# A MULTI-REGIONAL INPUT-OUTPUT MODEL FOR ITALY

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**Interventi, note e rassegne**

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# INTRODUCTION

Two stylised facts have mainly characterized the italian economic growth: the dualism between the two main macro-regions of the country (North-Centre and South) and the different kind of industrial economic growth experienced across the North-Central regions. While the North-West[1] part of the country, which led the italian take-off early in the last century, based its economic growth on the medium/large size enterprises; the North-Eastern and Central (NEC) regions (for the latter ones mainly Toscana and Marche) mostly grew during the 60s and 70s following the economic district model based on small size firms.

The main development of NEC was characterized by an endogenous propulsive push linked to peculiar socio-economic features, which also has been proved to be robust and self-reproducing with weak spreading effects on the South (only along the so called “via Adriatica”).

These different growth patterns imply a different set of structural parameters and so different responses to economic policies. By using a multi-regional I-O model would be possible to catch this differential behaviours.

Given the considerable tradition in estimating through survey methods (see Casini Benvenuti and Grassi 1977) or indirect methodologies (see for instance Casini Benvenuti, Martellato and Raffaelli, 1995) and in implementing MRIO models; IRPET has built a multi-regional I-O model for the year 1998, in order to analyse the multi-regional structural flows and the short run behaviour in response to different policy measures affecting, either directly or indirectly, final demand variables. The building of the I-O multi-regional table has been developed in the following way:

1) simultaneous balancing of Regional Accounting Matrices (RAM) at market prices and 30 industries (RR30 see Appendix 2) derived from the NACE Rev. 1, constrained to regional accounts and a national accounting matrix by us-

[1] The four macro-regions include the following regions (see Appendix 1):
- North-West: Piemonte, Valle d’Aosta, Lombardia, Liguria;
- North-East: Trentino Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia-Romagna;
- Centre: Toscana, Umbria, Marche, Lazio;
- South: Abruzzi, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia.

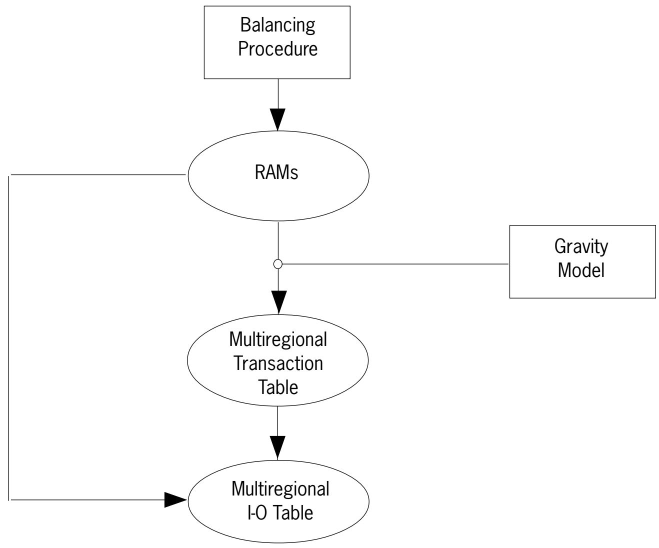
ing the Stone-Champernowne-Meade (1942) balancing procedure[2];

2) estimate of the multi-regional trade.

Section 1 will concentrate exclusively on point 1, while the description of the methods used in phases 2 and 3 will be analyzed in the following sections.

Figure 1 shows the main steps. It can be seen that RAMs estimates provide for the second step three –fully consistent- important pieces of information that will act as constraints: regional distributed production, regional domestic demand, foreign import, foreign export and net interregional imports. This data will be introduced in the gravity model for the estimate of the multi-regional transaction table.

FLOW CHART OF THE CONSTRUCTIVE STEPS OF THE MULTI-REGIONAL TABLE




The choice to produce separately RAMs and transaction table instead of computing them simultaneously, relies on the unfeasibility to produce plausible and unbiased initial values of multi-regional flows, so the strategy has been to provide unbiased and fully consistent estimate of the constraints utilized in the gravity model.

The last section will be composed by a structural analysis and simulation exercises in response to different exogenous and policy scenario.

[2] An effective application of such methodology at multiregional level can be found in R.P.Byron, P.J.Crossman, J.E.Hurley and S.C.E.Smith (1995). To be remarked that the Italian Central Statistical Office (ISTAT) introduced this methodology during the 80s and still applies it for balancing national economic accounts and Input-Output matrices (see for instance Mantegazza-Mastrantonio 2000).

# 1.
# THE CONSTRUCTION OF THE MULTI-REGIONAL TABLE

The methodology that will be described in this article resumes some of the constructive ideas of the previous (Casini Benvenuti, Martellato and Raffaelli 1995), on the other hand, radically renews the system of equations allowing to balance the regional accounting tables, point of departure for the construction of the table and the multi- regional model.

## 1.1
## The RAMs estimate

*The analytical background*

There are three main methods of balancing to be found in statistical-economic literature and described in R.P.Byron, P.J.Crossman, J.E.Hurley and S.C.E.Smith (1995, henceforth BCHS). The first consists in attributing to a variable the statistical discrepancies coming from the merging process of the various accounts. This method, called *residuals sink* from BCHS, assignes the possible discrepancies to a column of the final demand. The second method, whose use is certainly more frequent, is the biproportional balancing rAs (Stone 1961). It consists, given the marginal constraints, in a set of calculations T(0), in finding two correcting vectors - respectively r and s - for each row and column, so that is possible to produce a new set of balanced calculations. T(1)*:

[1] $T(1) = r \cdot T(0) \cdot s$

So the adjustment will be a function of the discrepancy between the constraints and the totals of line and column of T(0).

The rAs technique has the following mathematical properties (Bacharach 1970):

a) conservation of the original flow signs;
b) conservation of the non-zero flows;
c) unicity of the solution.

It can be interpreted as the solution to a problem of minimization of the distance of information contents between the set of calculations, still to be balanced T(0) and those already balanced T(1). Bacharach has proved that, if we set out a problem of minimization of the distance between the informative contents of the two sets of calculations.

T(0) and T(1) of the following type:

$$D\left[T(0);T(1)\right] = \sum_i \sum_j t_{ij}(1) \cdot \ln\left[\frac{t_{ij}(1)}{t_{ij}(0)}\right] = \min$$

st.

[2] $$\sum_j t_{ij}(1) = U_i(1)$$

$$\sum_i t_{ij} /1) = V_j(1)$$

The solution to such problem will be as follows:

[3] $$t_{ij}(1) = \exp(\lambda_i) \cdot t_{ij}(0) \cdot \exp(\mu_j - 1)$$

where $\lambda$ and $\mu$ are Lagrange multipliers that multiply the columns and the rows of the initial matrix, in the role of controls similar to the coefficients r and s. Therefore if we substitute:

[4.1] $$r_i = \exp(\lambda_i)$$

[4.2] $$s_i = \exp(\mu_i - 1)$$

we obtain the equation [1].

Modifications to the original version have been proposed later. Among the most relevant we should mention: the rAs with exogenous information, which allows the inclusion of cells known prior to T(1), and the ERAS (Extended rAs) method (Israelevich 1991). The third method - the one used in this article- is based on the estimator proposed by Stone, Champernowne and Meade (1942, henceforth SCM), that has subsequently undergone methodological improvement and a large number of applications.

The main hypothesis assumes that the 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[3]. The solution proposed by the authors consists in the application of a GLS estimator to the following problem: given an accounting matrix T (vectorization t) subject to k number of constraints, according to the aggregation matrix G:

[3] It has been proved (see for instance Lavanda et al. 1997) that rAs is a particular solution of SCM procedure when variance is set equal, or proportional through a scalar, to the initial values.

[5.1] $k = G \cdot t$

Using the initial estimate T(0) we obtain:

[5.2] $k + \varepsilon = G \cdot t(0)$

Assuming that the initial estimate T(0) is unbiased and has the following characteristics :

[5.3] $$\begin{aligned} t(0) &= t(1) + \varepsilon \\ E(\varepsilon) &= 0 \\ E(\varepsilon\varepsilon') &= V \end{aligned}$$

The use of GLS will lead therefore to the estimate of a vector $t^*(1)$ that will satisfy the accounting constraints in [5.1] and will be as near as possible to the actual data t(1).

