A MULTIREGIONAL STRUCTURAL ANALYSIS OF A DUALISTIC ECONOMY: THE ITALIAN REGIONS OVER A DECADE (1995-2006)

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INTRODUCTION

The main goal of this paper is to describe the changes of the Italian economic and productive structure at a sub-national level, in the 1995-2006 time span, investigating the role of spatial interdependencies among regions in the transmission of shocks.

This kind of analysis is particularly important in a dualistic economy like the Italian one. In the year 2005 the per capita GDP of the Southern regions of Italy was less than 60 per cent of that of the other regions. The gap between Centre-North and South of Italy is even wider looking at employment, poverty, education or indicators of conditions of living. Moreover, among the countries with huge regional disparities, Italy is the only one where these gaps have not reduced significantly in the long run and this phenomenon does not seem to be strictly related with the dynamic of economic growth of the whole country (Iuzzolino, 2009).

The analysis is based on the multiregional Input-Output (MRIO) model introduced by the IRPET. Important methodological improvements have concerned the multiregional trade flows estimate procedure, thanks to the availability of unique survey data gathered by the Banca d'Italia.

The paper is structured as follows. The first paragraph introduces the MRIO model, by explaining the method of construction, the structural form specification and by analysing the impact of interregional trade. The next two paragraphs are devoted to the structural analysis of the Italian production system, from two different points of view. Paragraph 2 describes the interdependencies between the four geographic macro areas in which Italy is typically divided, taking into account the external and interregional trade balances and the spatial effects of the triggering process in response to a change in the final demand. In paragraph 3 the methodology of the backward and forward linkages is applied, with a spatial perspective, to the single Italian regions, in order classify them and to identify the "nodal" ones. Paragraph 4 is dedicated to some conclusions.

1. THE MODEL

1.1 The multiregional Input-Output table

1.1.1 The accounting structure

The accounting structure of the multiregional SUT (MRSUT) is made up by two sets of accounts: the uniregional Supply and Use Tables, and a multiregional trade flow matrix.

For each regional SUT two identities provide a link between the use and resources account and that of the formation and destination of industry output, that is:

[1] $\underbrace{\mathbf{q} + \mathbf{mr} + \mathbf{mw}}_{z} \equiv \mathbf{U} \cdot \mathbf{i} + \mathbf{df} \cdot \mathbf{i} + \mathbf{er} + \mathbf{ew}$

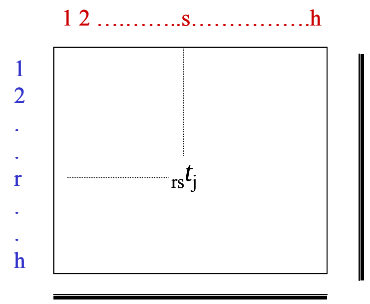
[2] $\mathbf{x} \equiv \mathbf{i'} \cdot \mathbf{U} + \mathbf{i'} \cdot \mathbf{Y}$

where:

U = Use matrix;
df = domestic final demand;
er = interregional export of products;
ew = foreign export of products;
q= product output;
mr= interregional import of products;

mw= foreign import of products;
x = sectoral output;
Y = industry value added matrix.

For each j-th product there is a trade matrix amongst the 20th (NUTS 2) regions:



The multiregional trade matrix T will be made up by the product trade matrices. The sum of the off-diagonal elements by row (export) and column (import) link the matrix **T** flows to the regional SUTs.

At multiregional level the identity [1] becomes:

[3] $\mathbf{q} + \mathbf{i}'\cdot\breve{\mathbf{R}} + \mathbf{mw} \equiv \mathbf{U}\cdot\mathbf{i} + \mathbf{DF}\cdot\mathbf{i} + \breve{\mathbf{R}}\cdot\mathbf{i} + \mathbf{ew}$

where: $\mathbf{R} \equiv \Theta \cdot vec(\mathbf{T})$

The MRSUT is estimated through a GLS[1] estimator as proposed by Stone, Champernowne e Meade (SCM) in Stone *et al.* (1942). The SCM balancing procedure, later developed by Byron (1978), is shown in details in the Appendix 1. The balancing structure of the multiregional table is mainly specified according to four groups of constraints (Appendix 2 for the accounting identities):

i. at regional level, both supply and demand of products and formation and use of output must be consistent;
ii. constraints supplied from regional accounts must be fulfilled;
iii. equality must be achieved between interregional flows of import and export by products at national level;
iv. consistency should also be achieved regarding the national SUT, that is the sum of the regional SUT must be equal to the national one except for interregional trade.

A crucial step in balancing the multiregional table using the SCM method is the availability of unbiased initial estimates, since the presence of bias could hinder the convergence of the balancing procedure or lead to final values of a positive/negative sign opposite to that expected. Far from being a weakness in the methodology, this actually leads us to pay greater attention to this aspect than in other methods of balancing based on the smoothing of data (e.g. rAs, *Cross Entropy*…).[2]

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[1] The main reasons why the SCM has been preferred to other methods has been well summarized by Round J. (2003). The author presents a review of the most utilized balancing methods (about SAM balancing): rAs, Cross Entropy and SCM, and clearly expresses his opinion in conclusion (p. 179, par.3) "... In spite of the apparent preference for the cross-entropy (CE) method by many compilers of SAMs, the Stone Byron method (SCM ed.) (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.". Furthermore we could add that SCM method is very sensitive to the degree of biasness of the initial estimates forcing the analyst to put more attention on those estimates than the other methods do, so it fits with the Round's recommendation on the same article "….It is a far better strategy to concentrate on improving the initial estimates and to use the smoothing techniques only in extremis or as final resort". The methodology that will briefly described in this paragraph resumes some of the constructive features of the previous (Casini Benvenuti, Martellato and Raffaelli 1995) IRPET models, and updates the methodology extensively described in Casini Benvenuti and Paniccià (2003) especially by taking into account the new accounting framework associated with the Supply and Use tables (henceforth SUT) released by the Italian Central Statistical Office (ISTAT) since 2005

[2] To quote Round (2003) again, "…it is a far better strategy to concentrate on improving the initial estimates and to use the smoothing techniques only in extremis or as a final resort."

1.1.2 Multiregional trade flow estimate

We refer to other publications for a more detailed description of the initial estimates used in the model,[3] focusing our attention here on an important component of the multiregional table: the multiregional trade matrix.

Evaluation of the trade flows of goods and services between the regions is one of the most delicate aspects in the construction of I-O regional tables, since it is through these bilateral trade flows between the various regions that the most appropriate **T** matrix for the multiregional transactions per product can be derived. Despite the importance of this phenomenon, the information sources available in Italy are scarce. Particularly relevant for the purposes of our analysis are:[4]

- the sample survey "Commodities Transport by Road", conducted annually 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;[5]
- the sample surveys of the Banca d'Italia on manufacturing and market services enterprises, which for 2009 recorded the nominal turnover "exported" from the region where the enterprise is located to the geographical macro area of destination (based on the NUTS 1 classification).

The advantage of the Istat data is that they detail trade from region to region, rather than from region to geographical area like those of the Banca d'Italia. On the other hand, the latter survey features characteristics which make it preferable to that of Istat for the purpose of constructing a matrix of trade between geographical areas; in effect, the Banca d'Italia survey:

1) also includes trade flows related to the services sector, which clearly could not be comprised in the commodities transport survey;
2) adopts a classification of the economic activities (Ateco) that is consistent with that used to identify the economic sectors in the national and regional accounts, unlike the classification adopted for commodities transport (NST/R);
3) indicates a magnitude (turnover in thousands of Euro at current prices) that is not influenced by the mix of products comprised in each group, unlike that recorded by Istat (tons of goods transported).

Since the interest of the analysis resides in the interdependencies between macro areas, consistent with the dimensions of the Istat regional and national accounts, we decided to use the data from the Banca d'Italia surveys to identify the initial estimates of the matrix of trade flows between areas.[6] This is a

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[3] See, for example, Casini Benvenuti (2000).

[4] Other research institutes produce estimates of interregional trade, that is between one region and all the others, in terms of both export and import. Recently Prometeia has produced estimates of the balances of interregional trade for the period 1995-2005 (Francescon and Guagnini, 2010); however, these flows are not suitable for the analysis of sectoral interdependence, since they do not take into consideration all the potential bilateral flows between regions (multiregional trade).

[5] The commodities are codified using the 24-group NST/R classification, used at international level for statistics on commodity transport; at regional level the data are aggregated in 5 macro-sectors. Starting from the records relating to the year 2006 Istat has progressed to a pattern of measurement based on vehicle journeys, from which the commodity itineraries are obtained as derivatives; while on the one hand this method ensures a higher degree of accuracy regarding information on the kilometres travelled by the commodities, on the other it also entails a discontinuity in relation to the statistics referring to previous years. The last data published refer to the years 2006 and 2007. For further information, see the Istat note available at: http://www.istat.it/salastampa/comunicati/non_calendario/20100402_00/noteinfo.pdf. We should like to thank Donatella Berna of Istat for her valuable cooperation.

[6] There proved to be quite a high correlation of the trade flows between geographical areas emerging from the two surveys. To carry out this analysis it was first necessary to reconcile the Ateco 2002 and NST/R classifications. This reconciliation was possible only for the manufacturing sector, at a very aggregate level and introducing a number of approximations. The macro-sectors prevalently common to the two classifications proved to be the following:

- Food products, beverages and tobacco products (Ateco 2002 subsection: DA);
- Textiles, apparel, leather and footwear, wood, manufacture of paper pulp and "other manufacturing industries"

unique and exclusive database, which for 2009 for the first time collected, inter alia, information on the turnover of 1,706 manufacturing enterprises and 697 service enterprises with at least 50 employees; the majority of these enterprises (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 in question.[7]

For the estimate of the trade flows between geographical macro areas, countries or divisions of the same, the class of gravity models is frequently used, although this is not to say that they are not without their limitations or critics.[8] In the case in question, the gravity masses are represented by the output of one macro area and the demand of another, while the distance between the same is approximated by a decay, or deterrence, function. The gravity model is defined as:

[4] $\quad {}_{rs}t_j = ({}_{r\bullet}t_j \bullet {}_{\bullet s}t_j)/t_j \bullet {}_{rs}\delta_j$

where ${}_{rs}t_j$ is the flow of sector j products that go from the macro area of origin r to that of destination s, ${}_{r\bullet}t_j$ is the total sector j production (net of foreign exports) in the macro area of origin r, ${}_{\bullet s}t_j$ is the total internal demand (net of imports from abroad) for sector j of the destination macro area s, t_j is a scale factor (total production net of sector j foreign exports) and ${}_{rs}\delta_j$ is an appropriate deterrence function.

