A methodology for building multiregional Supply and Use Tables for Italy

Renato Paniccià and Stefano Rosignoli

STUDI E APPROFONDIMENTI

IRPET
Istituto Regionale
Programmazione
Economica
della Toscana

ACKNOWLEDGMENTS

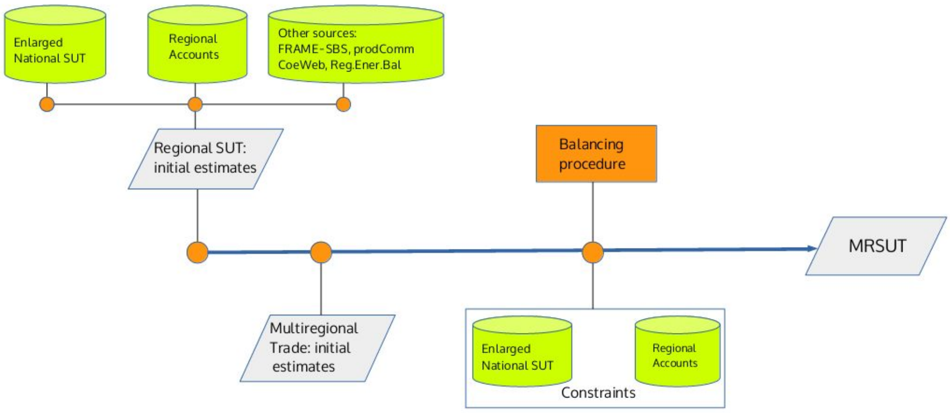
We would like to thank Chiara Bentivogli and Paola Monti from Banca d'Italia and our colleague Tommaso Ferraresi, for the helpful advices on upgrades and updates of the methodology. We are of course solely responsible for the content of the paper.

Lo studio presentato fa parte di una collana a diffusione digitale e può essere scaricato dal sito Internet: http://www.irpet.it

Introduction

This paper describes the most recent IRPET methodology for building a NUTS2 level multiregional Supply and Use Table (henceforth MRSUT), for the benchmark year 2011. This new approach upgrades what is presented in Cherubini and Paniccià (2013), through a more intensive use of regional data, recently released by ISTAT, and the breakdown of the multiregional and foreign trade in final and intermediate flows. In Figure 1 the assembly line of MRSUT.

FIGURE 1. MULTIREGIONAL SUPPLY AND USE TABLE: ASSEMBLY LINE



The structure of the paper is the following: section 1 illustrates the balancing algorithm, section 2 shows how initial estimates have been produced. In section 3 the system of balancing identities is presented along with the main numerical indexes of the balancing algorithm.

1 Balancing algorithm

1.1 A brief review

The problem of balancing accounting matrices has been solved in different ways and, before to describe the method utilzed in the IRPET approach, it could be helpful to define what is generally meant for "balancing problem".

Let $\Phi(0)$ the initial unbalanced accounting matrix of order r×c and let the vector $\tau(0)$, the vectorization (vec) of this matrix so:

$$\tau(0) = vec(\Phi(0)) \tag{1}$$

The elements of $\tau(0)$ will be $n = r \cdot c$.

The solution of the balancing problem is to find a new vector $\tau(1)$, from $\tau(0)$, such as:

$$\tau(1) = \tau(0) + \varepsilon \tag{2}$$

that satisfies p set of constraints defined by a set of equations:

$$\mathbf{g}_i \cdot \tau(1) = \mathbf{h}_i \qquad where \;\; i = 1..p \tag{3}$$

The equation [3] implies a problem of minimization of the distance metric function D[$\tau(0)$,$\tau(1)$] under a set **h** of p-*th* constraints.

The solution of [3] should take into considerations some mathematical and economic issues, that is:

1. The elements of $\tau(0)$ and $\tau(1)$ are economic flows so their range must be bounded in some way.
2. $\Phi(0)$ is often sparse matrix;
3. Some elements of matrix $\Phi(0)$could be negative (for instance change in inventories or net imports) and for some distance function (e.g. cross-entropy function) they are out of the function domain.

Many solutions has been proposed to solve the balancing problem and we will briefly review the most important ones, that is:

i) Data reconciliation and Residual sink (RS); ii) Biproportional balancing (rAs) and its generalization and extension (GrAs and KrAs); iii) Cross-entropy method (CE); iv) Stone-Byron and Generalized least square method (GLS or SCM).

1.1.1 Data reconciliation and residual sink

These method allows to balance matrices without using complex alghoritms.

The data reconciliation method suggests to reconcile discrepancies through the contributions of a panel of experts and data compilers (Pyatt and Roe (1977)). To make the procedure less arbitrary as possible, it has been suggested: firstly to estimate data from objective sources and put them in an accounting matrix $\Phi(0)$, then asking to experts an ordinal assessment of the relative reliability of the alternative estimates. After having chosen the most reliable estimates, the other less reliable values are scaled and manually adjusted to achieve consistency. Gaps and missing entries were usually handled differently from inconsistent estimates. Sometimes missing entries were estimated directly as residuals using the accounting constraints or they were eliminated by an aggregation of accounts. The whole process of smoothing data sets into a consistent set of estimates using panel experts assessment, involves more iteration steps.

The residual sink is a fast and simple way to balance an accounting matrix, because it assigns to a column/row of the accounting matrix the statistical discrepancies coming from the merging process of different accounts. Jensen and West (1986) suggested to use this method after some steps of manual balancing, in particular, improving the consistency between accounts until the relative error inserted into the residual column of the matrix is reduced to an acceptable level (e. g. under 5% of the total supply). Bayne and West (l989) included all the discrepancies in a third column of the final demand called "other final demand".

1.1.2 rAs-class of balancing algorithms

A very widespread method of accounting matrix balancing in the input-output literature, is the bi-proportional adjustment or rAs.The method was originally proposed in Deming and Stephan (1940) for balancing a two way contingency table, given its marginals. The mathematical properties of the method were explored later by Gorman (1963), and Bacharach (1970). After these seminal contributions, a significant amount of literature has been produced on the biproportional adjustment.

Accordingly to our notation, let $\Phi(0)$ the initial r$\times$c accounting matrix. Suppose to know the row and column marginal vectors (respectively $\upsilon(1)$ and $\nu(1)$ of the new accountant matrix. The rAs procedure operates on all cells of $\Phi(0)$ until will be generate a new matrix $\Phi(1)$ as close as possible to $\Phi(0)$ and consistent with the known row and column marginals, acting as constraints.

Deming and Stephan suggested to estimate matrix $\Phi(1)$ from $\Phi(0)$, minimizing the weighted sum of square of distance between their cells. From this first paper, many articles were written. Firstly Bacharach (cit.) and then Günlük-Şenesen and Bates (1988) showed that solving the rAs algorithm is very closed to the solution of a problem of distance minimization of information (accordingly to the definition of entropy measure in the information theory).

Further developments have been proposed by Schneider and Zenios (1990), they proposed an algorithm, called 'Diagonal Similarity Scaling' (DSS) which is formally similar to rAs but with an additional feature that enables to handle upper and lower bounds in total margins. Another relevant contribute has been given by Günlük-Senesen and Bates (cit.) by introducing both uncertainty in the row and column totals and negative elements.

rAs is not a constrained optimization procedure, it is an iterative scaling technique very helpful for its simplicity, however it has also some heuristic problems such as: i) inability to embed constraints on subsets of matrix elements; ii) inability to include reliability of the initial estimates and constraints; iii) inability to handle negative values and preserving the sign of matrix elements; iv) inability to handle conflicting external data. Indeed several authors have tried to overcome these limitations.

Paelinck and Waelbroeck (1963) and Allen and Lecomber (1975) extended the rAs method by inserting constraints on subsets of matrix elements (MrAs, modified rAs). Their method excludes non varying elements from initial matrix before starting balancing procedure and adding them at the end.

Gilchrist and St Louis (1999) and Gilchrist and St. Louis (2004) proposed a TrAs method (three-stage rAs) to constraints subsets of the matrix elements to known totals. Their algorithm uses an aggregation matrix to aggregate and rescale the elements of the submatrix to the known total. Dalgaard and Gysting (2004) included uncertainties of external constraints through reliabilities of row and column totals.

Junius and Oosterhaven (2003) proposed a generalised rAs (GrAs) algorithm which can adjust both negative and positive elements by separating them in two different matrices (one with non-negative elements and one with absolute values).

Lenzen et al. (2009) embedded features of TrAs, MrAs and GrAs algorithm, extending the possibility to handle conflicting marginal data and proposing the Konfliktfreies rAs (KrAs). It is a procedure able to balance and reconcile matrices under conflicting external information and inconsistent constraints.

1.1.3 Cross Entropy

This method origins from the first studies by Shannon (1948) on information theory and from the work of Kullback and Leibler (1951) on the definition of cross-entropy divergence between sets of information. The information theory was applied to the statistical inference by Jaynes (1957) and, to economics, by Theil and Theil (1971). Zellner linked this method to the Bayes theorem as a way to measure information gain from a prior to posterior distribution of Bayes formula. All this literature has been collected in the book of Golan et al. (1996), and it was applied to input output analysis and accounting matrices building by Golan et al. (1994) and by Robinson et al. (2001). Now this method is frequently used for SAM's balancing.

The target of the Cross-Entropy estimate is to improve the starting knowledge of reality (e.g. the value of initials dataset) by using all information available for the problem (e.g. marginal total vectors). This approach could be related to Bayesian inference, for which, a prior probability of an event will be transformed in to a posterior probability by using a new available information.

In the Cross-entropy approach the balancing procedure is an underdetermined estimation problem in which the number of parameters to be estimated is commonly higher then the number of data information. This type of problems need to define a prior structure of the parameters. In balancing an accounting matrix, this a priori could be the accounting matrix of a previous year or, in absence of other information, a uniform probability distribution (in this case the distance function has a new specification and the balancing procedure becomes a maximum entropy method).

A. Golan, G. Judge, S. Robinson (cit) and S. Robinson et al. (cit.) extended this procedure allowing for more flexibility, particularly they proposed a balancing algorithm (applied to a SAM) in which the elements of the preliminary matrix $\Phi(0)$ are affected by a random error. Inqualities, as bounded constraints, are also added to the set of constraints.

1.2 The Stone Byron algorithm

In balancing our accounting framework we have chosen an alternative methodology other than those reviewed in section 1.1, that is the Stone-Byron algorithm.

The method was firstly proposed by Stone et al. (1942) as a way to achieve the consistency between national account aggregates, given a known, or inferred, reliability measure of the initials estimates.