The estimator able to produce such an estimate is the following:

[5.4] $t^*(1) = (I - V \cdot G' \cdot (G \cdot V \cdot G')^{-1} \cdot G) \cdot t(0) + V \cdot G' \cdot (G \cdot V \cdot G')^{-1} \cdot k$

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

[5.5] $V^* = V - V \cdot G' \cdot (G \cdot V \cdot G')^{-1} \cdot G \cdot V$

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:

[6] $\vartheta = 5 \cdot (t^*(1)\text{-}t(1))' \cdot V^{-1} \cdot (t^*(1)\text{-}t(1)) + \lambda \cdot (G \cdot (t^*(1)\text{-}k) = \min$

where:
$\vartheta$ = quadratic loss
$\lambda$ = Lagrange multipliers

The first class conditions for minimizing the previous equation correspond to the following values of Lagrange multipliers:

[7.1] $\lambda = (G \cdot V \cdot G)^{-1} \cdot (G \cdot t(0) - k)$

so:

[7.2] $t^*(1) = t(0) - V \cdot G' \cdot \lambda^*$

that refers back to the estimator in [5.4]. 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 of the matrix $(GVG')^{-1}$. R.P. Byron proposed the conjugate gradient algorithm to reach an estimate of the Lagrange multipliers, by means of the system of linear equations:

[7.3] $$(G \cdot V \cdot G') \cdot \lambda = (G \cdot t(0) - k)$$

Since GVG' is symmetric defined positive, the conjugate gradient method provides a good solution of the $\lambda$ coefficients. As also stressed recently (Nicolardi 1999), even with very powerful computers, this method retains advantages compared to direct estimate using eq. [7.3] of large systems of accounts to balance. These are:

1) increasing control provided by the algorithm over possible inconsistencies of the initial estimates and of the Var-Cov matrix;
2) possibility to avoid the numerical instability tied to the inversion of the sparse matrix GVG'.

The algorithm of the conjugate gradient applied to the problem of balancing, could arise a numerical problem, or rather the possibility to get unexpected negative values. However this problem could be seen in a positive way, the result of unexpected negative estimates can be interpreted as an important warning of inconsistencies in the matrix V, in the constraints and/or biases in the initial estimates. This can therefore be a spur to check more carefully the components of the solution to the algorithm[4].

A crucial problem now is how to define the matrix V that determines, for each flow in T(0), the range of adjustment.

The first step concerns the identification of the estimates that are interdependent and or subject to autoregressive processes. This operation is very important because in the case of independent estimates theVar-Cov matrix will be diagonal.

Hypothesizing the presence of a diagonal Var-Cov matrix, the next step consists in the estimate of the reliability of each single data item. Most applications (see for instance Stone 1990) show that such reliability is transformed in variance through equation [8], that is:

[8] $$\sigma^2{}_{r,i,j} = \left(r_{r,i,j} \cdot t(0)_{r,i,j}\right)^2$$

It is important to notice that the relative variance affects the balancing process, so if the matrix V is multiplied by a scalar,

[4] In order to avoid unexpected negative signs it has been proposed to utilize quadratic programming (Harrigan and Buchanan 1984).

there is no modification to the result.

In the literature, the matrix V has nearly always developed a diagonal form, this implies initial estimates from independent sources. The condition of non-diagonality can be released when it is supposed that the preliminary estimates are not independent. We can release the diagonal condition for the existence of implicit covariance in the production of the in initial estimates. This happens when:

a) the same initial estimate figures in more than one account;
b) the estimate of a flow has (as its component) the element that figures in another account.

Many authors argue that also autoregressive processes should also be considered, even in uni-temporeal applications, within the Var-Cov matrix (Antonello 1995).

*The balancing structure*

The balancing structure of the RAMs refers to two different sets of constraints, the first associated to each regional sets and the second in relation to a corresponding set of national accounts.

Given the constraints imposed by the data availability on the regional economic accounts, has been possible to identify, for each RAM, blocks of accounting identities allowing to balance -for each sector- the resources and the uses. Figure 1.1 shows the lay-out of the accounting identities at regional level.

Therefore, the single RAM are composed by the following sub-matrices:

T(1;2): diagonal matrix of total intermediate costs;

T(2;j) j = 1,3,4,5,6,11; requirements for intermediate and final use:

- Intermediate input (j = 1)
- Households expenditure by producing sectors and purposes (j = 3);
- Government and NPISHs expenditure by producing sector and government function (j = 4);
- Investment goods by producing sector (j = 5);
- Changes in inventories (j = 6);
- Rest of the world (j = 11), export of goods and services by resident producer industry.

T(i;7) i = 3,6: components of the final domestic demand for:

- Household expenditure by purposes (i = 3);
- Expenditure by general government and NPISH (i=4);
- Investment goods (i = 5);
- Change in inventories (i = 6).

T(7;j) j = 2,8,10,11,16,20,21: aggregate net resources:

- Total Net Indirect taxes (j = 9);
- Total Net Imports (j = 8);
- Value Added at basic prices (j = 2);
- Total Transfers of products (j = 10);
- Total trade margins (j = 13);
- Total transport margins (j = 14).

These last three scalars are equal to zero.

1.1
RAM ACCOUNTING STRUCTURE

| | Intermediate input | Industries | Household Expenditure | Government Expenditure and NPISHs | Gross Fixed Investments | Changes in Inventories | Value Added at basic prices | Net Import |
|---|---|---|---|---|---|---|---|---|
| Intermediate input | | T(1;2) | | | | | | |
| Industries | T(2;1) | | T(2;3) | T(2;4) | T(2;5) | T(2;6) | | |
| Household Expenditure | | | | | | | T(3;7) | |
| Government Expenditure and NPISHs | | | | | | | T(4;7) | |
| Gross Fixed Investments | | | | | | | T(5;7) | |
| Changes in Inventories | | | | | | | T(6;7) | |
| Value Added at basic prices | T(7;2) | | | | | | | T(7;8) |
| Net Import | | | | | | | | |
| Net indirect Taxes | | | | | | | | |
| Indirect Taxes on products | T(10;2) | | | | | | | |
| Production Subsidies | T(11;2) | | | | | | | |
| Product Transfers | T(12;2) | | | | | | | |
| Net Interregional import | T(13;2) | | | | | | | |
| Rest of the world | T(14;2) | | | | | | | |
| Trade margins | T(15;2) | | | | | | | |
| Transport margins | T(16;2) | | | | | | | |

| | Net indirect Taxes | Indirect Taxes on products | Production Subsidies | Product Transfers | Net Interregional import | Rest of the world | Trade margins | Transport margins |
|---|---|---|---|---|---|---|---|---|
| Intermediate input | | | | | | T(2;14) | | |
| Industries | | | | | | | | |
| Household Expenditure | | | | | | | | |
| Government Expenditure and NPISHs | | | | | | | | |
| Gross Fixed Investments | | | | | | | | |
| Changes in Inventories | | | | | | | | |
| Value Added at basic prices | T(7;9) | | | T(7;12) | | | T(7;15) | T(7;16) |
| Net Import | | | | | T(8;13) | T(8;14) | | |
| Net indirect Taxes | | T(9;10) | T(9;11) | | | | | |
| Indirect Taxes on products | | | | | | | | |
| Production Subsidies | | | | | | | | |
| Product Transfers | | | | | | | | |
| Net Interregional import | | | | | | | | |
| Rest of the world | | | | | | | | |
| Trade margins | | | | | | | | |
| Transport margins | | | | | | | | |

Fonte: Irpet

T(9;j) i = 10,11: Components of the Net Indirect Taxes:

- Total Indirect Taxes on product (j = 10);
- Total production subsidies(j = 11).

T(8;j) j = 13,14: the balances that make up the total of the Net imports:

- Net inter-regional imports (j = 13);
- Net foreign imports (j = 14).

T(i;2) i = 7,14. components of sectorial resources:

- Value Added at basic prices (i = 7);
- Indirect taxes on product (i = 10);
- Production subsidies (i = 11);
- Product transfers (i = 12);
- Net inter-regional imports (i = 13);
- Foreign imports (i = 14);
- Trade margins on sectorial resources (i = 15);
- Transport margins on sectorial resources (i = 16).

Therefore, for each r-th region the following accounting identities are set up:

1) Calculation of the aggregate resources and uses:

[9.1] T(r;7;2) + T(r;7;8) + T(r;7;9) + T(r;7;12) + T(r;7;15) + T(r;7;16) = T(r;3;7) + T(r;4;7) + T(r;5;7) + T(r;6;7)

2) Sectorial resources and uses:

[9.2] T(r;1;2) + T(r;7;2) + T(r;10;2) – T(r;11;2) - T(r;12;2) + T(r;13;2) + T(r;14;2) + T(r;15;2)+ T(r;16;2) = T(r;2;1) + T(r;2;3) + T(r;2;4) – T(r;2;5) + T(r;2;6)

3) Total Intermediate costs:

[9.3] T(r;1;2) = T(r;2;1)

4) Households expenditure:

[9.4] *T(r;2;3) = T(r;3;7)*

5) Government and NPISHs expenditure:

[9.5] T(r;2;4) = T(r;4;7)

6) Investments:

[9.6] T(r;2;5) = T(r;5;7)

[9.7] T(r;2;6) = T(r;6;7)

7) Net Indirect Taxes:

[9.8] T(r;7;9) = T(r;9;10)-T(r;9;11)

[9.9] T(r;10;2) = T(r;9;10)

[9.10] *T(r;11;2) = T(r;9;11)*

8) Net Trade:

[9.11] T(r;7;8) = T(r;8;13) + T(r;8;14)

[9.12] T(r;13;2) = T(r;8;13)

[9.13] T(r;8;14) = T(r;14;2) - T(r;2;14)

9) Trade and Transport Margins:

[9.14] T(r;2;15) = T(r;7;15)

[9.15] T(r;2;16) = T(r;7;16)

Therefore, the elements of each accounting identity must be balanced inter-regionally with the corresponding component in the national accounting structure based on the NAM[5] according to [10]:

$$[10] \quad \sum_{r=1}^{n} T(r;i;j) = T(i,j)$$

where n = number of regions.