The specification of the deterrence function proves to be crucial to the estimate of the gravity model. In the case of trade flows this function represents the "transaction costs" between the two macro areas in a broad sense, without which the origin and destination flows would be independent: in conditions of equilibrium, the net overall production of a certain area and of a certain sector would thus be divided between the areas in proportion to the net overall demand of each of them. With a view to isolating the effect of the "transaction costs" thus defined we can use the variable:

[5] $\quad {}_{rs}\delta'_j = {}_{rs}m_j/({}_{r\bullet}m_j \bullet {}_{\bullet s}m_j/m_j)$

where ${}_{rs}m_j$ is the value of the goods/services belonging to sector j sold by the macro area of origin r to that of destination s as emerging from the sample surveys of the Banca d'Italia, while the product of the marginal distributions $({}_{r\bullet}m_j \bullet {}_{\bullet s}m_j/m_j)$ represents the value of the theoretical flow of goods/services that there would be without the "transaction costs" between the two macro areas. By definition, the variable ${}_{rs}\delta'_j$ 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 ${}_{rs}\delta'_j$ can therefore be used as a dependent in a model that comprises among the regressors all the factors that influence the "transaction costs" and, through these, the trade flows between geographical areas.

Principal among these factors is distance, the increase in which is generally proportionate to the expense of trading the commodities. This distance, in turn, is in effect greater or lesser depending on the extension of the network of links and the provision of infrastructures within the territory; for this

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(subsections: DB, DC, DD, DE, DN);

- Coke, refined petroleum products, nuclear fuels (subsection: DF);
- Chemical, rubber and plastic products (subsections: DG, DH);
- Non-metallic mineral products (subsection: DI);
- Metallurgy and metal products (subsection: DJ);
- Extended mechanics (subsections: DK, DM, DN).

The correlation coefficient between the quantities of the goods transported between macro areas (expressed in tons) and the value of turnover sold to the macro areas (in thousands of current Euros) proved to be comprised between 0.73 and 0.90 for all the macro-sectors, with the sole exception of that of refined petroleum products (–0,09); this result is justified by the fact that the transport of this type of product takes place by road only to a minimal degree, with other means of transport (oil pipelines, ships) being much more typically utilised.

[7] For further information on the distribution of the enterprises recorded, the sampling method used and the quality controls adopted for the data, see the Supplemento al Bollettino statistico della Banca d'Italia no. 38 dated 28 July 2010, available on: http://www.bancaditalia.it/statistiche/indcamp/indimpser/boll_stat/sb38_10/suppl_38_10.pdf.

[8] For a review of the literature, see for example Paarve R. (2008); apropos criticism of the use of these models, see Baldwin and Taglioni (2006), Egger (2000) and Porojan (2001).

reason, reference is made to the journey times of road transport, and in particular those of lorries, rather than to distances in kilometres.[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 economic development within the area could render the demand for goods and services originating from other areas less significant. 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 goods and services between geographical areas is the presence, in one of them, of manufacturing facilities belonging to an enterprise that has its administrative premises in the other area. 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 (Hewings and Munroe, 1999). In order to take this phenomenon into consideration, we have again made recourse to the surveys of the Banca d'Italia, which for some years now have recorded the distribution by geographical macro area of the employees of all the enterprises in the sample with at least 50 employees. The assumption is that, the greater the number of employees of an enterprise with administrative headquarters in one area that work in another area, the more intensive and frequent the trade between the two areas of products not connected with the local demand will be.

The nature 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 (Casini Benvenuti and Paniccià, 2003), and in order to take this into account it is important to have at disposal sector data that are as disaggregated as possible. In the analysis we have made reference in particular to the subsections of the Ateco 2002 classification (cf. Appendix 3). The tradability effect is, moreover, connected with that of geographical distance: larger distances between areas expand the impact of the cost of transport of the commodities.

The regression model used, which sets the "transaction costs" between two macro areas (approximated by the variable ${}_{rs}\delta'_j$ defined above) in relation to the principal factors influencing trade between them, is of a multiplicative type.[10] In log-log form, this can be expressed as:

[6] $\log({}_{rs}\delta'_j)=a+b\bullet\log({}_{rs}DIST)+c\bullet\log({}_{r}GDPP/{}_{s}GDPP)+d\bullet\log({}_{rs}NADD_j)+e\bullet\log({}_{rs}SETDIST_j)+\varepsilon$

where:

- ${}_{rs}DIST$ is the reciprocal of the distance (closeness) between the macro area of origin r and that of destination s, measured on the basis of the road journey time of the trade vehicles;
- ${}_{r}GDPP$ and ${}_{s}GDPP$ are the average per capita GDPs (1995-2006) of the origin and destination macro areas. The relation between the two variables, used in the analysis, provides a relative measurement of the economic importance of the two areas: if the ratio is greater than 1 the impact of macro area r is greater than that of macro area s, the opposite if the ratio is less than 1;
- ${}_{rs}NADD_j$ is, for every j sector, the average number of employees (1995-2006) belonging to industrial enterprises with administrative HQs in macro area r that are permanently employed in production units located in macro area s;
- ${}_{rs}SETDIST_j$ is an 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 ${}_{rs}DIST$ and a sector dummy, which ought to (at least partially) take in the tradability effect.

[9] The consideration of the journey time of the lorries rather than that of the kilometres travelled provides more precise indications about the effective distance between two areas, in that it implicitly takes into account the "physical stock" of the available transportation infrastructures, the speed and the actual functioning of the connections (Messina, 2007). The journey times used refer to 2008; the data, available at provincial level, have been aggregated by region and/or macro area via simple averages.

[10] This implies that the contribution of the original (not transformed) variables is of an exponential rather than linear kind.

The estimates were performed separately for manufacturing sectors[11] and for the services sector,[12] because the modes and "transaction costs" associated with the trade of commodities can be very different from those of services

Records in which r=s, namely relating to trade within the same region, have been eliminated from the database so that only interregional trade flows are considered. The estimates were performed using the OLS method and are robust for heteroscedasticity and for the clustering effect for pairs of macro areas.[13] The results of the estimates are illustrated in Table 1.[14]

Table 1 – *Results of the estimates of the deterrence function*
dependent variable: actual/theoretical trade ratio ($_{rs}\delta'_j$)

Regressors (in log)	Manufacturing industry	Services Sector
Distance reciprocal ("closeness")	0.268437 *	0.600327 **
Per capita GDP ratio	-0.090194	0.415392 ***
Number of "intra-industry employees"	0.115050 ***	
Interaction dummies:		
dist.recip.*DB	-0.010306	
dist.recip.*DC	-0.176002	
dist.recip.*DD	-0.133252	
dist.recip.*DE	0.043095	
dist.recip.*DF	0.578275	
dist.recip.*DG	0.193916 *	
dist.recip.*DH	-0.127741	
dist.recip.*DI	0.094702 *	
dist.recip.*DJ	0.034911	
dist.recip.*DK	0.051716	
dist.recip.*DL	0.182701 **	
dist.recip.*DM	0.094904	
dist.recip.*DN	-0.096694	
dist.recip.*H		-0.041849
dist.recip.*I		-0.175760
dist.recip.*K(1)		-0.222338
Constant	-0.254120	-0.350288
N	157	48
R^2	0.294	0.281

*legend: * prob. < 0.050; ** prob. < 0.010; *** prob. < 0.001*

(1) Real estate and rental activities excluded.

Source: Authors calculations on Banca d'Italia and Istat data.

From examination of the table we can note that for both manufacturing and services the "closeness" between two areas has a significant effect on trade, and with the expected sign: the closer the areas the more intensive the trade. The interaction dummies between the reciprocal of the distance and the type of product prove mostly to be insignificant, with the exception of the sectors of chemical, and non-

[11] More specifically, the Ateco 2002 subsections from DA to DN (manufacturing industry) have been considered in the analysis, for a total of 15 sectors of activity; the data relating to the mining (sections CA and CB) and energy sectors (section E), despite being recorded in the Banca d'Italia survey, were not included in the gravity model since they feature peculiar characteristics in terms of both localisation of the activity and modes of transport of the products (cf. also note 17 below).

[12] Sectors G, H, I, K are recorded in the Banca d'Italia survey (non-financial private services); in the analysis, real estate and rental activities were excluded from sector K in view of the intrinsic characteristics that render them inappropriate for transfer between geographical areas.

[13] STATA® robust and cluster options.

[14] OLS estimates were also carried out on models different from those selected, with a view to testing their "robustness". For example, excluding from manufacture the sector DF (coke, refined petroleum products, nuclear fuels) which could have different characteristics from the other sectors in terms of transport, and including the sector of real estate and rental activities in the services; or again by also inserting the simple sector dummies (that is not interacted with distance) or only the latter; finally, considering the manufacturing industry and the services sector together. The results of these control estimates – which the authors have at their disposal and can furnish to those who are interested – confirm the preferences for the chosen models. Improvements in the estimates could be made by having available more than one sample record on the turnover for exports to other areas and/or by having greater geographical details about the flows (e.g. at regional level rather than for macro areas).

metal mineral products and electrical appliances, for which the overall effect of the "closeness" between the areas proves to be even stronger.[15]

For manufacturing in particular, as to be expected, a major stimulus to the increase in trade flows is generated by intra-industrial connections between the two areas under consideration: the stronger these links are, the greater the flows of traded products. On the other hand, we have the apparently surprising fact that the relative dimensions of the area economies (the ratio of the per capita GDPs) do not have significant effects on trade. This could depend on the fact that part of the effect of the economic impact of the area relies, for manufacture, on the intra-industrial relations, which effect is estimated separately.

In the services sector, instead, in the absence of information about the links between enterprises belonging to different macro areas, the effect of the relative economic weight is significant: the greater the size (in economic terms) of the area in which the services are generated in comparison to that of destination, the greater the flow of non-financial private services to the latter area. On the other hand, the tradability effect is not significant: the different nature of the services (hotels and restaurant, transport, commerce etc.), associated with the distance between the areas, does not influence the volume of the trade flows.

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 have generated a "weakening" of the distance effect which, although it still remains the most important factor, nevertheless reveals a more modest impact.[16]

Moving on to the original multiplication model, we obtain the predicted values of the deterrence function:

[7.*i*] $\quad {}_{rs}\delta_j^* = a \bullet ({}_{rs}\mathrm{DIST})^{b} \bullet ({}_{r}\mathrm{GDPP}/{}_{s}\mathrm{GDPP})^{c} \bullet ({}_{rs}\mathrm{NADD}_j)^{d} \bullet ({}_{rs}\mathrm{SETDIST}_j)^{e}$ (manufacture)

[7.*ii*] $\quad {}_{rs}\delta_j^* = a' \bullet ({}_{rs}\mathrm{DIST})^{b'} \bullet ({}_{r}\mathrm{GDPP}/{}_{s}\mathrm{GDPP})^{c'} \bullet ({}_{rs}\mathrm{SETDIST}_j)^{e'}$ (non-financial private services)

The ${}_{rs}\delta_j^*$ values thus estimated can be substituted for the ${}_{rs}\delta_j$ in the gravity equation [4], so as to derive the ${}_{rs}t_j^*$ estimates, elements of the initial estimate $\mathbf{T}(0)$ of the matrix of the trade transactions by sector[17] between macro areas.[18]

1.2 The structural model and its reduced form

Once estimated the MRSUT for the 20th Italian regions (NUTS 2) it is possible to proceed toward a four macro areas aggregation (NUTS 1). Starting from this table the next step has been the transformation of the MRSUT in a symmetric MRIO table industry by industry according the *industry technology*[19].

