for estimating sub-territorial IOT

For simplicity and without loss of generality, henceforth we will refer to a national IOT that must be regionalised. In general, LQ approaches adjust the national technical coefficient (input coefficient) to take account of the potential for satisfying input needs locally. The simple location quotient (SLQ) is the most popular way to regionalize IOT. In this regard, let a_{ij}^{n} and a_{ij}^{r} respectively be the generic national and regional technical coefficient. The a_{ij}^{r} is estimated in the following way:

$$a_{ij}^{r}= SLQ_i \cdot a_{ij}^{n}, \tag{1}$$

where SLQ_i (the degree of modification of the national input coefficient) is the simple location quotient for the *i*th sector of the *r*th region defined as:

$$SLQ_i = \frac{x_i^r / x^r}{x_i^n / x^n}, \tag{2}$$

and x is the total output. We point out that 'In cases where regional output data are not consistently available, or where analysts feel it is appropriate, other measures of regional and national economic activity are often used – including employment (probably the most popular), personal income earned, value added, and so on, by sector' (Miller and Blair 2009, p. 349).

The previous ratio can be interpreted as the relative specialization of the region in the *i*th sector compared to the nation as a whole. The SLQ_i can be greater than, equal to, or less than one. When the location quotient is less than one, the corresponding regional sector is relatively less important than the same sector at national level. In this case, the regional sector will not be able to satisfy all local requirements, so that some of its products must be imported from other regions and no exports can be made.

By contrast, if the location quotient is greater than or equal to one, the sector is judged able to fulfil all requirements of regional purchasing sectors. In other words, the region is self-sufficient for that activity or has a relative advantage. Hence, in these circumstances, the regional technical coefficients are considered to be national technical coefficients. In this case, no adjustment is needed, and consequently the regional sector has the same technical coefficient as the nation.

Therefore, the regional technical coefficients are adjusted in the following way:

$$a_{ij}^{r} = \begin{cases} a_{ij}^{n} \cdot SLQ_i \text{ if } SLQ_i < 1 \\ a_{ij}^{n} \text{ if } SLQ_{\text{i}} \geq 1 \end{cases}. \tag{3}$$

One of the first enhancements of the SLQ method is the Cross-Industry location quotient (CILQ). Indeed, the SLQ method is a uniform adjustment that takes into consideration only the supply side (the row side), namely, only the size of the selling industry. Unlike the SLQ, the CILQ considers both supplying and purchasing sectors. This approach can describe the regional IOT relations more realistically than its predecessors. The CILQ formula can be written as follows:

$$CILQ_{ij} = \frac{x_i^r / x_i^n}{x_j^r / x_j^n} = \frac{SLQ_i}{SLQ_j}, \tag{4}$$

and:

$$a_{ij}^{r} = \begin{cases} a_{ij}^{n} \cdot CILQ_{ij} \text{ if } CILQ_{ij} < 1 \\ a_{ij}^{n} \textit{ if } CILQ_{ij} > 1 \end{cases}. \tag{5}$$

Contrary to the SLQ method, which is a uniform adjustment along each row of the national technological matrix, the CILQ method is an adjustment cell by cell. It is worthwhile looking at the logic of CILQ. If the share of sector *i* (producer) in region *r* (compared to the national level) is larger than the share of sector *j* (purchaser) in the same region (again compared to the national level), then the region can satisfy sector *j*'s input requirements in sector *i* ($CILQ_{ij} > 1$).

Likewise, if the share of industry *i* is smaller than the share of sector *j*, the region is not able to cover its own needs, and the coefficients in the table must be adjusted according to the above equations. It should be noted that CILQ can be expressed as the ratio of two location quotients.

Contrary to the SLQ, which rules out the possibility of cross-hauling (a region that imports from other regions yet does not export to them, but does the opposite), the CILQ does not preclude cross-hauling. Hence imports and exports can occur simultaneously.

However, because the CILQ always equals 1 when $i = j$, Smith and Morrison (1974) suggested that the previous two LQs should be combined:

$$CILQ_{ij} = \begin{cases} SLQ_i \text{ for } i = j \\ CILQ_{ij} \text{ for } i \neq j \end{cases}. \tag{6}$$

The SCILQ proposed by Oude Wansink and Maks (1998) is a variant of the traditional CILQ method. It is designed to take account of the possibility of deriving regional coefficients that exceed the national ones, thus overcoming the problem of asymmetric adjustments. It takes the following form:

$$SCILQ_{ij} = 2 - \frac{2}{CILQ^r_{ij} + 1}. \tag{7}$$

The logic behind this technique is as follows. If the CILQ equals zero or one, then the SCILQ equals zero or one. If the CILQ goes to infinity, the SCILQ goes to two. In so doing, the regional coefficients take account not only of the fact that sectors may be less concentrated in a region but also that sectors may be more concentrated.

Since this method allows upward adjustments, it may happen that the column sum of the coefficients is greater than one. In this case, a further adjustment of column coefficients is necessary.

The literature is remarkably rich in further modifications of the original LQ method. The semi-logarithmic quotient (RLQ) is another variant. Round (1978) noted that the adjustment coefficient should consider: (*i*) the relative size of the regional selling sector compared with that of the nation; (*ii*) the relative size of the regional purchasing sector; and (*iii*) the relative size of the region. The SLQ considers (*i*) and (*ii*) but does not take (*ii*) into account. The CILQ and SCILQ satisfy (*i*) and (*ii*) but not (*iii*). To take all these variables into account, Round (1978) proposed the RLQ method, which takes the following form and incorporates the properties of both the SLQ and CILQ methods:

$$RLQ_{ij} = \frac{SLQ_i}{log_2\left(1 + SLQ_j\right)} = \frac{x^r_i/x^r}{x^n_i/x^n} / \left[\log_2\left(1 + \frac{x^r_j}{x^r} \cdot \frac{x^n}{x^n_j}\right)\right]. \tag{8}$$

In regard to the above expression, it should be noted that the factor x^n/x^r (i.e., relative importance of the region) does not cancel as happens in the CILQ formula. Moreover, with the inclusion of SLQ_i and SLQ_j the method considers the relative size of both sectors. Like the others, the RLQ should not be more than a unit.

The RLQ is criticized for underestimating imports from other regions when the size of the region is small (e.g., Flegg and Webber 1997). To overcome the drawbacks, Flegg's LQ method (FLQ) was introduced:

$$FLQ_{ij} = \begin{cases} CILQ_{ij} \cdot \lambda \text{ for } i \neq j \\ SLQ_{ij} \cdot \lambda \text{ for } i = j \end{cases}, \tag{9}$$

where λ stands for the relative size of the region and takes the following form:

$$\lambda = \left[log_2 \left(1 + \frac{x^r}{x^n} \right) \right]^{\delta}, \tag{10}$$

and $0 \leq \delta < 1$,which is a sensitivity parameter that controls the degree of convexity in the previous equation. The larger the value of δ, the lower the value of λ, so that greater adjustments of regional imports are made.

The FLQ is the same as equation $CILQ_{ij}$ when $\delta = 0$. The FLQ was proposed to incorporate the advantages of both the CILQ and SLQ methods and to avoid their respective shortcomings. The relative size of the selling and purchasing sectors is taken into account through inclusion of the CILQ, while the relative size of the region appears in λ. The δ parameter is included to allow for greater modification of the regional imports. The implementation of the FLQ formula is carried out in a manner similar to other LQ methods:

$$a^r_{ij} = \begin{cases} a^n_{ij} \cdot FLQ_{ij} \text{ if } FLQ_{ij} < 1 \\ a^n_{ij} \text{ if } FLQ_{ij} \geq 1 \end{cases}. \tag{11}$$

The value of the parameter δ is the focus of the method. According to Flegg and Webber (1997), Flegg and Tohmo (2013) and Kowalewski (2015), an approximate value of 0.3 is appropriate. In general, the choice of the δ value is an empirical matter because only a small amount of empirical research has been produced.

McCann and Dewhurst (1998) pointed out the possibility that regional coefficients may exceed the national coefficients when there is regional specialization (i.e., the regional technical coefficient becomes larger than the national technical coefficients). Thus, the Augmented FLQ (AFLQ) was proposed. The AFLQ is defined as follows:

$$AFLQ_{ij} = \begin{cases} FLQ_{ij} \cdot \left[\log_2 \left(1 + SLQ_j \right) \right] \text{ for } SLQ_j > 1 \\ FLQ_{ij} \text{ for } SLQ_j \leq 1 \end{cases}, \tag{12}$$

where $\log_2 (1 + SLQ_j)$ represents the regional specialization of sector j and has been included to allow for the effects of regional specialization. If $SLQ_j > 1$ and $FLQ_{ij} \geq 1$, the national coefficients are scaled upwards. However, to avoid an excessive upward adjustment, the constraint $FLQ_{ij} \leq 1$ is imposed. Consequently, the regionalization is performed as follows:

$$a^r_{ij} = \begin{cases} a^n_{ij} \cdot AFLQ_{ij} \text{ if } SLQ_j > 1 \\ a^n_{ij} \cdot FLQ_{ij} \text{ if } SLQ_j \leq 1 \end{cases}. \tag{13}$$

3 Empirical evidence

As previously noted, several studies have examined the performance of the various quotient localization methods. They include Flegg and Webber (2000), Tohmo (2004), Lehtonen and

Tykkyläinen (2012), Flegg and Tohmo (2013), Kowalewski (2015) Harrigan et al. (1980), Harris and Liu (1998), Sawyer and Miller (1983) and Stevens et al. (1989).

The present study uses the WIOT for the years from 1995 to 2011. A simplified pattern of a WIOT is depicted in Figure 1, where:

- $\mathbf{Z}_{rr}$ (r = 1,..,41) is a 35 × 35 matrix whose elements are the flows for intermediate use from the ith sector of country r to the jth sector of the same country;
- $\mathbf{Z}_{rk}$ (r,k = 1,..,41 and $r \neq k$) is a 35 × 35 matrix whose elements are the exports for intermediate use from the ith sector of country r to the jth sector of country k;
- $\mathbf{E}_{rr}$ (r = 1,..,41) is a 35 × 5 matrix of the domestic final demand in country r;
- $\mathbf{E}_{rk}$ (r,k = 1,..,41 and r≠k) is a 35 × 5 matrix of the exports of country r for final demand purposes in country k;
- $\mathbf{x}_r$ (r = 1,..,41) is a 35 × 1 vector whose entries are the sectorial output of country r;
- $\mathbf{v}_r$ (r = 1,..,41) is a 35 × 1 vectors whose entries are the sectorial added-value of country r.

The methodology that we employed to analyse the behaviour of the various regionalization methods was the following. For every year (t) and each country (r) the intra-national matrix of technical coefficients ($\mathbf{A}_{rt} = [a_{rtij}]$) was determined:

$$\boldsymbol{A}_{rt} = \boldsymbol{Z}_{rrt} \langle \boldsymbol{x}_{rt} \rangle^{-1} \text{ for } r = 1, .., 41 \text{ and } t = 1995, .., 2011, \tag{14}$$

where $\langle \boldsymbol{x}_{rt} \rangle^{-1}$is the diagonal matrix whose elements are the inverse of the output (i.e., total production) of the generic economic sector.

Then the world matrix of technical coefficients ($\boldsymbol{A}_{Wt} = [a_{Wtij}]$) was determined. In this regard, let $\boldsymbol{Z}_{Wt} = \sum_{r=1}^{41} \boldsymbol{Z}_{rrt}$ and $\mathbf{x}'_{Wt} = \sum_{r=1}^{41} \mathbf{x}'_{rt}$ for t = 1995,..,2011:

$$\boldsymbol{A}_{Wt} = \boldsymbol{Z}_{Wt} \langle \boldsymbol{x}_{Wt} \rangle^{-1}. \tag{15}$$

In total we had 697 (i.e., 41 × 17) countries for time $\boldsymbol{A}_{rt}$ and 17 (i.e., one per year) world $\mathbf{A}_{Wt}$. Afterwards, using each one of the 17 world $\mathbf{A}_{Wt}$ and each one of the h methods described above, the countries' technical coefficient matrices were estimated ($\hat{\mathbf{A}}_{rth}$).

Following the experimentation of Bonfiglio and Chelli (2008) nine versions of the FLQ and AFLQ methods were considered, i.e. those for $0.1 \leq \delta < 1$ by 0.1.

Finally, in order to evaluate the behaviour of the indirect methods, the entries of the true $\mathbf{A}_{rt}$ and the estimated $\hat{\mathbf{A}}_{rth}$ were compared.

In this regard, three aspects were analysed: performances in reproducing the true technical coefficients, the variability, and the direction of bias.