It is important to notice two details concerning this second set of constraints. First, the total of the balances of the net inter-regional imports must cancel each other out on a national level, therefore we will have a constraint equal to 0 for the aggregate present in the national constraint, so:

$$[11] \quad \sum_{k=1}^{nreg} T(k;13;2) = 0$$

Second, the intermediary re-use present in the diagonal of T(r;2;1) and making up the total in T(r;1;2), are not subject to national constraints and are free to assume values deriving from the set of constraints of each RAM. The reason for such a choice is due to the fact that, according to ESA, only flows that occur between sub-branches of the same sector are accounted as intermediary re-use, cancelling out the exchanges within sub-branches, except for those coming from outside. The

[5] The last published national I-O table refers to 1992, in order to provide NAMs as national constraints we have also estimated National Accounting Matrices for the years 1995-1996, 1997 and 1998, through the SCM estimator. To be remarked that ISTAT has produced, so far, only industry by industry national tables.

consolidation of regional intermediary re-uses cannot, by definition, produce the diagonal of the national matrix, because in the national matrix, the inter-regional flows between the same sub-branches are set to zero.

Therefore it is possible to write the whole series of identities in a matrix notation according to the SCM equation as:

[12] $G \cdot t(0) = 0$

where:
t(0) = initial estimates of the vectorized RAMs;
G = matrix of the coefficients of aggregation related to the regional and national constraints.

Therefore, the variance-covariance V will also be diagonal in blocks. Given the big size, the calculation of the matrix GVG', crucial for the algorithm of the conjugate gradient, seems to be rather problematic in terms of computation, however the particular structures and characteristics of the matrices G and V make such a procedure much less difficult than expected. The calculation needs three elements. The first is represented by the sparcity of the matrices T, V and G. The second, by the block structure of the matrices V and G, and the third by the hypothesis of a diagonal matrix V. Furthermore, the speed of convergence in terms of iterations has been improved by scaling (pre-conditioning) the GVG' matrix as suggested by Byron (1978).

*The initial estimates: supply*

Besides the initial estimates of the value added at 30 industries, which is considered with full reliability (zero variance) since it has been provided by the Central Statistical Office (ISTAT), the key elements of supply are represented by intermediate inter-industry flows, foreign import and net interregional import.

- *The industrial intermediate flows*

In the base year 1995, the block T(r;2;1) has preliminarily been computed through the estimate of the intermediate inter-industry coefficients. This matrices has been obtained by the industry-mix (Shen 1960), the regionalization of the 92 sectors (henceforth RR92) national matrix (published by ISTAT for year 1992 and then updated by IRPET), to 30 regional industries. This procedure allows us to catch the regional diversity tied to the sectorial specialization in the composition of each single regional RR30 branch. The aggregation by means of industry-mix has come about according to the following equation:

[13] $a^*(r,i,j) = \sum_{k=1}^{ns(j)} {}_j a(i,k) \cdot_j QD_{96-rr92}(r,i,k)$

where:

ns(j) = number of the rr92 industry which belongs to *j-th* RR30 sector;
QD = industry-mix *r-th* region of the *j-th* branch RR30 based on the 1996 industrial Census.

However this first regionalization it is not sufficient to encompass regional peculiarities linked to, for example, district economies and mixed technologies in the same industries. Moreover, it fails to catch the regional specificities due to industries not identified in the initial RR92 classification[6].

As for the first and third kind of peculiarities there is no way to adjust the initial estimate, for the second one we have been able to make some adjustments to the initial estimates, at least for a particular technology mix generated by the multi-location of some enterprises.

For the same firm we can find local units with a strong component of manufacturing production as, in regions where their headquarters are based, a more marked administrative component[7].

Both local units are registered in the same sector but it is clear that they have a different structure of intermediate input, given the unavailability at national level of use and make matrices (see note 5), therefore the industry-mix regionalization should be integrated in order to consider the different composition of technologies. If we assign to administrative technology the column cost of a typical tertiary branch like "Business Service", we can identify for each RR92 national industries the corresponding manufacturing technology, through (for the *j-th* industry) the following equation:

$$[14] \quad {}_{b}a_{ij} = \frac{a_{ij} - {}_{w}a_{ij} \cdot w_j}{b_j} \quad i = 1, \text{ number of sectors}$$

where:

${}_{b}a_{ij}$ = manufacturing column cost
$a_{ij}$ = average column costs in the NAM
${}_{w}a_{ij}$ = administrative colum cost
w = administrative weight
b = manufacturing weight: (b = 1-w)

We have utilized as weights the number of administrative staff and blue collars from 1996 intermediate industry Census.

[6] The regionalization through industry-mix requires, to be more effective, that the starting level of aggregation, it should be more detailed as possible, but unfortunately the RR92 are affected by some "bugs". For instance the specialization of a region in producing "Furnitures" could not be fully caught because, at RR92 level, this production is considered with "musical instruments".

[7] This is particularly considerable in industries like Mining, Chemical products and Energy, where ( for example in some regions like Lombardia and Lazio) the headquarters are mostly concentrated as in other regions (like for instance Sicilia where there are the industrial plants).

By using regional blue-collars as mix variables, we have divided into regions the national RR92 $_bA$ matrix to the regional RR30. By hypothesizing the same administrative cost structure region-wide, the regional intermediate coefficients have come out (for the *j-th* industry of the *r-th* region) from the following equation:

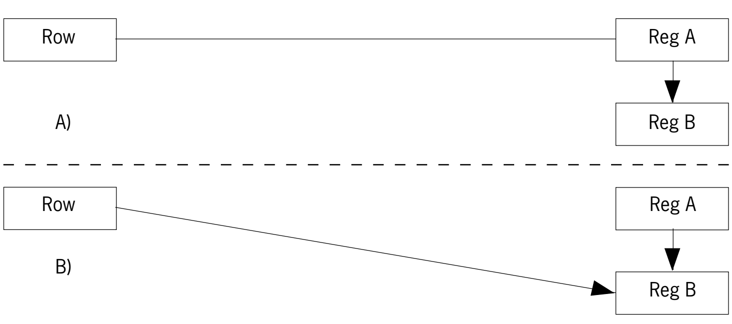
[15] $\quad {}_r a_{ij} = {}_{rb} a_{ij} \cdot {}_r b_j + {}_{rw} a_{ij} \cdot {}_w w_j$

So the coefficients are weighted average of the two cost structures. This adjustment has been made for those sectors which belong to Manufacturing, Mining and Energy.

The total intermediate costs (T(r;1;2)) have been obtained by using the value added coefficients drawn by a survey made by ISTAT on Economic Accounts of Enterprises and available, region-wide, at RR30 level. For the following years the initial estimates of both T(r;1;2) and T(r;2;1) have made use of the final estimates of coefficients of the previous year.

- *The foreign import*

After a first examination, the estimate of the foreign imports of goods and services would not point out any problems, ISTAT supplies for all regions, foreign import of goods and debts and credits related to services trade. However the data recorded by ISTAT are affected economically by a significant bias. Analizing them carefully, we discover that they are not significantly tied to the regional demand, but they are mainly located among regions, according to the role of trader and or multi-location degree of the region. The result is the following: the regions that import more are those with harbour/airports or headquarters of multi-plant enterprises like Lazio and Lombardia. The economic logic would assign these flows to the region that actually demands such goods and services. The difference can be seen in figure 1.3. The first route is the one registered by ISTAT. The flow of foreign goods demanded by region B is recorded as foreign import by region A, and as inter-regional import of region B from region A.




1.2
FOREIGN AND INTERREGIONAL IMPORTS

Source: IRPET

The correct route should be the second, the flow is assigned to region B demanding foreign import. In a table at market prices the registration would stop here, in a *depart-usine* version, where the commercial and transport margins are kept separated, there will be foreign imports of region B importing trading services by turn from region A.These considerations have kept us from using ISTAT data on regional imports. For the intermediate import we have regionalized the national import coefficients on intermediate demand at RR92 by means the different mix of regional intermediate demand, while the coefficients for final demand are supposed to be equal to the national ones region-wide.

Once defined the coefficients, the foreign import flows have been computed by multiplying the initial estimate of the total domestic demand by such parameters.

• *Net interregional imports*

For the base year, the initial values of sectorial net interregional import have been set as difference between the preliminary estimates of the sectorial internal demand and the distributed production. These interregional imports, which have balanced the resources and uses accounts for each regional sector (see identity [9.2]) could not be consistent both with the total interregional import (see identity [9.8]) -obtained independently as difference between the whole inter-regional balance supplied by ISTAT and the foreign net import, and the vector of sectorial interregional import at national set as zero (see identity [11]). For the following years we have utilized, as initial estimate, the net interregional import resulting from the balancing process of the previous year.