Some year after Theil and Schweitzer (1961) showed the statistical proprieties of this method considering its analogy with the GCLS estimator. Following the increasing computing capacity and the use of new computational methods to solve optimization problems, a seminal contribution to the development of the SCM methodology was provided by R.P. Byron (Byron (1977) and Byron (1978)) an the method was utilized to balancing large economic accounting matrices. After the van der Ploeg (1982) paper, this method has indifferently been called Stone-Champernowne-Meade (SCM), Stone-Byron (SB) or Generalized least square reconciliation method (GLSRM), and it has been used for many purposes other than matrix balancing such as reconciliation of time series systems or simulation of simultaneous equation system.

The SCM can be seen as the application of a generalized least square estimation subject to constraints of a linear model: this type of estimation is usually solved by way of constrained minimization of euclidean distance between observed and predicted vector and is known with the name of least squared constrained estimation.

The analogy to linear model estimation let us to consider as a vector estimate of model parameters, that under the same assumption of the analogous linear model, can be considered best linear unbiased parameter estimators and could be used for it all the statistical testing instruments (e.g. test of significance, test on linear combination of parameter, computation of confidence bound).

The SCM balancing procedure assumes that the initial flows to be balanced, are subjected to accounting constraints and can vary according to their own relative reliability. Instead of the linear bi-proportioning rAs, the concept of variance and covariance, associated to the reliability of $\tau(0)$ is explicitly introduced. The solution proposed by the authors consists in a constrained GLS estimator for solving the following problem: balancing an accounting matrix $\Phi(0)$, or vectorization $\tau(0)$, subject to a set of constraints h, according to the aggregation matrix $\mathbf{G}$ assiciated to a a var-cov matrix Σ of the initial estimates:

$$\mathbf{h} = \mathbf{G} \cdot \tau(1) \tag{4}$$

Using the initial estimate of $\Phi(0)$, we obtain:

$$\mathbf{h} + \varepsilon = \mathbf{G} \cdot \tau(0) \tag{5}$$

Assuming that the initial estimates $\tau(0)$ are unbiased and:

$$\begin{cases} \tau(0) = \tau(1) + \eta & a) \\ E(\eta) = 0 & b) \\ E(\eta\eta') = \Sigma & c) \end{cases} \tag{6}$$

The use of GLS will lead to estimate a vector $\widehat{\tau}(1)$ that will satisfy the accounting constraints in [a1] and will be as near as possible to the actual data $\tau(1)$. The estimator able to produce such an estimate is the following:

$$\widehat{\tau}(1) = \left[\mathbf{I} - \Sigma \cdot \mathbf{G}' \cdot \left(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}'\right)^{-1} \cdot \mathbf{G}\right] \cdot \tau(0) + \Sigma \cdot \mathbf{G}' \cdot \left(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}'\right)^{-1} \cdot \mathbf{h} \tag{7}$$

It is demonstrated that this kind of estimator is BLU, and its variance is given by:

$$\widehat{\Sigma} = \Sigma - \Sigma \cdot \mathbf{G}' \cdot \left(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}'\right)^{-1} \cdot \mathbf{G} \cdot \Sigma \tag{8}$$

Byron (1978) argued that the analogy of the SCM method to the application of generalized constrained least square estimation of vector coefficients of a linear model is inappropriate and rearranged it as a pure minimization constrained problem of a quadratic loss function proposing to solve it by way of conjugate gradient algorithm. The SCM estimator can be seen as a solution of the following minimization of quadratic loss function:

$$\vartheta = 0.5 \cdot (\widehat{\tau}(1) - \tau(1))' \cdot \Sigma^{-1} \cdot (\widehat{\tau}(1) - \tau(1)) + \lambda \cdot (\mathbf{G} \cdot \tau(1) - \mathbf{h}) \tag{9}$$

where λ is the Lagrange multiplier. The first class conditions for minimizing the previous equation correspond to the following values of Lagrange multipliers:

$$\widehat{\lambda} = \left(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}'\right)^{-1} + (\widehat{\Sigma} = \Sigma - \Sigma \cdot \mathbf{G}' \cdot \left(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}'\right)^{-1} \cdot \mathbf{G} \cdot \Sigma) \tag{10}$$

So that the estimator in [a4] will be:

$$\widehat{\tau}(1) = \tau(0) - \Sigma \cdot \mathbf{G}' \cdot \lambda \tag{11}$$

The contribution of R.P. Byron has allowed to overcome one of the problems that had hindered the use of the SCM procedure in the balancing of significant sets of national accounts and SAM, or rather the computational difficulty in inverting the matrix $(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}')$. R.P. Byron proposes the conjugate gradient algorithm to reach an estimate of the Lagrange multipliers, by means of the system of linear equations:

$$\left(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}'\right) \cdot \lambda = \mathbf{G} \cdot \tau(0) - \mathbf{h} \tag{12}$$

Since $(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}')$ is symmetric defined positive, the conjugate gradient method provides a good solution of the λ coefficients. As also stressed (Nicolardi (2000)), even with very powerful computers, this method retains advantages compared to direct estimate using [9] by increasing control provided by the algorithm over possible inconsistencies of the initial estimates Φ and of Σ and by avoiding the numerical instability tied to the inversion of $(\mathbf{G} \cdot \Sigma \cdot \mathbf{G}')$.

A crucial problem is how to define the variance-coveriance matrix that determines, for each flow in $\tau(0)$, the range of adjustment. Both type of minimization problems need to know this matrix. The best theoretical procedure would be to estimate each single element of $\tau(0)$ and the variance of its estimator by way of sampling estimation, this way is surely not proposable for the cost of such type of survey: for some account aggregates inserted as sub-matrices of $\Phi(0)$ it is possible to estimate variance of estimator elements but it is difficult compare it with the variance of other block elements of the matrix indirectly obtained.

However, the main reasons why the SCM has been preferred to other methods has been well summarized by Round (2003). In a review of the balancing methods applied to Social Accounting Matrices (rAs, Cross Entropy and SCM) the author clearly expresses his opinion in conclusion (p. 179, par.3): ... *In spite of the apparent preference for the Cross Entropy method by many compilers of SAMs, the Stone Byron method (possibly extended to include additional constraints) does seem to have some advantages over alternative methods. In particular, it allows us to incorporate judgement on the relative reliability of data sources and it is therefore closer to the spirit of the problem at hand".*

2 Initial estimates

In this chapter[1] will focus our attention on a crucial aspect of balancing procedure, that is the initial estimates and in particular on six components of MRSUT that is: i) value added and output, ii) use matrix, iii) supply

[1] Just a quick remind to the simbology used henceforth:
a) rrXY = sector type of aggregation, for instance: rr37 means 37 sectors Nace Rev.2 aggregation.
b) rrXY:xy = sector xy of the Nace Rev.2 classification in the rr37 aggregation, for instance rr37:B is "Fishing"
c) cpaXY= product type of aggregation, for instance : cpa54 means 54 products CPA aggregation Nace Rev.2
d) cpaXY:xy = product xy of the Nace Rev.2 classification in the cpaXY aggregation, for instance cpa63:10-12 is "Food products, beverages and tobacco products"

matrix, iv) domestic final demand, v) foreign import and export, vi) interregional trade. Before starting, just to remind (see Figure 1) that an enlarged national SUT table (henceforth eSUT) has preliminarily been estimated through: i) increasing the number of sectors (see appendix 2): ii) disaggregating the household expenditure by consumption products and consumption function COICOP-12, in order to get a bridge consumption matrix cpa64-COICOP-12: iii) for the public administration expenditure a bridge matrix cpa63-COFOG-10 has been estimated; iv) regarding gross fixed investments, two bridge matrices have been computed: the first one links investments products (cpa63) to investments by assets (P51), the second one investments by owner sector (rr28) to investments by asset (P51).

2.1 Value Added and Output

Value added at basic prices is released by ISTAT, at NUTS level, as part of the Regional Accounts (henceforth RegAcc), at 28 sectors (henceforth rr28), in a more aggregated way of what we need (37 sectors, henceforth rr37)[2]. For manufacturing and some market services, the initial estimates of missed rr37 sectors are based on SBS data, where value added at factors cost is available at two digit aggregation NACE-rev.2, and KAU level. For the other sectors the aggregated rr28 regional value added has been broken down using the share of employment drawn by Census11 for the benchmark year and Business Register ASIA-LU for the following ones. Value added estimated through SBS has then been adjusted, for making it consistent with local units definition, by using the ratio, at regional and two digit level, of lKAU/KAU employment drawn by Census11, therefore, the initial estimate of value added at factor cost for the j-*th* rr37 sector is defined as:

$$\widetilde{vafc}_{rj} = vafc_{rj}^{SBS,KAU} \cdot \frac{E_{rj}^{Census11,lKAU}}{E_{rj}^{Census11,KAU}} \tag{13}$$

The rr37 initial estimate of regional valued added at basic prices is then the result of a 3D TrAs (Eq. 14) which ensures consistency with: RegAcc rr28 and the national rr37 value added at basic prices.

$$\widetilde{\mathbf{vabp}} = TrAs(\mathbf{vabp}_{rr28}^{RegAcc}, \mathbf{vabp}_{rr37}^{eSUT}, \widetilde{\mathbf{vafc}}) \tag{14}$$

Once we have obtained the initial estimates of **vabp** we could proceed with computing output at basic prices. SBS dataset does not supply, at regional level, the value of output but only turnover and still at KAU level. This implies that, besides the lKAU/KAU adjustment, we should also correct for the difference between output and turnover. For doing that we use an adjustment factor taken from national SBS, that is:

$$\gamma_j = \frac{f_j}{x_j} \tag{15}$$

f_j=turnover sector j-*nth* x_j=output sector j-*nth* We could now compute the initial estimate of output at basic prices ($\widetilde{\mathbf{xbp}}$) by using the regional $\widetilde{\mathbf{vabp}}$, the turnover/va ratio: $\nu_{rj} = \frac{f_{rj}}{vafc_{rj}}$, and the correction factor γ. For the j-*th* sector and the r-*th* region the initial output at basic prices would be:

$$\widetilde{xbp}_{rj} = \widetilde{vabp}_{rj} \cdot \nu_{rj} \cdot \gamma_j \cdot \frac{E_{rj}^{Census11,lkau}}{E_{rj}^{Census11,kau}} \tag{16}$$

where: xbp = initial rr37 output at basic prices estimate.

e) ABCD-XY= ESA2010 nomenclature type of aggregation, for instance: COICOP-12 means the twelve COICOP consumption function

f) $\widetilde{x}$ =initial estimate of variable x

g) **x** =vector

h) **X**= matrix

[2]See appendix 3 for a comparison

Equation [16] represents the general approach in computing preliminary output, indeed for some sectors it is possible to use additional data source and trying to refine and strengthen the initial estimate. The most significant is represented by the primary macro-sector (agriculture, forestry and fishing). Indeed ISTAT is providing, at regional level, not only a very detailed rr37 sectoral production accounts (output, value added and intermediate costs) at basic price, but also data on the output of primary cpa54 products.