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[15] Significance tests on the sum of the coefficients of the interaction dummies and that of the distance reciprocal indicate that for several sectors (e.g. non-metal minerals, chemical products, mechanical and electrical devices) the distance is decisive for the intensity of trade flow between the areas; for other sectors (e.g. fashion system, wood, rubber and plastic, not otherwise classified manufacturing products) this factor is less important.

[16] In the estimates for Italy recorded in Ghezzi *et al.* (2009) on data at regional level and with a definition of distance based on kilometres, the distance reciprocal coefficient (in log) proves for example to be 0.87. Studies carried out on the trade flows between the U.S.A. and Canada yield similar values (0.82, cf. Anderson and van Wincoop, 2003) or greater than 1 (Wall, 2000).

[17] The same coefficients estimated for manufacture were applied to the mining sector. For the initial estimates of trade in the energy sector the Terna data were used (www.terna.it/default/Home/SISTEMA_ELETTRICO/statistiche.aspx). As regards the flows of financial services between areas, the regional data relating to the entity of cash loans reported to the Central Credit Register were used (source: Banca d'Italia) with reference to 31/12/2006, which make it possible to identify the loans made at bank branches located in one area to borrowers resident in another. For the remaining services (public sector, education, health etc.) reference has been made to the Istat REAs.

[18] The balancing process described in Appendices 1 and 2 also takes in the variance of the econometric estimate.

[19] We intentionally skip the debate on the technology representation (industry-product), debate that we have in mind but which is not the focus of our paper.

The MRIO model related to the above table is based on two main causal relations::

- a leontevian technical relation, which determines the regional demand of intermediaries product and then, with the exogenous final demand, the total demand of each macro region;
- an allocative relation (multiregional trade *pattern*), which determines the macro regional output by distributing across the regions the total interregional demand.

In a system without foreign trade it is possible to formalize the above relations in the following way

[8.*i*] $\mathbf{d} = \mathbf{A} \cdot \mathbf{x} + \mathbf{df}$

[8.*ii*] $\mathbf{x} = \mathbf{T} \cdot \mathbf{d}$

where **d** is the total demand of the system (final and intermediate). In the [8.*i*] the relation between the activation of the productive process and the demand of intermediate goods and services is quantified by the technical coefficient matrix **A**; regarding the [8.*ii*] the allocation pattern is represented by the matrix of the multiregional trade coefficients **T**[20].

The model assumes competitive interregional import with regional output and foreign import.

Hereafter the structural form:

[9.*i*] $\mathbf{x} + \mathbf{s_x} + \mathbf{mw} + \mathbf{mr} \equiv \mathbf{di} + \mathbf{df} + \mathbf{ew} + \mathbf{er}$

[9.*ii*] $\mathbf{di} = \mathbf{A} \cdot \mathbf{x}$

[9.*iii*] $\mathbf{df}_{pa} \equiv \mathbf{c} + \mathbf{ifl} + \mathbf{g} + \mathbf{div}$

[9.*iv*] $\mathbf{df} = \mathbf{df}_{pa} \cdot (\mathbf{I} - \mathbf{S_d}) \cdot \mathbf{L}_{df}$

[9.*v*] $\mathbf{ew} = \mathbf{ew}_{pa} \cdot (\mathbf{I} - \mathbf{S}_{ew}) \cdot \mathbf{L}_{ew}$

[9.*vi*] $\mathbf{s_x} = \mathbf{S_x} \cdot \mathbf{A} \cdot \mathbf{x}$

[9.*vii*] $\mathbf{mw} = \hat{\mathbf{M}} \cdot (\mathbf{A} \cdot \mathbf{x} + \mathbf{df})$

[9.*viii*] $\mathbf{mr} = \widehat{\mathbf{B}} \cdot (\mathbf{I} - \hat{\mathbf{M}}) \cdot [(\mathbf{A} \cdot \mathbf{x} + \mathbf{df})]$

[9.*ix*] $\mathbf{er} = \breve{\mathbf{B}} \cdot (\mathbf{I} - \hat{\mathbf{M}}) \cdot [(\mathbf{A} \cdot \mathbf{x} + \mathbf{df})]$

where: **x** = output at basic prices; **di** = intermediate demand at basic prices; $\mathbf{s_x}$ = net taxes on intermediary products; **mw** = foreign import (fob); **mr** = interregional import; **df** = domestic final demand at basic prices; $\mathbf{df}_{pa}$ = domestic final demand at purchasing prices ; **ew** = foreign export (fob) at basic prices; $\mathbf{ew}_{pa}$ = foreign export (fob) at purchasing prices; **er** = interregional export; **c** = household expenditure; **g** = government and NPISHs expenditure; **ifl** = gross fixed investment; **div** = changes in inventories; **A** = intermediate input coefficients; $\mathbf{L}_{df}$ **,** $\mathbf{L}_{ew}$ = matrices of allocation of trade and transport margins; $\mathbf{S_x}$ = net product taxes on intermediary products coefficients; $\mathbf{S_d}$ = net product taxes on domestic final demand coefficients ; $\mathbf{S}_{ew}$ = net product taxes on foreign export coefficients; **M** = foreign import coefficients; $\widehat{\mathbf{B}}$, $\breve{\mathbf{B}}$ = Interregional import-export coefficients from the transformation of the multi-regional trade flows coefficients matrix **T**. In particular:

[10] $\mathbf{T} = \mathbf{I} - \hat{\mathbf{B}} + \breve{\mathbf{B}}$

In equation [11] the reduced form of the model [9]:

[20] This is a typical Chenery(1953)-Moses (1955) class of models, in between the pool approach (Leontief et al. 1977) and the pure interregional model (Isard 1960). In the model we assume competitive interregional import with regional output and foreign import..

[11] $$\mathbf{x} = \left[\underbrace{(\mathbf{I}+\mathbf{S_x}) - \underbrace{\mathbf{T}\cdot(\mathbf{I}-\hat{\mathbf{M}})}_{\mathbf{R}}\cdot \mathbf{A}}_{\mathbf{INV}} \right]^{-1} \cdot \left[\underbrace{\mathbf{T}\cdot(\mathbf{I}-\hat{\mathbf{M}})}_{\mathbf{R}}\cdot \underbrace{\mathbf{df}_{pa}\cdot(\mathbf{I}-\mathbf{S_d})\cdot \mathbf{L}_{df}}_{\mathbf{df}} + \underbrace{\mathbf{ew}_{pa}\cdot(\mathbf{I}-\mathbf{S_{ew}})\cdot \mathbf{L}_{ew}}_{\mathbf{ew}} \right]$$

which could written as:

[12] $\mathbf{x} = \mathbf{INV}\cdot(\mathbf{R}\cdot\mathbf{df} + \mathbf{ew})$

The equation [12] constitutes the starting point for the computation of the multipliers of domestic final demand, final production and value added at purchasing prices which will be utilised later on the paper and analyzed more in detail in Appendix 4.

2. ANALYSIS OF THE STRUCTURAL CHARACTERISTICS OF THE PRODUCTION SYSTEM

A classic utilisation of the tables and of the MRIO model consists of an analysis of the interdependencies between the different areas. These relations represent the essence of any multiregional pattern since they contribute to determining the capacity of each macro area to "internalise" the multiplier effects of the domestic final demand, which remains partly exogenous in the model, and of external final demand. Consequently, through the multiregional model we can evaluate the exposure of the economy to the national and international cycle: two different but significant aspects for the growth of each region (Costa and Martellato, 1990).

The analysis of the characteristics of the Italian production system through the interdependencies between the four geographic macro areas (or NUTS-1 macro regions) into which the country is typically divided will be developed through three different approaches: the first, more aggregate, will concentrate on the analysis of the trade balances; the second will analyse in detail the flow of goods and services traded between the macro areas; finally, the third approach will be based on the analysis of the multipliers, with models at current prices, in order to identify the direct sectoral connections of spill lover and feedback characterising a multiregional system.

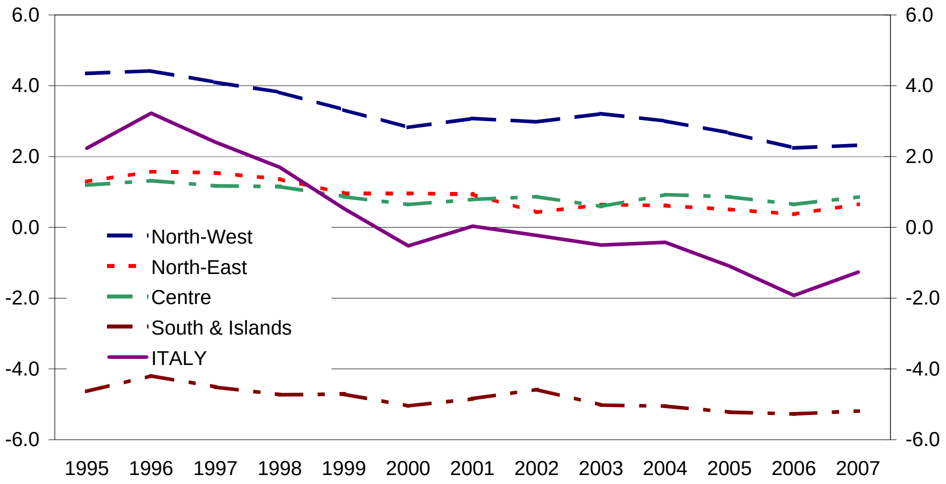
2.1 The trade balances

To focus some of the structural characteristics of the different areas of the country, we can start by taking a look at the trade balances. Figure 1 shows the data available in the Istat Regional Economic Accounts (REAs) for the period 1995-2007.[21]

The data demonstrate, firstly, the deterioration of the national foreign trade balance, which became permanently negative from 2002. From examination of the overall balances (interregional and foreign) of the single macro areas, it emerges that the South is the only area characterised by a trade deficit, falling slightly in the period under consideration (from –4.6 per cent of the national GDP in 1995 to –5.2 in 2007). The trade surpluses of the Centre and North East remain stationary at around 1 per cent of the national GDP, while that of the North West drops considerably, nonetheless remaining at levels higher than 2 per cent of the national GDP.