To analyse the performance or the accuracy of the various methods, following Wiebe and Lenzen (2016), the mean absolute difference index (MAD) was used:

$\mathbf{Z}_{1;1}$	$\mathbf{Z}_{1;2}$	…	$\mathbf{Z}_{1;40}$	$\mathbf{Z}_{1;41}$	$\mathbf{E}_{1;1}$	…	$\mathbf{E}_{1;41}$	$\mathbf{x}_1$
$\mathbf{Z}_{2;1}$	$\mathbf{Z}_{2;2}$	…	$\mathbf{Z}_{2;40}$	$\mathbf{Z}_{2;41}$	$\mathbf{E}_{2;1}$	…	$\mathbf{E}_{2;41}$	$\mathbf{x}_2$
…	…	…	…	…	…	…	…	…
$\mathbf{Z}_{41;1}$	$\mathbf{Z}_{41;2}$	…	$\mathbf{Z}_{41;40}$	$\mathbf{Z}_{41;41}$	$\mathbf{E}_{41;1}$	…	$\mathbf{E}_{41;41}$	$\mathbf{x}_{41}$
$\mathbf{v}'_1$	$\mathbf{v}'_2$	…	$\mathbf{v}'_{40}$	$\mathbf{v}'_{41}$				
$\mathbf{x}'_1$	$\mathbf{x}'_2$	…	$\mathbf{x}'_{40}$	$\mathbf{x}'_{41}$				

" ′ " is the transposition symbol.

Fig. 1. Pattern of a WIOT

$$MAD_{rth} = \sum_{i=1}^{35}\sum_{j=1}^{35}\frac{\left|a_{rtij}\text{-}\hat{a}_{rthij}\right|}{35{\cdot}35} \quad \text{for } r = 1,..,41; \; t = 1995,..,2011; \; h = 1,..,22. \tag{16}$$

The index measures the distance between the estimated and the true technical coefficients. As the index value approaches zero, the performance of the method improves. It should be specified that, in literature, other performance indices were introduced, such as, the standardized total percentage error (Miller and Blair 2009) and the weighted absolute deviation (Lahr 2001). Also in this enquiry we used other performance indices, including the ones just mentioned. The results (not shown but available on request), perfectly match those of the MAD index.

Focusing on the performance of the various methods, two types of analysis were conducted. In particular, Table 1 shows the mean of the MAD_{rth} index by year, while Table 2 shows the mean of the $\mathrm{MAD}_{\mathrm{rth}}$ index by country, namely:

$$MAD_{\bullet th} = \frac{1}{41}\sum_{r=1}^{41} MAD_{rth}, \tag{17}$$

$$MAD_{r\bullet h} = \frac{1}{17}\sum_{t=1995}^{2011} MAD_{rth}. \tag{18}$$

Considering Table 1, no particular situations are evident. The performance of the various methods of regionalization in time is practically the same. Nevertheless, SLQ, RLQ, FLQ and AFLQ for δ = 0.1 and δ = 0.2 are the methods with the lowest mean values (from 0.6 to 0.7) and thus the most reliable methods of regionalization.

By contrast, FLQ and AFLQ for δ = 0.6,..,0.9, are the methods with the highest value (0.10) and therefore are the worst methods.

Table 1. Performance ($MAD_{\bullet th}$) of the various methods by years. Values multiplied by 100

Methods	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SLQ	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
CILQ	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9
SCILQ	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
RLQ	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7
FLQ (δ = 0.1)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7
FLQ (δ = 0.2)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
FLQ (δ = 0.3)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
FLQ (δ = 0.4)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
FLQ (δ = 0.5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	0.9
FLQ (δ = 0.6)	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FLQ (δ = 0.7)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FLQ (δ = 0.8)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FLQ (δ = 0.9)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
AFLQ (δ = 0.1)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7
AFLQ (δ = 0.2)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
AFLQ (δ = 0.3)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
AFLQ (δ = 0.4)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
AFLQ (δ = 0.5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	0.9
AFLQ (δ = 0.6)	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
AFLQ (δ = 0.7)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
AFLQ (δ = 0.8)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
AFLQ (δ = 0.9)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 2. Performance ($MAD_{r\bullet h}$) of the various methods by countries. Values multiplied by 100

Countries	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
AUS	0.6	0.8	0.7	0.7	0.7	0.8	1.0	1.0	1.1	1.1	1.2	1.2	1.2	0.7	0.8	0.9	1.0	1.1	1.1	1.2	1.2	1.2
AUT	0.5	0.7	0.6	0.6	0.5	0.6	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.5	0.6	0.7	0.8	0.8	0.9	0.9	0.9	0.9
BEL	0.6	0.8	0.7	0.7	0.6	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	0.6	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0
BGR	0.6	0.8	0.7	0.7	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
BRA	0.6	0.7	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1
CAN	0.6	0.7	0.7	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0
CHN	0.7	0.9	0.8	0.7	0.9	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.3	0.9	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.3
CYP	0.6	0.9	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8
CZE	0.6	0.8	0.6	0.6	0.7	0.8	1.0	1.0	1.1	1.1	1.1	1.1	1.1	0.7	0.8	1.0	1.0	1.1	1.1	1.1	1.1	1.1
DEU	0.6	0.8	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0
DNK	0.6	0.8	0.7	0.7	0.6	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	0.6	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0
ESP	0.5	0.7	0.6	0.6	0.6	0.7	0.9	0.9	1.0	1.0	1.1	1.1	1.1	0.6	0.7	0.9	0.9	1.0	1.0	1.1	1.1	1.1
EST	0.6	0.8	0.7	0.7	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
FIN	0.6	0.8	0.6	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.1	1.1	1.1	0.7	0.8	0.9	1.0	1.0	1.0	1.1	1.1	1.1
FRA	0.5	0.7	0.6	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1
GBR	0.6	0.8	0.6	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0
GRC	0.6	0.7	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9
HUN	0.5	0.7	0.6	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0
IDN	0.7	0.9	0.8	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0
IND	0.7	0.9	0.8	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1
IRL	0.6	0.8	0.7	0.7	0.6	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.6	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.9
ITA	0.5	0.8	0.6	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.2	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.2
JPN	0.6	0.9	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1
KOR	0.6	0.9	0.6	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.2	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.2
LTU	0.6	0.9	0.7	0.7	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8
LUX	0.5	0.8	0.8	0.6	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6
LVA	0.6	0.9	0.7	0.7	0.7	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
MEX	0.6	0.7	0.6	0.6	0.6	0.6	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.6	0.6	0.7	0.8	0.8	0.9	0.9	0.9	0.9
MLT	0.6	0.9	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
NLD	0.6	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9
POL	0.6	0.7	0.7	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.1	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.1
PRT	0.6	0.7	0.6	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.1	1.1	1.1	0.7	0.8	0.9	1.0	1.0	1.0	1.1	1.1	1.1
ROM	0.7	0.8	0.8	0.7	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
ROW	0.5	0.7	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9
RUS	0.7	0.9	0.8	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1
SVK	0.6	0.8	0.7	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0

Table 2. (Continued)

Countries	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
SVN	0.6	0.7	0.6	0.6	0.6	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.0	0.6	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.0
SWE	0.6	0.8	0.7	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0
TUR	0.6	0.7	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.1	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.1
TWN	0.6	0.9	0.7	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0
USA	0.6	0.8	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	0.9	1.0	0.6	0.6	0.7	0.8	0.8	0.9	0.9	0.9	1.0

Close to the mean value of the SLQ, RLQ, FLQ and AFLQ (for $\delta = 0.1$ and $\delta = 0.2$) methods are those of the CILQ, AFLQ ($\delta = 0.3$), FLQ ($\delta = 0.3$) and SCILQ methods, indicating a similar performance in the regionalization of a national IOT.

Moreover, to be noted is that the optimal value of δ for both the FLQ and AFLQ methods is 0.1, and that the performance of the two methods decreases with the increases in δ. Furthermore, the performance of the two methods is in mean indistinguishable.

The same results are obtained on analysing Table 2, which shows the mean by countries of the MAD index ($MAD_{r\bullet h}$). In particular, also between the countries, the behaviour of the methods is very similar, and the results perfectly match those highlighted previously. To improve the readability of Tables 1 and 2, the results have been synthesised, by some descriptive statistics, in Table 3. Also in this case, the most important aspect that emerges is that the results perfectly match those previously obtained.

In conclusion, there is no method that is able to replicate the true technical coefficients, and in general the various methods considered have similar behaviours. Nevertheless, SLQ, RLQ, FLQ ($\delta = 0.1$ and $\delta = 0.2$) and AFLQ ($\delta = 0.1$ and $\delta = 0.2$) are those with a slightly higher performance. It should be noted that we cannot exclude that the results of the temporal analysis of the MAD index may be caused by the fact that the WIOT are mostly interpolated.

In consideration of the above results, a more detailed analysis was performed by ranking, in ascending order, in each one of the country and year considered, the MAD_{rth} index with respect to the various methods. In particular, let R_{rth} be the rank of the MAD_{rth} index of the hth method in the rth country at time t.

Hence, $1 \leq R_{rth} \leq 22$. In fact, if in the generic rth country at time t the MAD_{rth} of the hth method has the lower value, that is the method in question has the highest performance, then $R_{rth} = 1$. On the contrary, if in the generic rth country at time t the MAD_{rth} of the hth method has the higher value, that is the method in question has the lowest performance, then $R_{rth} = 22$.

Table 3. Descriptive statistics of the MAD index

Methods	Mean	St Dev	Min Val.	Max Val.	1 Quartile	Median	3 Quartile
SLQ	0.006	0.001	0.005	0.007	0.006	0.006	0.006
CILQ	0.008	0.001	0.007	0.009	0.007	0.008	0.009
SCILQ	0.007	0.001	0.005	0.008	0.006	0.007	0.007
RLQ	0.006	0.001	0.005	0.008	0.006	0.006	0.007
FLQ ($\delta = 0.1$)	0.007	0.001	0.005	0.009	0.006	0.006	0.007
FLQ ($\delta = 0.2$)	0.007	0.001	0.005	0.010	0.007	0.007	0.008
FLQ ($\delta = 0.3$)	0.008	0.001	0.005	0.010	0.007	0.009	0.009
FLQ ($\delta = 0.4$)	0.009	0.001	0.006	0.011	0.008	0.009	0.010
FLQ ($\delta = 0.5$)	0.009	0.001	0.006	0.012	0.008	0.009	0.010
FLQ ($\delta = 0.6$)	0.010	0.002	0.006	0.012	0.009	0.010	0.010
FLQ ($\delta = 0.7$)	0.010	0.002	0.006	0.013	0.009	0.010	0.011
FLQ ($\delta = 0.8$)	0.010	0.002	0.006	0.013	0.009	0.010	0.011
FLQ ($\delta = 0.9$)	0.010	0.002	0.006	0.013	0.009	0.010	0.011
AFLQ ($\delta = 0.1$)	0.007	0.001	0.005	0.009	0.006	0.006	0.007
AFLQ ($\delta = 0.2$)	0.007	0.001	0.005	0.010	0.007	0.007	0.008
AFLQ ($\delta = 0.3$)	0.008	0.001	0.005	0.010	0.007	0.009	0.009
AFLQ ($\delta = 0.4$)	0.009	0.001	0.006	0.011	0.008	0.009	0.010
AFLQ ($\delta = 0.5$)	0.009	0.001	0.006	0.012	0.008	0.009	0.010
AFLQ ($\delta = 0.6$)	0.010	0.002	0.006	0.012	0.009	0.010	0.010
AFLQ ($\delta = 0.7$)	0.010	0.002	0.006	0.013	0.009	0.010	0.011
AFLQ ($\delta = 0.8$)	0.010	0.002	0.006	0.013	0.009	0.010	0.011
AFLQ ($\delta = 0.9$)	0.010	0.002	0.006	0.013	0.009	0.010	0.011

We first looked at the rank sum of the various methods by countries for each considered year:

$$R_{\bullet th} = \sum_{r=1}^{41} R_{rth}. \tag{19}$$

Remembering that our database is made up of 41 countries and the regionalization methods considered are 22, if in the tth year, in each country, the hth method always has a rank equal to one then the minimum value of (19) is 41 (i.e., 1 × 41). Conversely, if in the tth year, in each country, the hth method always has a rank of 22, therefore the method always has the lowest performance then the maximum value of (19) is 902 (i.e., 22 × 41). Consequently, the lower the index value, the higher is the performance of the method.

Table 4 shows the results obtained. As can be seen, no particular differences compared to the previous analysis are evident. SLQ followed by AFLQ (δ = 0.1) and FLQ (δ = 0.1) are the methods with the lowest values in the index in consideration and thus with the highest performances. In the middle positions are the RLQ, SCILQ, AFLQ (δ = 0.2) and AFLQ (δ = 0.2) methods. Finally, occupying the last position, with the lowest performance, are the remaining methods.

Subsequently, the temporal rank sum was considered:

$$R_{r\bullet h} = \sum_{t=1995}^{2011} R_{rth}. \tag{20}$$

For each country, Equation 20 is the temporal sum of rank of the hth method. If in the generic rth country, for each considered year, the hth method always has a rank equal to one then the minimum value of Equation 20 in each country is 17 (i.e., 1 × 17). On the contrary if in the generic rth country, for each considered year, the hth method always has the highest rank then the maximum value of (20) is 374 (i.e., 22 × 17). Also in this case, the lower the index value, the higher is the performance of the method.

The results of this analysis are shown in Table 5. Once again, the SLQ method is the one that shows, in the considered set, the lowest values. In 68 per cent of countries it is always in the first position; however, in 22 per cent of cases it is in third place. Finally, in the remaining countries it never exceeds the 11th position. The FLQ (δ = 0.1) is the best method in 46 per cent of countries, and in the remaining situations it never exceeds the 5h position.

