

## **The Interregional Trade in the Context of a Multirregional Input-Output Model for Spain**

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### **ABSTRACT**

In this paper we introduce the first version of a interregional input-output model for the Spanish Economy, built by a group of researchers from the L.R. Klein Institute using the following information:

- A complete set of 17<sup>th</sup> regional input-output tables built (or updated) for 1995 (one for each of the 17<sup>th</sup> Spanish regions-NUT2). All of them coherent with the National input-output Table.
- A set of interregional trade matrices, estimated for each kind of product.

Apart from a brief description of the main underpinnings of the model and the process of estimation, we focus on the strategy used for the estimation of this set of interregional trade matrices, using transport flows and value/weight relations indirectly deduced from detailed international trade statistics. Finally, by means of coefficients, maps and gravitational models, we analyse the most important intra and interregional flows in the light of the expected relations among flow intensity, geographical distance and sectoral specialisation.

**Keywords:** multiregional input-output model; interregional trade; spatial economy; gravity model; regional balances of goods; transports flows; origin and destination matrices, regional economics.

## **El Comercio inter-regional en el contexto de un modelo input-output multi-regional para España**

### **RESUMEN**

En este artículo se presenta un modelo input-output interregional de la economía española, que ha sido construido por un equipo de investigadores del Instituto L.R. Klein a partir de dos piezas de información:

- Una colección completa de 17 tablas input-output uni-regionales construidas (o actualizadas) para 1995 (una para cada Comunidad Autónoma) y armonizadas con los datos de la Contabilidad Regional y la Tabla Input-Output de España para 1995 del INE.
- Una colección de matrices interregionales de comercio estimadas para cada tipo de producto.

A parte de una breve descripción de los fundamentos del modelo y el proceso de estimación, el artículo se concentra en la metodología utilizada para la estimación de las matrices de comercio interregional, mediante el uso de flujos de transporte y relaciones valor/peso deducidas de las estadísticas de comercio internacional. Finalmente, mediante coeficientes, mapas y modelos gravitatorios se analizan los principales flujos intra e interregionales tratando de medir la importancia de la proximidad geográfica y especialización sectorial en las relaciones comerciales.

**Palabras Clave:** Modelo input-output multirregional; comercio interregional; economía espacial modelo de gravedad; balances regionales de bienes; flujos de transporte; matrices de origen-destino, economía espacial.

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## 1. INTRODUCTION

With the progressive consolidation of the European Single Market and the introduction of the Euro as a single currency, trade between Euro-countries takes place almost in the same way than between their regions. Before this two milestones of the European integration process, some authors discussed about their effects in terms of allocation of output and trade creation and diversion. Most of this works highlighted the importance of sectoral specialisation as one of the critical variables that would determine the final impact of this processes in each sector, region or country (European Economy, 1990, 1995, 1996; Eurostat & CEPII, 1996).

In parallel with this debate, some authors have pointed out the importance of the inter-european relations in some small and truly open economies such as Belgium and The Netherlands (Oosterhaven, 1981, 1995; Van der Linden et al, 1995; Llano C. 1998). Additionally, others have illustrated the existence of international clusters (Dietzenbacher 1997), that may induce higher inter-sectoral relations between a group of countries than those taking place in their own territory (Kollmann, 1995; Costello, 1993). As a consequence, sectoral specialisation of some regions could induce deeper backward or forward relations with foreign economies than with their neighbours, imposing stronger synchronicities with the cycle of other countries rather than with the national one (Cuadrado Roura et al, 1998).

Apart from these singular cases, although there are evidences about an increase in the intensity of intra-European economic relations (Oosterhaven J., 1995; Van der Linden et al, 1995; Llano C. 1998), most part of trade relations still takes place within the national territory (Munroe and Hewings, 1998; Llano, C. 2001; Oliver 2003). As a consequence, although regional dependence on international trade may increase in most of the European regions, it is expected that most part of the economic growth of a single region should still be explained by national causes (intra+interregional shocks).

Unfortunately, due to the usual lack of information on interregional economic relations, knowledge on this important part of the economy remains partially secluded.

In order to cope with this important gap, we introduce a multiregional-multisectoral model for the Spanish Economy, where the interregional linkages that are fuelling the economic growth of the Spanish regions are specifically considered. The model combines the spatial and sectoral dimensions, assuming the theoretical and empirical possibilities and limitations of the interregional input-output model (Isard, 1951; Oosterhaven J. 1984, 1988).