[21] The values of the net national exports differ from those published by Istat since, consistently with the REAs – and unlike the national accounts published by the same Institute – the expenditure of non-residents within the macro region and of residents abroad and/or in other macro regions have been excluded from the interregional and foreign imports and exports. The REAs data refer to the Istat publications of November 2009.

Figure 1 – *Ratio of net total exports to national GDP, 1995-2007*



Source: Authors calculations on Istat data

The multiregional tables referring to 1995, 2001 and 2006 make it possible to break down the above balances, not only in relation to the interregional and foreign characteristics, but also by area of origin/destination. Table 2, read by column, summarises this information, proposing the net balances as percentage of the GDP of the macro region of destination. For example, in 2006 the North-West recorded positive net exports in relation to the North-East amounting to 2.6 per cent of its GDP, while for the North-East this balance obviously recorded an opposite sign, representing 3.6 per cent of the GDP of the macro region.

Table 2 – *Net interregional and foreign exports as percentages of the GDP of the destination macro area*

		Area of destination								
	Area of origin	North-West		North-East		Centre		South & Islands		ITALY
1995	North-West			-4.3	(-4.3)	0.4	(-1.7)	-4.8	(-4.9)	
	North-East	2.9	(3.0)			0.5	(-0.5)	-2.8	(-2.8)	
	Centre	-0.3	(1.1)	-0.5	(0.5)			-4.7	(-4.6)	
	South & Islands	3.5	(3.6)	3.0	(3.0)	5.4	(5.3)			
	Total Areas	6.1	(7.7)	-1.8	(-0.8)	6.3	(3.1)	-12.3	(-12.3)	
	Rest of the World	7.2		7.6		-0.6		-7.0		2.2
2001	North-West			-3.7	(-3.8)	0.4	(-1.3)	-4.1	(-4.2)	
	North-East	2.6	(2.6)			0.7	(-0.3)	-2.9	(-3.0)	
	Centre	-0.3	(0.8)	-0.6	(0.2)			-4.1	(-4.0)	
	South & Islands	3.1	(3.2)	3.2	(3.2)	4.7	(4.6)			
	Total Areas	5.4	(6.6)	-1.1	(-0.4)	5.8	(3.0)	-11.1	(-11.2)	
	Rest of the World	4.2		5.4		-1.9		-8.8		0.0
2006	North-West			-3.6	(-3.5)	0.7	(-1.1)	-3.5	(-3.4)	
	North-East	2.6	(2.5)			0.9	(-0.4)	-2.3	(-2.3)	
	Centre	-0.5	(0.8)	-0.9	(0.4)			-4.5	(-3.5)	
	South & Islands	2.6	(2.5)	2.5	(2.4)	5.0	(3.9)			
	Total Areas	4.7	(5.8)	-2.0	(-0.7)	6.6	(2.4)	-10.3	(-9.2)	
	Rest of the World	2.4		3.7		-3.5		-11.6		-1.9

Source: Authors calculation on Istat and MRIO-IRPET data
Note: in brackets the net balances of interregional flows excluding collective consumption services (CCS)

Examination of the table 2 confirms the deterioration in the balance of the net national exports, which dropped from 2.2 per cent in 1995 to –1.9 in 2006, which is the result of a weakening of the balance of trade that affected all the macro regions. Among them, the North-East consolidates its position as the macro region with a relative foreign trade balance better than the others.

As regards interregional trade, the South confirms its negative balance position in relation to all the other macro regions. In the three years taken into consideration, this position has been attenuated by around two percentage points on the area GDP. The negative value of the net exports from the South illustrates a significant relationship of dependency between the South and the rest of the country which persists even in the 2000 years. It should also be noted that we have to add to this dependency a value of net imports from abroad that has undergone a marked increase in the twelve years under consideration.

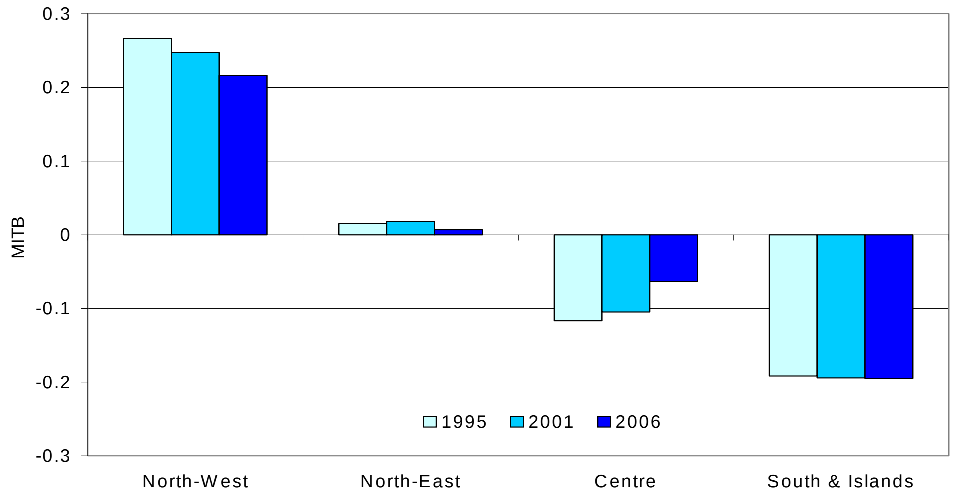
Netting the interregional flows of collective consumption services (CCS, cf. Appendix 5) we obtain the values shown in brackets in Table 2. In this case too, the North-West regions confirm a markedly greater activity than the other macro areas. In the three years examined, there is a very slight attenuation of the liability situation of the North-East towards the North-West and of its assets situation in relation to the South. The latter area continues to be distinctly dependent on the others, even considering trade net of the CCS flows, although the attenuation of the phenomenon over time proves to be more distinct (around 3 percentage points).

The macro area of the Centre needs to be dealt with separately, in view of the presence of the Lazio region which is characterised by a major interregional surplus of CCS. If we eliminate these data from the multiregional flows, the balances change significantly: the trade balance of the Centre drops in relation to the rest of the country by about 4-5 percentage points of the GDP passing from net exporter to importer in relation to the North.

From the examination of the accounts we can then move on to an ex ante analysis of the trade balances between the macro areas using the marginal interregional trade balance (MITB) introduced by Costa and Martellato (1987). This index proves to be particularly useful in that it makes it possible to estimate the triggering of interregional deficits/surpluses in the different economic systems in response to an impulse of the internal final demand of the area that simultaneously involves all the areas; this takes on positive values in the case of an impact on interregional exports greater than that on imports, and negative in the opposite case.[22]

Figure 2 shows, for the four macro areas of the country taken into consideration, the MITBs for the entire economic system net of the interregional CCS flows.

Figure 2 – *Marginal interregional trade balance (MITB) per macro area*



Source: Authors calculations on Istat and MRIO-IRPET data
Note: balances net of interregional flows of collective consumption services(CCS)

We can observe that a unitary increase in the internal final demand of each macro area triggered in the South a multiplier effect on exports to the other macro areas lower than the multiplier effect of the

[22] The MITB of the r-th region is defined by the following ratio:

$$\text{MITB}_r = \frac{\left(\sum_k \alpha_{rk} - \sum_k \alpha_{kr}\right)}{\alpha_{rr}} \text{ per } k \neq r,$$

where: α_{kr} = multiplier of the imports from k to r; α_{rk} = multiplier of the exports from r to k; α_{rr} = multiplier of internal production.

imports from the same macro areas, determining a negative MITB (amounting to around –0.19) in all three years considered; the trigger is negative in the Central regions too, albeit in progressive improvement (from –0.12 in 1995 to –0.06 in 2006). On the contrary, the same impulse triggered in the North-West a multiplier effect of interregional exports greater than that of the imports from the other macro regions, generating a MITB that was positive, albeit progressively weaker (from 0.27 in 1995 to 0.22 in 2006). Finally, the North-East registered a practically zero MITB, indicating the substantial equivalence between the multiplier effects of exports and imports between the macro areas, in response to a common stimulus of the internal final demand.

As already mentioned (cf. note 21) the uses and resources accounts of the individual regions are published by Istat in a different format from that of the corresponding national accounts. While in the regional economic accounts only the domestic final expenditure of households is recorded, in the national accounts the national final expenditure is entered. This results in an allocation of the expenditure flows of residents abroad to import of services, while consumption includes only the expenditure of residents in the national territory. The balancing with the GDP is obtained by allocating the expenditure of the non-residents within the national territory to export of services. Using the IRPET estimates of the interregional expenditure flows of resident families[23] and the Banca d'Italia data regarding the foreign expenditure of the non-residents[24] it was possible to modify the trade balances of Table 2 and render them consistent with those published by Istat for the national economic accounts (Table 3).

Table 3 – *Net interregional and foreign exports (net of CCS flows) including the balances of expenditure of resident and non-resident families, as percentage of GDP of the destination macro area*

		Area of destination									
	Area of origin	North-West		North-East		Centre		South & Islands		ITALY	
1995	North-West			-3.5	(-4.3)	-0.9	(-1.7)	-4.3	(-4.9)		
	North-East	2.4	(3.0)			-0.4	(-0.5)	-2.6	(-2.8)		
	Centre	0.6	(1.1)	0.4	(0.5)			-4.6	(-4.6)		
	South & Islands	3.2	(3.6)	2.8	(3.0)	5.2	(5.3)				
	Total Areas	6.2	(7.7)	-0.3	(-0.8)	3.9	(3.1)	-11.5	(-12.3)		
	Rest of the World	7.8	(7.2)	10.8	(7.6)	2.0	(-0.6)	-6.5	(-7.0)	3.8	(2.2)
2001	North-West			-3.2	(-3.8)	-1.0	(-1.3)	-3.8	(-4.2)		
	North-East	2.2	(2.6)			-0.2	(-0.3)	-2.8	(-3.0)		
	Centre	0.6	(0.8)	0.2	(0.2)			-3.9	(-4.0)		
	South & Islands	2.8	(3.2)	3.0	(3.2)	4.5	(4.6)				
	Total Areas	5.6	(6.6)	0.0	(-0.4)	3.3	(3.0)	-10.5	(-11.2)		
	Rest of the World	4.6	(4.2)	7.8	(5.4)	0.5	(-1.9)	-8.2	(-8.8)	1.4	(0.0)
2006	North-West			-2.9	(-3.5)	-0.8	(-1.1)	-2.8	(-3.4)		
	North-East	2.0	(2.5)			-0.5	(-0.4)	-2.0	(-2.3)		
	Centre	0.5	(0.8)	0.4	(0.4)			-3.3	(-3.5)		
	South & Islands	2.1	(2.5)	2.1	(2.4)	3.6	(3.9)				
	Total Areas	4.6	(5.8)	-0.4	(-0.7)	2.3	(2.4)	-8.1	(-9.2)		
	Rest of the World	2.8	(2.4)	5.4	(3.7)	-1.4	(-3.5)	-11.0	(-11.6)	-0.8	(-1.9)

Source: Authors calculations on Istat, UIC and MRIO-IRPET data

We can note that, with the introduction of this new definition of the final expenditure of households, we obtain, especially for the macro regions with a more marked tourist vocation, balances different from those recorded in Table 2 (repeated for convenience in brackets). We can also note an improvement in the foreign balances for all the macro regions, which is obviously reflected at national level (in 2006 the balance went from –1.9 to –0.8 per cent).