2.2 The USE matrix

A key elements of a regional SUT is represented by the intermediate product-sectors flows or: Use matrix. In the benchmark year the estimate is characterized by two sequential steps. First, the initial **B** regional coefficients matrices are obtained by means the industry-mix approach[3] (hereafter IMIX). This implies the regionalization of the cpa54:rr63e national B matrix, into the rr37 regional industries. This procedure allows us to catch the regional diversities tied to the sectoral specialization in the composition of each single regional rr37 sector input structure. The aggregation by means IMIX has come about according to the following equation:

$$\widetilde{b}_{rij} = \sum_{k=1}^{ns(j)} b_{ik}^{eSUT} \cdot QD_{rk} \qquad \forall\, k \in j \tag{17}$$

where:

ns(j) = number of the rr63e industries belonging to j-*th* rr37 sector;

QD= industry-mix of j-*th* rr37 sector of the r-*th* region based on the Census2011.

IMIX should use the output as mixing-aggregating factor, but information on this variable is not available, at NUTS2 level and at such level of detail[4]. To overcome this problem, in many examples of this approach, employment has been used. This of course misses to take into consideration differences in productivity among the aggregating sectors which, in some cases, could produce significant biases. In order to correcting them, sub sectors shares of employment have been adjusted by a factor which includes differences in productivity taken from national SBS. In particular the j-*th* industry mix QD of the r-*th* region is defined as:

$$QD_{rk} = \frac{1}{1 + \pi_j \dfrac{\dfrac{1}{\pi_k} - 1}{q_{rk}}} \qquad \forall\, k \in j \tag{18}$$

where:

π = labour productivity, from national SBS, for industry k-*nth* belonging to j-*nth*

q = share of employment of the k-*nth* industry

Equation [18] has the following properties $\forall\ k \in j$:

1) if $\pi_j = \pi_k$ then $QD_{rjk} = q_{rjk}$

2) if $\pi_j < \pi_k$ then $QD_{rjk} > q_{rjk}$

3) if $\pi_j > \pi_k$ then $QD_{rjk} < q_{rjk}$

4) $\sum_{k=1}^{ns(j)} QD_{rjk} = 1$

Second, once available the regional **B** coefficients, it is straightforward to compute the Use matrices using the output at basic prices taken from the [16], so:

$$\widetilde{u}_{rij} = \widetilde{b}_{rij} \cdot \widetilde{xbp}_{rj} \tag{19}$$

This type of regionalization it is not sufficient to encompass regional peculiarities linked to, for instance, specific regional technologies. Hereafter we will discuss some particular cases for which we have information on a regional and sectoral basis which allow us to introduce in [19] a specific regional $\widetilde{b}_{ik}$.

[3]

[4] See section 2.1

2.2.1 Specific sectors

- Agricolture, Forestry and Fishing (rr37:AA and rr37:AB) ISTAT provides detalied regional production accounts on agricolture, forestry and fishing sectors, in quantity/value of output, value added, and some particular intermediate costs (ie, energy expenditure).

- Coke and refined petroleum products (rr37:CD) From the regional energy balances (REB) provided by ENEA it is possible to estimate the regional share of cpa54:19 Coke and refined petroleum products entering as input cost in the homonym rr37 sector. This is particular important not only per se but also for correcting the input cost structure from the effects of multi-plant enterprises with big headquarters in Lombardy and Lazio. The higher is the incidence of these headquarters on the regional output of sector rr37:19 the closer to a business service sector will be the input cost structure on the contrary the highest is the share of cpa54:19 entering as input the closest the input cost will be linked to the refinery and coke production.

- Electric power generation (NACE-rev.2:35.11) Electric power generation is a sub-sector of rr37 industry "D:Electricity, Gas, Steam And Air-Conditioning". At regional level we do have some significant information on quantity and energy products utilized for generating electric power. The higher is the percentage of renewable used for producing electricity the lower is the input needed from two cpa54 products that is: B Mining and quarrying (natural gas and coal), and cpa54:19 Refinery and coke (Fuel Oil). Not only, amongst the renewables we have also information about how much of them are from biomass (cpa54:2 Forestry and cpa54:16 Wood and wood products) and from non renewable wastes (cpa54:37 Waste management). On the basis of these information a specific input cost structure for electric power generation has been assigned to each region and introduced in the equation [17].

2.3 The Supply matrix

Supply matrix makes explicit the dichotomy between sectors and products in the production process and it is the key matrix for determining technology and aggregation in computing symmetric I-O tables. Unlike the Use matrix there no information available on the output of products at regional level because the ProdComm survey on manufactured goods is representative at national level, but, we could proceed, for the benchmark year, through refinement steps, trying to use all information available from other sources. The first steps, is computing, starting from national matrix **C** coefficents at rr63e, the regional initial estimates of **C** trough IMIX:

$$\widetilde{c}_{rji} = \sum_{k=1}^{ns(j)} c_{ki}^{eSUT} \cdot QD_{rki} \qquad \forall\, k \in j \tag{20}$$

where:

QD = industry mix operator as in [17].

Once estimated the regional C matrices we could obtain the regional Supply matrices through output at basic prices:

$$\widetilde{s}_{rji} = \widetilde{c}_{rji} \cdot \widetilde{xbp}_{rj} \tag{21}$$

As for the Use matrices it is possible, after IMIX, to refine the initial estimates of subsets of the regional supply matrices by using other data sources. We could divide this refinement in two types: i) in the first case the adjustment has been made before the aggregation process by introducing specific regional c_{ik}; ii) in the second type, the initial estimate of supply table cell is obtained by a breakdown of national supply table value through a regional share indicator.

2.3.1 Specific product output

- Farm holidays output (NACE-rev.2:55.20.52) The regional product output of primary sector (agriculture, livestock forestry and fishery) is supplied by the ISTAT at very detailed level. Nonetheless, some farms are also producers of accommodation and food services (farm holidays). This type of tourism is particular relevant in regions like Tuscany. These flows are recorded in the supply matrix at the cell crossing sector rr37:AA and cpa54:I. The initial estimate of those cells have been obtained through the breakdown of the national supply table value according the regionale incidence of night spent in farm holidays:

$$\widetilde{s}_{r;rr37:AA,cpa54:I} = s_{rr37:AA,cpa54:I} \cdot \frac{nh_r}{nh} \tag{22}$$

where: nh_r = night spent in farm holidays for region r-*th*

- Oil and Gas extraction (r63a:06) The regional information about the output product of crude oil and natural gas from Minister of Economic Development (MISE) enters in the industry mix aggregation procedure of C matrix by introducing a regional specific rr63a c_{ik} value crossing: rr63a:Oil&gas extraction, cpa54:Mining and quarrying. In this case the importance relies in the fact that some regions are very specialized in extracting fossil fuels like Basilicata as others are less devoted to extraction and more to providing services because location of headquarter of multi-plant enterprises.

- Coke and refined petroleum products (cpa54:19) Refinery and Coke output product crosses supply table at rr37:CD and cpa54:19 and the regional specific value has been computed through a second type of adjustment that is:

$$\widetilde{s}_{r;rr37:CD,cpa54:19} = s_{rr37:CD,cpa54:19} \cdot \frac{Ref_r}{Ref} \tag{23}$$

where: Ref_r = Refineries output for region r-*th* expressed in ktoe from REBs

- Electric Power generation (NACE-rev.2:35.11) Electric Power generation output product crosses supply table at rr37:EP and cpa54:EL The regional specific value has been computed using as spreading indicator the regional megawatt-hours produced:

$$\widetilde{s}_{r,rr37(21),cpa54(13)} = s_{rr37(10),cpa54(23)} \cdot \frac{mwh_r}{mwh} \tag{24}$$

where: mwh_r = megawatt produced in the region r-th

- RD production (cpa54:72) RD output is a typical secondary product of many manufacturing enterprises (intra-muros RD) besides the specific output of sector rr37:MB (extra-muros). At regional level ISTAT publishes the whole RD production, both intra and extra muros. At national level, the extra-muros is released by producing sector. The regional intra-muros by sectors rr37 has then been computed through the national sectoral intensity of intra-muros RD over output, that is:

$$\widetilde{rd}_{rj} =_r \cdot \frac{rd_j}{xbp_j} \tag{25}$$

$\widetilde{rd}_{r.}$ have then been constrained to the total regional intra-muros

2.4 Foreign trade

2.4.1 Foreign exports

Foreign exports of goods is released by ISTAT, at NUTS2 level and 3 digits NACE-rev.2 and they are expressed at purchasing prices. The adjustment to be operated is the extraction of taxes on products and trade and transport margins. Both operations should been done using national parameters, in particular for taxes, trade and transport margins we have utilized the corresponding matrices available at national level, so for each i-*th* cpa54 products and r-*th* region, the initial values of foreign export of goods at fob and basic prices is computed as following:

$$\widetilde{ew}_{ri} = ew_{ri}^{pp} \cdot (1 - \tau_i) \cdot (1 - \vartheta_i) \tag{26}$$

where:

τ= taxes on products ratio for the national foreign export of the i-*nth* product

ϑ= trade and transport margins coefficient for the national foreign export of the i-*nth* product.

Once computed the initial ew_{ri} values, they have been re-balanced with the corresponding national SUT values. Trade and transport margins extracted through [26] have then been added to the initial estimates of the corresponding cpa54 products, as taxes on products will be assigned to foreign export taxes. Regarding export of services, they are available at regional level from ISTAT-ICE report as export credits, as for goods, for making the initial estimates consistent we have extracted taxes on products as in [26] and then rebalanced to foreign export values from national SUT.

2.4.2 Foreign Import

From Appendix 1 it is possible to note that cpa54 foreign import has been broken down in two groups: intermediate and final import. This distinction is extremely important in terms of economic analysis and implies an additional effort of estimate. As for export, foreign imports of goods at three digits NACE-rev.2 are supplied by ISTAT through the CoeWeb dataset as for services using the credits/debits in the Bank of Italy database.

In the following part the general procedure just for manufacturing goods is presented.