A similar behaviour is recorded for the RLQ method. This method is positioned in the top places of the classification for almost half of the countries. Instead, in 34 per cent of cases its place is between the third and the fourth positions. In the remaining countries, except for Luxembourg where it is classified in 18th place, its place is never below the 12th position.

Also the position of the AFLQ (δ = 0.1) method for 46 per cent of countries is at the top of the classification, and in the remaining cases never below the fourth position.

Continuing forward we find the FLQ (δ = 0.2) and AFLQ (δ = 0.2) methods. The position of these methods in the considered set is never below the 7th position. Then follow the SCILQ method, which in 68 per cent of countries is ranked between 2nd and 5th place, while in the remaining countries it is ranked between the 7th and 20th positions.

Ranking lower are the FLQ (δ = 0.3) and AFLQ (δ = 0.3) methods, whose positions are between the fifth and the ninth. Finally, we have:

- The FLQ (δ = 0.4) and AFLQ (δ = 0.4) methods, whose positions are between the 7th and 11th;
- The FLQ (δ = 0.5) and AFLQ (δ = 0.5) methods, whose positions are between the 9th and 14th;
- The FLQ (δ = 0.6) and AFLQ (δ = 0.6) methods, whose positions are between the 12th and 16th;

Table 4. Rank sum of the various methods by countries for each year

Methods/Years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SLQ	106	115	117	115	104	86	81	83	85	85	77	76	74	78	71	73	71
CILQ	358	360	371	387	393	398	383	377	371	375	395	407	412	433	458	502	512
SCILQ	214	219	227	231	221	228	225	222	208	207	216	226	238	256	236	271	269
RLQ	175	167	171	165	176	179	165	170	164	159	152	157	161	185	161	172	178
FLQ (δ = 0.1)	128	131	125	126	120	123	122	121	122	121	123	119	117	119	112	110	94
FLQ (δ = 0.2)	245	242	240	240	243	239	245	243	245	245	241	236	233	234	229	227	213
FLQ (δ = 0.3)	348	349	343	344	344	342	344	347	351	349	347	344	340	335	337	342	318
FLQ (δ = 0.4)	435	435	436	434	435	432	435	436	438	436	435	434	433	425	431	440	414
FLQ (δ = 0.5)	521	520	520	519	519	520	523	522	523	523	520	520	519	514	518	530	501
FLQ (δ = 0.6)	604	603	603	601	602	602	605	606	606	608	607	607	607	602	603	616	583
FLQ (δ = 0.7)	686	685	685	684	685	686	687	688	688	690	690	690	691	685	689	704	666
FLQ (δ = 0.8)	768	767	767	766	767	770	769	770	770	772	773	773	773	770	773	790	747
FLQ (δ = 0.9)	850	849	849	848	849	852	851	852	852	854	855	855	856	852	856	874	829
AFLQ (δ = 0.1)	126	129	124	125	119	121	121	120	121	120	122	118	115	117	111	108	94
AFLQ (δ = 0.2)	244	241	239	239	242	238	244	242	244	244	240	235	232	232	228	225	213
AFLQ (δ = 0.3)	347	348	342	343	343	341	350	346	358	348	346	343	339	334	336	340	318
AFLQ (δ = 0.4)	434	434	435	433	434	431	434	435	437	435	434	433	432	424	430	438	414
AFLQ (δ = 0.5)	520	519	519	518	518	519	522	521	522	522	519	519	518	513	517	528	501
AFLQ (δ = 0.6)	603	602	602	600	601	601	604	605	605	607	606	606	606	601	602	614	583
AFLQ (δ = 0.7)	685	684	684	683	684	685	686	687	687	689	689	689	690	684	688	702	666
AFLQ (δ = 0.8)	767	766	766	765	766	769	768	769	769	771	772	772	772	769	772	788	747
AFLQ (δ = 0.9)	849	848	848	847	848	851	850	851	851	853	854	854	855	851	855	872	829

Table 5. Rank sum of the various methods by year for each country

Countries	SLQ	CILQ	SCILQ	RLQ	FLQ (δ = 0.1)	FLQ (δ = 0.2)	FLQ (δ = 0.3)	FLQ (δ = 0.4)	FLQ (δ = 0.5)	FLQ (δ = 0.6)	FLQ (δ = 0.7)
AUS	19	120	60	37	81	129	164	198	234	268	302
AUT	49	158	85	68	25	103	147	184	220	255	289
BEL	47	204	109	84	26	84	136	180	216	253	287
BGR	23	132	69	46	53	110	150	186	220	254	288
BRA	20	90	59	37	71	116	152	187	221	255	289
CAN	30	130	99	71	33	91	153	187	221	255	289
CHN	28	96	57	27	75	117	152	186	220	254	288
CYP	109	326	279	216	27	70	108	147	182	217	252
CZE	23	118	74	57	68	110	149	183	217	251	286
DEU	25	228	107	88	33	94	134	170	211	249	285
DNK	45	166	109	78	23	85	141	183	219	255	289
ESP	21	108	59	40	66	113	150	186	221	255	289
EST	19	108	71	36	58	114	153	187	221	255	289
FIN	17	108	53	36	66	117	152	187	221	255	289
FRA	18	152	66	42	67	112	159	196	232	268	304
GBR	18	190	86	58	38	93	130	167	202	236	270
GRC	25	166	95	72	37	96	143	181	219	253	287
HUN	23	118	67	52	51	114	151	185	220	254	289
IDN	17	208	86	41	51	99	139	177	217	252	287
IND	21	150	78	45	54	100	148	185	220	254	288
IRL	47	196	125	96	27	74	130	177	216	253	287
ITA	21	136	56	37	65	106	148	185	221	255	289
JPN	47	184	33	32	65	100	138	178	221	255	289
KOR	21	144	53	38	65	104	151	186	220	254	288
LTU	39	324	123	98	30	77	133	170	204	241	275
LUX	193	338	319	290	56	32	93	134	168	203	238
LVA	39	171	100	60	50	93	145	181	216	250	284
MEX	57	163	126	88	25	92	144	181	215	249	283
MLT	135	346	259	200	19	66	107	148	184	219	253
NLD	49	200	141	108	19	72	130	178	215	251	286
POL	21	122	67	46	61	112	149	185	219	254	288
PRT	21	104	57	40	64	115	152	187	221	255	289
ROM	31	130	76	59	43	105	150	185	220	254	289
ROW	23	222	163	114	53	70	116	163	207	247	282
RUS	21	126	73	42	54	108	150	186	221	255	289
SVK	19	128	71	52	51	108	149	186	221	255	289
SVN	17	100	47	52	65	117	152	187	221	255	289
SWE	17	142	82	61	41	103	148	186	221	255	289
TUR	23	124	64	45	54	112	149	186	221	255	289
TWN	18	200	80	40	59	108	147	190	230	268	306
USA	41	216	31	28	64	99	132	163	196	234	272

- The FLQ (δ = 0.7) and AFLQ (δ = 0.7) methods, whose positions are between the 14th and 18th;
- The FLQ (δ = 0.8) and AFLQ (δ = 0.8) methods, whose positions are between the 16th and 20th;
- The FLQ (δ = 0.9) and AFLQ (δ = 0.9) methods, whose positions are between the 9th and 20th.

A general overview of the two analyses just conducted is provided in Table 6, which shows the number of times that a method has a certain rank in all 697 considered cases (i.e., 41 × 17).

Table 5. (Continued)

Countries	FLQ (δ = 0.8)	FLQ (δ = 0.9)	AFLQ (δ = 0.1)	AFLQ (δ = 0.2)	AFLQ (δ = 0.3)	AFLQ (δ = 0.4)	AFLQ (δ = 0.5)	AFLQ (δ = 0.6)	AFLQ (δ = 0.7)	AFLQ (δ = 0.8)	AFLQ (δ = 0.9)
AUS	336	370	62	114	157	184	220	254	288	322	356
AUT	323	357	24	102	146	183	219	254	288	322	356
BEL	322	357	25	83	135	179	215	252	286	321	356
BGR	322	356	53	110	150	186	220	254	288	322	356
BRA	323	357	71	116	152	187	221	255	289	323	357
CAN	323	357	33	91	153	187	221	255	289	323	357
CHN	322	356	75	117	152	186	220	254	288	322	356
CYP	286	320	27	70	108	147	182	217	252	286	320
CZE	320	354	68	110	149	183	217	251	286	320	354
DEU	320	354	33	94	134	170	211	249	285	320	354
DNK	323	357	23	85	141	183	219	255	289	323	357
ESP	323	357	66	113	150	186	221	255	289	323	357
EST	323	357	58	114	153	187	221	255	289	323	357
FIN	323	357	66	117	152	187	221	255	289	323	357
FRA	341	378	67	112	159	196	232	268	304	341	378
GBR	304	336	38	93	130	167	202	236	270	304	336
GRC	322	357	37	96	143	181	219	253	287	322	357
HUN	323	357	51	114	151	185	220	254	289	323	357
IDN	321	355	51	99	139	177	217	252	287	321	355
IND	322	356	54	100	148	185	220	254	288	322	356
IRL	322	356	27	74	130	177	216	253	287	322	356
ITA	323	357	65	106	148	185	221	255	289	323	357
JPN	323	357	65	100	138	178	221	255	289	323	357
KOR	322	356	65	104	151	186	220	254	288	322	356
LTU	309	343	30	77	133	170	204	241	275	309	343
LUX	273	307	56	32	93	134	168	203	238	273	307
LVA	318	352	50	93	145	181	216	250	284	318	352
MEX	317	351	25	92	144	181	215	249	283	317	351
MLT	287	321	19	66	107	148	184	219	253	287	321
NLD	320	354	19	72	130	178	215	251	286	320	354
POL	322	356	61	112	149	185	219	254	288	322	356
PRT	323	357	64	115	152	187	221	255	289	323	357
ROM	323	357	43	105	150	185	220	254	289	323	357
ROW	320	355	53	70	116	163	207	247	282	320	355
RUS	323	357	54	108	150	186	221	255	289	323	357
SVK	323	357	51	108	149	186	221	255	289	323	357
SVN	323	357	65	117	152	187	221	255	289	323	357
SWE	323	357	41	103	148	186	221	255	289	323	357
TUR	323	357	54	112	149	186	221	255	289	323	357
TWN	342	378	59	108	147	190	230	268	306	342	378
USA	304	336	63	98	139	162	195	233	271	303	335

This last index takes values from 0 (if the generic *h*th method is never classified in a certain rank) to 697 (if the generic *h*th method is always classified in the same rank).

As will be seen, no differences compared to the previous two analyses are evident. In particular, the SQL method is in the top three places of the classification in 94.5 per cent of cases. Then follow the RLQ, AFLQ and FLQ methods for $\delta = 0.1$, which are classified in the top three positions respectively in 55.4 per cent, 54.8 per cent and 54.1 per cent of cases. The AFLQ and FLQ methods, both for $\delta = 0.9$, in 93.8 per cent of cases are always classified in the last three places.

To analyse the variability of the various methods, the standard deviation of the MAD_{rth} index was determined. The variability of the various methods is related to the property of a

Table 6. Rank frequencies distribution occupied by the various methods

Rank	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
1	469	0	21	26	166	14	1	0	0	0	0	0	0	166	14	1	0	0	0	0	0	0
2	16	0	26	346	119	8	0	0	0	0	0	0	0	119	8	1	0	0	0	0	0	0
3	174	0	259	14	92	24	2	0	0	0	0	0	0	97	24	2	0	0	0	0	0	0
4	0	46	5	166	255	94	1	0	0	0	0	0	0	263	94	2	0	0	0	0	0	0
5	10	3	205	5	59	41	25	1	0	0	0	0	0	50	41	25	1	0	0	0	0	0
6	0	190	0	75	5	271	36	0	0	0	0	0	0	1	275	36	0	0	0	0	0	0
7	6	3	93	0	0	230	23	22	0	0	0	0	0	0	239	23	22	0	0	0	0	0
8	0	178	0	23	1	14	188	19	0	0	0	0	0	1	2	187	19	0	0	0	0	0
9	1	1	29	0	0	1	403	18	21	0	0	0	0	0	0	417	18	21	0	0	0	0
10	0	84	0	4	0	0	18	133	17	0	0	0	0	0	0	1	133	17	0	0	0	0
11	2	1	9	0	0	0	0	487	12	19	0	0	0	0	0	0	504	12	19	0	0	0
12	0	56	0	2	0	0	0	17	87	17	0	0	0	0	0	0	0	87	17	0	0	0
13	1	0	6	0	0	0	0	0	543	8	18	0	0	0	0	0	0	560	8	18	0	0
14	0	29	0	1	0	0	0	0	17	64	17	0	0	0	0	0	0	0	64	17	0	0
15	1	0	1	0	0	0	0	0	0	572	8	17	0	0	0	0	0	0	589	8	17	0
16	0	17	0	1	0	0	0	0	0	17	48	17	0	0	0	0	0	0	0	48	17	0
17	0	0	0	0	0	0	0	0	0	0	589	9	17	0	0	0	0	0	0	606	9	17
18	0	10	0	0	0	0	0	0	0	0	17	38	17	0	0	0	0	0	0	0	38	17
19	17	0	0	0	0	0	0	0	0	0	0	599	9	0	0	0	0	0	0	0	616	9
20	0	4	0	34	0	0	0	0	0	0	0	17	34	0	0	0	0	0	0	0	0	34
21	0	12	31	0	0	0	0	0	0	0	0	0	603	0	0	0	0	0	0	0	0	620
22	0	63	12	0	0	0	0	0	0	0	0	0	17	0	0	2	0	0	0	0	0	0

method which has the same performance whatever the region and time. Indeed, a method that exhibits a null or low level of variability, allows analysts to know in advance and with relative precision the extent of the method performance:

$$\sigma_{rth} = \left[\frac{1}{35^*35}\sum_{i=1}^{35}\sum_{j=1}^{35}\left(\left|a_{rtij} - \hat{a}_{rthij}\right| - \mathrm{MAD_{rt}}\right)^2\right]^{0.5}. \tag{21}$$

Then, as in the performance analysis, the following mean variability indices were taken into account. The results are reported respectively in Tables 7 and 8:

$$\sigma_{\bullet th} = \frac{1}{41}\sum_{r=1}^{41}\sigma_{rth} \ \ \text{(variability by time)} \tag{22}$$

$$\sigma_{r\bullet h} = \frac{1}{17}\sum_{t=1995}^{2011}\sigma_{rth} \ \ \text{(variability by countries)} \tag{23}$$

Considering temporal variability (Table 7), all the considered methods exhibit generally constant and very low values. The temporal variability varies from a minimum of 1.5 (SLQ method for the year 1995) to a maximum of 2.6 (AFLQ (δ = 0.9) method for the years 2009 and 2010). Moreover, SLQ, SCILQ and RLQ are the methods that always exhibit the minimum temporal variability, and AFLQ (δ = 0.9) is the method with always the maximum value.