As regards interregional trade, in 2006 the balances of the South improved in relation to all the other macro regions; the new classification has a positive impact on the Centre and the North-East, while it results in a deterioration of the balances of the North-West in relation to the other areas.

[23] See Falocci, Paniccià and Stanghellini (2009).

[24] These are data collected through the Italian international tourism survey "Turismo internazionale dell'Italia" (http://www.bancaditalia.it/statistiche/rapp_estero/altre_stat/turismo-int).

2.2 Analysis of the spatial activation process

The trade balances examined so far do not provide details on the direction and intensity of the activation processes generated by the domestic and external final demand (interregional and foreign) of the macro regions. These processes are fundamental to understand the relations of interdependence between the various areas, and between these and abroad. We need to explore in greater depth the analysis of the structural characteristics of a system, since these have an impact on the speed and intensity with which a shock generated in one area and one sector of the system spreads to the rest of the economy. The domestic final demand multipliers derived from the MRIO tables are an efficacious instrument of analysis for this purpose.

Initial indications regarding regional interdependence can be deduced from the spatial distribution of the production triggered by an increase of 100 Euro of internal final demand in each macro region.

Table 4, which illustrates these multipliers, shows for example that an increase of 100 Euro of domestic final demand in 2006 in the North-West triggered a production of 113.8 Euro in the area itself, of 13.4 in the North-East, of 10.9 in the Centre and of 10.3 in the South. Consequently, for the country as a whole, the production triggered by the increase amounted to 148.3 Euro, in addition to 23.5 Euro of imports from abroad. In the South the same 100 Euro triggered a production in the area itself of 96.9 Euro and total imports of 72 Euro, including around 52 originating from the Centre-North.

Table 4 – *Multipliers of 100 Euro of domestic final demand at purchasing prices*

	Standard				Normalised			
	North-West	North-East	Centre	South & Islands	North-West	North-East	Centre	South & Islands
North-West	106.9	24.5	21.7	22.0	65.1	14.9	13.1	13.4
North-East	15.3	96.6	18.6	16.4	9.3	58.7	11.3	10.0
Centre	11.2	13.7	92.7	17.3	6.8	8.4	56.1	10.5
South & Islands	10.1	10.5	13.7	92.5	6.1	6.4	8.3	56.3
ITALY	144.8	146.1	147.1	148.6	87.4	88.4	88.8	90.2
Rest of the World	20.6	19.2	18.4	16.1	12.6	11.6	11.2	9.8
North-West	109.9	21.9	20.7	21.7	64.6	13.1	12.1	12.7
North-East	14.6	99.5	17.6	15.9	8.6	59.3	10.3	9.4
Centre	11.6	13.8	97.0	17.4	6.8	8.2	56.9	10.2
South & Islands	10.9	10.5	14.8	96.8	6.4	6.3	8.7	56.9
ITALY	147.3	146.1	150.5	152.1	86.4	86.9	88.0	89.2
Rest of the World	23.1	22.0	20.5	18.3	13.6	13.1	12.0	10.8
North-West	113.8	20.5	18.5	20.2	66.2	12.1	10.9	11.9
North-East	13.4	102.4	15.4	14.3	7.8	60.8	9.1	8.5
Centre	10.9	12.6	101.1	17.3	6.3	7.5	59.4	10.3
South & Islands	10.3	9.4	13.2	96.9	6.0	5.6	7.8	57.4
ITALY	148.3	144.9	148.3	148.7	86.3	86.0	87.1	88.0
Rest of the World	23.5	23.6	22.0	20.2	13.7	14.0	12.9	12.0

Source: Authors calculation on MRIO-IRPET data

Moreover, with a view to attenuating the industry mix effect on the values of the aggregate multipliers, normalised multipliers were constructed by setting as 100 the sum of production and imports from abroad generated by an increase in the domestic final demand of each area. From the examination of these indicators, we can confirm that the North-West is the area with the most elevated capacity for activating output within itself (so-called integration capacity): in 2006 almost two-thirds of the multiplier effect of the demand remained in the regions of the North-West. On the contrary, the creation of spill over effects by the South for the other areas of the country is relatively stronger: over 30 per cent of the multiplier effect of the demand within the area was in fact "dispersed" in the regions of the Centre-North.

The normalised multipliers also indicate that the direct and indirect requirement for imports from abroad has grown over time in all the macro regions, especially in the North-East and in the South; the lower incidence of this phenomenon in the latter area depends on the fact that the majority of the resources necessary to fill the gap between domestic demand and production come from the other areas.

These characteristics prove to be even more accentuated if we consider only the manufacturing sector. From the examination of the normalised balances shown in Table 5 we can note, more specifically, that in relation to an increase in the domestic final demand in each area the requirement of input imported from abroad is more significant, and that the growth of this requirement over time was in general more clear-cut; associated with this is a lesser capacity for triggering the overall production of the country, which appears to decrease over time.

Table 5 – *Multipliers of 100 Euro of domestic final demand at purchasing prices, manufacturing industry*

	Standard				Normalised			
	North-West	North-East	Centre	South & Islands	North-West	North-East	Centre	South & Islands
North-West	90.0	40.7	37.0	38.8	49.5	22.5	20.9	21.1
North-East	25.7	71.9	31.6	30.5	14.1	39.7	17.8	16.6
Centre	16.6	20.0	60.8	23.1	9.1	11.0	34.3	12.6
South & Islands	14.4	16.2	16.6	63.1	7.9	8.9	9.4	34.3
ITALY	142.7	146.2	143.9	150.3	80.7	82.2	82.4	84.5
Rest of the World	35.1	32.3	31.1	28.5	19.3	17.8	17.6	15.5
North-West	88.5	35.5	33.4	37.5	49.0	19.8	18.9	20.1
North-East	23.2	69.9	29.6	29.9	12.9	39.1	16.7	16.1
Centre	15.7	18.6	63.0	23.3	8.7	10.4	35.5	12.5
South & Islands	13.9	16.7	17.1	64.8	7.7	9.3	9.6	34.8
ITALY	137.3	137.5	141.9	151.0	78.3	78.6	80.7	83.5
Rest of the World	39.2	38.2	34.2	30.8	21.7	21.4	19.3	16.5
North-West	91.1	30.8	31.8	34.7	50.7	17.9	18.2	19.3
North-East	21.5	71.0	26.7	26.8	12.0	41.1	15.2	14.9
Centre	15.0	16.4	63.8	22.6	8.3	9.5	36.4	12.5
South & Islands	13.1	13.0	15.8	61.3	7.3	7.5	9.0	34.1
ITALY	137.3	131.1	138.9	144.4	78.3	76.0	78.9	80.8
Rest of the World	39.0	41.4	37.0	34.6	21.7	24.0	21.1	19.2

Source: Authors calculation on MRIO-IRPET data

For the Centre-North these two phenomena may be partly caused by the progressive delocalisation of the production processes that took place essentially in some sectors of the manufacturing industry, which – by increasing the use of intermediate and semi-processed goods originating from abroad – contributed to raising the import element incorporated into certain final productions.[25] In all three years there continues to be a major dependence (in normalised terms around 50 per cent) on the other macro regions by the South, the area in which the manufacturing industry has a lower impact on the local economic system.

The multipliers illustrated up to now are, as a consequence of the construction characteristics of the model [8.*i*-8.*ii*], conditioned in terms of both the pattern of trade of the different types of input between the macro regions (through the transactions matrix **T**) and of the set of production techniques used (through the technology matrix **A**). If we are interested in determining the productive capacity demanded of each macro region in order to satisfy the share of domestic demand of the area itself and that originating from other areas, we have to take into consideration solely the pattern of multiregional trade, net of the effects due to the regional differences in technology. This leads to a calculation of the production triggered solely by multiregional trade, that is "commanded" by the trade matrix **T**, neutralising the effects due to technology. The [8.*ii*] will therefore be transformed into:

[8.*ii**] $\mathbf{x} = \mathbf{T}\mathbf{x}$

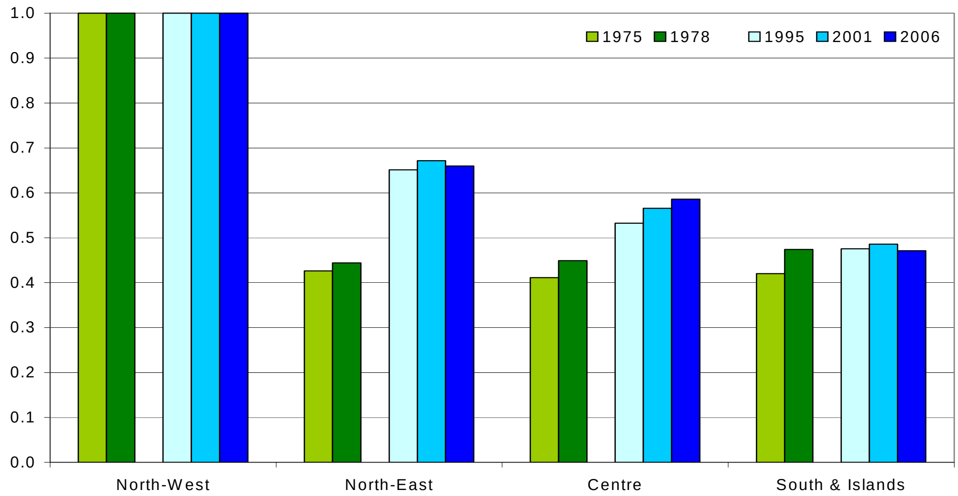
The (non banal) solution of the homogenous system [8.*ii**] is obtained by extracting the eigenvector associated with the unit eigenvalue of the matrix **T**. The elements of the eigenvector represent the ratios between the levels of production in the various macro regions (but not the levels themselves) admitted by the matrix **T** (Costa and Martellato, 1987 and 1990).

[25] An analysis of this phenomenon has been made by various authors using the I-O models; for a review see Ghezzi *et al.* (2009).