The paper begins with a brief description of the Isard extension of the Input-Output model. Then, we describe the theoretical underpinnings of the model and the method of construction. Then we focus on the estimation of the interregional trade matrices, that have been deduced indirectly using interregional physic transport flows and translated into monetary flows using international export prices. The article conclude

with a short analysis of the Spanish interregional trade in 1995, which is the reference date of the whole interregional input-output model.

## 2. THE INPUT-OUTPUT MODEL AND ITS SPATIAL EXTENSIONS

The Leontief open input-output model was conceived both as an accounting framework and a simulation model. Since input-output tables capture the economic relations between industries, primary inputs and final demand, they appears as the “bread and batter model” to analyse intersectoral economic relations (West G. 1995).

Using mathematical notation, this accounting relations are expressed using the following well known expressions,

$$X = AX + F \quad [1]$$

$X$  = Vector of total output produced by each sector.

$A$  = Matrix of total technical coefficients obtained from  $A = ZX$ .  
Being  $Z$  the Matrix of inter-industry demand relations.

$F$  = Vector of final demand

$$X = (I - A)^{-1}F = LF \quad [2]$$

Based on this classical specification of a national input-output table/model, different authors have proposed spatial extensions with the purpose of capturing the economic relations between industries of different countries or regions. The first spatial extension of the Leontief Model was the “Interregional input-output model” developed by Isard (Isard, 1951), where the spatial and sectoral origin and destination of intermediate and final relations were captured.

Following the classical notation (Miller y Blair 1985), an Interregional Input Output Model with  $N$  regions and  $n$  sectors can be denoted as:

$$\begin{bmatrix} X^1 \\ \dots \\ X^N \end{bmatrix} = \begin{bmatrix} A^{11} & \dots & A^{1N} \\ \dots & \dots & \dots \\ A^{N1} & \dots & A^{NN} \end{bmatrix} \times \begin{bmatrix} X^1 \\ \dots \\ X^N \end{bmatrix} + \begin{bmatrix} F^1 \\ \dots \\ F^N \end{bmatrix} \quad [3]$$

Being  $Z, A, X, F$ :

$$Z = \begin{bmatrix} Z^{11} & Z^{12} & \dots & Z^{1N} \\ Z^{21} & Z^{22} & \dots & Z^{2N} \\ \dots & \dots & \dots & \dots \\ Z^{N1} & Z^{N2} & \dots & Z^{NN} \end{bmatrix} \quad A = \begin{bmatrix} A^{11} & A^{12} & \dots & A^{1N} \\ A^{21} & A^{22} & \dots & A^{2N} \\ \dots & \dots & \dots & \dots \\ A^{N1} & A^{N2} & \dots & A^{NN} \end{bmatrix}$$

$$X = \begin{bmatrix} X^1 \\ \dots \\ X^N \end{bmatrix} \quad F = \begin{bmatrix} F^1 \\ \dots \\ F^N \end{bmatrix}$$

Where  $Z$  we have a block matrix with  $Z^{RL}$  off-diagonal matrices containing the intermediate relations<sup>1</sup> between region  $R$  and region  $L$  (inter-regional intermediate flows), and  $Z^{LL}$  on-diagonal matrices, with intermediate flows of region  $L$  (intra-regional intermediate flows). Each  $Z^{RL}$  off-diagonal matrix contains  $z_{ij}^{RL}$  elements, indicating the intermediate products from sector "i" in region  $R$  sold to sector "j" in region  $L$  (inter-regional intermediate flows) in one year.

Applying the Leontief Matrix approach to the inter-regional input output accounts, we have that:

$$X = (I - A)^{-1} F$$

$$\begin{bmatrix} X^L \\ \dots \\ X^N \end{bmatrix} = \left( \begin{bmatrix} I & \dots & 0 \\ \dots & \dots & \dots \\ 0 & \dots & I \end{bmatrix} - \begin{bmatrix} A^{LL} & \dots & A^{LN} \\ \dots & \dots & \dots \\ A^{NL} & \dots & A^{NN} \end{bmatrix} \right)^{-1} \times \begin{bmatrix} F^L \\ \dots \\ F^N \end{bmatrix} \quad [4]$$