Also the variability of the methods among the considered countries (Table 8) has very similar values. SLQ and RLQ are the methods with the lowest variability. By contrast, FLQ and AFLQ for δ = 0.6,..,0.9 are the methods with the highest variability. Finally, as is very evident, the variability of the FLQ and AFLQ methods increases with the δ values.

In regard to the direction of bias, Tables 9 and 10 show respectively the percentage by year and by countries of the overestimated technical coefficients, that is, those greater than the true technical coefficients.

Analysing Table 9, once again, a clear pattern is evident. Except for the SLQ, CILQ, RLQ and SCILQ methods, which tend to underestimate the true technical coefficients, and the FLQ (δ = 0.1), which has a neutral behaviour, the other methods show quite a strong tendency to overestimate the technical coefficients.

The AFLQ (δ = 0.9) is the method with the highest percentage of overestimated technical coefficients (in mean about 91%), while the SLQ method is the one with the lowest percentage (in mean about 40%). Finally, the overestimate percentage of the AFLQ and FLQ methods increases with the δ value.

The same considerations can be drawn by analysing Table 10 relating to the percentage of the overestimated technical coefficients in the countries. In particular, the SLQ method underestimates the technical coefficients in five countries (AUS, CHN, ITA, RUS and USA), CILQ in two countries (CHN and ITA), and the SCILQ method in two countries (AUS and CHN).

Except for the RLQ, FLQ (δ = 0.1) and AFLQ (δ = 0.1) methods, which in some countries underestimate the technical coefficients, all the other methods always have a strong tendency to overestimate the input coefficient. Finally, to be noted is that the behaviour of the AFLQ is very similar to that of the FLQ method.

To recapitulate, the results that emerge from the analysis highlight, on the one hand, that none of the 22 methods considered were able to replicate the true technical coefficients, and on the other, that the methods showed a very similar performance.

Table 7. Variability of the MAD index by year ($\sigma_{\bullet th}$). Values multiplied by 100

Methods	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SLQ	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6
CILQ	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0	2.1	2.2	2.2	2.2
SCILQ	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2.0
RLQ	1.6	1.5	1.6	1.5	1.6	1.5	1.6	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.8	1.8	1.8
FLQ (δ = 0.1)	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8
FLQ (δ = 0.2)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0	2.0
FLQ (δ = 0.3)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.2
FLQ (δ = 0.4)	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3
FLQ (δ = 0.5)	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4
FLQ (δ = 0.6)	2.4	2.4	2.4	2.3	2.3	2.3	2.4	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.4
FLQ (δ = 0.7)	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5
FLQ (δ = 0.8)	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5
FLQ (δ = 0.9)	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.5
AFLQ (δ = 0.1)	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.8	1.8	1.8
AFLQ (δ = 0.2)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0	2.0
AFLQ (δ = 0.3)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.2
AFLQ (δ = 0.4)	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3
AFLQ (δ = 0.5)	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4
AFLQ (δ = 0.6)	2.4	2.4	2.4	2.3	2.3	2.3	2.4	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.4
AFLQ (δ = 0.7)	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5
AFLQ (δ = 0.8)	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5
AFLQ (δ = 0.9)	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.5

Table 8. Variability of the MAD index by Countries ($\sigma_{r \bullet h}$). Values multiplied by 100

Countries	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
AUS	1.4	1.9	1.6	1.5	1.7	2.0	2.2	2.4	2.5	2.6	2.6	2.6	2.7	1.6	1.9	2.2	2.3	2.4	2.5	2.6	2.6	2.7
AUT	1.5	1.9	1.7	1.6	1.5	1.7	1.8	2.0	2.0	2.1	2.1	2.2	2.2	1.5	1.7	1.8	2.0	2.0	2.1	2.1	2.2	2.2
BEL	1.7	2.2	1.9	1.8	1.7	1.9	2.0	2.1	2.2	2.3	2.3	2.3	2.4	1.7	1.9	2.0	2.1	2.2	2.3	2.3	2.3	2.4
BGR	1.7	1.9	1.8	1.7	1.8	2.1	2.3	2.4	2.4	2.5	2.5	2.5	2.5	1.8	2.1	2.3	2.4	2.4	2.5	2.5	2.5	2.5
BRA	1.3	1.4	1.4	1.3	1.6	1.9	2.1	2.3	2.4	2.5	2.6	2.6	2.6	1.6	1.9	2.1	2.3	2.4	2.5	2.6	2.6	2.6
CAN	1.4	1.7	1.6	1.5	1.5	1.7	1.9	2.1	2.2	2.2	2.3	2.4	2.4	1.5	1.7	1.9	2.1	2.2	2.2	2.3	2.4	2.4
CHN	1.7	1.9	1.8	1.7	2.1	2.4	2.6	2.8	2.9	3.0	3.1	3.2	3.3	2.1	2.4	2.6	2.8	2.9	3.0	3.1	3.2	3.3
CYP	1.4	2.1	1.9	1.7	1.6	1.8	1.9	2.0	2.1	2.1	2.1	2.1	2.1	1.6	1.8	1.9	2.0	2.1	2.1	2.1	2.1	2.1
CZE	1.5	1.9	1.7	1.6	1.8	2.1	2.3	2.5	2.6	2.6	2.6	2.7	2.7	1.8	2.1	2.3	2.5	2.6	2.6	2.6	2.7	2.7
DEU	1.6	2.2	1.8	1.7	1.7	1.8	2.0	2.1	2.2	2.3	2.3	2.4	2.4	1.7	1.8	2.0	2.1	2.2	2.3	2.3	2.4	2.4
DNK	1.6	2.1	1.9	1.8	1.8	2.0	2.2	2.3	2.4	2.5	2.5	2.5	2.5	1.8	2.0	2.2	2.3	2.4	2.5	2.5	2.5	2.5
ESP	1.4	1.9	1.5	1.4	1.6	1.9	2.1	2.2	2.4	2.4	2.5	2.5	2.6	1.6	1.9	2.1	2.2	2.4	2.4	2.5	2.5	2.6
EST	1.6	2.0	1.9	1.8	1.8	2.0	2.2	2.3	2.3	2.3	2.3	2.3	2.3	1.8	2.0	2.2	2.3	2.3	2.3	2.3	2.3	2.3
FIN	1.2	1.8	1.6	1.4	1.5	1.7	1.9	2.0	2.1	2.2	2.2	2.2	2.2	1.5	1.7	1.9	2.0	2.1	2.2	2.2	2.2	2.2
FRA	1.3	1.8	1.5	1.4	1.5	1.7	1.9	2.1	2.2	2.3	2.3	2.4	2.4	1.5	1.7	1.9	2.1	2.2	2.3	2.3	2.4	2.4
GBR	1.5	2.1	1.7	1.6	1.6	1.8	2.0	2.1	2.3	2.3	2.4	2.5	2.5	1.6	1.8	2.0	2.1	2.3	2.3	2.4	2.5	2.5
GRC	1.2	1.7	1.5	1.4	1.4	1.6	1.8	2.0	2.0	2.1	2.1	2.1	2.1	1.4	1.6	1.8	2.0	2.0	2.1	2.1	2.1	2.1
HUN	1.3	1.6	1.4	1.4	1.3	1.6	1.8	1.9	2.0	2.1	2.1	2.1	2.1	1.3	1.6	1.8	1.9	2.0	2.1	2.1	2.1	2.1
IDN	1.9	2.2	2.1	2.0	2.2	2.5	2.7	2.8	2.9	3.0	3.0	3.0	3.0	2.2	2.5	2.7	2.8	2.9	3.0	3.0	3.0	3.0
IND	1.6	1.9	1.8	1.7	1.9	2.2	2.4	2.5	2.6	2.7	2.8	2.8	2.8	1.9	2.2	2.4	2.5	2.6	2.7	2.8	2.8	2.8
IRL	1.7	2.1	2.0	1.8	1.9	2.1	2.3	2.4	2.4	2.5	2.5	2.5	2.5	1.9	2.1	2.3	2.4	2.4	2.5	2.5	2.5	2.5
ITA	1.1	1.8	1.3	1.2	1.4	1.7	1.9	2.0	2.2	2.3	2.3	2.4	2.4	1.4	1.7	1.9	2.0	2.2	2.3	2.3	2.4	2.4
JPN	1.4	2.2	1.4	1.4	1.7	1.9	2.1	2.2	2.4	2.5	2.6	2.6	2.7	1.7	1.9	2.1	2.2	2.4	2.5	2.6	2.6	2.7
KOR	1.7	2.3	1.7	1.6	2.1	2.4	2.7	2.9	3.0	3.1	3.1	3.2	3.2	2.1	2.4	2.7	2.9	3.0	3.1	3.1	3.2	3.2
LTU	1.4	2.1	1.8	1.6	1.4	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.4	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.9
LUX	1.4	2.1	2.0	1.6	1.4	1.5	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.4	1.5	1.7	1.7	1.8	1.8	1.8	1.8	1.8
LVA	1.4	2.1	1.9	1.7	1.7	2.0	2.2	2.2	2.3	2.3	2.3	2.3	2.3	1.7	2.0	2.2	2.2	2.3	2.3	2.3	2.3	2.3
MEX	1.8	2.1	1.9	1.8	1.9	2.1	2.3	2.4	2.5	2.6	2.6	2.7	2.7	1.9	2.1	2.3	2.4	2.5	2.6	2.6	2.7	2.7
MLT	1.5	2.1	1.9	1.8	1.6	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0	1.6	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0
NLD	1.4	1.9	1.8	1.7	1.4	1.5	1.7	1.8	1.9	2.0	2.0	2.0	2.1	1.4	1.5	1.7	1.8	1.9	2.0	2.0	2.0	2.1
POL	1.5	1.7	1.7	1.6	1.5	1.8	1.9	2.1	2.1	2.2	2.2	2.3	2.3	1.5	1.8	1.9	2.1	2.1	2.2	2.2	2.3	2.3
PRT	1.4	1.9	1.6	1.5	1.8	2.1	2.3	2.4	2.5	2.6	2.6	2.6	2.6	1.8	2.1	2.3	2.4	2.5	2.6	2.6	2.6	2.6
ROM	1.7	1.9	1.8	1.8	1.9	2.2	2.4	2.5	2.5	2.6	2.6	2.6	2.6	1.9	2.2	2.4	2.5	2.5	2.6	2.6	2.6	2.6
ROW	1.5	2.0	1.7	1.6	1.6	1.7	1.8	2.0	2.1	2.2	2.2	2.3	2.3	1.6	1.7	1.8	2.0	2.1	2.2	2.2	2.3	2.3
RUS	1.5	1.7	1.7	1.6	1.6	1.8	2.0	2.2	2.3	2.3	2.4	2.4	2.4	1.6	1.8	2.0	2.2	2.3	2.3	2.4	2.4	2.4
SVK	1.7	2.0	1.8	1.8	1.8	2.1	2.2	2.3	2.4	2.4	2.4	2.5	2.5	1.8	2.1	2.2	2.3	2.4	2.4	2.4	2.5	2.5

Table 8. (Continued)