First, the 3 digits NACE-rev.2 regional imports are aggregated at cpa54 and in two groups: intermediate and final destination. This operation has been possible by using the MIGs classification[5] which allow to distinguish 3 digits roducts by destination that is: energy, intermediate, final durables, final non durables, final investments and services. Energy and intermediate will constitute the cpa54 intermediate import.

Second, once defined two cpa54 vectors for each region, that is: intermediate ($\widetilde{\mathbf{mwi}}^*$) and final ($\widetilde{\mathbf{mwf}}^*$) foreign import, the **MWI** matrices have then been re-scaled by comparing their sum with the national **MWI** drawn by the national SUT, this will also allow to correct the import flows of products for cif/fob evaluation. The new initial estimate of **MWI** for the r-*th* region will be:

$$\widetilde{\mathbf{mwi}}_r = \widetilde{\mathbf{mwi}}_r^* \cdot \frac{\mathbf{mwi}}{\sum_{r=1}^{nr} \widetilde{\mathbf{mwi}}_r} \tag{27}$$

Same procedure has been developed for foreign final import. As for the intermediate import, **MWF** matrices have then been re-scaled to the national **MWF**, drawn by the national SUT, so the new initial estimate of **MWF** for the r-*th* region will be:

$$\widetilde{\mathbf{mwf}}_r = \widetilde{\mathbf{mwf}}_r^* \cdot \frac{\mathbf{mwf}}{\sum_{r=1}^{nr} \widetilde{\mathbf{mwf}}_r} \tag{28}$$

[5] The Main Industrial Groupings, abbreviated as MIG, provide an alternative statistical breakdown of the economic activities of Manufacturing, as compared to the sectoral breakdown of NACE.

The MIG are at an intermediate level between the NACE Sections on the one hand and the Divisions and Groups on the other.

There are five MIG groups: intermediate goods; capital goods; consumer durables; consumer non-durables; energy.

However the are problems of identifying regional destination in the regional CoeWeb import data for some products. Because of the way they are recorded[6] it could be found that foreign imports of some products are not significantly tied to the regional demand. Two examples among others. First, according to import data Tuscany should be one of the most important demanding foreign cars region. Indeed this is due to the fact that Tuscany is an important access point of imported cars through the Leghorn harbor. The same applies for Veneto, in this case the crucial role is played by the Verona inland terminal. Second example is the import of natural gas trough regassification plants. In this case import of gas is assigned to the region where the plant is located.

After a careful examination of import and demand data we came to the identification of such as problem for some cpa54 products. Once defined them we replaced the **MWI** and **MWF** corresponding rows by spreading the corresponding national values according the regional intermediate/final demand.

2.5 Domestic final demand

2.5.1 Household and PA expenditure

In the regional SUT, household expenditure is expressed by a bridge matrix connecting the COICOP-12 consumption function with the cpa54 consumption products. The ISTAT RegAcc provides the regional COICOP-12 values so the initial estimates has been made by multiplying these values by the shares of cpa54 products by COICOP-12 derived from the national eSUT. Same procedure for the cpa54-COFOG-10 matrices of regional SUT, in this case ISTAT RegAcc supplies the regional PA expenditure by COFOG-10.

2.5.2 Gross Fixed Investments

Information provided by RegAcc are: Investments by demanding sector at rr28 and Investments in Construction so the calculation of the initial cpa54-P51 gross fixed investment bridge matrix for any region has been computed through the following steps: i) investments at rr28 have been transformed in investment by assets trough the national corresponding bridge matrix, ii) then the regional vectors of the resulting investments by asset have been distributed through the cpa54 investment products using the corresponding bridge matrix from the national eSUT.

2.6 Multiregional trade

The regional bilateral trade flows of goods and services is a crucial aspect in the construction of I-O regional tables, since it is through these bilateral trade flows that the most appropriate matrix of multiregional transactions per product can be derived. Despite the importance of this phenomenon, the information sources available in Italy are relatively scarce. Particularly relevant for the purposes of our analysis are: • the sample yearly survey Road Freigth Transport (RFT) by Istat, which records the flows of quantities of goods expressed in tons transported by road from one region to another, broken down into commodity macro-sectors; • the sample surveys of the Banca d'Italia (INVIND)[7] on manufacturing and service KAUs, which, for 2009, recorded the turnover "exported" from the NUTS2 region where the KAU is located to the geographical NUTS1 macro area of destination.

The main pros of RFT is that it details trade from region to region, rather than from region to geographical area like INVIND. On the other hand, INVIND has some advanteges vs RFT, in particular:

[6] In many cases import is assigned to enterprise and so the region of the headquarter instead lKAU actually using the imported product ii) In other cases to the access point region (see for instance inland terminal, harbor, airports, regassification plants for natural gas)

[7] This is a unique and exclusive database, which for 2009 for the first time collected, inter alia, information on the turnover of 1,706 industrial firms and 697 service firms with 50 or more workers; the majority of these firms (1,338 and 624 respectively) also provided details of the breakdown of turnover between the four geographical macro areas, which were then used for the estimates.

1. includes trade flows related to the services sector, which are not registered in RFT;
2. INVIND is using the ATECO classification, unlike RFT adopts the commodities transport (NST/R);
3. RFT records tons of freigth and the trade size of each sector is clealry affected by the commodity releated composition

Given pros and cons of both sources we decided to use the Bank of Italy survey has key dataset for estimating the product multiregional intermediate[8] flows among regions through a deterrence function as proposed in Leontief and Strout (1963) (LS) formulation of multiregional trade.

The LS algorithm has the following specification as:

$$t_{rs;j} = \frac{z_{r;j} \cdot z_{s;j}}{z_j} \cdot \delta_{rs;j} \tag{29}$$

where:
$t_{rs;j}$ = intermediate flow delivered from sector j-*th* of region r-*th* to region s-*th*,
$z_{r;j}$ = total output, net of foreign exports, of sector j-*th* belonging to region r-*th* (supply pool).
$z_{s;j}$ = domestic demand, net of imports from abroad of sector j-*th* of the destination region s-*th* (demand pool),
z_j = scale factor, total output net of sector j foreign intermediate exports,
$\delta_{rs;j}$= deterrence factor.

The estimate of the deterrence factor proves to be crucial to the estimate of the gravity model in [30]. In the case of trade flows this parameter represents the transaction costs between the two areas, without which the origin and destination flows would be simply driven by the concentration of supply and demand. To isolating the effect of the transaction costs and, in turn computing the deterence factor, we could approximate it through:

$$\tilde{\delta}_{rs;.j} = \frac{t_{rs;.j}}{t^*_{rs;j.}} \tag{30}$$

where:
$t^*_{rs;j}$= represents the value of the theoretical flow of goods/services that there would be without the transaction costs between the two areas.

By definition, the variable $\delta_{rs;j}$ illustrates the impact of such costs on bilateral commercial trade: if it is less than 1 the transaction costs depress the volume of trade; if it is greater than 1 these costs are fairly low and the trade thus proves to be particularly intensive. The variable $\delta_{rs;.j}$ can therefore be used as a dependent one in a model (deterrence/decay function) that includes among the regressors all the factors that influence the transaction costs and, through these, the trade flows between geographical areas so:

$$\delta_{rs;.j} = f\left(x(1)_{rs}, .., x(i)_{rs}, ..., x(l)_{rs}\right) \qquad i = 1, l \tag{31}$$

The LS formulation in [30] will become:

$$t_{rs;j} = \frac{z_{r;j} \cdot z_{s;j}}{z_j} \cdot f\left(x(1)_{rs}, .., x(i)_{rs}, ..., x(l)_{rs}\right) \tag{32}$$

2.6.1 Intermediate flows

The steps for computing initial estimates of intermediate multiregional flows from INVIND dataset have been the following:

[8]This is the main upgrade from the procedure adopted in Cherubini and Paniccià (2013) where INVIND was utilized as dataset for the estimate of the undistingushed final/intermediate interregional product flows

1. Specification and estimate of the deterrence function [32] at NUTS1 level,
2. Estimate of interregional NUTS2-NUTS2 flows by using the corresponding NUTS1 deterrence functions parameters,
3. because survey data are by sectors we have transformed the rr37 sectors interregional flows to cpa54 flows using the corresponding initial estimates of the regional make matrices.

Following the literature, the main explanatory variable in the deterrence function is the distance, which is generally proportionate to the expense of trading the commodities. Distance, in turn, is greater or lesser depending on the extension of the links network and the provision of infrastructures within the territory; for this reason, reference is made to effective distance[9]. The importance of the two areas, in economic terms, ought to influence the reciprocal trade. We would expect that the greater the economic weight of the area, the more significant the flows of products and services sold elsewhere will be; moreover the level of economic development within the area could render the demand for goods and services originating from other areas less significant so the higher is the distance in term of economic development the lower should be the propensity to trade intermediate goods For the purposes of this analysis the economic impact of an area is considered approximate to the per capita GDP. Another variable to be borne in mind in the analysis of the trade of intermediate goods and services between geographical areas is related to multiplant enterprise which localize lKAU in different regions. In this case, part of the flow of goods between the two areas is not determined by demand and supply but rather by the intra-industrial trade, so that it does not precisely reflect the sectoral interdependencies between the areas (**?**) In order to take this phenomenon into consideration, INVIND have recorded the distribution by geographical macro area of the employees of all KAUs in the sample with at least 50 workers. The assumption is that, the greater the number of workers of an enterprises localized in another one, the more intensive and frequent the trade of intermediate products. The commodity type of the products traded also determines greater or lesser transaction costs": for example, transporting slabs of marble costs more than transporting toys. Here we are talking about the so-called tradability effect" (Benvenuti and Paniccià (2003)), and in order to take this into account it we have introduced a sectoral dummy variable. The regression model used, which sets the transaction costs" between two NUTS1 regions (approximated by the variable \delta defined above) in relation to the principal factors influencing trade between them, has a log-log finctional form and it can can be expressed as follows (expected signs):

$$\ln(\delta_{RS;j}) = \beta_0 + \beta_1 \cdot ln\left[(ED_{RS})^{-1}\right] - \beta_2 \cdot ln\left(\frac{GDPpc_R}{GDPpc_S}\right) + \beta_3 \cdot ln\,(NE_{RS;j}) + \beta(j)_4 \cdot \ln\,(SED_{RSj}) \tag{33}$$

where:

ED_{RS} = effective distance (or closeness) between the NUTS1 area of origin R-*th* and destination S-*th*, measured through API Google application;

GDPpc = average per capita GDPs (1995-2006) of the origin and destination macro areas. The ratio of the two GDPs provides a relative measure of the economic closeness of the two areas;

NEj = average number of employees (1995-2006) belonging to KAU in NUTS1 $r-th$ that are permanently employed in production lKAUs located in NUTS1 s-*th*

SED_{RSj} = interaction variable between j sector economic activity (type of goods produced) and the distance between macro areas R and S, obtained as a product of the variable ED and a sector dummy, which ought to (at least partially) take in the tradability effect The estimates were performed separately for the manufacturing and the services sectors, because tradebility and transaction costs associated with the trade of commodities can be very different from those of services The estimates were performed using OLS and are robust for heteroscedasticity and for the clustering effect for pairs of areas. The results of the estimates are illustrated in Table 1.