Note that, although the mathematical notation of the one-region model is similar to that of the inter-regional one, the later includes new and more restrictive assumptions: now, on the on-diagonal elements of the  $A$  matrix, we have "Intra-regional Trade

Coefficients" ( $a_{ij}^{LL} = \frac{z_{ij}^{LL}}{X_j^L}$ ) while in the off-diagonal elements we have "interregional

<sup>1</sup> We use "intermediate flow" instead of "inter-industry flow" in order to avoid misunderstandings between "inter-sectoral flows of non-final products" and the concept of "inter-industry flow" used in the New Trade Theory.

trade coefficients" defined as  $a_{ij}^{LR} = \frac{z_{ij}^{LR}}{X_j^R}$ . As a consequence, apart from the "technical coefficients stability assumption" of a one-region input-output model, in the interregional one it is also assumed the stability of the intra and interregional trade coefficients.

## 2.1. The estimation of interregional trade: methods and examples

One of the critical factors that determines the kind of model to be estimated is the availability of interregional trade data. Usually, neither national statistical systems nor regional ones satisfy the sectoral and spatial detail required for the pure interregional input-output model. As a consequence, a large number of researchers have look for less-expensive approaches, watering down some theoretical assumptions (Chenery-Moses approach, Leontief Pool-approach...), or developing non-survey techniques for the estimation of regional and interregional technical and trade coefficients (see Batten 1983; Oosterhaven, 1984; Miller y Blair 1985).

**Table 1: Interregional trade within Multirregional input-output models: possible approaches**

	TECHNIQUE USED FOR THE ESTIMATION	SOME MODELS
<b>A POSTERIORI → A PRIORI</b>	<b>INDIRECT ESTIMATION</b>	
	Use of Gravitational model	TIM, (Funck et al. 1975 quoted in Batten 1983)
	Use of Entropy Maximising Paradigm	Batten (1983)
	Pool-Approach of Leontief	Leontief (1977) INTEREG (Benvenuti et al, 1995)
	<b>DIRECT ESTIMATION BASE ON REAL DATA</b>	
	Use of International trade flows	EU-IRIO (Oosterhaven et al., 1995)
	Use of Transport flows	MRIO-HERP (Polenske 1980; Hewings, 1993; Kazumi H., 2000). INTERTIO, (Llano, C 2004)
	Use of surveys designed ad-hoc for producers and consumers.	JAPAN IRIO TABLES (1960-70)
	Note: Classification proposed by the author based on previous work (Batten 1983)	

According to previous classifications (Oosterhaven J., 1984), our Multirregional Input-Output model, that combines survey-regional input-output tables, non-survey ones and a complex set of 26 interregional trade flows matrices, should be considered in a mixed position between the pure-survey vs pure-non-survey approaches: "as an hybrid between the so-called "multi-regional-columns-only input-output table" and its "inter-regional-columns-only" equivalent.

### 3. THE SPANISH MULTI-REGIONAL MODEL<sup>2</sup>

#### 3.1 The data

The construction of a *complete* multi-regional input-output model for the Spanish economy could be seen both as a process of spatial-disaggregation of the 1995 National Input-Output Table or as the interconnection of a complete set of 19 regional input-output tables (one for each of the Spanish regions plus Ceuta and Melilla plus Extra-regio<sup>3</sup>). Since not of our regions have a survey input-output table (or even if they have it they have been built with different methodologies), the interregional framework was obtained combining all the regional information available and the use of non-survey techniques for updating or estimating the old or non-existing ones. At the same time, once that the 19 regional input-output tables were estimated, the interconnection of all of them requires the use of interregional trade data. As a consequence of this requirements, the model is based on two different pieces of information:

- A complete set of 19 regional Input-Output tables, built (or updated) for 1995 (one for each of the 19 Spanish regions-NUT2), and harmonized individually to the constrain figures of the 1995 National Input-Output Table and the Regional Spanish Accounts, both from the Spanish National Institute of Statistics (SNIS).
- A set of Interregional trade matrices (26 origin-destination matrices, one per each sector), that were estimated indirectly for each kind of product using available data about domestic transport flows of goods, and translated into “monetary flows” by means of international export prices.