Countries	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
SVN	1.6	1.7	1.7	1.7	1.6	1.8	2.0	2.1	2.2	2.2	2.2	2.2	2.2	1.6	1.8	2.0	2.1	2.2	2.2	2.2	2.2	2.2
SWE	1.5	1.9	1.7	1.6	1.6	1.8	1.9	2.0	2.1	2.2	2.2	2.2	2.2	1.6	1.8	1.9	2.0	2.1	2.2	2.2	2.2	2.2
TUR	1.4	1.8	1.6	1.5	1.7	2.0	2.2	2.3	2.4	2.5	2.5	2.5	2.6	1.7	2.0	2.2	2.3	2.4	2.5	2.5	2.5	2.6
TWN	1.6	2.2	1.8	1.7	1.9	2.1	2.3	2.5	2.5	2.6	2.6	2.7	2.7	1.9	2.1	2.3	2.5	2.5	2.6	2.6	2.7	2.7
USA	1.4	1.9	1.3	1.3	1.5	1.6	1.8	1.9	2.0	2.1	2.2	2.3	2.3	1.5	1.6	1.8	1.9	2.0	2.1	2.2	2.3	2.3

Table 9. Percentage of the overestimated technical coefficients by year

Methods	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SLQ	39.87	39.80	39.25	38.58	39.20	39.35	40.25	41.09	42.22	40.57	40.76	39.85	39.93	39.98	39.55	39.61	39.32
CILQ	38.23	38.11	37.45	36.85	37.43	37.53	38.35	39.20	40.20	38.57	38.65	37.73	37.71	37.76	37.31	37.36	37.00
SCILQ	37.49	37.45	36.81	36.10	36.77	36.82	37.64	38.53	39.54	37.97	38.15	37.28	37.31	37.42	37.00	36.98	36.63
RLQ	39.36	39.69	39.59	39.42	39.87	40.02	41.42	42.78	43.68	42.36	43.10	42.54	42.63	43.51	43.38	43.46	43.37
FLQ (δ = 0.1)	57.49	57.36	56.88	56.31	56.61	57.35	58.74	59.38	60.78	58.00	58.02	56.83	56.65	56.36	55.95	55.90	55.42
FLQ (δ = 0.2)	68.59	68.47	68.09	67.55	68.23	68.76	70.83	71.20	72.80	69.34	69.03	68.09	67.70	67.30	66.78	66.51	66.14
FLQ (δ = 0.3)	75.90	76.01	75.77	75.35	75.95	76.47	78.83	78.95	80.61	76.92	76.42	75.63	75.44	75.26	74.58	74.45	74.08
FLQ (δ = 0.4)	80.90	81.18	80.85	80.51	81.12	81.49	84.13	83.93	85.79	81.89	81.33	80.62	80.52	80.23	79.76	79.70	79.36
FLQ (δ = 0.5)	84.45	84.63	84.45	84.08	84.53	84.79	87.51	87.21	89.33	85.19	84.73	84.03	83.85	83.65	83.11	83.06	82.83
FLQ (δ = 0.6)	86.76	87.01	86.77	86.44	86.72	86.92	89.74	89.40	91.72	87.40	86.96	86.37	86.34	86.04	85.63	85.56	85.40
FLQ (δ = 0.7)	88.36	88.61	88.36	88.09	88.27	88.47	91.29	91.00	93.33	88.84	88.54	88.02	87.95	87.69	87.35	87.23	87.09
FLQ (δ = 0.8)	89.41	89.61	89.35	89.14	89.28	89.47	92.30	92.05	94.41	89.89	89.59	89.19	89.17	88.95	88.56	88.43	88.35
FLQ (δ = 0.9)	90.10	90.26	90.03	89.87	90.02	90.14	92.96	92.92	95.27	90.69	90.34	90.05	90.02	89.85	89.44	89.34	89.26
AFLQ (δ = 0.1)	57.44	57.31	56.82	56.26	56.56	57.30	58.68	59.32	60.73	57.96	57.97	56.78	56.59	56.31	55.91	55.84	55.37
AFLQ (δ = 0.2)	68.56	68.43	68.07	67.52	68.19	68.73	70.79	71.16	72.77	69.30	68.99	68.05	67.67	67.27	66.75	66.48	66.11
AFLQ (δ = 0.3)	75.88	75.98	75.74	75.33	75.93	76.44	78.81	78.93	80.58	76.90	76.39	75.60	75.41	75.22	74.55	74.42	74.05
AFLQ (δ = 0.4)	80.88	81.16	80.83	80.49	81.11	81.48	84.11	83.91	85.77	81.87	81.31	80.60	80.49	80.20	79.74	79.67	79.32
AFLQ (δ = 0.5)	84.44	84.62	84.43	84.07	84.52	84.78	87.50	87.20	89.32	85.18	84.71	84.02	83.84	83.63	83.10	83.05	82.80
AFLQ (δ = 0.6)	86.75	86.99	86.77	86.44	86.72	86.92	89.73	89.39	91.71	87.39	86.96	86.37	86.33	86.03	85.63	85.56	85.39
AFLQ (δ = 0.7)	88.35	88.60	88.35	88.09	88.27	88.46	91.29	90.99	93.32	88.84	88.53	88.01	87.94	87.69	87.35	87.22	87.09
AFLQ (δ = 0.8)	89.41	89.60	89.35	89.13	89.28	89.47	92.30	92.05	94.41	89.89	89.59	89.18	89.17	88.95	88.56	88.43	88.34
AFLQ (δ = 0.9)	90.09	90.26	90.03	89.87	90.02	90.14	92.96	92.92	95.27	90.69	90.34	90.05	90.02	89.85	89.44	89.34	89.26

Table 10. Percentage of the overestimates technical coefficients by Country

Countries	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ (δ=0.8)	AFLQ (δ=0.9)
AUS	55.2	49.6	51.0	50.1	69.1	79.7	86.7	91.3	94.2	95.8	96.8	97.4	97.7	67.2	78.5	85.7	90.5	93.7	95.5	96.6	97.3	97.6
AUT	36.7	35.5	34.9	55.0	62.3	78.7	88.5	93.3	95.6	97.1	97.9	98.4	98.7	62.1	78.6	88.4	93.3	95.6	97.1	97.8	98.4	98.7
BEL	31.1	30.3	29.6	53.9	48.8	62.1	72.6	80.1	85.0	88.4	90.3	91.6	92.4	48.6	62.1	72.6	80.0	85.0	88.4	90.3	91.6	92.4
BGR	39.8	38.3	37.2	34.9	62.1	75.5	82.6	86.9	89.3	90.9	91.9	92.6	93.2	62.1	75.5	82.6	86.9	89.3	90.9	91.9	92.6	93.2
BRA	42.7	40.9	41.0	38.8	57.7	68.4	74.7	79.6	83.2	86.0	88.0	89.6	90.8	57.7	68.4	74.7	79.6	83.2	86.0	88.0	89.6	90.8
CAN	42.3	38.4	39.4	39.3	58.0	70.9	79.9	86.2	90.2	92.7	94.6	95.3	95.8	58.0	70.9	79.9	86.2	90.2	92.7	94.6	95.3	95.8
CHN	60.4	59.1	57.5	50.1	69.9	74.3	78.0	80.3	82.2	83.6	84.7	85.4	85.9	69.9	74.3	78.0	80.3	82.2	83.6	84.7	85.4	85.9
CYP	23.5	23.2	22.0	23.0	40.9	53.8	65.8	74.9	80.5	84.4	86.4	87.2	87.8	40.9	53.8	65.8	74.9	80.5	84.4	86.4	87.2	87.8
CZE	42.8	41.6	40.6	45.1	65.3	77.5	84.9	88.7	90.7	92.1	92.7	93.1	93.4	65.3	77.5	84.9	88.7	90.7	92.1	92.7	93.1	93.4
DEU	37.8	36.2	36.0	60.0	51.8	61.7	69.6	75.4	80.0	83.4	86.2	88.1	89.5	51.8	61.7	69.6	75.4	80.0	83.4	86.2	88.1	89.5
DNK	28.4	27.8	26.7	33.9	47.5	61.0	71.5	78.4	83.5	86.8	89.1	90.9	92.0	47.5	61.0	71.5	78.4	83.5	86.8	89.1	90.9	92.0
ESP	43.5	41.6	41.6	46.3	61.1	73.5	81.2	86.1	89.4	91.2	92.4	93.2	93.6	61.1	73.5	81.2	86.1	89.4	91.2	92.4	93.2	93.6
EST	42.8	42.3	40.5	41.1	69.1	82.5	88.8	91.4	92.6	93.2	93.6	93.9	94.2	69.1	82.5	88.8	91.4	92.6	93.2	93.6	93.9	94.2
FIN	47.9	45.7	45.5	47.6	68.2	79.7	86.3	89.9	91.9	92.9	93.4	93.8	94.0	68.2	79.7	86.3	89.9	91.9	92.9	93.4	93.8	94.0
FRA	39.4	36.6	36.8	38.0	53.2	63.7	71.0	76.0	80.1	83.2	85.7	87.5	88.9	53.2	63.7	71.0	76.0	80.1	83.2	85.7	87.5	88.9
GBR	41.5	37.3	38.3	59.0	53.6	64.2	72.3	78.1	82.8	86.1	88.8	90.8	92.1	53.6	64.2	72.3	78.1	82.8	86.1	88.8	90.8	92.1
GRC	29.9	27.7	26.9	25.4	45.3	56.8	67.1	74.9	80.2	83.1	85.5	87.5	89.2	45.3	56.8	67.1	74.9	80.2	83.1	85.5	87.5	89.2
HUN	45.9	43.9	43.7	41.0	70.4	82.2	87.4	89.7	91.0	92.0	92.7	93.3	93.6	70.4	82.2	87.4	89.7	91.0	92.0	92.7	93.3	93.6
IDN	32.7	31.9	30.8	25.8	46.1	54.7	61.8	66.9	70.3	73.2	75.6	77.2	78.5	46.1	54.7	61.8	66.9	70.3	73.2	75.6	77.2	78.5
IND	48.2	45.8	45.2	38.4	58.5	65.5	70.7	74.5	77.1	79.0	80.6	82.0	83.1	58.5	65.5	70.7	74.5	77.1	79.0	80.6	82.0	83.1
IRL	36.7	31.4	31.7	35.9	53.1	67.3	77.9	84.2	87.9	90.2	91.5	92.3	92.7	53.1	67.3	77.9	84.2	87.9	90.2	91.5	92.3	92.7
ITA	51.8	51.3	49.7	62.4	66.2	74.5	80.4	84.3	87.0	88.7	89.8	90.9	91.8	66.2	74.5	80.4	84.3	87.0	88.7	89.8	90.9	91.8
JPN	49.2	46.6	47.0	68.2	60.1	67.7	73.7	78.4	81.7	84.4	86.7	88.3	89.6	60.1	67.7	73.7	78.4	81.7	84.4	86.7	88.3	89.6
KOR	37.9	36.2	35.4	42.6	51.7	62.1	70.1	76.0	80.6	83.5	85.5	86.9	87.9	51.7	62.1	70.1	76.0	80.6	83.5	85.5	86.9	87.9
LTU	41.9	41.0	39.1	37.8	65.2	78.0	85.5	89.7	91.7	92.8	93.3	93.6	93.7	65.2	78.0	85.5	89.7	91.7	92.8	93.3	93.6	93.7
LUX	20.5	16.7	16.5	36.8	31.5	43.5	53.6	62.6	68.8	73.3	76.2	78.0	79.1	31.5	43.5	53.6	62.6	68.8	73.3	76.2	78.0	79.1
LVA	38.3	36.9	35.5	33.8	59.8	71.7	79.7	83.6	86.0	87.3	88.3	89.0	89.6	59.8	71.7	79.7	83.6	86.0	87.3	88.3	89.0	89.6
MEX	31.4	29.0	29.0	28.9	48.2	58.9	66.9	73.1	78.1	82.3	85.6	87.7	89.1	48.2	58.9	66.9	73.1	78.1	82.3	85.6	87.7	89.1
MLT	22.9	22.0	21.1	25.5	40.8	53.1	63.3	70.9	75.8	79.7	82.3	83.9	85.5	40.8	53.1	63.3	70.9	75.8	79.7	82.3	83.9	85.5
NLD	33.4	31.2	31.5	36.7	51.7	64.2	72.5	79.0	84.0	87.7	90.1	91.6	92.5	51.7	64.2	72.5	79.0	84.0	87.7	90.1	91.6	92.5
POL	47.0	45.7	45.0	41.6	68.6	79.5	85.8	88.7	90.7	91.9	92.5	92.9	93.2	68.6	79.5	85.8	88.7	90.7	91.9	92.5	92.9	93.2
PRT	35.5	35.6	33.6	38.8	56.9	70.3	79.6	85.8	89.5	91.6	92.9	93.5	93.8	56.9	70.3	79.6	85.8	89.5	91.6	92.9	93.5	93.8
ROM	36.3	35.2	34.2	30.7	55.0	65.8	72.2	76.0	78.7	80.4	81.2	81.7	82.0	55.0	65.8	72.2	76.0	78.7	80.4	81.2	81.7	82.0
ROW	43.5	41.3	40.6	34.5	54.8	63.8	71.1	77.2	82.1	86.1	88.9	91.4	93.4	54.8	63.8	71.1	77.2	82.1	86.1	88.9	91.4	93.4
RUS	50.6	46.9	47.1	40.9	62.4	71.3	77.7	82.2	85.9	88.4	90.3	91.7	92.8	62.4	71.3	77.7	82.2	85.9	88.4	90.3	91.7	92.8
SVK	39.2	37.2	36.7	34.8	63.2	78.1	86.6	90.2	91.8	92.8	93.2	93.7	94.1	63.2	78.1	86.6	90.2	91.8	92.8	93.2	93.7	94.1

Table 10. (Continued)

Countries	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ (δ=0.8)	AFLQ (δ=0.9)
SVN	39.4	39.4	37.8	45.7	68.9	81.8	87.7	90.6	92.4	93.3	93.8	94.0	94.1	68.9	81.8	87.7	90.6	92.4	93.3	93.8	94.0	94.1
SWE	44.9	43.2	42.2	57.7	65.4	78.3	85.7	88.9	90.8	92.0	92.5	92.8	93.0	65.4	78.3	85.7	88.9	90.8	92.0	92.5	92.8	93.0
TUR	41.6	40.6	38.8	36.3	60.8	71.2	79.0	84.4	87.7	89.5	90.6	91.4	91.9	60.8	71.2	79.0	84.4	87.7	89.5	90.6	91.4	91.9
TWN	32.7	30.1	29.4	37.5	47.9	59.1	67.9	74.7	79.7	83.2	86.0	87.7	88.8	47.9	59.1	67.9	74.7	79.7	83.2	86.0	87.7	88.8
USA	53.0	47.2	48.4	62.4	58.8	64.2	68.5	72.3	75.1	77.4	79.1	80.8	82.2	58.8	64.2	68.5	72.3	75.1	77.4	79.1	80.8	82.2

In mean, the MAD index values range from 0.006 to 0.010 (Table 3), and the most reliable regionalization method is the SLQ; a result consistent with the findings in the literature. See for example Morrison and Smith (1974).