[9]The effective distance between two ares has been proxied by the average crossed travel time between the NUTS3 components of the two areas computed through Google API

TABLE 1. RESULTS OF THE ESTIMATES OF THE DETERRENCE FUNCTION, DEPENDENT VARIABLE: ACTUAL/THEORETICAL TRADE RATIO

Regressors	Manufacturing	Services
$\ln\left(ED^{-1}\right)$	0.2684	0.6003
$\ln\left(\frac{\mathrm{GDPpc_r}}{\mathrm{GDPpc_s}}\right)$	-0.0902	0.4154
$\ln(NE_{rs})$	0.1151	
constant	-0.2541	-0.3503
n	157	48
R^2	0.294	0.281

SOURCE:AUTHORS CALCULATION

In general we should note that, in comparison to estimates made in other studies, the availability of information on the destination of the turnover and the breakdown of employees by geographical area appears to weaken the distance effect which, although it still remains the most important factor, nevertheless reveals a more modest impact[10]. Moving on to the original multiplication model, we would obtain the predicted values of the deterrence function for any NUTS2 region level by extrapolating the relationships computed at NUTS1 level, so that:

$$\widetilde{\delta}_{rs;j} = \beta_0 \cdot \left[(ED_{rs})^{-1}\right]^{\beta_1} \cdot \left(\frac{GDPpc_r}{GDPpc_s}\right)^{\beta_2} \cdot (NE_{rs;j})^{\beta_3} \cdot (SED_{rs;j})^{\beta(j)_4} \qquad \nabla r \in R \qquad \nabla s \in S \tag{34}$$

Then we could specify the LS relationships for any j-*th* sectoral intermediate multiregional, from origin region r-*th* and to destination region s-*th*:

$$\widetilde{tx}_{rs;.j} = \frac{\widetilde{z}_{r;.j} \cdot \widetilde{z}_{s;.j}}{z_j} \cdot \widetilde{\delta}_{rs;.j} \tag{35}$$

where:

z_{sj} = initial estimate of regional intermediate demand of sector j-*th*, net of intermediate foreign import estimated by using the initial regional s-*th* Use matrix and the market shares from initial Supply matrix[11]

$z_{r;j}$ = initial estimate of regional intermediate output of sector j-*th*, net of intermediate foreign export[12]

[10]For a deeper discussion on the estimate results see Cherubini and Paniccià (2013)

[11]

$$\widetilde{z}_{s;j} = \sum_j \sum_i \tilde{d}_{s;ji} \cdot \tilde{u}_{s;ij} \tag{36}$$

where: $\tilde{d}_{s;ji}$= market share of product i-*th* in output of sector j-*th*, region s-*th*

$\tilde{u}_{s;ij}$ = intermediate input of product i-*th* in output of sector j-*th* , region s-*th*

[12]Crossing the MIGs and ATECO2007 classification we could compute the number of employers embedded in the intermediate production by rr37 sectors (Ex) and using this information for spreading the intermediate output, derived from national SUT, over the regions according to the following formulation which rewards regions and sectors with a LQ greater than 1:

$$\widetilde{xpbx}_{rj} = xpbx_j^{eSUT} \cdot \frac{1}{1 + \frac{Ex_r}{Ex} \cdot \frac{\frac{1}{\frac{Ex_{rj}}{Ex_j}} - 1}{\frac{Ex_{rj}}{Ex_j}}} \tag{37}$$

so:

$$\widetilde{z}_{rj} = \widetilde{xpbx}_{rj} - ewi_{rj} \tag{38}$$

Nonetheless the multiregional trade in the initial SUTs is expressed by product, therefore we should move from sectors to products by using the initial estimate of regional Supply matrices; in particular the product shares. The initial estimate of intermediate trade between region r-*th* and the region s-*th* for the i-*th* cpa54 products is defined as:

$$\widetilde{tx}_{rs;i} = \sum_{j=1}^{37} d_{r;ij} \cdot \widetilde{tx}_{rs;j} d_{s;ji} \tag{39}$$

where:
$d_{r;ji}$ = product i-*th* share of sector j-*th*, region r-*th*
$d_{s;ji}$ = product i-*th* share of sector j-*th*, region s-*th* (transpose)

2.6.2 Domestic Final demand

For domestic final demand we intend the sum, by product, of five final demand components, that is: household expenditure , PA expenditure, NPIHS, Gross fixed Investment and Acquisition less disposal of valuables (AlDV). We suppose that interregional flows of final demand is led only by the concentration pool of supply and demand, which means, in terms of Leontieff-Strout formulation, a unity value of factor δ. As for the intermediate products, agglomeration and production chains are very significant in explaining origin and destination of interregional flows, in determining the final demand import/export trade sector is becoming more and more important the large scale retail channels in influencing the destination of final production. In a relative not big country like Italy, distances (transportation costs) tend to be overwhelming by concentration of final demand. Just a evidence, from the national SUT it is possible note that trade and transport margins accounts for 11% of intermediate goods cost the percentage rise up to 40% for consumption goods and 30% for investments goods. The initial estimates for final demand flows of product i-nth from origin region r-nth to destination s-nth will be defined as:

$$\widetilde{tf}_{rs;i} = \frac{\widetilde{f}_{r;i} \cdot \widetilde{f}_{s;i}}{f_i} \tag{40}$$

where:
$f_{s;i}$ = initial estimate of regional domestic final demand of product i-*th*, net of final foreign final import
$f_{r;i}$ = initial estimate of regional domestic final output of product i-*th*, net of final foreign final export

2.6.3 Special products

Not all trade flows products (final and intermediate) have been estimated by using the procedures presented above. In some cases we have derived the initial estimates in different ways because of: i) institutional causes; ii) typical features of the products; iii) availability of more information on multiregional trade flows

-Mining and quarrying (cpa54:B), natural gas and crude oil Trade flows of cpa54:B is mainly made up by two components: extraction of coal, oil and natural gas and other minerals so that trade flows of the product table is the sum of these two parts. For the other minerals the methodology presented in 2.6.1 is used, as for the energy products mining we have used information from MISE and Unione Petrolifera for determining the trade flows in quantity from producing regions, mainly Extra-region (off-shore fields) and Basilicata (on shore).

-Public Administration and defence services (cpa54:84) In a multi-regional trading system there are flows that are not attributable to endogenous processes in the economic system and/or KAUs multilocalization. We refer in particular to non market services related collective consumption (CCS)[13] trade flows of such as type of services is due to the highest density of loca lunits of national and local public institutions in certain areas/regions of the country. It would seem counterintuitive that CCS could be exported or imported, but when comparing, regionwide, the regional output of these services with the domestic expenditure, it is noticed that most regions show a production deficit, while only a few record a significant surplus. Since there is no foreign trade, such deficit/surplus can only be balanced by assigning them to regional import/export. The presence of unbalanced CCS accounts arises because demand for them are recorde in per capita basis as output according to the output of lKAUS. Indeed it is no coincidence that the region that shows the strongest surplus is the capital region Lazio where the localization of central government headquarters produces much more than the demand expressed on a per capita basis from the inhabitants of that region[14]

Given that, the initial multiregional trade flows has been built through the following procedure: i) identification of net exporters/ importers regions; ii) spreading of the multiregional surplus from the net exporters regions over the net importers on a per capita basis. Hereafter the formulation:

if: $xpb_{r;cpa54:84} > cc_r$ (net exporter)

$$\widetilde{t}_{rs;cpa54:84} = \widetilde{xpb}_{r;cpa54:84} \cdot {}^{pop_s}/_{pop} \quad \nabla r, s \tag{41}$$

if: $xpb_{r;cpa54:84} < cc_r$(net importer)

$$\begin{cases} \widetilde{t}_{rr;cpa54:84} = \widetilde{xpb}_{r;cpa54:84} & (a) \\ \widetilde{t}_{sr;cpa54:84} = \widetilde{xpb}_{s;cpa54:84} \cdot {}^{pop_r}/_{pop} \quad \nabla r \neq s & (b) \end{cases} \tag{42}$$

where:
cc = collective services demand
pop = territorial population

- Construction (cpa54:F) and Repair and installation services of machinery and equipment (cpa54:33) In compiling accounts ESA2010 recommends the territorial approach, thats is: activities resulting from factors of production would be allocated to the region in which the economic activities are actually carried out, irrespective of the resident regions of either the factor of production or the production units. This means that activities of the Constrction and repairing would be allocated to the region where the building site or machinery to repaired are located no matter the residence of who is doing bulding or reparing. In turn this means that external flows are almost null a part from very few cases and the trade flows matrices of both products are almost diagonal.

- Real estate services (cpa54:L), imputed rent The main components of real estate services are: i) imputed rent; ii) effective rent; iii) other housing services. The first two are the most important components of this product. For the effective rent and the first owned dwelling the territorial approach identify the dwellings are lKAUs of the host region producing effective/imputed rent almost excluding any type of trade flows. In case an household is owning a second dwelling in another region used by the owning household for own final consumption, the rental value should be registered as an interregional export from the region where the dwelling is located to the region where the owner resides. The latter region thus imports this service and uses it for final consumption expenditure of households. As in the case of mixed income, the operating surplus resulting from this production process will differ from the operating surplus in the allocation of primary income

[13]According to the ESA2010, the PAs production responds to two different types of demand: 1) from the household sector for individual consumption; 2) from the whole community (collective consumption). In the COFOG classification, the following PA expenditure functions can be defined as collective consumption: 1. General services; 2. Defense; 3. Public order; 4. Economic affairs; 5. Environmental protection; 6. Housing and community protection; all of them are in the cpa54:88 product.