The use of 1995 as reference date for the model is explained by the construction method and the requirement of a large set of survey input-output tables: to date, the 1995 Spanish Input-Output Table is the most recent national one; another factor in support of this date is that a large number of Spanish regions have published survey input-output tables between 1990 and 1995. Additionally, it is important to notice that in 1995 the National Institute of Statistics and most of the Regional ones started using the new ESA-95 methodology for National Accounts and Input-Output Tables<sup>1</sup>. This important change added additional problems of consistency between old and new statistics and enforced the use of 1995 as the reference date for the whole model.

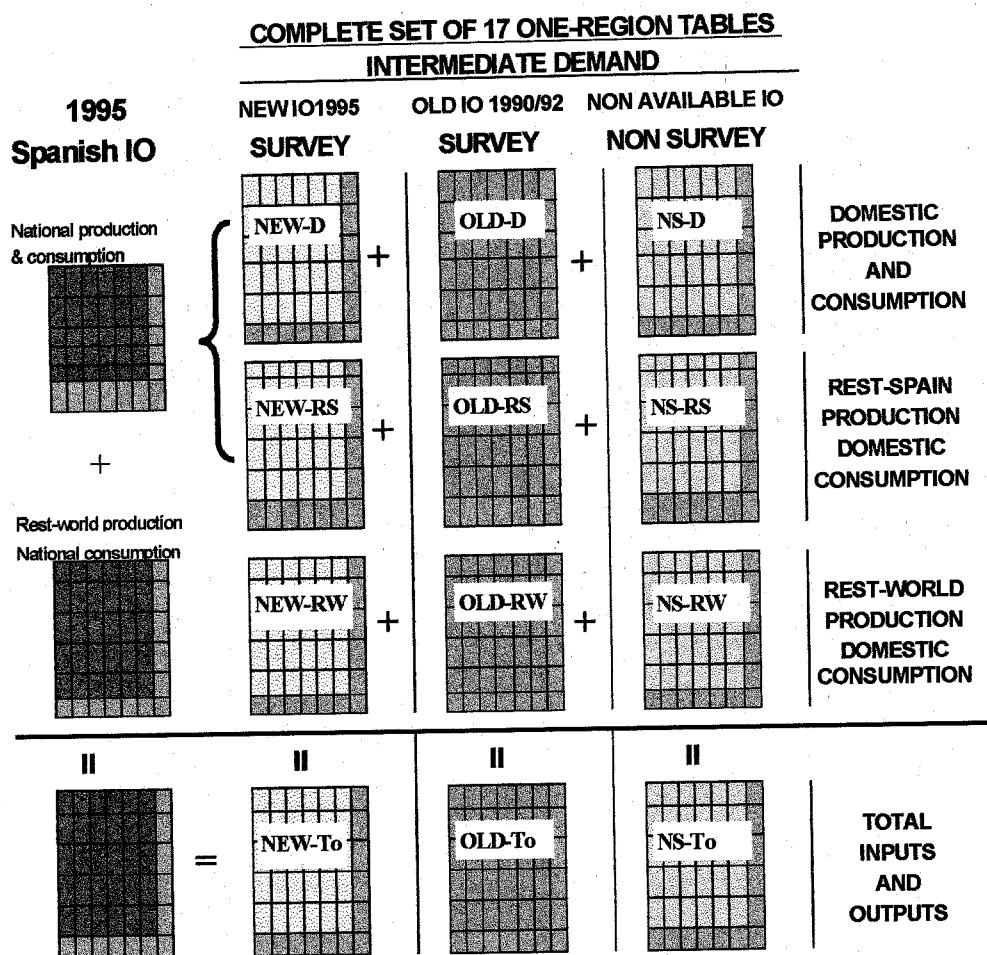
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<sup>2</sup> This chapter is based in other works such as Perez J., Llano C., 2004; Perez J. et al 2000

<sup>3</sup> Extra-regio accounts non-territorialized economic activities such as diplomatic services, etc.

<sup>4</sup> New estimations of the whole database will come as soon as new regional and national input-output tables were published (the 2000 Spanish IO has not been published yet).