This method is also the one with less variability both temporal and between countries. The RLQ method has the same performance level as the SLQ, but a slightly greater variability. These last two methods generally underestimate the input coefficients.

Occupying intermediate positions, with a MAD mean value equal to 0.007, are the SCILQ, FLQ ($\delta = 0.1$ and $\delta = 0.2$) and AFLQ ($\delta = 0.1$ and $\delta = 0.2$) methods. These methods, compared to the previous ones, are characterized by a greater variability in the MAD index. Moreover, except for the SCILQ – which in general underestimates the input coefficients – the others have a quasi-neutral behaviour, with a percentage of overestimation of about 6 per cent.

Finally, the CILQ, FLQ ($\delta \geq 0.3$) and AFLQ ($\delta \geq 0.3$) with a MAD mean value from 0.008 to 0.010 close the classification. These methods, except for the CILQ, which is characterized by a low variability and generally underestimated input coefficients, are those with the greatest variability and the highest percentage (from 54% to 99%) of overestimated input coefficients.

Very interesting is the similar behaviour of the FLQ and AFLQ methods. As δ increases, the performance of the methods decreases, the variability and the percentage of overestimated input coefficients increase, and for $\delta \geq 0.6$ they are the worst methods on all the considered criteria.

Limited to the FLQ and AFLQ methods a further experiment was conducted considering for δ parameters some values between 0.001 and 0.1. The results are not reported but available on request and show that for $\delta < 0.1$ the performance of these last two methods did not improve.

To conclude this section, we would like to stress that the estimation methods considered must be used with extreme caution.

In fact, by way of example, Table 11 shows, for Italy, the sectorial total output observed ($\mathbf{y}$) and that estimated ($\hat{\mathbf{y}}$). The latter is calculated in the following way:

$$\hat{\mathbf{y}} = \left(\mathbf{I} - \hat{\mathbf{A}}\right)^{-1}\mathbf{x}, \tag{24}$$

where $\mathbf{x}$ is the vector of final consumptions, whereas $\hat{\mathbf{A}}$ is the technical coefficients matrix estimated by means of the SLQ method, which is, according to our results, one of the best.

As will be noted, if the difference between $\mathbf{A}$ and $\hat{\mathbf{A}}$ is minimal, this should not mislead because the difference between $\mathbf{y}$ and $\hat{\mathbf{y}}$ may be very significant.

Following the literature (Miller and Blair 2009; Flegg and Tohmo 2016) in the analysis conducted until now, the total output was used has regionalization measure of the national technical coefficients.

In order to make the above results[1] more robust and significant we repeated the experiment using the added value and employment (the two most common alternatives to the total output) to regionalize the national technical coefficients.

Moreover, since the constant spatial technology hypothesis may not match reality, in this last experimentation, a more cohesive subset of countries, namely, the European Union Nations plus Canada, Japan, Russia and USA, were used.

For comparison purposes, using this last subset of countries, we repeated the analysis regionalizing the national technical coefficients with the total output. The results obtained, see Table 12, (those detailed are not shown but available on request), perfectly agree with the previous ones. In a nutshell, SLQ, FLQ ($\delta = 0.1$) and AFLQ ($\delta = 0.1$) are the methods with the highest performance.

[1] Following the suggestions of an anonymous Referee.

Table 11. Difference between the sectorial output observed and estimated by the SLQ method for the IO Table of Italy (values in millions of USA $)

Sectors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1995	20848.7	2343.6	12162.0	–2834.2	–4416.1	–635.7	3293.1	–1360.2	–4985.3	–3933.5	9845.5	29384.7	–320.5	871.1	–5747.9	2098.2	1544.3	20635.8
1996	22192.3	2953.5	12313.3	–5045.5	–5644.3	–1012.7	2931.4	–1915.6	–4312.9	–3785.5	10898.1	29484.2	–102.0	1805.5	–5481.7	1617.9	1824.8	22554.7
1997	19580.4	3017.3	11991.6	–5763.7	–3920.6	–1649.9	2328.1	–2044.3	–4430.8	–3622.9	9887.5	28149.2	–70.9	2860.6	–4422.3	2047.1	2361.5	22103.0
1998	18527.5	2527.7	12785.3	–3405.9	–4622.3	–592.9	3158.0	–3367.6	–2616.6	–2015.4	9854.6	29761.4	2166.0	3023.9	–5260.4	2221.5	2482.9	22126.6
1999	17312.0	3042.3	12430.6	–3190.4	–3882.8	456.7	4116.9	–3845.5	–965.2	–2058.0	11319.8	29974.1	5000.4	4214.4	–2988.5	3065.9	2980.2	22133.3
2000	14640.9	2513.5	13007.1	–2559.7	–3325.6	276.0	4544.0	–4381.2	–6758.1	–3776.2	10803.7	24528.2	4081.4	4727.0	–4830.9	3344.0	6273.9	19274.4
2001	15060.7	3586.3	12821.6	–3092.2	–3518.6	–129.3	4605.0	–5348.3	–6363.9	–4721.4	11836.3	25985.3	3809.3	4369.3	–4762.8	2856.4	6563.0	19714.3
2002	14978.8	2131.3	15199.8	16421.1	7136.7	6229.5	5876.6	5341.3	–373.1	11568.4	20233.1	61787.2	15670.2	4562.8	10664.8	8691.6	23756.2	20081.8
2003	6596.0	–639.4	13258.7	–4905.2	–4528.8	2494.5	17124.5	–9613.5	–6823.9	–1926.2	18887.8	40572.9	8106.4	15565.6	–4127.5	5417.5	12814.9	26518.1
2004	19613.8	5043.3	18959.1	–6209.6	–3793.7	–3.9	6500.4	–6404.2	–3676.3	–4905.8	20640.6	43800.3	6978.3	11458.6	–5042.5	7629.6	9557.1	30784.5
2005	16969.1	6124.4	18068.5	–9266.2	–5500.5	–1039.6	5532.1	–5835.3	–9015.5	–8094.8	21119.7	42842.4	6471.0	11666.7	–4684.6	8992.0	11214.0	35316.7
2006	15840.8	5013.1	17045.8	–3510.8	–7170.6	–3192.0	4947.9	–4727.0	–10645.9	–11000.3	20701.5	41290.0	3774.6	10290.7	–6651.9	8664.9	20506.9	37211.5
2007	18162.3	6204.4	21473.6	–8442.7	–9102.3	–4280.2	5559.1	–3525.0	–11111.4	–13386.2	22892.5	48621.6	1902.8	8894.3	–7477.5	10100.5	21308.6	43572.9
2008	21173.3	7479.4	25185.6	–20392.1	–11041.9	–6511.7	5242.4	–1754.6	–10708.4	–14982.5	21676.9	49467.5	1167.5	12322.3	–8976.7	11135.6	35152.2	48286.7
2009	17904.5	6159.3	21161.2	–23868.0	–14108.6	–5941.7	2517.5	–7235.5	–9543.1	–15270.0	12806.6	19608.5	–3940.5	5642.5	–9601.3	8728.1	22951.0	41536.8
2010	16283.0	5287.9	18162.8	–27491.3	–16168.4	–7080.0	768.6	–8771.4	–17295.9	–18059.7	11419.9	19667.5	–6647.8	1642.0	–0705.3	8604.0	20002.5	37302.3
2011	17239.7	5778.0	18642.8	–36188.9	–19600.7	–7494.1	–243.6	–9778.9	–23315.1	–21584.0	10282.3	19783.5	–6427.0	–6479.2	–2227.6	9349.6	15695.9	39643.5

Sectors	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1995	7853.4	23138.1	23371.0	3612.2	17033.8	–4215.8	1981.6	203.0	1797.1	8773.1	8556.8	22398.1	–4299.4	1955.7	3000.1	4361.3	–138.6
1996	10001.6	25122.1	23499.4	5298.1	21566.3	–3420.8	2325.6	631.8	2626.6	13296.3	11216.7	28890.1	–3857.5	2274.0	3713.5	5547.3	–148.1
1997	11028.7	26550.2	21562.1	5562.2	19361.2	–3078.7	2512.2	1630.8	2587.9	14498.5	10830.0	29423.1	–3674.5	2128.9	4170.5	5672.0	–142.3
1998	11245.8	27497.7	22707.1	7314.0	21551.5	–4209.7	2675.3	2362.4	3096.5	21035.4	11197.4	29880.6	–3545.0	2208.8	4621.7	6263.1	–161.0
1999	10998.3	29761.2	22939.3	7411.3	21204.4	–3966.2	3305.3	4937.3	3689.3	23750.4	12362.1	36129.5	–3327.7	2400.7	4432.6	7855.7	–161.9
2000	10259.2	31476.5	21112.5	8120.7	20178.0	–3420.3	3377.9	8980.1	3269.1	21772.3	10979.7	35360.7	–3129.7	2131.9	4145.3	6143.7	–147.1
2001	10243.5	32603.0	24418.6	7988.1	20454.1	–2893.3	3192.7	11028.5	5176.8	21179.7	12195.3	37259.4	–3341.3	1904.2	4233.3	5976.1	–146.9
2002	13850.5	66941.5	39706.3	10862.5	41976.6	–854.8	2503.6	15695.1	6051.5	9712.4	24761.4	67382.4	–2898.5	2793.1	3891.0	13437.7	–41.0
2003	21205.5	76712.1	34020.8	16264.6	32444.4	–1007.3	4980.2	27539.6	22980.3	36707.5	45978.6	149251.6	–2709.2	3289.8	6916.1	20996.0	–150.9
2004	14903.4	58497.0	37880.9	9897.2	36065.4	–3777.5	1790.8	12530.3	9138.1	43150.0	22965.9	60181.4	–5503.8	2485.4	4602.4	7714.2	–190.0
2005	16194.2	60506.5	35637.7	9521.6	39562.7	–4526.0	1342.1	14908.1	9394.1	43169.9	21639.8	59785.4	–6060.0	660.9	3303.7	5094.2	–200.8
2006	16942.9	64197.2	35640.5	9843.0	40536.8	–4756.7	1109.9	15003.3	8485.0	41325.5	24752.4	59313.1	–6298.3	637.3	3551.6	3987.6	–217.9
2007	19641.3	71417.4	43755.3	12274.4	48309.9	–5164.2	1067.4	17117.6	10060.3	44407.9	24578.0	71237.3	–7151.3	662.1	3811.4	4800.5	–238.4
2008	21806.0	79560.9	49417.0	13885.3	57894.7	–5373.0	1644.0	19448.4	10573.1	49954.1	29983.9	82952.9	–8130.2	–79.7	4757.4	4040.1	–241.5
2009	19821.9	72300.0	44126.5	11522.5	47177.3	–6117.6	858.5	15906.9	7871.1	39761.5	27665.3	84996.1	–7714.8	–249.7	5786.8	1044.3	–226.3
2010	19556.4	66324.3	41567.6	9700.4	45600.7	–6056.5	325.8	16273.4	6860.8	34905.5	30626.4	82419.2	–6999.1	533.2	6448.8	–46.4	–225.9
2011	21136.0	70081.3	44388.1	9730.0	48682.1	–7010.6	149.5	17998.4	6539.7	35117.7	35583.6	90875.7	–7994.9	6560.9	–611.4	–239.0	
													485.1				