*The initial estimates: demand*

Concerning demand, there are more variables which can derive from the regional accounts provided by ISTAT, so the critical points refer to the bridge matrices T(r;2;3) and T(r;2;5) which link, respectively, the individual consumption by purpose and the gross fixed investments by type to the producing sectors.

• *Households expenditure by producing sectors and purposes*

In the base year, the initial bridge matrices in T(r;2;3) have been estimated through regionalization of a more disaggregated matrix. Indeed at national level ISTAT is supplying expenditure purposes at the highest COICOP disaggregation (3-digit, 39 items, henceforth COICOP39, see Appendix 2) while at regional level, data are released at the COICOP 2-digit (12 items, henceforth COICOP12)[8]. The regionalization process is based

[8] The COICOP 2-digit classification put together in the same item expenditure categories, which could be resulting from quite different consumption behaviour. For instance, in the COICOP12 "Furnishing, household equipment and routine maintenance of the house" there are durable goods like "Electrical household appliances" and services like "routine maintenance of the house". Something different happens when COICOP12 item is a residual item with an high heterogenity like "Miscellaneous goods and services".

on the expenditure mix from COICOP39 to COICOP12 and it could catch many of the regional specificities, especially those due to the tourism expenditure[9].

The regionalization has followed 4 steps:

a) estimate at national level of two bridge matrices linked to tourism expenditure and resident household consumption. These two matrices are at maximun level disaggregation in terms of expenditure purposes;
b) regionalization of the resident household consumption bridge matrix, through the regional expenditure mix drawn by regional HBS, while the bridge matrix of tourism consumption has been considered as constant region-wide;

Once determined the two bridge matrices at regional level, we have multiplied them by the estimates of regional expenditure, by purpose for resident household -making a difference between the domestic household expenditure provided by ISTAT T(r;3;7)- and the tourism expenditure previously estimated by IRPET; therefore the values in T(r;2;3) are the result of the sum of the two bridge matrices.

- *Gross Fixed Investments*

In the RAMs the Gross Fixed Investments can be found by type of investment (provided by ISTAT) and by producing sector. The bridge matrix T(r;2;5) distributes the investment types recorded in T(r;5;7) among the producing industries. At regional level, ISTAT supplies only two types of investments: “Construction” and “Other Goods and Services” which mainly consist in: machinery equipment, transport equipment and software. As for the first type of investment the assignment to the producing industry is straightforward (and with 0 variance associated), it is more complex in the case of the second type of investment, because there are no other sources which can mix variables. Therefore, the only feasible opportunity is using the corresponding NAM’s bridge matrix.

- *Foreign exports*

The foreign exports should be distinguished in export of goods and export of services. Such distinction is explained by the difference in the initial estimates and associated reliabilities.

[9] In some regions the tourism expenditure is quite relevant as proportion of the domestic household expenditure (see the following table):

SHARE OF THE TOURISM EXPENDITURE ON THE DOMESTIC HOUSEHOLD EXPENDITURE

| | | | |
|---|---|---|---|
| Piemonte | 3.3 | Marche | 9.4 |
| Valle D’aosta | 29.3 | Lazio | 10.2 |
| Lombardia | 5.3 | Abruzzo | 7.9 |
| Trentino A. Adige | 28.6 | Molise | 4.2 |
| Veneto | 9.8 | Campania | 4.7 |
| Friuli Venezia Giulia | 15.5 | Puglia | 4.3 |
| Liguria | 9.4 | Basilicata | 3.4 |
| Emilia Romagna | 11.0 | Calabria | 4.0 |
| Toscana | 9.5 | Sicilia | 3.2 |
| Umbria | 8.3 | Sardegna | 7.3 |

Source: authors calculations on IRPET data

The foreign exports of goods are provided by ISTAT and have a high reliability, on the contrary the foreign import, represent well the foreign demand addressed to italian regions.

The export of services has been estimated using the data on credits supplied by the ISTAT at regional level for two sectors: Financial Intermediation and Business Services. For the remaining service sectors, the initial estimate has been made by dividing among regions the corresponding datum figuring in the NAM. The following function (Costa and Martellato, 1988) determines the regional share of *i-th* region as function of the location quotient, and in turn, as proxy for productivity and competitiveness:

$$qx(r,i) = \frac{1}{1 + q(r) \cdot \frac{\frac{1}{q(r,i)} - 1}{q(r,i)}} \qquad [16]$$

where:
q (r) = total production share of the *r-th* region
q(r,i) = production share of sector i-th, region r-th

*The variance-covariance matrix*

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. There are different options to be found in literature, varying from the purely subjective approach to those more and more objective. In the first case an ordinal scale of judgement is formed, that can be associated to ranges of errors (UKCSO).

BCHS have followed this procedure and have associated a subjective ordinal scale of reliability to a value of variation coefficient. The subjective reliability judgement is based, principally, on the information of the data producers. A more objective reliability assignment is provided by Van der Ploeg (1982) and by Van der Ploeg and Weale (1984).

In following articles (Weale 1988) has been indicated how is possible to reach an estimate of the matrix of Var-Cov, 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.

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 specificities, 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[10] technique. The reliabilities have been distributed in an ordinal way, according to 10 degrees and transformed in variance according to the equation [17] (Stone 1990):

$$[17] \quad \sigma^2{}_{r,i,j} = \left(r_{r,i,j} \cdot t(0)_{r,i,j}\right)^2$$

The range of reliability varies from the highest one (0 variance), for all regional variables provided by ISTAT (like Value Added, Household expenditure by purposes, foreign export of goods), to the lowest assigned to net interregional import. The next table shows some unweigthed average reliabilities resulting from some accounts (Table 1.3).

As mentioned at the beginning of the section, most of the preliminary estimates come as the result of linear combinations or products of other initial estimates. In particular there are two variables used for this purpose: the total domestic regional demand and the production[11].

1.3
AVERAGE RELIABILITIES

| | Average |
|---|---|
| Intermediate inter-industry flows | 2.51 |
| Households expenditure (bridge matrix) | 1.23 |
| Gross Fixed Investments (bridge matrix) | 0.59 |
| Government and NPISHs expenditure (bridge matrix) | 1.52 |
| Net Interregional imports | 7.76 |
| Indirect Taxes | 3.30 |
| Foreign Imports | 5.14 |
| Foreign exports | 2.83 |

Source: authors calculation on IRPET data

Therefore, an important consequence would be covariances different from 0 and the Var-Cov matrix no longer diagonal. We preferred to continue with a diagonal matrix for two reasons. The first one, strictly practice, because the loss of diagonality

[10] Indeed for some variables we could utilize the sampling standard deviation as provided by ISTAT. This is the case of the total intermediary costs drawn by the survey on "Economic Accounts of Enterprises".

[11] For instance the reliability of the net interregional import, as it has been estimated, should considerate the reliability associated to the total domestic demand and the distributed production.

in V would have led to heavy algorithmic and computational implications. The second, more numerical, is tied to the fact that the covariances have been resulted as relatively very low, so it has been thought that such omission (however to be overcome in the next developments) would have affected the final estimates in an unbiased way.

*Some results of balancing process for the base year*

The results of the balancing process, in terms of mean absolute percentage adjustment, are shown in table 1.4.

The MAPA is the function of the structure of the variance of each initial RAMs, and it is possible to observe how, *mutatis mutandis*, the balancing procedure has operated more in the southern regions and in the smaller ones. In table 1.4 the aggregates most affected by the balancing have been the foreign trade and the net interregional import. It is interesting to notice how, in regions with a more marked positive/negative tourism balance, the consumption bridge matrices are more affected.