**Figure 1: Relation between 1995 National Input-Output Table and a complete set of 17 One-Region Input-Output Tables harmonized with Regional Accounts.**



Taking into account the heterogeneous situation of our regions in terms of availability of input-output tables for 1995, the estimation of the model was based on a case by case process depending on the availability of regional input-output tables, their antiquity, sectoral classification (CNAE 89 vs CNAE 92) and method of construction (ESA-74 vs ESA-95). The main statistics used were:

- National Input-Output Table, 1995. EAS-95. SNSI. (SPAIN 1995 in Figure 1)
- Regional Input-Output Tables:
  - Survey-1995-IO-tables: Navarra 1995, Madrid 1996, País Vasco 1995, Asturias 1995, Andalusia 1995, Castilla y León 1995. ("NEW:1995" in Figure1)
  - Old-Survey-IO-tables to be updated: Comunidad Valenciana 1990, Galicia 1990, Extremadura 1990, Canarias 1992, Aragón 1992, Cataluña 1987. (group "OLD: 1990/92" in Figure 1)
  - Non-available-IO-tables to be created "ex-novo": Murcia, Cantabria, Castilla-La Mancha, Ceuta y Melilla. (group "NON AVAILABLE" in Figure 1)
- Other statistics used as sectoral/regional constrains for Regional IO Table:
  - Regional Accounts 1995 Base, EAS-95. (SNSI)
  - Regional Accounts 1986 Base, EAS-79. (SNSI)

## 3.2 The estimation process

### Step 1: Estimation of a general macroeconomic framework.

The aim of this step is the estimation of the basic macro-magnitudes that will be used as constrains for the disaggregation of the 1995 National IO Table.

#### I. Supply

- a) Regional Gross Value added in basic prices (GVA. b.p) for 26 sectors.
  - Starting with the 1995-Base Regional Accounts we obtain a vector of GVA b.p. for each of the 17 regions and 26 sectors. Then by means of a RAS-like bi-proportional distribution procedure (Allen et al, 1975; Dijkman H. et al., 1994; Polenske et al, 1987), we estimate GVA b.p. for each of the 17 regions and 26 sectors consistent with the National input-output table.
- b) Taxes.
  - After estimating a vector of regional GDP using National GDP, Regional per capita GDP and regional population, we obtain "Net Total Taxes" as a difference between GDP and GVA b.p.

#### II. Demand

- a) Private and Public Expenditures are obtained by the regional breakdown of 1995 national totals using the regional structure of the 1986-Base Regional Accounts.



- b) Gross Fixed Investments, are estimated using data on regional investments (Mas M. et al, 2000) and national values distributed using data from the most recent 1995-Regional IO Tables (Andalusia and Madrid).
- c) Changes in Stocks for each region is obtained using the coefficients of Stock/Production derived from available regional IO Tables (regions with no IO Table, uses ratios from the closest region in terms of productive structure<sup>6</sup>).
- d) Exports and imports to/from the "Rest of the World" per region are estimated by the regional distribution of national figures using data on exports and imports of goods and services, taking also into account different regional indicators about tourism and average net expenditure of non-residents in each region.
- e) Balance with the "Rest of the Country". Using the difference between regional GDP and the rest of final demand, plus the Rest of World balance, we obtain a National External Balance.

## Step 2. Main aggregates in Regional IO Tables.

### I. Total Output in basic prices.

Using ratios between vectors of "Total Output" and "Gross Value Added" from available regional IO Tables (or regional IO Tables from the most similar region when there is no), and the available information on GVA b.p. from the Regional Accounts, a complete set of 19 "Total Output"  $1 \times 26$  vectors is obtained.

### II. Taxes disaggregation.

We start with "Total taxes" per sector and aggregate demand components from the 1995 National IO Table, and the "Total net taxes" per region estimated in step (1.1.b). Next, using national ratios and by means of bi-proportional procedures, we obtain a definitive table of taxes based on national sectoral figures and compatible with regional totals.

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<sup>6</sup> In the different steps, we have used data from the closest region in terms of sectoral structure (smaller quadratic sum of differences between percentages of VA in each of the 26 considered branches). After this analysis on sectoral similarities among regions, we have used the following tables as substitutes when it was required:

#### Regions without available IO Table

Baleares  
 Cantabria  
 Castilla La Mancha  
 Cataluña  
 Murcia  
 Rioja  
 Ceuta y Melilla  
 Extra-Regio

#### Substitute Table

Canarias  
 País Vasco  
 Extremadura  
 Comunidad Valenciana  
 Comunidad Valenciana  
 Aragón  
 Andalucía  
 Madrid

### **III. Sectoral disaggregation of domestic demand figures.**

Once again, bi-proportional distribution process is applied to the demand magnitudes obtained in previous steps, using as constraints national totals by sectors and regional totals (without taxes -2.2- and without net non-resident consumption per region -1.2.d).