Table 12. Rank frequencies distribution occupied by the various methods

Rank	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
1	332	0	19	12	150	13	0	0	0	0	0	0	0	150	13	0	0	0	0	0	0	0
2	2	0	23	244	90	4	0	0	0	0	0	0	0	90	4	0	0	0	0	0	0	0
3	157	0	182	10	58	22	2	0	0	0	0	0	0	59	22	2	0	0	0	0	0	0
4	0	24	2	130	199	86	0	0	0	0	0	0	0	200	86	1	0	0	0	0	0	0
5	9	0	148	5	29	27	24	0	0	0	0	0	0	27	27	24	0	0	0	0	0	0
6	0	154	0	69	0	194	30	0	0	0	0	0	0	0	195	30	0	0	0	0	0	0
7	5	1	78	0	0	177	18	21	0	0	0	0	0	0	178	18	21	0	0	0	0	0
8	0	131	0	20	0	3	142	15	0	0	0	0	0	0	1	141	15	0	0	0	0	0
9	1	1	24	0	0	0	306	14	20	0	0	0	0	0	0	309	14	20	0	0	0	0
10	0	59	0	1	0	0	4	107	15	0	0	0	0	0	0	0	107	15	0	0	0	0
11	2	0	7	0	0	0	0	366	8	18	0	0	0	0	0	0	369	8	18	0	0	0
12	0	41	0	1	0	0	0	3	73	16	0	0	0	0	0	0	0	73	16	0	0	0
13	1	0	3	0	0	0	0	0	407	6	17	0	0	0	0	0	0	410	6	17	0	0
14	0	24	0	1	0	0	0	0	3	52	16	0	0	0	0	0	0	0	52	16	0	0
15	1	0	0	0	0	0	0	0	0	431	7	16	0	0	0	0	0	0	434	7	16	0
16	0	14	0	0	0	0	0	0	0	3	38	17	0	0	0	0	0	0	0	38	17	0
17	0	0	0	0	0	0	0	0	0	0	445	7	16	0	0	0	0	0	0	448	7	16
18	0	7	0	0	0	0	0	0	0	0	3	31	17	0	0	0	0	0	0	0	31	17
19	16	0	0	0	0	0	0	0	0	0	0	452	7	0	0	0	0	0	0	0	455	7
20	0	3	0	33	0	0	0	0	0	0	0	3	28	0	0	0	0	0	0	0	0	28
21	0	11	29	0	0	0	0	0	0	0	0	0	455	0	0	0	0	0	0	0	0	458
22	0	56	11	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0

Notes: Regionalization variable: total output. Countries: EU + CAN + JPN + RUS + USA.

Also when, instead of the output, we use employment, see Table 13, (those detailed are not shown but available on request) no particular differences appear. Indeed, in this case:

1. SLQ, FLQ ($\delta = 0.1$) and AFLQ ($\delta = 0.1$) are the methods with the highest performance and low variability between countries and time;
2. FLQ and AFLQ both for $0.3 \leq \delta \leq 0.9$ are the methods with the lowest performance that decreases with the increase of the δ value;
3. AFLQ method does not improve the performance of the FLQ method.
4. SLQ, CILQ, SCILQ and RLQ methods generally underestimate the technical coefficients, contrary to the other methods.

Finally, when the analysis considers the added value, the results, see Table 14 (those details are not shown but available on request) perfectly match the previous ones. In this case, the performance of the various methods is slightly higher and the variability between countries and time remains virtually unchanged. Moreover, the percentage of the overestimated technical coefficients generally decreases.

The analyses carried out so far are based exclusively on an aggregate measure (MAD index) performance. Looking at Tables 6 and 12–14, it can be seen that the SLQ method has a very high performance from 72 per cent to 94.5 per cent of the cases. However, for some situations, the method in question has a rank equal to 19 out of a total of 22.

A thorough analysis of these cases shows that the SLQ method registers a poor performance when applied to the IOT of small countries such as Malta, Luxembourg and Cyprus, which are characterized by a high percentage of zero or modest flow.

Given that the problem regards the estimate of technical coefficients close to zero with the SLQ method, we felt it appropriate to investigate whether the reduced capacity of this method to reproduce the close to zero technical coefficients was also present in the IOT of the other countries, but was not registered accurately enough by an absolute and aggregate index such as the MAD. We also tried to identify a threshold value of technical coefficients below which the SLQ method significantly reduces its ability to estimate.

Considering the first aspect, the analyses carried out reveal that this problem is also present in the IOT of other countries. In this regard, using the colormap technique which draws a pseudocolor plot of the entries of a matrix, we show in Figures 2, 3 and 4 some examples of the IOT of the USA (2008), Germany (2008) and England (2008).

In these tables, the SLQ method is the one that, based on the MAD values, has the best performance. As can be see, the greatest estimation errors of the SLQ method correspond to the smaller technical coefficients.

Regarding the second aspect a further experiment was conducted by analysing the error of each estimate of technical coefficients obtained from each of the 22 considered methods. The index used is the following:

$$ER_{rthij} = \begin{cases} \left|a_{rtij} - \hat{a}_{rthij}\right| \text{ if } a_{rtij} \leq \varepsilon \\ \dfrac{\left|a_{rtij} - \hat{a}_{rthij}\right|}{a_{rtij}} \text{ if } a_{rtij} > \varepsilon \end{cases}, \tag{25}$$

where ε is a threshold value fixed *a priori*. As a summary measure associated with the previous error we used the following index:

$$\mathrm{TER_{rth}} = \frac{\sum_{i=1}^{35}\sum_{j=1}^{35} ER_{rthij}}{35^2}. \tag{26}$$

Table 13. Rank frequencies distribution occupied by the various methods

Rank	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ $\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)
1	214	46	9	52	0	0	0	0	0	0	0
2	44	113	40	39	206	0	0	0	0	0	0
3	123	34	49	121	84	1	0	0	0	0	0
4	42	113	177	29	31	84	0	0	0	0	0
5	48	33	76	75	19	32	0	0	0	0	3
6	1	70	84	99	187	11	43	0	0	0	0
7	11	5	24	22	0	10	19	0	0	0	14
8	2	47	12	20	0	389	14	19	0	0	0
9	5	4	7	6	0	0	1	9	0	0	0
10	1	7	4	8	0	0	450	29	16	0	2
11	1	3	2	5	0	0	0	3	7	0	4
12	2	3	4	4	0	0	0	465	20	15	2
13	1	1	1	2	0	0	0	1	3	6	41
14	0	3	0	0	0	0	0	1	437	19	14
15	0	1	0	1	0	0	0	0	21	3	80
16	1	3	0	2	0	0	0	0	23	363	2
17	0	0	1	0	0	0	0	0	0	38	38
18	0	1	0	0	0	0	0	0	0	83	327
19	22	0	9	0	0	0	0	0	0	0	0
20	9	2	26	0	0	0	0	0	0	0	0
21	0	10	2	28	0	0	0	0	0	0	0
22	0	28	0	14	0	0	0	0	0	0	0

Notes: Regionalization variable: employments. Countries: EU + CAN + JPN + RUS + USA.

Table 14. Rank frequencies distribution occupied by the various methods

Rank	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
1	322	19	16	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	15	24	208	22	157	6	0	0	0	0	0	0	0	157	6	0	0	0	0	0	0	0
3	116	116	34	71	95	0	0	0	0	0	0	0	0	95	0	0	0	0	0	0	0	0
4	18	61	115	151	44	50	0	0	0	0	0	0	1	44	50	0	0	0	0	0	0	1
5	26	38	18	97	17	70	0	0	0	0	0	0	0	17	70	0	0	0	0	0	0	0
6	0	117	61	48	213	17	30	0	0	0	0	1	0	213	17	30	0	0	0	0	1	0
7	3	8	11	56	0	11	29	0	0	0	0	0	0	0	11	29	0	0	0	0	0	0
8	0	69	18	8	0	372	9	27	0	0	1	0	0	0	372	9	27	0	0	1	0	0
9	4	0	3	18	0	0	9	14	0	0	0	0	0	0	0	9	14	0	0	0	0	0
10	0	24	2	3	0	0	449	6	23	1	0	0	0	0	0	449	6	23	1	0	0	0
11	2	0	1	7	0	0	0	5	14	0	0	0	0	0	0	0	5	14	0	0	0	0
12	0	9	1	0	0	0	0	474	3	21	0	0	0	0	0	0	474	3	21	0	0	0
13	0	0	0	0	0	0	0	0	4	15	0	0	0	0	0	0	0	4	15	0	0	0
14	0	2	0	0	0	0	0	1	483	3	21	0	0	0	0	0	1	483	3	21	0	0
15	0	0	1	0	0	0	0	0	0	2	15	0	0	0	0	0	0	0	2	15	0	0
16	0	0	0	0	0	0	1	0	0	485	2	21	0	0	0	1	0	0	485	2	21	0
17	1	0	1	0	0	0	0	0	0	0	3	15	0	0	0	0	0	0	0	3	15	0
18	0	0	0	0	0	1	0	0	0	0	485	1	20	0	1	0	0	0	0	485	1	20
19	20	0	0	0	0	0	0	0	0	0	0	4	16	0	0	0	0	0	0	0	4	16
20	0	0	19	17	1	0	0	0	0	0	0	485	1	1	0	0	0	0	0	0	485	1
21	0	5	13	20	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	4
22	0	35	5	2	0	0	0	0	0	0	0	0	485	0	0	0	0	0	0	0	0	485

Notes: Regionalization variable: added value. Countries: EU + CAN + JPN + RUS + USA.

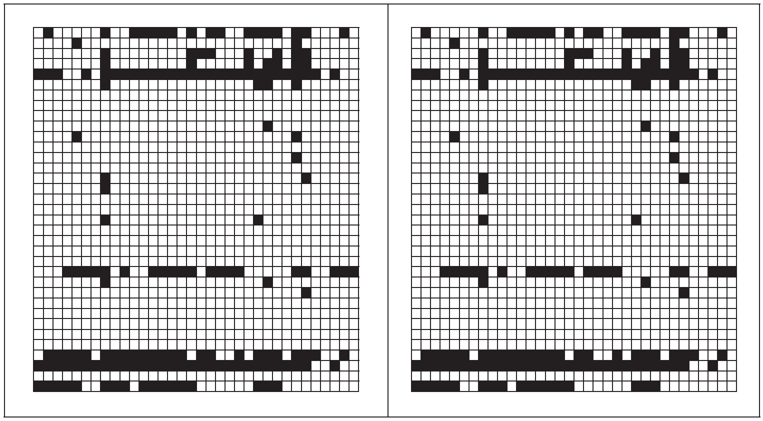

Fig. 2. On the left is the matrix of technical coefficients observed for the US IOT (2008). In black technical coefficients equal to zero or close to zero. On the right is the matrix of the errors of the estimates obtained with the SLQ method. Significant errors in black

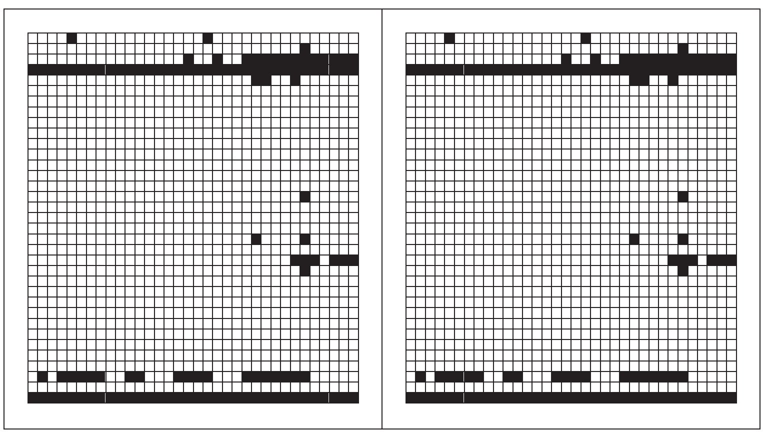

Fig. 3. On the left is the matrix of technical coefficients observed for the German IOT (2008). In black technical coefficients equal to zero or close to zero. On the right is the matrix of the errors of the estimates obtained with the SLQ method. Significant errors in black

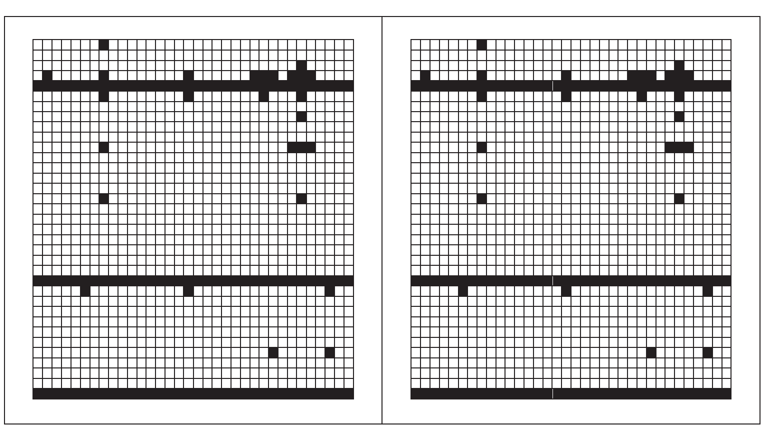

Fig. 4. On the left is the matrix of technical coefficients observed for the English IOT (2008). In black technical coefficients equal to zero or close to zero. On the right is the matrix of the errors of the estimates obtained with the SLQ method. Significant errors in black