1.4
MEAN ABSOLUTE PERCENTAGE ADJUSTMENT (MAPA)

| Regions | Intermediary Input | Household Expenditure | Gross Fixed Investments | Net Interregional import | Foreign Import | Net Indirect Taxes |
|---|---|---|---|---|---|---|
| Piemonte | 8.0 | 3.5 | 1.6 | 12.8 | 3.8 | 5.2 |
| Val D'Aosta | 14.0 | 21.9 | 7.5 | 24.2 | 22.1 | 20.0 |
| Lombardia | 5.5 | 6.9 | 4.6 | 15.8 | 6.8 | 10.5 |
| Trentino A.A. | 17.5 | 19.5 | 7.3 | 26.9 | 19.5 | 28.7 |
| Veneto | 6.7 | 1.9 | 1.6 | 19.7 | 4.3 | 3.8 |
| Friuli V.G. | 9.7 | 2.5 | 0.8 | 24.3 | 7.0 | 3.5 |
| Liguria | 6.0 | 4.8 | 3.9 | 20.6 | 7.6 | 4.3 |
| E.Romagna | 8.6 | 2.2 | 1.6 | 10.6 | 4.8 | 5.7 |
| Toscana | 6.6 | 1.6 | 2.3 | 9.7 | 6.1 | 5.8 |
| Umbria | 12.3 | 3.7 | 2.0 | 19.6 | 11.8 | 6.8 |
| Marche | 7.2 | 1.4 | 2.1 | 16.8 | 15.5 | 11.4 |
| Lazio | 8.2 | 3.9 | 2.7 | 9.3 | 12.0 | 4.3 |
| Abruzzo | 12.8 | 5.3 | 4.2 | 26.8 | 20.9 | 16.0 |
| Molise | 16.6 | 5.4 | 3.0 | 31.8 | 22.8 | 26.6 |
| Campania | 10.2 | 6.4 | 4.2 | 18.4 | 9.3 | 6.8 |
| Puglia | 9.8 | 8.6 | 6.5 | 16.6 | 10.4 | 12.9 |
| Basilicata | 15.1 | 4.7 | 5.2 | 33.1 | 20.5 | 20.7 |
| Calabria | 17.3 | 9.5 | 3.9 | 34.9 | 24.3 | 9.4 |
| Sicilia | 10.5 | 2.2 | 3.3 | 24.5 | 25.2 | 27.6 |
| Sardegna | 16.4 | 8.6 | 3.7 | 26.0 | 20.4 | 23.9 |

Source: authors calculations on IRPET data

## 1.2
## The multi-regional trade

The estimate of the trade flows among regions, is one of the most relevant problems for the building of multi-regional I-0 tables, especially because the most common situation is a big lack of data concerning that trade.

As quoted before, the availability of fully consistent RAMs allows to use for each region: the total domestic demand, the total distributed production, the net interregional import, the foreign import and the foreign export.

For each single sector *i-th* we got the following regional values*:*

a) $_{r.}t_{i}$ –total production net of foreign export;

b) $_{s}t_{i}$ - total domestic demand net of foreign import.

Given those elements, a broad amount of literature suggests, for estimating matrix T, the class of gravity models derived by newtonian physics (for a good review see Isard 1998).

The main hypothesis suggests basically that the flows between two regions are directly proportional to their "economic masses" and inversely proportional to a decay (deterrence) function, which should represent the cost of transaction between the *r-th* and *s-th* region for sector *i-th*. Following the Leontief-Strout (1963) formalization we can write:

[18] $${}_{rs}t_{i} = ({}_{r}X_{i} \cdot {}_{s}D_{i}) / Q_{i} \cdot f({}_{rs}\delta_{i})$$

The interregional flows between *r* and *s* are function of the output mass X (expulsion force), from the demand mass *s* (attraction force), through a connection or decay function.

Their economic masses are represented by the total output X in the *r-th* and the total demand D in the *s-th* region. Q is the total amount of products of sector *i-th* and f(d) is the decay function. It is possible to hypothesize that such function should be inversely proportional to the economic distance, and also to other variables that will be discussed later. To be noticed that, without any decay function, the flows between the two regions will be only the product of the *r-th* region's probability to sell and the *s-th* region's probability to import, which means the assumption of independence between origin and destination[12].

Concerning our case, the masses will be represented by the marginals $_{r.}t_{i}$ and $_{.s}t_{i}$, so the solution of the gravity model will be double constrained (eq. 19):

[19] $${}_{rs}t_{i} = ({}_{r.}t_{i} \cdot {}_{.s}t_{i}) / t_{i} \cdot f({}_{rs}\delta_{i})$$

st.

$${}_{r.}t_{i} = \sum_{s=1}^{n} {}_{rs}t_{i}$$

$${}_{.s}t_{i} = \sum_{r=1}^{n} {}_{rs}t_{i}$$

*The deterrence function: specification*

For estimating and testing the deterrence function, we have utilized some data drawn by an ISTAT survey on commodities interregional flows (ISTAT 1998), in quantity (tons) and

[12] This is the main hypothesis of the pooled multi-regional model proposed by Leontief. et al. (1977).

aggregated by 5 macro-sectors. By using those data there are two possible solutions to econometric estimate. First, we can estimate the deterrence functions for any *k-th* macro-branch, later we can extrapolate that function for the *i-th* sector belonging to the *k-th* macro-branch. The second solution consists in a pooled estimate for all macro-branches and all regions. Given the high aggregation and the heterogeneity of the macro-sectors, we decided to perform a pooled (regions/sectors) regression. In order to specify the decay model we should answer to the following question: given the marginals, what could facilitate the products flow of sectors *i-th* from region *r-th* to region *s-th.*

The first variable to be included is the distance, as proxy of the transport cost, between region *r-th* and region *s-th*. Its calculation is based on provinces (NUTS-3) making up regions, so the distance between two regions is equal to the average distance between their own provinces. This methodology allow to compute the distance of a region (diagonal of the matrix) as average distance among provinces of the same region.

Another important explanatory variable is the propensity to intra-industry trade[13] which can be caused by (Stone 1997, quoted in Munroe and Hewings 2000):

a) Industry based determinants (vertical product differentiation, vertical interregional production integration, cost structure);
b) Regional characteristics (mainly income level) product.

Another cause is strictly linked to classification and its degree of aggregation. This is a sector-specific variable and it has been measured by the Grubel-Lloyd index[14] computed at national level for foreign trade. The hypothesis is that, *ceteris paribus*, a higher propensity to intra-industry trade could reduce the effect of the economic distance. Another sector specific explanatory variable is the degree of trade-ability. This (see Bower et al. 1983) should indicate the propensity of the products of a sector to be traded, given their physical features. This indicator has been proxied by a trade openess index[15] computed at national level.

The relative regional economic size (share of GDP) should act as region specific factor.

Therefore, the deterrence model should be the following:

$$[20] \quad {}_{rs}f_i = \ell({}_{rs}d, IIT_i, TRADE_i, {}_r SIZE) \quad r,s=1,\text{number of regions}; \; i=1,\text{number of sectors}$$

where:
IIT = Grubel-Lloyd Intra Industry Trade index
d = economic distance
TRADE = degree of trade-ability
SIZE = region economic size

13 At interregional level see for instance Munroe-Hewings (2000).

14 See Grubel; and Lloyd (1971), "The empirical measurement of intra-industry trade", *Economic Records*.

15 The degree of openess is computed for each sector as: $u_i = (ew_i+mw_i)/x_i$.

*The deterrence function: estimate*

The first step for the econometric estimate of the deterrence function is the computing of the difference between the flow calculated without any deterrence function interaction and the actual ones. This step would allow to isolate the effect of the decay function on the multi-regional flows. Our estimate has been based on the data of commodity flows in quantity for five macro-sectors, so for each *k-th* of them, we can write the following equation:

[21] $${}_{rs}\phi_k = {}_{rs}\text{Actual}_i / {}_{rs}\text{Expected}_i$$

where:
Expected = $({}_{r.}t_i \cdot {}_{.s}t_i) / t_i$

This will allow to estimate the following pooled model in log-log specification:

[22] $$\log({}_{rs}\phi_k) = a + b \cdot \log({}_{rs}d) + c \cdot \log(IIT_i) + \\ + d \cdot \log(TRADE) + e \cdot \log({}_{r}SIZE)$$

r,s=1,number of regions;
k = 1, number of macro-branches

In table 1.5 the result of regression.

1.5 PARAMETERS ESTIMATE OF THE DETERRENCE FUNCTION

| Explanatory variables | Parameters | Standard eErrorerrors | R-square bar |
|---|---|---|---|
| Intercept | 0.92171 | 0.37587 | 0.5160 |
| 1/distance | 0.90220 | 0.05575 | |
| IIT index | 0.14351 | 0.05636 | df. |
| TRADE | 0.44638 | 0.08129 | 970 |
| SIZE | -0.19330 | 0.11428 | |

Source: authors calculations on IRPET data

The results are encouraging both in terms of goodness of fit, parameters signs and specification tests.

We can extrapolate this function for all sectors by inserting the deterrence explanation variables in equation [23] for all sectors. That equation should be expanded as follows:

[23] $${}_{rs}t^*_i = a \cdot \left[({}_{r.}t_i \cdot {}_{.s}t_i)/t_i\right] \cdot \\ \cdot \left[\cdot(1/{}_{rs}d)^b \cdot (IIT_i)^c \cdot (TRADE_i)^d \cdot ({}_{r}SIZE)^e\right]$$

The equation [26] does not guarantee multi-regional consisted flows with marginal constraints, so they should be adjusted subsequently through a bi-proportional procedure[16].

[16] Concerning gravity model terminology; this means the calculation of the balancing factors such as the equation [26] becomes:

$${}_{rs}t_i = {}_{r}\alpha_i \cdot {}_{s}\beta_i \cdot \left[({}_{r.}t_i \cdot {}_{.s}t_i)/t_i\right] \cdot \left[\cdot(1/{}_{rs}d)^b \cdot (IIT_i)^c \cdot (TRADE_i)^d \cdot ({}_{r}SIZE)^e\right]$$

# 2.
# THE MULTI-REGIONAL MODEL

## 2.1
## Where do we stand in Italy

Despite the strong and persistent dualism and different regional growth patterns, Input-Output modelling at regional and multi-regional level has not found fertile ground in Italy, as in some other EU countries (see for instance the Netherlands), both at academic and institutional.