By means of final demand distribution coefficients from regional input-output tables, we proceed to the distribution of Private expenditures, Public expenditures, Net fixed capital investments and Changes in Stocks. Since some regions had old tables built according to the EAS-79 methodology that imposes "null values" to a number of demand elements and sectors (i.e.: null exports from the Building or some Public Services sectors), the demand distribution coefficients for this regions/sectors had to be corrected by national coefficients (National IO Table is based in EAS-95).

### **Step 3. Estimation of total Intermediate inputs.**

Starting with regional and sectoral figures on Effective Production, Gross Value Added, VAT and Other net taxes, the "total intermediate inputs by region and sector" were obtained. Then, by means of a bi-proportional distribution method applied to  $z_{ij}/z_{.j}$  coefficients (note that  $z_{.j}$  denote intermediate inputs, not total output) from the regional input-output tables and the national one, the total column values of intermediate inputs were distributed between sectors along the rows. As in previous steps, in some cases the regional coefficients had to be corrected by national ones in order to make the whole table compatible with the new EAS-95 methodology. At the end of this process, a matrix of total intermediate inputs (without information on the spatial origin-destination of each flow) per regions and sectors was obtained.

### **Step 4. Sectoral distribution of trade with "Rest of the Country" (RC) and "Rest of the World" (RW).**

The aim of this step is the allocation of international and interregional imports and exports per region and sector, both consistent with the figures available about international trade as well as the Net Internal Balance of interregional trade per region (step 1.2.e). At the end of the process we obtain four matrixes, two for exports (RC, RW) and two for imports (RC, RW), with total values per each region and sector. The information used for this process was the following:

- I.** "Rest of the World" exports and imports by regions (1.2.d)
- II.** National External Balance by regions (1.2.e)
- III.** "Rest of the World" export and import by sectors (from National IO Table)

**IV.** Net Total Exchange Balance by regions and sectors (sum of total exports minus total interregional and international imports) obtained as a difference between total output and total demand per region (r) and sector (s), in the following way:

$$Balance_{r,i} = Production_{r,i} - \sum_{i=1}^{26} Intermediate\ Inputs_{r,i} - \sum_{q=1}^4 Final\ Demand_{r,q} \quad [5]$$

In order to assure the sectoral equilibrium of interregional trade, the total interregional exports per sector should be equal to the total imports of the same sector.

For each of that matrixes we are about to estimate, initial adopted values will be:

- Rest of the World imports/ Rest of the Country imports: Will be the sum, of the application of import ratio in each cell of intermediate inputs matrix and final demand matrix from Regional IO Tables to the new values of intermediate inputs and final demand estimated in previous stages.

$$Imports^{RW}_{r,i} = \sum_{i=1}^{26} Intermediate\ Inputs_{r,i} * \frac{\Pi_{r,i}^{RW}}{\Pi_{r,i}} - \sum_{d=1}^4 Final\ Demand_{r,q} \frac{FD_{q,i}^{RW}}{FD_{q,i}} \quad [6]$$

$$Imports^{RC}_{r,i} = \sum_{i=1}^{26} Intermediate\ Inputs_{r,i} * \frac{\Pi_{r,i}^{RC}}{\Pi_{r,i}} - \sum_{q=1}^4 Final\ Demand_{q,i} \frac{FD_{q,i}^{RC}}{FD_{q,i}} \quad [7]$$

- Rest of the World exports / Rest of the Country exports: This can be obtained by applying the export ratios with base on estimated production over available regional IO Tables to the new estimated values of production.

$$Exports^{RW}_{r,i} = Production_{r,i} * \frac{EXP_{r,i}^{RW}}{O_{r,i}} \quad [8]$$

$$Exports^{RC}_{r,i} = Production_{r,i} * \frac{EXP_{r,i}^{RC}}{O_{r,i}} \quad [9]$$

Being  $EXP_{r,s}^{RW}$  exports to the Rest of the World in region r and sector i, and  $O_{rs}$  the sector i total output in region r.

In both cases original coefficients were adjusted with those from the National IO Table so that the coherence with the EAS-95 was assured.