[14]About the importance of such as flows, the zeroing of interregional balance of product cpa54:84 would cause for the capital region a change in total net import, which would be positive

accounts of households. So for cpa54:L the most important trade flows is determined by the imputed rent of second dwellings of non resident owners. The counterpart of the imputed rent in the households account is the household gross operating surplus, and from the ISTAT regional household accounts it possible to distinguish two kind of HGOS: i) by region of production (territorial distribution); ii) by region of residence (destination). The difference between this two aggregates will define net importer and exporters of imputed rent $HGOS_r^{prod} - HGOS_r^{res} = nHGOS_r$. As expected the regional unbalances are strictly related with those of tourism so the deficit/surplus has then been distributed across regions following this procedure:

if: $nHGOS_r > 0$ (net exporter)

$$\widetilde{t}_{rs;cpa54:L} = nHGOS_{r;cpa54:L} \cdot {}^{ins_{sr}}\!/_{ins_{.r}} \quad \nabla r \neq s \tag{43}$$

if: $nHGOS_r < 0$(net importer)

$$\begin{cases} \widetilde{t}_{rr;cpa54:84} = xpb_{r;cpa54:84} & (a) \\ \widetilde{t}_{sr;cpa54:L} = nHGOS_{s;cpa54:L} \cdot {}^{ins_{rs}}\!/_{ins_{.s}} \quad \nabla r \neq s & (b) \end{cases} \tag{44}$$

where:

ins = nigth spent by italians non resident in the region

- Electricity, gas, steam and air-conditioning (cpa54:D): electricity In section 2.2.1 we discussed how REB have been use for building the the row of uses and the columns of costs in the Use matrix for sector rr37:D and product cpa54:D. Same information could be utilized for estimating the trade matrices of the cpa54:D product. Given the surplus/deficit in the interemdiary and final trade of electricity provided by the REBs (nEl$_r$) the multiregional trade flows matrix have been built through the following formulas:

if: $nElx_r > 0$ (net intermediate exporter)

$$\widetilde{tx}_{rs;cpa54:D} = pun \cdot nElx_{r;cpa54:D} \cdot \frac{xpb_s}{xpb} \quad \nabla r \neq s \tag{45}$$

if: $nElx_f > 0$ (net final exporter)

$$\widetilde{tf}_{rs;cpa54:D} = pun \cdot nElf_{r;cpa54:D} \cdot {}^{twh_s}\!/_{twh} \quad \nabla r \neq s \tag{46}$$

if: $nElx_r < 0$(net intermediate importer)

$$\begin{cases} \widetilde{tx}_{rr;cpa54:D} = pun \cdot twx_r & (a) \\ \widetilde{tx}_{sr;cpa54:L} = pun \cdot nElx_{s;cpa54:D} \cdot {}^{xpb_r}\!/_{xpb} \quad \nabla r \neq s & (b) \end{cases} \tag{47}$$

if: $nElf_r < 0$(net final importer)

$$\begin{cases} \widetilde{tf}_{rr;cpa54:D} = pun \cdot twh_r & (a) \\ \widetilde{tf}_{sr;cpa54:L} = pun \cdot nElf_{s;cpa54:D} \cdot {}^{twh_r}\!/_{twh} \quad \nabla r \neq s & (b) \end{cases} \tag{48}$$

where:

pun = National electricity single price per TWh

twh = tera-watt consumed for housing purposes

twx = tera-watt consumed for productive purposes

2.7 Initial estimates for non benchmark years

For the non benchmark year the procedure balanced utilizes $(t-1)$ coefficients. In particular the initial estimate of Supply and Use matrices have been performed through the balanced B e C coefficients at time $(t-1)$, as vabp and xbp are estimated as in subsection 2.1. Therefore for the r-*th* region at time (t) the initial Use matrix is obtained through:

$$\widetilde{\mathbf{U}}_{r,(t)} = \mathbf{B}_{r,(t-1)} \cdot \widehat{\widetilde{\mathbf{xpb}}}_{r,(t)} \tag{49}$$

The Supply matrix is the result of the following multiplication:

$$\widetilde{\mathbf{S}}_{r,(t)} = \widehat{\widetilde{\mathbf{xpb}}}_{r,(t)} \cdot \mathbf{C}_{r,(t-1)} \cdot \tag{50}$$

Same for the bridge matrices of household expenditure, public administration expenditure and gross fixed investments. The incidence of expenditure by demand function/asset and product at time (t) have been utilized for spreading the RegAcc available at time t (COICOP-12, COFOG-10, Gross investments by owner sector) over the cpa54 product and services.

This new initial estimates will have as variance the ex-post variance resulting from the balancing process at time $(t-1)$.

3 Balancing the initial estimates

3.1 Defining constraints

We could distinguish three kind of constraints: i) internal, ii) from RegAcc, iii) national SUT. We call internal constraints what derives from the accounting system so for instance total product supply of a regional must be equal to total product demand, total interregional product export must be equal to total interregional product import. The second type of constraints are from the availability of a series of data provided by official statistical sources at regional level. This means above the Regional accounts. At the present ISTAT is providing the following data: i) Value added at basic prices rr28, ii) Total net indirect taxes on products, iii) household expenditure at market prices COICOP-12, iv) PA expenditure at market prices COFOG-10, v) total NPIHS, vi) total AlDV plus Changes on inventories, vii) Net total import. Third type of constraints relies on the national SUT

3.2 The balancing accounting identities

The balancing of the MRSUT according to SCM procedure, that is; the single regional SUTs and the multi-regional trade matrices (intermediate and final) T has been performed simultaneously, through the following system of balancing identities:

$$
\begin{cases}
\widetilde{\mathbf{S}}\cdot i+\check{\check{\mathbf{T}}}_x\cdot i+\check{\check{\mathbf{T}}}_f\cdot i+\widetilde{\mathbf{mwi}}+\widetilde{\mathbf{mwf}}\equiv\widetilde{\mathbf{U}}\cdot i+\widetilde{\mathbf{F}}\cdot i+\check{\check{\mathbf{T}}}_x\cdot i+\check{\check{\mathbf{T}}}_f\cdot i+\widetilde{\mathbf{ew}} & (a)\\
\check{\mathbf{T}}_x\cdot i+\check{\mathbf{T}}_f\cdot i\equiv\check{\mathbf{T}}_x\cdot i+\check{\mathbf{T}}_f\cdot i & (b)\\
i\cdot\widetilde{\mathbf{S}}\equiv i\cdot\widetilde{\mathbf{U}}+i\cdot\widetilde{\mathbf{Y}} & (c)\\
\overline{\mathbf{Y}}\equiv\widetilde{\mathbf{Y}}\cdot\mathbf{G}_y & (d)\\
\overline{\mathbf{F}}\equiv\widetilde{\mathbf{F}}'\cdot i & (e)\\
\mathbf{nm}\equiv\left[(\check{\mathbf{T}}_x\cdot i+\check{\mathbf{T}}_f\cdot i)-(\check{\mathbf{T}}_x\cdot i+\check{\mathbf{T}}_f\cdot i)\right]\cdot i+\left[(\widetilde{\mathbf{mwi}}+\widetilde{\mathbf{mwf}})-\widetilde{\mathbf{ew}}\right]\cdot i & (f)\\
\begin{bmatrix} 0 & \mathbf{U}_{ita} & \mathbf{F}_{ita} & \mathbf{ew}_{ita}\\ \mathbf{S}_{ita} & 0 & 0 & 0\\ 0 & \mathbf{Y}_{ita} & 0 & 0\\ \mathbf{mwi}_{ita} & 0 & 0 & 0\\ \mathbf{mwf}_{ita} & 0 & 0 & 0 \end{bmatrix}\equiv\sum_{j=1}^{k}\begin{bmatrix} 0 & \mathbf{U}_j & \mathbf{F}_j & \mathbf{ew}_j\\ \mathbf{S}_j & 0 & 0 & 0\\ 0 & \mathbf{Y}_j & 0 & 0\\ \mathbf{mwi}_j & 0 & 0 & 0\\ \mathbf{mwf}_j & 0 & 0 & 0 \end{bmatrix} & (g)
\end{cases}
\tag{51}
$$

where:
k = number of NUTS2 regions;
m= rr37 sectors;
m*= rr28 sectors;
n= cpa54 products;
q = domestic final demand components;
p=value added components;
S = blocks-diagonal regional Supply matrices $[(k\cdot n)\times(k\cdot m)]$;
i = column vector
T = block multiregional trade matrix $[(k\cdot n)\times(k\cdot n)]$ for intermediate (subscript x) and final (subscript$f$) where diagonals of each single trade matrix is set to 0
mwi/mwf = vector of products intermediate/finale foreign import $(k\cdot n)$;
U = blocks-diagonal regional Use matrices $[(k\cdot n)\times(k\cdot m)]$;
$\overline{\text{F}}$= Regional domestic final demand components constraints $(k\cdot q)$ by RegAcc;
F = blocks-diagonal regional domestic final demand matrices $[(k\cdot n)\times(k\cdot q)]$;
ew = vectors of products foreign export $(k\cdot n)$;
$\overline{\text{Y}}$= blocks-diagonal regional primary input components constraints $[(k\cdot p)\times(k\cdot m^*)]$ by RegAcc;
Y = blocks-diagonal regional primary input components $[(k\cdot p)\times(k\cdot m)]$;
G_y = aggregation matrix from m rr37 to m* rr28 supplied by regional accounts $[(k\cdot m)\times(k\cdot m^*)]$;
nm = Regional Total Net Import provided by RegAcc (k).