While the national I-O tables have been produced on a regular basis by ISTAT, since 1959, I-O tables at uniregional and interregional level were only built by regional research Institute or private associations. Many of them were built by using non survey methods, through the division into regions of national I-O matrix, while only in five regions have been utilized survey methods to estimate parts of the matrix. Except for one case (Tuscany), the regional and multi-regional tables listed below, were completely left without any kind of maintenance and data updating. Paradoxically, in Italy was built the first biregional I-O table by W.Chenery (1953) for the US Mutual Agency as regionalization of the first national I-O matrix. Later in the 60' were produced uniregional tables for Sicilia, Piemonte, Friuli-Venezia Giulia Sardegna and Veneto[17]. Nevertheless, the "golden age" of the I-O modelling in Italy could be dated in the 70s' and in the first part of the 80s, when many regions were "covered" by I-O tables[18]. Even at multi-regional/biregional level there were four I-O North-South tables[19] and one macroregional I-O matrix[20].

No other I-O regional matrices have been built in the 90's except for the multi-regional table set by IRPET in 1995 (Casini, Raffaelli and Martellato, 1995), which is still the base dataset for other regional and interregional economic models (see amongst the most relevant Fachin and Venanzoni, 2002), and the current one which develops on the basis of the previous.

[17] For a review of regional I/O tables during the 50's and the 60's see B. Ferrara.

[18] See Casini Benvenuti, Cavalieri, Grassi and Martellato (1988) for a I-O regional tables review for 70's and 80's.

[19] Pilloton e Schacter (1983), Ferrara (1976), Di Palma, Bracalente and Daddi (1981) as in D'Antonio, Leonello and Colaizzo (1988) the biregional I-O was inserted in a SAM framework.

[20] Costa and Martellato (1988).

## 2.2
## Model structure

The model is based on two main causal relations:

1) technical: which is the main determinant of the regional intermediary demand:
2) allocative: which is the determinant of the production distribution among regions. Given the exogenity of the final demand, we can formalize them as follow:

[24.1] $d = A \cdot x + f$

[24.2] $x = T \cdot d$

The causation of the total demand is measured by the technical coefficients, as for the allocative pattern by the interregional trade coefficients matrix T. This is the typical approach of Chenery (1953)-Moses(1955) class of models, in between the pool approach (Leontief et al. 1977) and the "pure" interregional model (Isard 1960)[21]. The main assumption of such class of I-O model is that the interregional import flow of *i-th* good from *r-th* region to *s-th* region is a constant share of the demand of sectors of i-*th*, which implies stability of interregional market shared by each sector. It is important to notice that the previous assumption leads to competitive interregional import, and in the IRPET model (henceforth IRPET-MRIO) we also assume that foreign import is competitive with regional production and interregional import.

Hereafter the structural form[22]:

[25]

$$
\begin{aligned}
&[\text{I}] \quad x + s + tn - d + mw + mr = A \cdot x + f + ew + er\\
&[\text{II}] \quad f = c + g + i + dsc\\
&[\text{III}] \quad s = S \cdot (A \cdot x + f)\\
&[\text{IV}] \quad tn = N \cdot x\\
&[\text{V}] \quad d = \hat{D} \cdot x\\
&[\text{VI}] \quad mw = \hat{M} \cdot (I - S) \cdot (A \cdot x + f)\\
&[\text{VII}] \quad mr = \hat{B} \cdot (I - M) \cdot [(I - S) \cdot (A \cdot x + f)]\\
&[\text{VIII}] \quad er = \breve{B} \cdot (I - M) \cdot [(I - S) \cdot (A \cdot x + f)]
\end{aligned}
$$

where:

x = Production at basic prices
s = Indirect Taxes on products and VAT
tn = Product Transfers
d = Production Subsidies

[21] See for a review of the classes of models and their hypothesis: Batten-Martellato 1988 and Hewings-Jensen 1986.

[22] An IRPET-MRIO version close to household expenditure is forthcoming.

mw = Foreign import (fob)
mr = Interregional Import
f = Final regional domestic demand
ew = Foreign export (fob)
er = Interregional export
c = Household expenditure
g = Government and NPISHs expenditure
i = Gross Fixed Investments
dsc = Changes in inventories
A = Intermediate input coefficients.
S = Indirect Taxes and VAT coefficients
D = Production Subsidies coefficients.
N = Product Transfers coefficients.
M = Foreign import coefficients
$\hat{B}, \breve{B}$ = Interregional import-export coefficients deriving from the transformation of the multi-regional trade flows coefficients matrix T.

In particular:

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

In equation [29] the reduced form of the model:

[27] $$x = \left[(I + N - D) - T \cdot (I - M) \cdot (I - S) \cdot A\right]^{-1} \cdot \left\{\left[T \cdot (I - M) \cdot (I - S)\right] \cdot f + ew\right\}$$

if:

[28] $$R = T \cdot (I - M) \cdot (I - S) \cdot A$$

we could write:

[29] $$x = [I + T - D - R \cdot A]^{-1} \cdot \{(R \cdot f) + ew\}$$

The interpretation of the structural form is the following: the initial identity defines the sectorial resource and uses, as identity [25.I] compounds the domestic final demand. In equation [25.III] the indirect taxation on products and VAT is set as function of the total regional domestic demand. To be noticed that at national level the same variable is function of the level of production. This difference comes out because ISTAT shares out the indirect taxes on product among the regions through the regional total demand, so taxes on product are assigned to the regions which pay for them, buying intermediate and final products, both imported and coming from their own production. Equations [25.IV] and [25.V] complete the definition of distributed production through the specification of production subsidies and Product transfers. Equations [25.VI] consider the foreign import as function of total internal demand net of indirect taxes on product, as equation 25.VII and 25.VIII explain the interregional trade both import and export.

## 3.
## APPLICATION OF THE MODEL

### 3.1
### Some data on Italian regional disparities

Italy is the EU country with the highest regional disparities. Only Germany, after the reunification, has reached the same level in terms of variance of regional per capita GDP. As Calabria is to be considered among the poorest regions, Lombardia and Emilia-Romagna belong to the richest club. The North-Centre economic system is a very advanced one, while the southern one maintains still several characteristics of a marginalized economy.

The following table 3.1, shows some economic indicators by it is possible to notice the gap and the polarization between the two main macro-regions in all variables listed below, except for the small regions (Umbria, Trentino Alto Adige and Valle d'Aosta).

3.1
MAIN ECONOMIC INDICATORS FOR ITALIAN REGIONS 1998 (*)

| | Per capita GDP (Italy=100) | Per capita Household expenditure (Italy=100) | Share of Value Added Manufacturing | Unemployment rate |
|---|---|---|---|---|
| Piemonte | 115.9 | 105.9 | 28.23 | 8.3 |
| Valle d'Aosta | 130.6 | 155.3 | 8.99 | 5.3 |
| Lombardia | 131.5 | 112.1 | 28.63 | 5.5 |
| Trentino-Alto Adige | 133.3 | 137.0 | 14.90 | 3.2 |
| Veneto | 117.7 | 106.6 | 28.81 | 5.0 |
| Friuli-Venezia Giulia | 112.0 | 108.4 | 22.36 | 5.6 |
| Liguria | 107.2 | 115.1 | 11.73 | 10.2 |
| Emilia Romagna | 127.9 | 116.1 | 26.96 | 5.4 |
| Toscana | 109.5 | 108.0 | 23.21 | 7.8 |
| Umbria | 95.7 | 100.7 | 19.83 | 8.6 |
| Marche | 100.7 | 102.0 | 26.17 | 6.3 |
| Lazio | 110.0 | 107.5 | 10.64 | 11.8 |
| Abruzzo | 83.8 | 90.9 | 21.14 | 9.1 |
| Molise | 77.9 | 85.1 | 17.67 | 16.8 |
| Campania | 64.4 | 78.6 | 9.48 | 23.8 |
| Puglia | 65.2 | 79.9 | 14.03 | 20.3 |
| Basilicata | 70.3 | 78.6 | 15.57 | 18.1 |
| Calabria | 60.9 | 82.0 | 6.35 | 26.1 |
| Sicilia | 65.9 | 83.4 | 9.23 | 24.2 |
| Sardegna | 75.9 | 90.2 | 10.36 | 20.6 |
| ITALY | 18630.1 (**) | 14591.1 (**) | 21.1 | 11.8 |

Source: authors calculations on ISTAT data

(*) ISTAT data on regional economic accounts available on the 1st of September 2002

(**) Millions of euros

The net resources and uses accounts for the four main macro-regions are introduced below (Table 3.2). As we expected, emerges that the regions with the highest negative net imports are in the NW and in the NE, while strongly negative are the performances of the southern regions. In between, the central regions with positive balances towards abroad and the southern regions, and also negative net export towards Northern regions.