Figure 3 demonstrates the relations between the levels of production triggered in the various macro areas for the set of all the sectors, setting as 1 the production that is triggered solely by multiregional trade in the North-West (macro area where the phenomenon is greater) for the three years taken into consideration in this study and for 1975 and 1978, derived from Costa and Martellato (1987).[26]

We can observe how the production "commanded" to the southern regions did not undergo any substantial variations between 1978 and 2006, remaining less than half that of the production of the North-West. Instead, in the North-East and in the Centre, the production triggered by the pure trade flow has increased in recent years to arrive, in relation to that of the North-West, at around 65 per cent in the North-East and little under 60 per cent in the Centre (in 1978 the relations between the levels of production were, for both areas, below those of the South); this demonstrates that these two macro regions have increasingly integrated their production with that of the North-West.[27]

Figure 3 – *Production triggered by interregional trade net of the effects attributable to technology (North-West=1)*



Source: Costa and Martellato (1987) for the years 1975 and 1978, authors calculations on MRIO-IRPET data for the years 1995, 2001 and 2006

3 INTERREGIONAL BACKWARD AND FORWARD LINKAGES: A TAXONOMY

An important structural analysis is based on the classification of the industries according to the extension and intensity of their backward and forward linkages[28]. The ultimate aim of this analysis is to identify the key (nodal) sectors (*à la* Hirshman), or more in general, a taxonomy of industries. In this exercise the object of analysis, instead of sectors, will be the interregional/foreign intermediate and final linkages of the Italian regions.

[26] On page 41 of the cited work we find the same indicators calculated for the four geographical areas with a model that is similar, in terms of spatial disaggregation and theoretical approach, to that used in this study: the INTEREG model. The results of Costa and Martellato for 1975 and 1978 can therefore be compared – for macro area and for the complex of sectors – with those of the years 1995, 2001 and 2006.

[27] These features can be observed, for example, in relation to the South by using the data recorded in Ferrara (1976) regarding the percentage breakdown of the resources of the area on the basis of their origin and their destination, available with reference to the year 1969. In the 37 years separating the two analyses, as against a drop of around 10 percentage points of the impact of both internal demand and production, that of net foreign imports has gone up (from 3 to 5 percentage points), while that of net interregional imports has remained practically unchanged (about 3/4 percentage points).

[28] The most important contributions are those of Rasmussen (1957) and Chenery-Watanabe (1958). For an exhaustive review cf. Miller and Blair (2009)

3.1 The methodology

In this paper we will utilize the approach proposed by Dietzenbacher (1992), which allows to weight the different sectors proportionally to their size of linkages. Before to define the taxonomy a brief review of this methodology. Respect to Chenery-Watanabe and Rasmussen approach, Dietzenbacher weights the elements of matrix **A**, (that technical coefficient) and **B**, Goshian coefficient[29], proportionally to their back/forward linkages size. The problem is how to estimate these weights. By weighting numerator and denominator of the Chenery-Watanabe we could express the backward linkages as:

$$[13.1] \quad L_B = n \cdot \frac{q'A}{q'Ai}$$

and the forward linkages as:

$$[13.2] \quad L_F = n \cdot \frac{Bz}{z'Bi}$$

where: n = number of sectors/regions; ***z***, ***q*** = column vectors of weights proportional to linkages. Dietzenbacher has demonstrated that vectors ***z*** and ***q*** are the right and left eigenvectors associated to the dominant eigenvalue of **B** and **A**, so [13.1] could be written in the following way:

$$[14.1] \quad L_B = \frac{nq'}{q'i}$$

where ***z*** is the eigenvector associated to the dominant eigenvalue of: $q'A = \lambda q'$

as in [13.2] will be:

$$[14.2] \quad L_F = \frac{nz}{iz'}$$

In this case ***z*** is the eigenvector associated to the dominant eigenvalue of: $Bz = \lambda z$

In taxonomic terms a value of L_B and L_F greater than unity identifies a region with significant forward/backward linkages. In a system closed to external trade this allows to define a double entry classification by combining the occurrences (0,1) of the elements of vectors L_B and L_F when they are greater (1) or lower (0) than 1, allowing to assign the sectors/regions to four categories (Table 6).

Table 6 – *Classification by type of linkages (closed economy)*

		Output destination (*forward*)	
		Intermediate	Final
Output formation (*backward*)	Intermediate	**(I)** $L_F > 1$ and $L_B > 1$	**(III)** $L_F < 1$ and $L_B > 1$
	Primary	**(II)** LF >1 and LB <1	**(IV)** LF <1 and LB <1

In the previous table we could distinguish (roman numbers):

I. Intermediate-Intermediate regions/sectors, with high requirement of intermediate products and services. They also prevalently sell intermediate products and services to other regions/sectors, showing strong backward and forward linkages. These are the nodal regions;

[29] The use of the Goshian coefficients in quantifying the forward linkages follows Beyers (1976) and Jones(1976)

II. Primary-intermediate regions/sectors, with high requirement of primary inputs (value added). They sell intermediate products and services. These are regions/sectors with specialization in capital or labour intensive sectors;
III. Intermediate-final regions/sectors, which buy intermediate products and sell to final demand;
IV. Primary-final regions/sectors, which demand and sell a low amount of intermediate products and thus have low linkages with other regions/sectors.

3.2 The taxonomy of the Italian regions

In doing our analysis we have to come back to the MRIO model at 20 regions (NUTS 2 classification) and utilize the following matrices computed from the MRIO table:

i) matrix **TX** describing the total intermediate flows mongst region, the generic element is tx_{ij} = total intermediate flows from region *i* to region *j*;

ii) matrix **TF** representing the total regional final demand flows within the region, to the other regions (interregional export) and foreign export so for instance $tf_{i(ew)}$ = total regional final demand of region *i* to foreign export;

iii) vector **tw** of total intermediate foreign import by the regions;

iv) vector of regional value added **ty**.

The total regional output will be:

[15] $x = iTX + tw + ty$

From these matrices it is possible to estimate the coefficients needed for the analysis, in particular:

[16] $R = TX \cdot \hat{x}^{-1}$

It is the amount of intermediate input required by region *i* from region *j* needed to produce one unit of output in region *j*.

If we add the foreign import of intermediate products to the diagonal of **TX** we obtain the matrix of total intermediate input, in particular for region *i* we could compute the matrix **A**:

[17] $A = (TX + tw) \cdot \hat{x}^{-1}$

which will be similar to **R** except for the diagonal which represents the total amount of intermediate input required by the region *j*.

In our analysis we will also utilize the Goshian coefficient matrix **B** computed as follows:

[18] $B = \hat{h}^{-1} \cdot TX$

where:

[18.1] $h = TXi + TFi$

The Dietzenbacher approach needs some integrations when utilized in a multiregional system because it should necessarily take into accounts:

a) intermediate input could be imported from abroad;
b) final demand should be separated by destination, that is national (local and interregional) and foreign.

The analysis will be performed in three steps. First, L_b and L_f have been computed through matrices A and B (see eqs [17] and [18]). Second, regions with L_B>1 have been divided in regions with prevalence of intermediate inputs imported from abroad by means the matrix R (see eq [16]) so that we could compute the following backward linkages:

[19] $$ {}_{R}L_{B} = n \cdot \frac{z'R}{z'Ri} $$

As in the case of total linkages, ${}_{R}L_{B}<1$ identifies prevalence of intermediate input coming from abroad. Third, once regions with the main destination of output towards final demand have been identified, through L_F (see eq [14.2]), we need to assess whose are mostly exporters to abroad. If we compute for each single region the allocation shares of the final demand (matrix **TF**) we could write the following relation:

[20] $$ LF_{EX} = n \cdot \frac{fi}{i'fi} $$

where $\boldsymbol{f}$= vector of share of exported final demand. If LF_{EX} is greater than 1, a region allocates a significant part of final demand for foreign export.

The integration operated leads to an additional breakdown of Table 6, shown in Table 7:

Table 7 – *Classification by type of linkages (open economy)*

			Output destination (*forward*)		
			Intermediate	Final	
				National (local and interregional)	Foreign Export
Output formation (*backward*)	Intermediate	National	**(Ia)** ($L_F>1$ and $L_B>1$) and (${}_{R}L_{B}>1$)	**(IIIa)** ($L_F>1$ and $L_B>1$) and (${}_{R}L_{B}>1$) and ($LF_{EX}<1$)	**(IIIc)** ($L_F>1$ and $L_B>1$) and (${}_{R}L_{B}>1$) and ($LF_{EX}>1$)
		Imported from abroad	**(Ib)** ($L_F>1$ and $L_B>1$) and (${}_{R}L_{B}<1$)	**(IIIb)** ($L_F>1$ and $L_B>1$) and (${}_{R}L_{B}<1$) and ($LF_{EX}<1$)	**(IIId)** ($L_F>1$ and $L_B>1$) and (${}_{R}L_{B}<1$) and ($LF_{EX}>1$)
	Primary		**(II)** [($L_F>1$) and ($L_B<1$)]	**(IVa)** [($L_F<1$) and ($L_B<1$)] and ($LF_{EX}<1$)	**(IVb)** [($L_F<1$) and ($L_B<1$)] and ($LF_{EX}>1$)

According to Table 7 regions could be defined as follows:

I. Intermediate-Intermediate: in a open economy only a part of them (Ia) could considered “nodal” because their intermediate demand does not activate foreign import (Ib);

II. Primary-intermediate (as in Table 6);

III. Intermediate-final: it could be further divided according to:

IIIa. backward linkages with other regions and prevalence of local/interregional final demand;

IIIc. backward linkages with other regions and prevalence of foreign export: these regions have a positive significant impact on foreign trade balance;

IIIb. backward linkages fulfilled prevalently with foreign import and local/interregional destination of final demand: these regions have a negative significant impact on foreign trade balance;

IIId. backward linkages prevalently fulfilled with foreign import partly balanced by output destination to foreign export;

IV – Primary-final with output destination to final local demand (IVa) or abroad (IVb).

.

The "adjusted" Dietzenbacher procedure has produced the taxonomy of Italian regions shown in Table 8.

Table 8 – *Classification of the Italian regions by type of linkages*

<table>
<tr><td colspan="3" rowspan="3"></td><td colspan="3">Output destination (*forward*)</td></tr>
<tr><td rowspan="2">Intermediate</td><td colspan="2">Final</td></tr>
<tr><td>National (local and interregional)</td><td>Foreign Export</td></tr>
<tr><td rowspan="3">Output formation (*backward*)</td><td rowspan="2">Intermediate</td><td>National</td><td>Piedmont, Lombardy, Emilia-Romagna</td><td></td><td>Veneto, Tuscany, Marches, Friuli-VeneziaGiulia</td></tr>
<tr><td>Imported from abroad</td><td>Sardinia</td><td></td><td></td></tr>
<tr><td colspan="2">Primary</td><td>Valle d'Aosta, Umbria, Lazio</td><td>Molise, Campania, Apulia, Calabria, Basilicata, Sicily</td><td>Trentino-Alto Adige, Liguria, Abruzzo</td></tr>
</table>

The main results are the following:

- We can consider key (nodal) regions Piedmont, Lombardy and Emilia-Romagna (Ia), while Veneto, Tuscany Friuli-Venezia Giulia and the Marches (IIIc) are the intermediate-exporters.
- There are no regions in position IIIb (net importers) as the majority of regions have a significant share of value added in their output formation.
- As expected, Southern regions are in position IVa, with low forward intermediate linkages with other regions, high value added requirement and national destination of output.
- The capital region Lazio is in position II, due to the presence of public administration (intermediate) services.