3.3 The variance-covariance matrix of the initial estimates

A crucial point in the SCM procedure is represented by the estimate of the Var-Cov matrix. As has been previously described, in order to determine that matrix we should associate each flow to a degree of reliability. Several options have been proposed in literature, varying from purely subjective approach to those more objective. In the first case an ordinal scale of the reliabilities is built on the basis of experienced judgment of producers (this procedure was suggested by Stone (1981)), applied by van der Ploeg (cit.) in UKCSO accounts, and used by Byron et al. (1993) to balance regional accounting matrices. Van der Ploeg (1984), Weale (1988), Solomou and Weale (1993)has proposed a more objective method, particularly these last authors described how is possible to reach an estimate of the Var-Cov matrix, without knowing the reliability of the data item in a system of dynamic calculations, in presence of stationary variance and mean, using as basis the standard deviation over time. If it is difficult to estimate cells variances it is more difficult to do it for bi variate covariances (not diagonal elements of the matrix Σ): the value of these coefficient depend from the way in which cells values have been obtained (dependently or independently one with each others). Anyway most part of balancing procedure set them to zero to avoid estimation and computational problems. The ideal procedure would estimate for each flow the relative reliability, on the basis of its own error profile supplied by the data producers and therefore would associate it to the matrix of Var-Cov. Concerning our application, the building of the matrix of Var-Cov had to tackle two kinds of problem. The first concerns the shortage of information on relative reliability and on standard deviation of the estimates. The second concerns the procedure of construction of some initial data which cannot be considered independent, as usually assumed, because they are built on the basis of other initial estimates. An obligatory step in the determination of the matrix Var-Cov has been the tracing of an assignment paradigm of reliability, on the basis of the known economic regional specificity's, numerical and constructive characteristics of the initial data. The model of reliability assignment tries to considerate the factors that could describe the precision of the initial estimate. Once identified, they have been properly combined in order to determine the reliability. The guidelines of the reliabilities assignment have therefore led to a mixed subjective-objective technique. The reliabilities have been distributed in a cardinal way according to two different dimension, that is: by accounts and by regions and then transformed in variance according to the following equation (Stone 1990):

$$\sigma_{rij} = (\rho_{ij} \cdot \rho_r^* \cdot \phi_{r,ij}(0)) \tag{52}$$

where:

ρ_{ij}= account reliability

ρ_r^* = regional specific reliability

The range of reliability by accounts varies from 0, highest reliability and so 0 variance, to 1.5 (lowest reliability). Maximun reliability has been assigned to national SUT values and to all regional variables provided by ISTAT RegAccounts, that is: i) Value Added at basic prices rr28, ii) Household expenditure COICOP-12, iii) PA expenditure COFOG-10, iv) total NPIHS, v) total inventory and acquisition less disposal of values, v) total indirect taxes on products, vi) total net import, vii) foreign export of goods cpa54. The next table (Table 2)

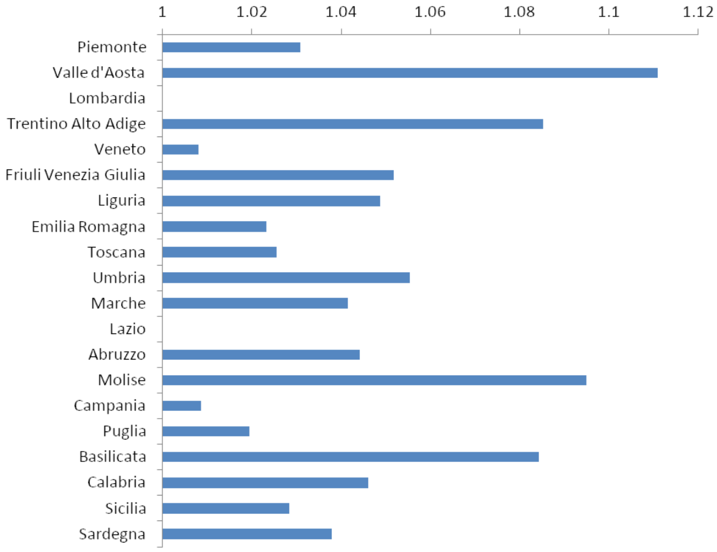
TABLE 2. UNWEIGHTED RELIABILITIES BY ACCOUNT

	min.	max.	mean
Use	0	0.20	0.18
Supply	0	0.20	0.15
Value Added rr37	0	0.01	0.01
Net indirect taxes on products rr37	0.01	0.05	0.03
Household expenditure cpa54-COICOP-12	0	0.10	0.06
PA expenditure cpa54-COFOG-10	0.10	0.10	0.10
NPIHS cpa54	0.10	0.10	0.10
Gross Fixed Investments cpa54-p10	0	0.10	0.08
Changes in inventories cpa54	0.50	0.80	0.78
Acquisition less disposal of values cpa54	0.10	0.10	0.10
Foreign export of goods (interm./final) cpa54	0	0	0
Foreign export of services (interm./final) cpa54	0.10	0.30	0.17
Foreign import of goods (interm./final) cpa54	0.10	0.50	0.30
Foreign import of services (interm./final) cpa54	0.20	0.50	0.32
Multiregional flows cpa54 (interm./final) cpa54	1.00	1.20	1.18
Net regional import	1.00	1.00	1.00
Net foreign import	0.05	0.20	0.16

SOURCE: AUTHORS CALCULATIONS

Figure 2 shows the region specific multipliers of accounts unreliability. A proxy of this latter type of reliability has been provided by the relative regional percentage error of the Labour Force Survey. Lazio and

FIGURE 2. REGIONAL SPECIFIC UNRELIABILITIES



SOURCE: AUTHORS CALCULATIONS

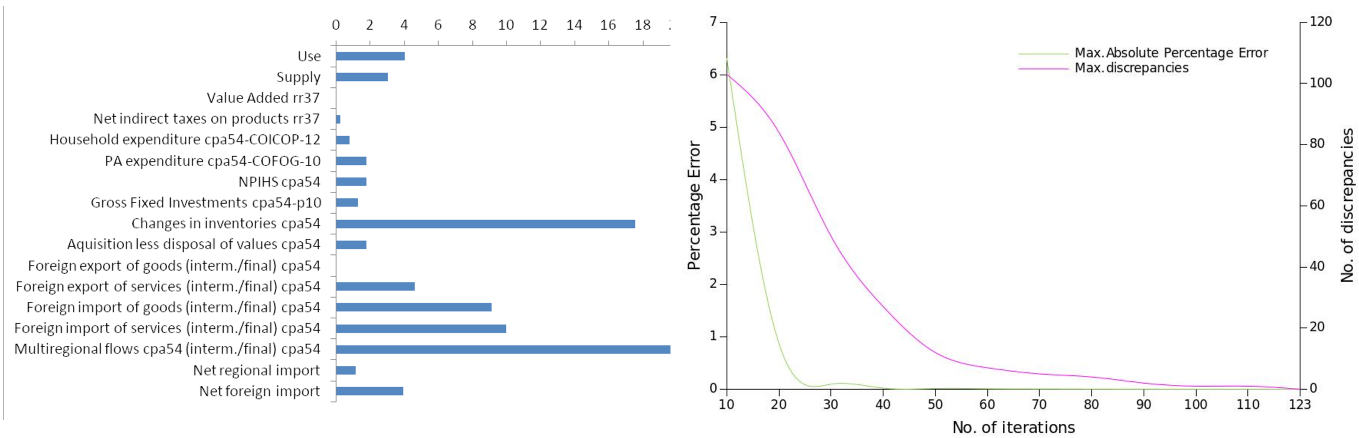
Lombardy regions are almost not affected by region-specific reliability factor as Valle d'Aosta, Trentino Alto Adige, Molise and Basilicata(the smallest regions) have the highest regional factor

3.4 The balancing adjustment: main figures

In this subsection two important pieces of information about the balancing process for the benchmark year 2011 will be shown. First, the mean absolute percentage adjustment of MRSUT accounts, as in Figure 3a, second how the conjugate gradient algorithm has worked for reaching the convergence is shown in Figure 3b, besides the maximum percentage error, the number of discrepancies are displayed.

FIGURE 3. STONE-BYRON BALANCING RESULTS

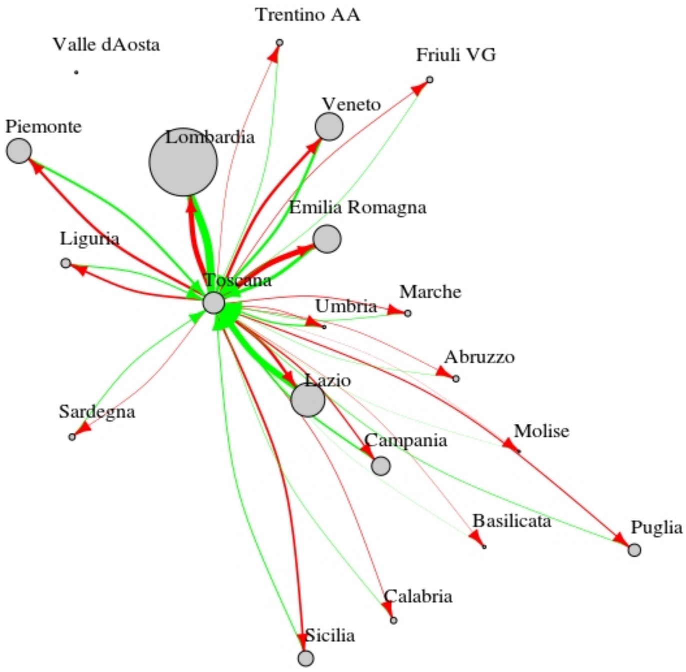
(a) MAPA by account (b) Max discrepancies and Max. Perc.Error by iterations



SOURCE:AUTHORS CALCULATIONS

The most important additional contribution of a MRSUT is the estimate of the multiregional trade and its implications i terms of trade balance. As an example of that, referring to others publications for the economic implications of those flows, in Figure 4 is shown the multiregional trade of Tuscany as resulting from MRSUT balancing process.

FIGURE 4. MULTIREGIONAL IMPORT-EXPORT: TUSCANY 2011



SOURCE: AUTHORS CALCULATIONS
NOTES: ARROW SIZE PROPORTIONAL TO IMPORT-EXPORT FLOW

References

Allen, R. I. and Lecomber, J. R. C. (1975). Some tests on a generalised version of ras. *Estimating and projecting input-output coefficients*, pages 43–56.

Bacharach, M. (1970). *Biproportional matrices and input-output change*, volume 16. CUP Archive.

Benvenuti, S. C. and Paniccià, R. (2003). *A multi-regional input-output model for Italy*. IRPET.

Byron, R. P. (1977). Efficient estimation and inference in large econometric systems. *Econometrica: Journal of the Econometric Society*, pages 1499–1515.

Byron, R. P. (1978). The estimation of large social account matrices. *Journal of the Royal Statistical Society. Series A (General)*, pages 359–367.

Byron, R. P., Crossman, P. J., Hurley, J. E., and Smith, S. (1993). Balancing hierarchical regional accounting matrices.

Cherubini, L. and Paniccià, R. (2013). A multiregional structural analysis of italian regions. *Macroeconomic modelling for policy evaluation*, 120:101–133.

Dalgaard, E. and Gysting, C. (2004). An algorithm for balancing commodity-flow systems. *Economic Systems Research*, 16(2):169–190.

Deming, W. E. and Stephan, F. F. (1940). On a least squares adjustment of a sampled frequency table when the expected marginal totals are known. *The Annals of Mathematical Statistics*, 11(4):427–444.

Gilchrist, D. and St. Louis, L. (2004). An algorithm for the consistent inclusion of partial information in the revision of input-output tables. *Economic Systems Research*, 16(2):149–156.

Gilchrist, D. A. and St Louis, L. V. (1999). Completing input–output tables using partial information, with an application to canadian data. *Economic Systems Research*, 11(2):185–194.

Golan, A., Judge, G., and Robinson, S. (1994). Recovering information from incomplete or partial multisectoral economic data. *The Review of Economics and Statistics*, pages 541–549.