3.2
AGGREGATE NET RESOURCES AND DOMESTIC USES ACCOUNTS FOR ITALIAN MACROREGIONS
Millions of euro 1998 (*)

| | North-West | North-East | Centre | South |
|---|---|---|---|---|
| *Net Resources* | | | | |
| Gross Domestic Product | 348950.9 | 240139.1 | 22179.0 | 261486.9 |
| Net Import | -41976.9 | -16093.0 | -9575.5 | 42686.7 |
| origin: North-West | 0.0 | 6194.2 | 2236.7 | 15057.5 |
| North-East | -6312.8 | 0.0 | 129.5 | 8770.8 |
| Centre | -2350.6 | -133.6 | 0.0 | 10452.1 |
| South | -15503.9 | -8861.3 | -10240.7 | 0.0 |
| Abroad | -17809.7 | -13292.4 | -1701.1 | 7948.6 |
| *Domestic Uses* | | | | |
| Household expenditure | 194722.7 | 137087.6 | 131785.6 | 179286.5 |
| NPISHs expenditure | 1381.0 | 1178.2 | 1151.1 | 1163.5 |
| Government expenditure | 47758.8 | 35614.9 | 38814.3 | 70329.0 |
| Gross Fixed Investments | 60638.9 | 47441.7 | 39151.1 | 51496.4 |
| Changes in inventories | 2472.5 | 2723.6 | 1235.3 | 1898.2 |

Source: authors calculations on ISTAT and IRPET data

(*) ISTAT data on regional economic accounts available on the 1st of September 2002

## 3.2
## Some structural evidences

*A demand side structural explanation of regional performances*

The current debate on the short term performances of the italian regions often fails to consider the structural features of the regional economies, which can affect quite substantially their short term behaviour. If we assume that in the short run the regional performances are mainly driven by final demand components, we can apply the multi-regional model in order to estimate, in a proper way, the contribution of each of them in determining the GDP. Such information is quite important because could shed light on the determinants of the cyclical behaviour of the regions. The result is influenced by three structural factors:

1) the relative size (share) of the final demand components. A region with a high share of foreign export over the total final demand is likely to get, *ceteris paribus*, a high share of value added activated by them;
2) the industry-mix of the total (direct and indirect) intermediary inputs activated by each final demand component;
3) the allocative factor which should determine the ability of a region to retain its own impact (to lower the spill over) and to catch the spill-over of other regions.

In table 3.3 figures the percentage of total Value Added at basic prices activated by the different exogenous component of final demand.

The italian regions are clearly differentiated concerning the value added determinants (Table 3.3).

3.3 PERCENTAGE SHARE OF VALUE ADDED DETERMINED BY SELECTED FINAL DEMAND COMPONENTS

| | Household expenditure | | Gov. and | Gross Fixed Investments | | Changes in | Foreign |
|---|---|---|---|---|---|---|---|
| | Resident Households | Tourism | NPISHs expenditure | Construction | Others | inventories | Export |
| Piemonte | 38.3 | 3.7 | 12.8 | 5.8 | 7.4 | 0.8 | 25.3 |
| Valle d'Aosta | 30.7 | 9.9 | 24.6 | 7.2 | 4.2 | 0.4 | 11.9 |
| Lombardia | 38.3 | 4.7 | 11.3 | 5.4 | 7.1 | 0.6 | 27.1 |
| Trentino Alto Adige | 24.9 | 19.4 | 18.7 | 8.3 | 5.1 | 0.6 | 14.7 |
| Veneto | 32.5 | 9.7 | 12.2 | 6.9 | 6.4 | 0.7 | 24.7 |
| Friuli V. Giulia | 31.4 | 10.0 | 16.8 | 5.7 | 5.9 | 0.6 | 24.0 |
| Liguria | 38.7 | 10.9 | 18.7 | 4.7 | 6.4 | 0.5 | 15.5 |
| Emilia-Romagna | 35.1 | 9.0 | 12.5 | 6.6 | 6.7 | 0.9 | 22.6 |
| Toscana | 34.5 | 11.2 | 16.0 | 5.6 | 5.7 | 0.6 | 20.9 |
| Umbria | 39.3 | 8.3 | 18.3 | 6.6 | 5.9 | 0.7 | 14.2 |
| Marche | 37.9 | 8.5 | 16.2 | 6.0 | 6.0 | 0.4 | 19.0 |
| Lazio | 38.2 | 8.5 | 23.2 | 6.2 | 5.5 | 0.3 | 12.0 |
| Abruzzo | 36.9 | 9.1 | 19.6 | 6.5 | 5.6 | 0.6 | 15.3 |
| Molise | 37.0 | 5.9 | 24.8 | 7.3 | 5.0 | 0.6 | 12.1 |
| Campania | 40.3 | 5.9 | 25.1 | 6.2 | 5.3 | 0.5 | 10.5 |
| Puglia | 41.8 | 7.2 | 23.1 | 5.9 | 5.0 | 0.5 | 10.7 |
| Basilicata | 37.3 | 4.9 | 25.3 | 8.4 | 4.9 | 0.6 | 10.3 |
| Calabria | 42.7 | 7.3 | 27.4 | 6.9 | 4.1 | 0.3 | 4.3 |
| Sicilia | 42.1 | 5.9 | 27.3 | 6.7 | 4.1 | 0.1 | 7.0 |
| Sardegna | 35.1 | 9.9 | 24.4 | 8.5 | 4.7 | 0.3 | 8.6 |

Source: authors calculations on IRPET data

First, the interregional difference in the share of foreign export is quite wide, from the highest percentages recorded in Lombardia, Veneto, Piemonte and Emilia-Romagna, to the lowest of Calabria, Sicilia and Sardegna (almost 20 percentage points difference). Among the southern regions, only Abruzzo recorded a "northern type" share. Second, the role of government expenditure shows a complete different interregional profile. Except for the autonomous regions and Lazio, exists a wide difference between southern and northern region. The difference between Calabria (the highest share) and Lombardia (the lowest one) is about 16%. A third differentiating factor is the tourism expenditure, which plays a strategic role in some regions. It is the case of two small regions like Valle d'Aosta and, above all, Trentino Alto Adige, where the value added activated by such expenditure is respectively 14% and 20%. Friuli Venezia Giulia, Veneto and Toscana are the industrial developed regions which can also rely on an additional significant push provided by a high impact of tourism expenditure. Among the southern regions, only Abruzzo and Sardegna can get shares in line with the northern and central regions. To be noticed the different contributions provided by both types of investments. As other types of investments (mainly machinery and transport equipment) are important for the Northern regions (mainly Lombardia, Veneto and Emilia-Romagna), investments in construction do not follow a determined North/South pattern.

Previous given details should work as a warning in using a national model in order to design economic policies. Indeed, national policies without any spatial constraints are affecting in a significant way regional disparities.

3.4
PERCENTAGE INCREASE IN GDP PER CAPITA DUE TO A 10% SHOCK IN THE FINAL DEMAND COMPONENTS AT NATIONAL LEVEL

| | Household expenditure | Govt. and NPISHs Expenditure | Gross fixed Investments | | Foreign Export |
|---|---|---|---|---|---|
| | | | Construction | Equipment | |
| North-West | 4.5 | 1.2 | 0.7 | 0.5 | 2.3 |
| North-East | 4.5 | 1.3 | 0.6 | 0.7 | 2.2 |
| Centre | 4.4 | 1.6 | 0.5 | 0.6 | 1.9 |
| Lazio | 4.2 | 2.2 | 0.5 | 0.6 | 1.1 |
| South | 4.1 | 2.4 | 0.5 | 0.6 | 0.8 |

Source: authors calculation on IRPET data

Table 3.4 displays the estimate of the dis-equalizing impact of the changes on final demand component due to a national shock. According to the table above, 10% increase in foreign export, *ceteris paribus*, could increase the per capita GDP in the NW region by 2.3% and only 0.8% in the South, therefore the gap would increase by 1.5%. On the other hand, southern regions are more sensitive to public expenditure. Currently these are not some good news, given the hard budget constraints imposed by EU Stability Pact, even at local level, which means that they could have a significant dis-equalizing impact by turn. More flat is the elasticity of the household expenditure and investments in construction.

*Losers and winners in the interregional trade*

If we provide a small impulse to the regional final demand the result in term of aggregated value added[23] will be function both of the allocative and technological patterns embedded in the inverse matrix in [29] and of the final demand injection pattern. By dividing the value added totals resulting from the solution of the reduced forms and by appropriate sums of final demand injections, we will end up with some indicators showing either a dampener or multiplier region. As in Casini, Martellato and Raffaelli (1995), we define dampener when the change of the value added in a *r-th* region is lower than the final demand change of the same region, so the result is smaller than unity. For that region, the allocative and technological pattern embedded in the inverse act as dampeners, because the value added is partially spilled over other regions. If the result for a region is greater than unity, we may instead conclude that for region *r-th* the allocative and technological patterns act as multipliers.

Figure 3.5 shows the value added multipliers and dampeners by region.