4. CONCLUSIONS

In this article we have presented a Multiregional Input-Output (MRIO) model that introduces significant improvements for the estimate of trade flows between the regions – a key element in all sub-national models – by exploiting information gathered through sample surveys of industrial enterprises and non-financial private service enterprises.

From an analytic point of view, the adopted model is typically demand-driven and makes it possible to assess the spatial distribution of the trigger, in terms of output and added value, deriving from changes in the final demand. The time-span investigated – the twelve years between 1995 and 2006 – is sufficiently broad to take in any changes in the structure of the spatial and sectoral interdependencies of the Italian economy.

The results obtained confirm, first and foremost, the position of negative trade balance of the South in relation to all the other macro regions, indicating a significant dependence of this area on the Centre-North. Added to this dependency is a level of net imports from abroad that has grown considerably over the twelve years considered. Therefore, an increase in the internal final demand triggers in the southern regions a multiplier effect that tends to deteriorate its interregional trade balance. The creation of spill over effects for the Centre-North proves to be even clearer if we consider only the manufacturing sector, the impact of which on the economic system of the South is lower than that of the other areas. Even allowing for the differences in the productive technology employed, the production globally "commanded" to the southern regions to meet the internal final demand for the area and that originating from the Centre-North is around half that of the most developed area of the country, the North-West.

In short, the study casts light on the fact that the demand for goods and services addressed to the South only partially produces effects on the local economy, while it triggers production in other geographical areas, in particular in the North-West. We therefore have confirmation of the persistence of an "un-equalising" effect of the final demand trigger to the detriment of the South.

In the period under analysis, the evidence does not indicate any significant changes. But how different is the current situation from that of the past?

The quantitative comparison with bi-regional models developed in previous studies on the subject is not very robust, given the differences of construction and theoretical approach. Nevertheless, in the few cases in which it has been possible to find the necessary information (Ferrara, 1976; Bracalente *et al.*, 1981), the marked dependence of the southern economy in terms of trade balance and production trigger has always been noted.

A comparison that takes into consideration the four macro regions instead of the classical North/South classification – which is made possible by the INTEREG model (Costa and Martellato, 1987) – brings the following evidence: i) there has been over time a general increase in the volume of multiregional trade in both absolute and relative terms; ii) the propensity towards foreign imports has grown in all the macro regions; iii) the North-East and the Centre have started to close the gap in relation to the North-West in terms of multiregional trade, also increasing their integration with the latter macro region; iv) on the other hand the integration capacity of the Southern economy, which between 1975 and 1978 grew in relation to the North-West to the point of overtaking that of the Centre and North-East, has not achieved any significant improvements since then.

The analysis of the backward and the forward linkages, applied to the regions instead of sectors with a simple extension of the Dietzenbacher (1992) procedure, has confirmed that the key Italian regions are mainly located in the Centre-North, while the Southern regions demand and sell a lower amount of intermediate products and thus have low linkages with other regions.

One last methodological observation is worth: the different behaviour that emerges from the analyses performed in terms of triggering of the macro areas – and above all that of the South in relation to the rest of the country – sets the policy makers a problem related to the expediency of utilising solely national models. If it is true that in the design of public intervention on the economy "we have to bear in mind the potential divergence of application in the different territories and prepare appropriate corrective measures ex ante" (Draghi, 2010), then we feel that analyses such as that proposed here can make an important contribution in this direction. Indeed, while a national model may be strongly conditioned by the leading regions, thus concealing the asymmetrical effects of the shocks and the economic policies on the various areas of the country, a model of a multiregional and multi-sector type, such as that used in this study, can take into consideration the interrelations existing between all the elements of a dualistic system such as that of Italy.

Appendix 1– The SCM balancing procedure

The Stone, Champernowne and Meade balancing procedure assumes that the initial flows to be balanced are subjected to accounting constraints and can vary according to the relative reliability of preliminary estimate. Instead of the linear bi-proportioning rAs, the concept of variance and covariance (Var-Cov), associated to the reliability of the initial accounting set T(0) is explicitly introduced . The solution proposed by the authors consists in a GLS estimator for solving the following problem: given an accounting matrix $\mathbf{\Gamma}$, or vectorization $\mathbf{r}=\text{vec}(\mathbf{\Gamma})$, subject to a set of constraints $\mathbf{v}$, according to the aggregation matrix G :

[a1] $\mathbf{v} = \mathbf{G}\bullet \mathbf{r}$

Using the initial estimate of $\mathbf{\Gamma}$, $\mathbf{r}(0)$, we obtain:

[a2] $\mathbf{v}+\varepsilon = \mathbf{G}\bullet \mathbf{r}(0)$

Assuming that the initial estimates $\mathbf{t}(0)$ are unbiased and:

[a3.1] $\mathbf{r}(0) = \mathbf{r}(1)+\varepsilon$

[a3.2] $E(\varepsilon) = 0$

[a3.3] $E(\varepsilon\varepsilon') = \mathbf{\Lambda}$

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

[a4] $\mathbf{r}^*(1) = (\mathbf{I} - \mathbf{\Lambda}\bullet\mathbf{G'}\bullet(\mathbf{G}\bullet\mathbf{\Lambda}\bullet\mathbf{G'})^{-1}\bullet\mathbf{G})\bullet \mathbf{r}(0) + \mathbf{\Lambda}\bullet\mathbf{G'}\bullet(\mathbf{G}\bullet\mathbf{\Lambda}\bullet\mathbf{G'})^{-1}\bullet\mathbf{v}$

It is demonstrated that this kind of estimator is BLU, and it's variance is given by:

[a5] $\mathbf{\Lambda}^* = \mathbf{\Lambda} - \mathbf{\Lambda}\bullet\mathbf{G'}\bullet(\mathbf{G}\bullet\mathbf{\Lambda}\bullet\mathbf{G'})^{-1}\bullet\mathbf{G}\bullet\mathbf{\Lambda}$

A seminal contribution to the development of the SCM methodology was provided by R.P.Byron (1977,1978). According to the author the estimator SCM can be seen as a solution to a minimization of a quadratic loss function of the kind:

[a6] $\zeta = .5\bullet(\mathbf{r}^*(1)- \mathbf{r}(1))' \bullet\mathbf{\Lambda}^{-1}\bullet(\mathbf{r}^*(1)- \mathbf{r}(1)) + \lambda\bullet(\mathbf{G}\bullet \mathbf{r}^*(1)-\mathbf{v})$

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

[a7] $\lambda^* = (\mathbf{G}\bullet\mathbf{\Lambda}\bullet\mathbf{G'})^{-1}\bullet(\mathbf{G}\bullet \mathbf{r}(0)-\mathbf{v})$

So that the estimator in [a4] will be:

[a8] $\mathbf{r}^*(1) = \mathbf{r}(0) - \mathbf{\Lambda}\bullet\mathbf{G'}\bullet \lambda^*$

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 $(\mathbf{G}\bullet\mathbf{\Lambda}\bullet\mathbf{G'})^{-1}$. R.P.Byron proposes the conjugate gradient algorithm to reach an estimate of the Lagrange multipliers, by means of the system of linear equations:

[a9] $(\mathbf{G}\bullet\mathbf{\Lambda}\bullet\mathbf{G'})\bullet\lambda = (\mathbf{G}\bullet \mathbf{r}(0)-\mathbf{v})$

Since $(\mathbf{G}\bullet\mathbf{\Lambda}\bullet\mathbf{G'})$ is symmetric defined positive, the conjugate gradient method provides a good solution of the λ coefficients. As also stressed (Nicolardi 1999), even with very powerful computers, this method retains advantages compared to direct estimate using [a9] by increasing control provided by the algorithm over possible inconsistencies of the initial estimates $\mathbf{\Gamma}$ and of $\mathbf{\Lambda}$ and by avoiding the numerical instability tied to the inversion of the sparse matrix $(\mathbf{G}\bullet\mathbf{\Lambda}\bullet\mathbf{G'})$.

Appendix 2 – System of balancing identities

The balancing of the MRSUT according to SCM procedure, that is; the single regional SUTs and the multiregional trade matrix **T** is performed simultaneously, through the following system of balancing identities

[b1] $\mathbf{S}' \cdot \mathbf{i} + \mathbf{T}' \cdot \mathbf{i} + \mathbf{m} \equiv \mathbf{U} \cdot \mathbf{i} + \mathbf{F} \cdot \mathbf{i} + \mathbf{T} \cdot \mathbf{i} + \mathbf{e}$

[b2] $\mathbf{i}' \cdot \mathbf{S}' \equiv \mathbf{i}' \cdot \mathbf{U} + \mathbf{i}' \cdot \mathbf{Y}$

[b3] $\overline{\mathbf{Y}} \equiv \mathbf{Y} \cdot \mathbf{G}_Y$

[b4] $\overline{\mathbf{F}} \equiv \mathbf{F}' \cdot \mathbf{i}$

[b5] $\mathbf{i} \cdot \mathbf{T}^* \equiv \mathbf{T}^* \cdot \mathbf{i}'$

[b6] $\mathbf{T}^* \equiv \mathbf{\Theta} \cdot \mathrm{vec}(\mathbf{T})$

[b7] $$\sum_{j=1}^{k} \begin{bmatrix} 0 & {}_j\mathbf{U} & {}_j\mathbf{F} & {}_j\mathbf{e} \\ {}_j\mathbf{S} & 0 & 0 & 0 \\ 0 & {}_j\mathbf{Y} & 0 & 0 \\ {}_j\mathbf{m}' & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & {}_{\mathbf{ita}}\mathbf{U} & {}_{\mathbf{ita}}\mathbf{F} & {}_{\mathbf{ita}}\mathbf{e} \\ {}_{\mathbf{ita}}\mathbf{S} & 0 & 0 & 0 \\ 0 & {}_{\mathbf{ita}}\mathbf{Y} & 0 & 0 \\ {}_{\mathbf{ita}}\mathbf{m}' & 0 & 0 & 0 \end{bmatrix}$$

whwre, *k* (region), *m* (sectors), *n* (products), *q* (domestic final demand components), *p* (value added components):
S = blocks-diagonal regional Supply matrices *Supply* [(*k·m*)x(*k·n*)];
i = column vector
T = multiregional trade matrix [(*k·n*)x(*k·n*)];
m = vector of products foreign import (*k·n*);
U = blocks-diagonal regional Use matrices [(*k·n*)x(*k·m*)];
$\overline{\mathbf{F}}$ = the regional domestic final demand components constraints [(*k·q*)];
F = blocks-diagonal regional domestic final demand matrices [(*k·n*)x(*k·q*)];
e = vector of products foreign export (*k·n*);
$\overline{\mathbf{Y}}$ = blocks-diagonal regional primary input components constraints [(*k·p*)x(*k·m**)];
Y = blocks-diagonal regional primary input components [(*k·p*)x(*k·m*)];
$\mathbf{G}_y$ = aggregation matrix from m sectors to m* industry supplied by regional accounts [(*k·m*)x(*k·m**)].