Golan, A., Judge, G. G., Miller, D., et al. (1996). Maximum entropy econometrics. Technical report, Iowa State University, Department of Economics.

Gorman, W. (1963). Estimating trends in leontief matrices: a note on mr. bacharach's paper. *Nuffield College, Oxford, duplicated.*

Günlük-Şenesen, G. and Bates, J. M. (1988). Some experiments with methods of adjusting unbalanced data matrices. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, pages 473–490.

Jaynes, E. T. (1957). Information theory and statistical mechanics. *Physical review*, 106(4):620.

Jensen, R. C. and West, G. (1986). *Input-Output for Practitioners: Theory and Applications*. Number 1. Australian Govt. Pub. Service.

Junius, T. and Oosterhaven, J. (2003). The solution of updating or regionalizing a matrix with both positive and negative entries. *Economic Systems Research*, 15(1):87–96.

Kullback, S. and Leibler, R. A. (1951). On information and sufficiency. *The annals of mathematical statistics*, 22(1):79–86.

Lenzen, M., Gallego, B., and Wood, R. (2009). Matrix balancing under conflicting information. *Economic Systems Research*, 21(1):23–44.

Leontief, W. and Strout, A. (1963). Multiregional input-output analysis. In *Structural interdependence and economic development*, pages 119–150. Springer.

Nicolardi, V. (2000). Balancing large accounting systems: an application to the 1992 italian io table. In *Proceedings of the "XIII International Conference on Input-Output Techniques", University of Macerata, Italy, August*, pages 21–25.

Paelinck, J. H. P. and Waelbroeck, J. (1963). *Etude empirique sur l'evolution de coefficients input-output: essai d'application de la procedure" RAS" de Cambridge au tableau interindustriel belge*.

Pyatt, G. and Roe, A. (1977). *Social accounting for development planning with special reference to Sri Lanka*. CUP Archive.

Robinson, S., Cattaneo, A., and El-Said, M. (2001). Updating and estimating a social accounting matrix using cross entropy methods. *Economic Systems Research*, 13(1):47–64.

Round, J. (2003). Constructing sams for development policy analysis: lessons learned and challenges ahead. *Economic Systems Research*, 15(2):161–183.

Schneider, M. H. and Zenios, S. A. (1990). A comparative study of algorithms for matrix balancing. *Operations research*, 38(3):439–455.

Shannon, C. E. (1948). A mathematical theory of communication, part i, part ii. *Bell Syst. Tech. J.*, 27:623–656.

Solomou, S. and Weale, M. (1993). Balanced estimates of national accounts when measurement errors are autocorrelated: the uk, 1920-38. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, pages 89–105.

Stone, R. (1981). *Aspects of economic and social modelling*, volume 1. Librairie Droz.

Stone, R., Champernowne, D. G., and Meade, J. E. (1942). The precision of national income estimates. *The Review of Economic Studies*, 9(2):111–125.

Streicher, G. and Stehrer, R. (2015). Whither panama? constructing a consistent and balanced world sut system including international trade and transport margins. *Economic Systems Research*, 27(2):213–237.

Theil, H. and Schweitzer, A. (1961). The best quadratic estimator of the residual variance in regression analysis. *Statistica Neerlandica*, 15(1):19–23.

Theil, H. and Theil, H. (1971). Principles of econometrics. Technical report.

van der Ploeg, F. (1982). Reliability and the adjustment of sequences of large economic accounting matrices. *Journal of the Royal Statistical Society. Series A (General)*, pages 169–194.

Weale, M. (1988). The reconciliation of values, volumes and prices in the national accounts. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, pages 211–221.

Appendix 1. Classifications in regional SUTs

TABLE 3. SECTORS: RR37 AND RR28

NACE rev.2 rr37	Description	NACE rev.2 rr28
AA	Agriculture, Hunting, Forestry, Logging And Related Services	AA
AB	Fishing, Aquaculture, Support Services To Fishing	AB
B	Mining And Quarrying	B
CA	Food, Beverages And Tobacco	CA
CB	Textiles, Wearing Apparel And Leather	CB
CCA	Wood And Of Products Of Wood And Cork, Except Furniture	CCA.CCB
CCB	Paper And Paper Products, Printing And Reproduction Of Recorded Media	
CD	Coke And Refined Petroleum Products	CD-CE-CF
CE	Chemicals And Chemical Products	
CF	Basic Pharmaceutical Products And Pharmaceutical Preparations	
22	Rubber And Plastic Products	CG (22-23)
23	Other Non-Metallic Mineral Products	
CH	Basic Metals, Fabricated Metal Products, Except Machinery And Equipment	CH
CI	Computer, Electronic And Optical Products	CI-CJ-CK
CJ	Electrical Equipment	
CK	Machinery And Equipment N.E.C.	
CL	Transport Equipment	CL
CM	Manufacturing N.E.C, Repair And Installation Of Machinery And Equipment	CM
D	Electricity, Gas, Steam And Air-Conditioning	D
E	Natural Water; Water Treatment, Sewerage; Waste Collection	E
F	Construction	F
G	Wholesale And Retail Trade; Repair Of Motor Vehicles And Motorcycles	G
H	Transportation And Storage	H
I	Accommodation And Food Service Activities	I
JA	Publishing, Motion Picture, Video, Sound And Broadcasting Activities	JA-JB-JC
JB	Telecommunications Activities	
JC	Computer Programming, Consultancy And Related Activities	
K	Financial And Insurance Activities	K
L	Real Estate Activities	L
MA	Legal And Accounting Consulting, Architectural And Engineering Activities	MA-MB
MB	Scientific Research And Development Activities	
MC-N	Other Administrative Activities	MC-N
O	Public Administration And Defence; Compulsory Social Security	O
P	Education	P
Q	Human Health And Social Work Activities	Q
R	Arts, Entertainment And Recreation	R
S-T-U	Others Services	S-T-U

TABLE 10. THE RR63 SECTOR FURTHER DISAGGREGATED IN THE RR63 EXTENDED

rr63	Description	rr63 extended	Description
B	Mining and quarrying	05-06	Extraction of oil, gas and coal
		07-08	Other minerals
		09	Mining services
13-15	Textiles, wearing apparel, leather and related products	13	Textiles
		14	Wearing apparel
		15.1	Tanning and dressing of leather; luggage, handbags, saddleryar
		15.2	Footwear
31-32	Furniture and other manufactured goods	31	Furniture
		32.1	jewellery, bijouterie and related articles
		32	Other manufacture
D	Electricity, gas, steam and air conditioning supply	35.1	Electric power generation, transmission and distribution
		35.2-35.3	Gas, steam and air conditioning supply

Table 4. Products: cpa54

CPA2008 Code	Description
1	Products of agriculture, hunting and related services
2	Products of forestry, logging and related services
3	Fish and other fishing products; aquaculture products; support services to fishing
B	Mining and quarrying
10-12	Food products, beverages and tobacco products
13-15	Textiles, wearing apparel and leather products
16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials
17	Paper and paper products
18	Printing and recording services
19	Coke and refined petroleum products
20	Chemicals and chemical products
21	Basic pharmaceutical products and pharmaceutical preparations
22	Rubber and plastics products
23	Other non-metallic mineral products
24	Basic metals
25	Fabricated metal products, except machinery and equipment
26	Computer, electronic and optical products
27	Electrical equipment
28	Machinery and equipment n.e.c.
29	Motor vehicles, trailers and semi-trailers
30	Other transport equipment
31-32	Furniture; other manufactured goods
33	Repair and installation services of machinery and equipment
D	Electricity, gas, steam and air-conditioning
36	Natural water; water treatment and supply services activities and other waste management services
37-39	Sewerage; waste collection, treatment and disposal activities
F	Constructions and construction works
45	Wholesale and retail trade and repair services of motor vehicles and motorcycles
46	Wholesale trade services, except of motor vehicles and motorcycles
47	Retail trade services, except of motor vehicles and motorcycles
49	Land transport services and transport services via pipelines
50	Water transport services
51	Air transport services
52	Warehousing and support services for transportation
53	Postal and courier services
I	Accommodation and food services
58	Publishing services
59-60	Motion picture, video and television programme production services, sound recording and music publishing
61	Telecommunications services
62-63	Computer programming, consultancy and related services; information services
64	Financial services, except insurance and pension funding
65	Insurance, reinsurance and pension funding services, except compulsory social security
66	Services auxiliary to financial services and insurance services
L	Real estate services
69-71	Legal and accounting consulting services and Architectural and engineering services
72	Scientific research and development services
73-75	Advertising and market research services + Other professional, scientific and technical services
77-82	Other administrative activities
84	Public administration and defence services; compulsory social security services
P	Education services
86-88	Human health and social services
90-93	Creative, arts entertainment and cultural services+ sporting and amusement services
94-96	Other personal services
T-U	Services of households as employers; undifferentiated goods and services produced by h. for own use

Table 5. Household Expenditure Functions: COICOP-12

COICOP code	Description
01	Food and non-alcoholic beverages
02	Alcoholic beverages, tobacco
03	Clothing and footwear
04	Housing, water, electricity, gas, other fuels, actual and imputed rent
05	Furnishings, household equipment and routine maintenance of the house
06	Health
07	Transport
08	Communication
09	Recreation and culture
10	Education
11	Restaurants and hotels
12	Miscellaneous goods and services

Table 6. Public Administration Expenditure Functions: COFOG-10

COFOG code	Description
01	General public services
02	Defence
03	Public order and safety
04	Economic affairs
05	Environmental protection
06	Housing and community amenities
07	Health
08	Recreation, culture and religion
09	Education
10	Social protection

Table 7. Gross Fixed Investments: non financial assets

Non Financial Asset code	Description
115	Cultivated biological resources
1131	Transport equipment
11321	Computer hardware
11322	Telecommunications equipment
1139-114	Other machinery and equipment and weapons systems
111-112	Total construction
1171	Research and development
1172-1174-1179	Mineral exploration and evaluation, entertainment, literary or artistic originals
1173	Computer software and databases

Table 8. Other final demand components

	Description
P.52	Changes in inventories
P.53	Aquisition less disposal of values
S.15	NPISH expenditure
P.6ri	Regional export of goods and services, intermediate
P.6rf	Regional export of goods and services, final
P6w	Foreign export of goods and services

Table 9. Primary inputs and import

	Description
D1-B3	Value Added at basic prices
D21-D31	Net Taxes on products
P.7ri	Regional import of goods and services, intermediate
P.7rf	Regional import of goods and services, final
P.7wi	Foreign import of goods and services, intermediate
P.7wf	Foreign import of goods and services, final