### Step 5. Disaggregation of intermediate and final demand values by spatial origin.

Then, we disaggregate each cell of the intermediate and final demand matrixes into three origins -domestic, interregional and international imports- applying an n-proportional distribution process using the following values as constrains:

- I. The sum along regions ( $z_{ij}^{\cdot}$  or  $f_{iq}^{\cdot}$ ) of domestic and interregional imports of an specific cell on the intermediate ( $z_{ij}^{rs}$ ) or final demand matrix ( $f_{iq}^{rs}$ ) should be equal to the domestic total of the equivalent cell on the National IO Table ( $z_{ij}^{NN}$  or  $f_{iq}^{NN}$ ).
- II. The sum along regions ( $z_{ij}^{RW}$  or  $f_{iq}^{RW}$ ) of international imports of an specific cell on the intermediate ( $z_{ij}^{RWS}$ ) or final demand matrix ( $f_{iq}^{RWS}$ ) should be equal to total imports of the equivalent cell on the National Input-Output Table ( $z_{ij}^{RWN}$  or  $f_{iq}^{RWN}$ ).
- III. The sum by rows of domestic, interregional and international exports estimated in previous steps per each sector, should be equal to total output per region and sector.
- IV. The partial sums of international and interregional imports per region and sector had to be adjusted to the totals estimated in previous steps.
- V. For each region/sector cell, the sum of domestic, international and interregional imports should coincide with the total figure estimated for the same cell in previous stages.

The n-proportional process takes as starting values the ratios obtained from regional input-output tables and then iterates until new values coherent with the total figures estimated above are obtained:

$$\begin{aligned}
 \text{Intermediate Inputs}_{r,i}^{DOM} &= \text{Intermediate Inputs}_{r,i} * \frac{\Pi_{r,i}^{DOM}}{\Pi_{r,i}} & \text{Intermediate Inputs}_{r,i}^{RW} &= \text{Intermediate Inputs}_{r,i} * \frac{\Pi_{r,i}^{RW}}{\Pi_{r,i}} \\
 \text{Intermediate Inputs}_{r,i}^{RC} &= \text{Intermediate Inputs}_{r,i} - \text{Intermediate Inputs}_{r,i}^{DOM} - \text{Intermediate Inputs}_{r,i}^{RW} \\
 \text{Final Demand}_{r,i}^{DOM} &= \text{Final Demand}_{r,i} * \frac{FD_{r,i}^{DOM}}{FD_{r,i}} & \text{Final Demand}_{r,i}^{RW} &= \text{Final Demand}_{r,i} * \frac{FD_{r,i}^{RW}}{FD_{r,i}} \\
 \text{Final Demand}_{r,i}^{RC} &= \text{Final Demand}_{r,i} - \text{Final Demand}_{r,i}^{DOM} - \text{Final Demand}_{r,i}^{RW}
 \end{aligned} \tag{10}$$

At the end of the process, we obtain a complete set of 19 homogeneous Regional Input-Output Tables (17 Autonomous Communities + Ceuta&Melilla + Extra-Regio) based on the original (new, old or non-survey) tables and coherent cell by cell with the 1995 National Input-Output Table. Like in most of the regional survey input-output tables, total figures per each cell on the intermediate and final demand matrixes appears split in three origins: domestic, interregional and international imports.

Since this data-bank did not include information on the specific spatial origin or destination of each interregional flow, the next step was the estimation of detailed interregional trade data to be used for the interconnection of the 19 one-region tables.

## Step 6. Regional distribution of intra-national trade flows.

In order to cope with this requirement, a complete set of 26 interregional trade matrices was estimated (one per sector), using the methodology that is reviewed in detail in the following section.

Once that the 26  $T_i$  trade matrices (18\*18) had been estimated, we proceeded to the interconnection of the 19 on-region tables considering, like in previous works (Oosterhaven J., 1984; Van der Linden et al, 1995), the restrictive assumption of equal spatial structure for every intermediate and final interregional import along rows.

As a result of this complex process that is summarised in Figure 2, we obtained a first version of a 1995 Multiregional Input-Output Table (Figure 3), coherent with the National Table and the most important figures from the Regional Accounts from SINS.