Table 15. Rank frequencies distribution occupied by the various methods

Rank	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
1	645	1	8	17	15	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0
2	21	0	32	522	55	0	0	0	0	0	0	0	0	83	0	0	0	0	0	0	0	0
3	27	5	425	33	102	0	0	0	0	0	0	0	0	125	1	0	0	0	0	0	0	0
4	0	66	16	99	139	5	0	0	0	0	0	0	0	390	6	0	0	0	0	0	0	0
5	3	5	185	13	332	9	0	0	0	0	0	0	0	73	18	0	0	0	0	0	0	0
6	1	414	5	11	54	58	0	0	0	0	0	0	0	14	170	0	0	0	0	0	0	0
7	0	4	24	2	0	242	1	0	0	0	0	0	0	0	474	2	0	0	0	0	0	0
8	0	155	1	0	0	383	8	0	0	0	0	0	0	0	28	41	0	0	0	0	0	0
9	0	0	1	0	0	0	184	0	0	0	0	0	0	0	0	622	0	0	0	0	0	0
10	0	45	0	0	0	0	504	0	0	0	0	0	0	0	0	32	2	0	0	0	0	0
11	0	0	0	0	0	0	0	140	0	0	0	0	0	0	0	0	676	0	0	0	0	0
12	0	2	0	0	0	0	0	557	0	0	0	0	0	0	0	0	19	0	0	0	0	0
13	0	0	0	0	0	0	0	0	125	0	0	0	0	0	0	0	0	691	0	0	0	0
14	0	0	0	0	0	0	0	0	572	0	0	0	0	0	0	0	0	6	0	0	0	0
15	0	0	0	0	0	0	0	0	0	121	0	0	0	0	0	0	0	0	695	0	0	0
16	0	0	0	0	0	0	0	0	0	576	0	0	0	0	0	0	0	0	2	0	0	0
17	0	0	0	0	0	0	0	0	0	0	121	0	0	0	0	0	0	0	0	695	0	0
18	0	0	0	0	0	0	0	0	0	0	576	0	0	0	0	0	0	0	0	2	0	0
19	0	0	0	0	0	0	0	0	0	0	0	121	0	0	0	0	0	0	0	0	695	0
20	0	0	0	0	0	0	0	0	0	0	0	576	0	0	0	0	0	0	0	0	2	0
21	0	0	0	0	0	0	0	0	0	0	0	0	121	0	0	0	0	0	0	0	0	695
22	0	0	0	0	0	0	0	0	0	0	0	0	576	0	0	0	0	0	0	0	0	2

Notes: Regionalization variable: total output. $\varepsilon = 0.001$.

Table 16. Rank frequencies distribution occupied by the various methods

Rank	SLQ	CILQ	SCILQ	RLQ	FLQ ($\delta = 0.1$)	FLQ ($\delta = 0.2$)	FLQ ($\delta = 0.3$)	FLQ ($\delta = 0.4$)	FLQ ($\delta = 0.5$)	FLQ ($\delta = 0.6$)	FLQ ($\delta = 0.7$)	FLQ ($\delta = 0.8$)	FLQ ($\delta = 0.9$)	AFLQ ($\delta = 0.1$)	AFLQ ($\delta = 0.2$)	AFLQ ($\delta = 0.3$)	AFLQ ($\delta = 0.4$)	AFLQ ($\delta = 0.5$)	AFLQ ($\delta = 0.6$)	AFLQ ($\delta = 0.7$)	AFLQ ($\delta = 0.8$)	AFLQ ($\delta = 0.9$)
1	0	0	0	0	26	170	48	11	2	0	0	0	0	34	384	126	13	2	0	0	0	0
2	0	0	0	0	34	322	85	2	0	0	0	0	0	21	106	8	0	0	0	0	0	0
3	6	0	0	0	64	43	112	22	2	0	0	0	0	96	114	301	52	4	0	0	0	0
4	1	0	0	0	79	89	245	30	2	0	0	0	0	49	28	54	1	0	0	0	0	0
5	13	0	0	0	79	19	54	64	19	2	0	0	0	111	26	152	242	32	3	0	0	0
6	0	0	2	3	94	16	132	189	13	1	0	0	0	61	1	46	20	0	0	0	0	0
7	16	0	1	2	49	7	13	82	47	14	2	0	0	77	17	5	291	173	18	2	0	0
8	0	0	4	5	58	10	3	265	128	4	0	0	0	35	0	3	60	3	0	0	0	0
9	22	0	5	3	27	9	4	18	66	39	5	1	0	44	12	1	7	409	134	7	1	0
10	1	1	1	10	31	3	0	3	364	95	2	0	0	14	0	0	11	46	0	0	0	0
11	40	2	4	2	19	2	1	11	31	57	36	4	0	35	2	1	0	8	437	104	6	0
12	0	3	0	6	23	0	0	0	6	401	66	2	0	8	0	0	0	17	69	1	0	0
13	31	1	8	0	8	1	0	0	14	53	62	33	4	17	1	0	0	3	10	449	86	6
14	0	4	3	9	13	0	0	0	3	8	410	53	2	2	0	0	0	0	16	88	0	0
15	35	3	6	0	5	4	0	0	0	15	73	58	30	9	6	0	0	0	10	12	435	77
16	0	7	3	7	5	2	0	0	0	8	9	399	47	1	0	0	0	0	0	18	116	0
17	16	3	6	3	42	0	0	0	0	0	17	95	59	75	0	0	0	0	0	16	11	426
18	0	6	2	6	41	0	0	0	0	0	15	11	391	8	0	0	0	0	0	0	22	125
19	467	41	6	1	0	0	0	0	0	0	0	22	102	0	0	0	0	0	0	0	20	15
20	43	77	62	454	0	0	0	0	0	0	0	19	15	0	0	0	0	0	0	0	0	27
21	6	28	479	136	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	21
22	0	521	105	50	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0

Notes: Regionalization variable: total output. $\varepsilon = 0.0005$.

Results show that for the values $\varepsilon \geq 0.001$ the SLQ and RLQ methods continue to have the best performance while this drops with the FLQ and AFLQ methods (both for $\delta = 0.1$). However if $\varepsilon < 0.001$ then the performance of the techniques shows significant differences. In particular, the performance of the SLQ method drops significantly and conversely that of the AFLQ (for $0.2 \leq \delta \leq 0.3$) and FLQ (for $\delta = 0.2$) methods rises. Moreover, the CILQ, SCILQ and RLQ methods are those with the worst performance.

However, the most important aspect that emerges from this analysis is that the SLQ method often fails in providing correct significant digits of technical coefficients less than 0.001. By way of example, Tables 15 and 16 show the ranking of the different methods for $\varepsilon = 0.001$ and $\varepsilon = 0.0005$.

In summary, although the SLQ has been found to be one of the most robust method, its performance diminishes when the IOT is characterized by a high percentage of technical coefficients close to zero.

In conclusion, the results show quite clearly that a discriminating feature in the choice of the regionalization method is in fact the size of the regions. When dealing with small economic systems the AFLQ (for $0.2 \leq \delta \leq 0.3$) and FLQ (for $\delta = 0.2$) methods should be preferred. On the contrary the SLQ method should be used when the percentage of technical coefficients close to zero is low, also in view of its simplicity.

4 Conclusion

In the analysis of the IOT, a recent research area consists in its extension to a territorial sub-level. In this case, the data necessary to build the table directly are rarely available. Usually, the so-called indirect estimation methods or non-survey methods are applied.

The goal of indirect methods is to estimate the sub area input coefficients by multiplying the area input coefficient with some adjustment coefficients. Generally, these coefficients coincide with the location quotient index.

The aim of this paper has been to contribute to the debate on the performance of non-survey methods. The paper has reported an empirical analysis based on real data and, in particular, on the World IO Table, which covers 41 countries for the period from 1995 to 2011 with a classification for 35 industries (economic sectors).

There is already a body of literature dealing with the performance of different non-survey methods (for example: Round 1978; Harrigan et al. 1980; Tohmo 2004; Flegg and Webber 2000; Bonfiglio and Chelli 2008; Flegg and Tohmo 2013; Kowalewski 2015). In general, the results show that the location quotient method (FLQ) developed by Flegg and Webber (1997) tends to outperform the other methods. Nevertheless, the main obstacle to its widespread use is the optimal value of the *d* exponent (the sensitivity parameter), which can be determined only by reviewing the literature.

In our case study, the behaviours of a battery of non-survey techniques were analysed. In particular, three aspects were considered: the performances of the methods in reproducing ‘true’ input coefficients, the variability of error, and the direction of bias.

Unlike but not in contrast with previous studies, the main results of a first set of analysis do not privilege any non-survey technique in particular. Indeed, regarding the aspects analysed, with the exceptions of some minor differences, the methods seem to have a similar behaviour.

However, it is particularly interesting to highlight the behaviour of the SLQ that has a performance not inferior to other methods.

Relating to the performance and error variability, results showed that SLQ, RLQ, FLQ and AFLQ (both for $\delta \leq 0.1$) methods have a slightly better behaviour than the others, whilst, regarding the direction of bias, only the FLQ ($\delta \leq 0.1$) has a neutral behaviour.

Contrary to the findings in the literature, the accuracy of the FLQ and AFLQ methods is not better than that of the other methods and in particular, compared to the SLQ and RLQ methods. See for example: Flegg and Webber (2000), Tohmo (2004), Flegg and Tohmo (2013), Lehtonen and Tykkyläinen (2014) and Kowalewski (2015). Moreover, in accordance with Flegg and Webber (2000) the FLQ matches the performance of the AFLQ method (i.e., yields very similar behaviour).

No particular differences emerged when more cohesive subset of countries were considered and instead of the output, employment and added value were used in the regionalization of the technical coefficients. The only difference is related to a better, but not superior compared to the SLQ method, performance of the FLQ and AFLQ methods for $\delta = 0.1$. From a more detailed analysis it emerged that the SLQ method often fails in providing correct significant digits if $a_{rtij} < 0.001$.

Therefore, although the SLQ method has been identified as one of the most robust methods, its performance is reduced substantially when confronted with the IOT characterized by a high percentage of technical coefficients close to zero. In a similar way it also reduces the performance of CILQ, SCILQ and RLQ methods. On the contrary, it increases that of the FLQ (for $\delta = 0.2$) and AFLQ (for $0.2 \leq \delta \leq 0.3$) methods. The performance of other methods remains substantially unchanged.

In conclusion, results show quite clearly that a discriminating feature in the choice of the method is the size of the regions. When dealing with small economic systems the FLQ (for $\delta = 0.2$) and AFLQ (for $0.2 \leq \delta \leq 0.3$) methods should be preferred. On the contrary the SLQ method should be used when the percentage of technical coefficients close to zero is low, also in view of its simplicity.

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Resumen. Este estudio es una contribución al debate en curso sobre el desempeño de varias técnicas no basadas en encuestas para construir tablas *input-output* sub-territoriales. Se analizan tres aspectos del comportamiento de los métodos: los desempeños en la reproducción de coeficientes *input* 'verdaderos', la variabilidad del error y la dirección del sesgo. El análisis utiliza datos reales y, en particular, la tabla mundial de *input-output*. El aspecto más importante que surge del análisis es que aunque el cociente de localización simple (SLQ, por sus siglas en inglés) se ha identificado como uno de los métodos más robustos, su desempeño disminuye cuando es comparado con las tablas *input-output*, caracterizadas por un alto porcentaje de coeficientes técnicos cercanos a cero. El cociente de localización entre sectores (CILQ), el cociente de localización semilogarítmico (RLQ) y los métodos de cociente de localización simétrico entre sectores (SCILQ) se comportan también de manera similar (todas las siglas procedentes del inglés). Por el contrario, el desempeño de los métodos del cociente de localización de Flegg (FLQ) para δ = 0,2 y el cociente de localización de Flegg aumentado (AFLQ) para 0,2 $\leq \delta \leq$ 0,3 no se ve afectado por esta situación (todas las siglas procedentes del inglés).

抄録:本稿は、地域以下のレベルの産業連関表を作成するための様々なノンサーベイ法のパフォーマンスに関する現在の議論に資するものである。ノンサーベイ法の性質の3つの側面、すなわち正しい投入係数を算出する精度、エラーの変動、バイアスの方向を分析する。分析では実際のデータ、具体的には世界の産業連関表を使用する。分析から最も重要な側面として現れたのは、SLQ (simple location quotient)法は、最も頑健な方法であることが確認されているが、特徴としてゼロに近い係数の割合が高い産業連関表に対しては精度が大きく低下するということである。CILQ (cross industry location quotient)法、RLQ (semi logarithmic location quotient)法、SCILQ (symmetric cross industry location quotient)法も同じ性質をもつ。一方、δ = 0.2のFLQ (Flegg location quotient)法と0.2 $\leq \delta \leq$ 0.3のAFLQ (Augmented Flegg location quotient)法はこの状態の影響を受けない。