Appendix 3 – Sectors in MRIO (Ateco 2002)

A	Agriculture, hunting and forestry
B	Fishing
CA	Mining and quarrying of energy producing materials
CB	Mining and quarrying, non energy producing materials
DA	Food products, beverages and tobacco
DB	Textiles and textile products
DC	Leather and leather products
DD	Wood and wood products
DE	Pulp, paper and paper products
DF	Coke, refined petroleum products and nuclear fuel
DG	Chemicals, chemical products and man-made fibres
DH	Rubber and plastic products
DI	Other non-metallic mineral products
DJ	Basic metals and fabricated metal products
DK	Machinery and equipment n.e.c.
DL	Electrical and optical equipment
DM	Transport equipment
DN	Manufacturing n.e.c.
E	Electricity, gas and water supply
F	Construction
G	Wholesale and retail trade
H	Hotels and restaurants
I	Transport, storage and communication
J	Financial intermediation
70, 71	Business activities, R&D and IT
72, 73, 74	Public administration
L	Education
M	Health and social work
N	Other community, social and personal service activities
O, P, Q	Real estate and renting

Appendix 4 – Multipliers

The economic system drawn by equations [8] in the structural form and by equations [11] and [12] in the reduced form is activated by the final production **pf** at basic prices defined by:

[c1] $\mathbf{pf} = \mathbf{T(I - M)} \cdot \mathbf{df} + \mathbf{ew} = \mathbf{R} \cdot \mathbf{df} + \mathbf{ew}$

It is made up by foreign exports **ew** and domestic final demand **df**, coming from the aggregates at purchasing prices (cf. equations [9.*iv*] and [9.*v*]), as these aggregates have a real impact on the economic system. Moreover, domestic final demand is subjected to two different processes before becoming final production: i) leakages in final imports of goods and services from abroad; ii) as the rest of it is distributed among regions through the multiregional trade matrix **T**.

The domestic final demand multipliers, at purchasing prices, are derived from equation [12]:

[c2] $$\frac{\Delta \mathbf{x}}{\Delta \mathbf{df}_{pa}} = \mathbf{INV} \cdot \mathbf{R} \cdot (\mathbf{I} - \mathbf{S}_d) \cdot \mathbf{L}_{df}$$

The multipliers of other endogenous variables, particularly: value added and the imports from abroad, are generated recursively.

The value added multiplier is defined by:

[c3] $$\frac{\Delta \mathbf{y}}{\Delta \mathbf{df}_{pa}} = \hat{\mathbf{V}} \cdot \mathbf{INV} \cdot \mathbf{R} \cdot (\mathbf{I} - \mathbf{S}_d) \cdot \mathbf{L}_{df}$$

where the diagonal matrix $\hat{\mathbf{V}}$ contains the coefficients $v_{rj} = \frac{y_{rj}}{x_{rj}}$, which represent the value added requirement per unit of production of the sector j and region r.

The multiplier of the imports from abroad, that sums up the activation of final and intermediate imports of goods and services, is given by:

[c4] $$\frac{\Delta \mathbf{mw}}{\Delta \mathbf{df}_{pa}} = \left[\hat{\mathbf{M}} \cdot (\mathbf{I} + \mathbf{INV} \cdot \mathbf{R} \cdot (\mathbf{I} - \mathbf{S}_d) \cdot \mathbf{L}_{df})\right].$$

In the same way for multiregional imports is:

[c5] $$\frac{\Delta \mathbf{mr}}{\Delta \mathbf{df}_{pa}} = \left[\hat{\mathbf{B}} \cdot \left(\mathbf{I} - \hat{\mathbf{M}}\right) \cdot (\mathbf{I} + \mathbf{INV} \cdot \mathbf{R} \cdot (\mathbf{I} - \mathbf{S}_d) \cdot \mathbf{L}_{df})\right]$$

and for multiregional export:

[c6] $$\frac{\Delta \mathbf{er}}{\Delta \mathbf{df}_{pa}} = \left[\breve{\mathbf{B}} \cdot \left(\mathbf{I} - \hat{\mathbf{M}}\right) \cdot (\mathbf{I} + \mathbf{INV} \cdot \mathbf{R} \cdot (\mathbf{I} - \mathbf{S}_d) \cdot \mathbf{L}_{df})\right]$$

The multipliers of the endogenous variables allow to specify the trigger of all the components of the national goods and services account in response, for example, either to a change in the domestic multiregional final demand at basic prices Δ**df** (Table C1) or to a variation in foreign exports Δ**ew** (Table C2).

Table C1 – *Triggering of the components of the goods and services account in response to a change of multiregional final demand, at basic prices*

GDP	(a)	(b)+(c)
Value added	(b)	$\hat{\mathbf{V}} \cdot \mathbf{INV} \cdot \mathbf{R} \cdot \Delta\mathbf{df}$
Net indirect taxes	(c)	$\Delta\mathbf{df} \cdot \left(\mathbf{S_x} \cdot \mathbf{A} \cdot \mathbf{INV} \cdot \mathbf{R}\right)$
Multiregional imports	(d)	$\left[\overset{\frown}{\mathbf{B}} \cdot \left(\mathbf{I} - \mathbf{M}\right) \cdot (\mathbf{I} + \mathbf{INV} \cdot \mathbf{R})\right] \cdot \Delta\mathbf{df}$
Imports from abroad	(e)	$\left[\mathbf{M} \cdot (\mathbf{I} + \mathbf{INV} \cdot \mathbf{R})\right] \cdot \Delta\mathbf{df}$
Total resources		(a)+(d)+(e)
Internal final demand	(f)	$\Delta\mathbf{df}$
Multiregional exports	(g)	$\left[\breve{\mathbf{B}} \cdot \left(\mathbf{I} - \mathbf{M}\right) \cdot (\mathbf{I} + \mathbf{INV} \cdot \mathbf{R})\right] \cdot \Delta\mathbf{df}$
Foreign exports	(h)	-
Total uses		(f)+(g)

Table C2 – *Triggering of the components of the Goods and services account in response to a change of foreign exports*

GDP	(a)	(b)+(c)
Value added	(b)	$\hat{\mathbf{V}} \cdot \mathbf{INV} \cdot \Delta\mathbf{ew}$
Net indirect taxes	(c)	$\Delta\mathbf{ew} \cdot \left[\mathbf{S_{ew}} + \left(\mathbf{S_x} \cdot \mathbf{A} \cdot \mathbf{INV}\right)\right]$
Multiregional imports	(d)	$\left[\overset{\frown}{\mathbf{B}} \cdot \left(\mathbf{I} - \mathbf{M}\right) \cdot \mathbf{INV}\right] \cdot \Delta\mathbf{ew}$
Imports from abroad	(e)	$\left[\mathbf{M} \cdot \mathbf{INV}\right] \cdot \Delta\mathbf{ew}$
Total resources		(a)+(d)+(e)
Internal final demand	(f)	-
Muliregional exports	(g)	$\left[\breve{\mathbf{B}} \cdot \left(\mathbf{I} - \mathbf{M}\right) \cdot \mathbf{INV}\right] \cdot \Delta\mathbf{ew}$
Foreign exports	(h)	$\Delta\mathbf{ew}$
Total uses		(g)+(h)

Appendix 5 – Interregional trade flows and institutional localization

In a system of multiregional trade flows some of them are not related to processes which are endogenous to the economic system and/or to the multi-localization of firms. We are referring to the flows of collective consumption services (CCS)[30], which are generated by the different density of localization of national institutions (or part of them) in some areas of a country.

It would seem counterintuitive that CCS – like general administration, security, justice and defence – can be exported or imported. Anyway, if the output of these services is compared, for any single region, with the expenses, which are located according to the geographic distribution of the population, it results that most of the regions have a productive deficit while only few of them have a significant surplus.[31] In absence of external flows of CCS, these deficits/surpluses can only be balanced assigning them to interregional imports/exports.

It is not casually that Lazio is the Italian region with the biggest surplus followed by the autonomous border regions. As for Lazio, the Italian capital region, the surplus is due to the presence of central offices of many Public Institutions which produce more services than the needs of the inhabitants of the same region. Regarding the border regions, particularly Friuli-Venezia Giulia, the surplus is generated by a massive production of defence services, due to the diffuse presence of military installations for the oversight of the national boundaries.

In the following table are detailed, with regard to the year 2006 data, the first three regions with the highest CCS surplus and the relative incidence on the total regional exports, and the three ones with the highest CCS deficit on the total regional imports.

Proportion of import and export of CCS, year 2006

Prime tre regioni esportatrici nette di SCC	quota % sull'export regionale	Prime tre regioni importatrici nette di SCC	quota % sull'import regionale
Lazio	9,7	Lombardia	4,2
Friuli Venezia Giulia	4,1	Piemonte	2,2
Valle d'Aosta	2,3	Emilia-Romagna	2,1

Source: authors' computations from MRIO-IRPET

The share of exports of CCS is particularly strong for the regional CCS exports of Lazio (9.7 per cent), while the fraction of Friuli-Venezia Giulia is slightly lower (4.1), descending from 7.0 per cent in the year 1995. The incidence of imports of CCS is significant for Lombardy (4.2 per cent), followed by Piedmont and Emilia-Romagna.

The interregional flows of CCS have a significant effect also on the net regional balances. For example, should the export of CCS from Lazio become zero, the net regional exports would change their sign from positive to negative. Obviously, this has consequences on results referred to geographic macro areas (cf. Table 2).

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30 According to the SEC 1995 classification the production of services by the Public administration satisfies two kind of demands: a) that arising from the household sector for individual consumption, and b) that coming from the whole society (collective consumption). In the COFOG classification the following function of expenses by the Public administration can be defined as collective consumption:

1. General public services;
2. Defence;
3. Public order;
4. Economic affairs;
5. Environment protection;
6. Housing and land use.

31 In the adopted balancing procedure both the expenses of the Public administration and the production of its services come from the regional economic accounts by Istat; for this reason they are treated like constraints.

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