[23] $y = \hat{V} \cdot [I + T - D - R \cdot A]^{-1} \cdot \{(R \cdot f) + ew\}$ where V=diagonal value added coefficients matrix.

3.5
DAMPENERS AND MULTIPLIERS REGIONS


From the figure above, we can trace the profile of the multipliers regions: Piemonte, Lombardia (the highest ratio) Veneto, Emilia Romagna and Lazio[24], in successive order figure those regions which are very close to unity, that we call neutral: Toscana, Friuli Venezia Giulia, Liguria and Marche. Except for Valle d'Aosta and Trentino Alto Adige, where the strong tourism expenditure and the small regional dimension could affect the result, the dampeners and highly dampeners regions are all southern regions and Umbria.

## 3.3
## A policy simulation: The effect of a fiscal policy measure

The fiscal federalism, the re-emerging debate on spatial inequality, and the hard budget constraints imposed by the EU Stability Pact, have focused the attention on the fiscal policies at local (regional level) and their coordination with the national policy. Except for expenditure linked to interests on Public Debt, the instruments to keep the PSBR ratio under control are taxation

[24] Lazio is the capital region and most part of multiplier effects is due to the highest net export of Public Administration services. At first sight this seem to be quite counterintuitive because they should not be tradable, but what comes out from the regional accounts is a wide and significant imbalance between the Public Administration production and demand in Lazio, contrary to the other regions that seem "to buy" non tradable Public Administration services (like for instance Defense) from Lazio.

and public expenditure. Would be crucially important to know the costs and benefits on average (in GDP terms) concerning the use of those instrument, in particular income taxation which is becoming the most sensitive policy measure. In order to realize this simulation we are forced to use the bi-regional (North-South) version of the IRPET-MRIO model, because for those two macro-regions only, data on households disposable income account, according to ESA95 (courtesy by SVIMEZ 2002), are available, which has allowed to estimate at this level of spatial aggregation, a model partially closed to household expenditure. The equation that must be added to the model [27] is the following:

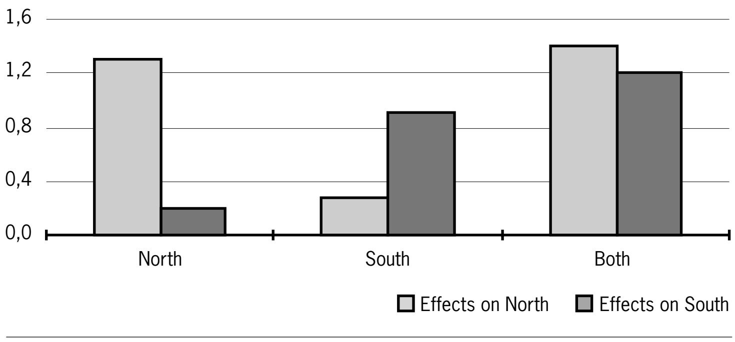
[27.IX] $$c = H \cdot x + k$$

Household expenditure is divided into two components. The first one -k- is exogenous and composed by expenditure related to public transfers (mainly pensions) and non resident consumption (mainly tourism). The second one is endogenous and linked to primary and, partially, secondary distribution (represented in the parameters in H). The simulation is based on 10% shock on the income tax bill, in both macroregions, which corresponds to:

a) 1.9% of the income tax rate over GDP in the North and 1.3% in the South;
b) 2.2% average income tax rate on disposable income in the North and 1.8% in the South. The main simulation hypothesis is an unchanged average propensity to consume.

In Figure 3.6 it is possible to see the GDP elasticities vs. shocks on income tax.

3.6
BIREGIONAL GDP EFFECTS OF AN INCOME TAX REDUCTION




Source: authors calculation on IRPET data

In the North there will be an increase in GDP by 1.3%, higher than the southern (0,9%) GDP growth. The spill-over effects are less in the North comparing to the South. By summing up the decrease by 10% of the income tax bill, the differential growth among the two regions will increase by 0,4%.

# IN LIEU OF A CONCLUSION

The MRIO-IRPET is at first stage of implementation and it has already been extensively utilized[25] for impact analyses. The second stage of construction should improve two particular aspects: a better estimate of multiregional trade and an endogenization of household expenditure. Nevertheless we have been able, for a macroeconomic policy, to show the importance of control for regional differential patterns of economic growth. This can be noticed particularly in Italy, where disparities are extremely high compared to the EU, and where designing policy measures at national level could get spatially dis-equalizing effects. In a dualistic system, a national model could be driven mainly by the leading macro-region, producing biased framework for designing economic policies, in this way only a multi-regional/multi-industry model could tackle properly different economic performances and structures.

Despite I-O multi-regional modelling in Italy is currently neglected both by policy makers and by many research institutes, we hope that the new institutional (see federalism) and economic (regional cohesion policies) challenges will get a renewed interest for such class of models, especially for policy analysis.

[25] For instance IRPET-MRIO has been utilized by the national government for assessing the impact of the infrastructural plan on the economy of southern regions (Ministry of the Economy and Finance, DPEF 2003-2006).

APPENDICE

A.1
ITALIAN REGIONS AND MACRO-REGIONS

A.2 ESA95 NACE REV. 1 CODE AND DENOMINATION OF THE 30 SECTORS

| | |
|---|---|
| A | Agriculture, hunting and forestry |
| B | Fishing |
| CA | Mining and quarrying of energy producing materials |
| CB | Mining and quarrying, except of energy producing materials |
| DA | Manufacture of food products, beverages and tobacco |
| DB | Manufacture of textiles and textile products |
| DC | Manufacture of leather and leather products |
| DD | Manufacture of wood and wood products |
| DE | Manufacture of pulp, paper and paper products; publishing and printing |
| DF | Manufacture of coke, refined petroleum products and nuclear fuel |
| DG | Manufacture of chemicals, chemical products and man-made fibres |
| DH | Manufacture of rubber and plastic products |
| DI | Manufacture of other non-metallic mineral products |
| DJ | Manufacture of basic metals and fabricated metal products |
| DK | Manufacture of machinery and equipment n.e.c. |
| DL | Manufacture of electrical and optical equipment |
| DM | Manufacture of transport equipment |
| DN | Manufacturing n.e.c. |
| E | Electricity, gas and water supply |
| F | Construction |
| G | Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods |
| H | Hotels and restaurants |
| I | Transport, storage and communication |
| J | Financial intermediation |
| 72 - 73 - 74 | Business services, R&D and IT |
| L | Public administration and defence; compulsory social security |
| M | Education |
| N | Health and social work |
| O-P-Q | Other community, social and personal service activities |
| 70 - 71 | Real estate and renting |

A.3
ESA95: COICOP CODE (3 DIGITS) AND DENOMINATION

| | |
|---|---|
| 01 | Food and non-alcoholic beverages |
| 01.1 | Food |
| 01.2 | Non-alcoholic beverages |
| 02 | Alcoholic beverages, tobacco |
| 02.1 | Alcoholic beverages |
| 02.2 | Tobacco |
| 03 | Clothing and footwear |
| 03.1 | Clothing |
| 03.2 | Footwear |
| 04 | Housing, water, electricity, gas and other fuels |
| 04.1 | Actual rentals for housing |
| 04.2 | Actual rentals paid by tenants including other actual rentals |
| 04.3 | Maintenance and repair of the dwelling |
| 04.4 | Water supply and miscellaneous services relating to the dwelling |
| 04.5 | Electricity, gas and other fuels |
| 05 | Furnishings, household equipment and routine maintenance of the house |
| 05.1 | Furniture and furnishings, carpets and other floor coverings |
| 05.2 | Household textiles |
| 05.3 | Household appliances |
| 05.4 | Glassware, tableware and household utensils |
| 05.5 | Tools and equipment for house and garden |
| 05.6 | Goods and services for routine household maintenance |
| 06 | Health |
| 06.1 | Medical products, appliances and equipment |
| 06.2 | Out-patient services |
| 06.3 | Hospital services |
| 07 | Transport |
| 07.1 | Purchase of vehicles |
| 07.2 | Operation of personal transport equipment |
| 07.3 | Transport services |
| 08 | Communication |
| 08.1 | Postal services |
| 08.2/3.0 | Telephone and telefax equipment and telephone and telefax services |
| 09 | Recreation and culture |
| 09.1 | Audio-visual, photographic and information processing equipment |
| 09.2 | Other major durables for recreation and culture |
| 09.3 | Other recreational items and equipment, gardens and pets |
| 09.4 | Recreational and cultural services |
| 09.5 | Newspapers, books and stationery |
| 09.6 | Package holidays |
| 10 | Education |
| 11 | Restaurants and hotels |
| 11.1 | Catering services |
| 11.2 | Accommodation services |
| 12 | Miscellaneous goods and services |
| 12.1 | Personal care |
| 12.3 | Personal effects n.e.c. |
| 12.4 | Social protection |
| 12.5 | Insurance |
| 12.6 | Financial services n.e.c. |
| 12.7 | Other services n.e.c. |

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