Figure 2: Estimation process of the 1995 Interregional Input-Output Table

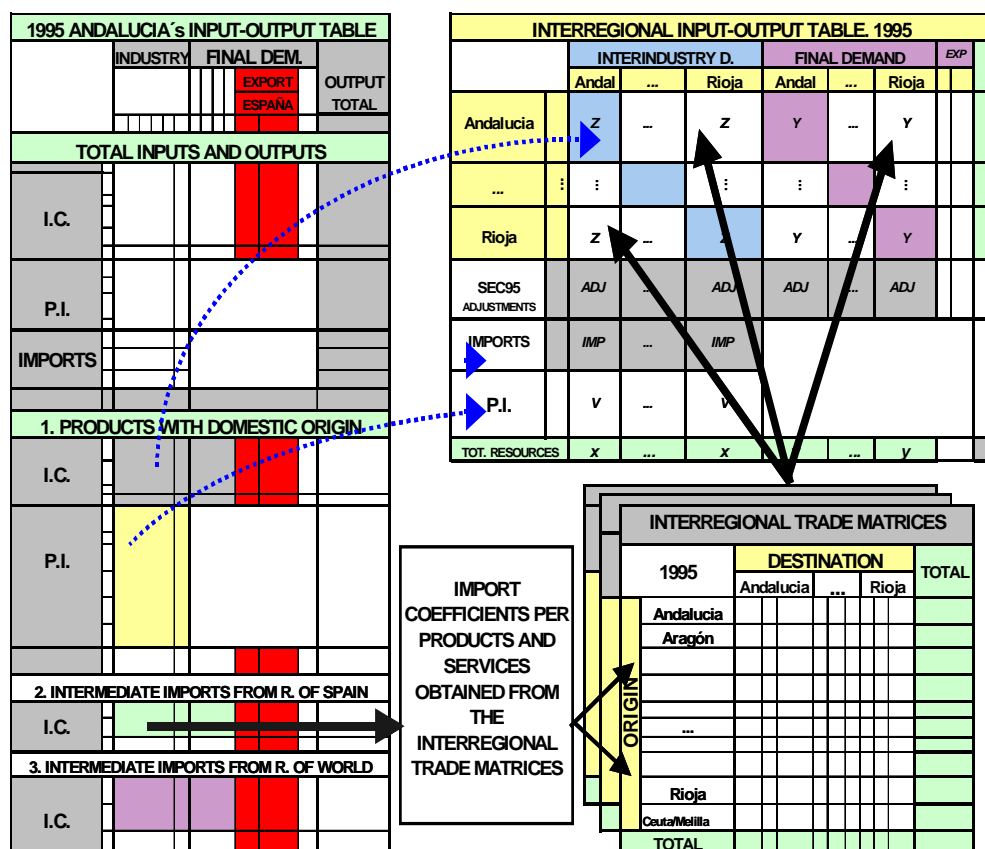


Figure 3: The 1995 Interregional Input-Output Table

		INTERMEDIATE DEMAND			SPANISH FINAL DEMAND			EXPORTS	OUTPUT
		ANDALUSIA	...	RIOJA	ANDALUSIA	...	RIOJA		
INTERMEDIATE DEMAND	ANDALUSIA	$Z^{AN\ AN}$ (26*26)	...	$Z^{AN\ RI}$ (26*26)	$Y^{AN\ AN}$ (26*Q)	...	$Y^{AN\ RI}$ (26*Q)	$EXP^{AN}$ (26*1)	$X^{AN}$ (26*1)
	:	:	:	:	:	:	:	:	:
	RIOJA	$Z^{RI\ AN}$ (26*26)	...	$Z^{RI\ RI}$ (26*26)	$Y^{RI\ AN}$ (26*Q)	...	$Y^{RI\ RI}$ (26*Q)	$EXP^{RI}$ (26*1)	$X^{RI}$ (26*1)
INTERMED. IMPORTS		$IMP^{AN}$ (26*26)	...	$IMP^{RI}$ (26*26)					
PRIMARY INPUTS + IMPORTS		$V^{AN}$ (P*26)	...	$V^{RI}$ (P*26)					
OUTPUT		$X^{AN}$	...	$X^{RI}$					

## 4. THE ESTIMATION OF INTERREGIONAL TRADE<sup>7</sup>

### 4.1. Possible approaches based on the availability of statistics

Although there is a relatively large number of statistics with partial information on the Spanish interregional trade (Table 2), the only way to estimate directly (excluding pure non-survey processes) the specific origin and destination of interregional flows lies on the use of transport data. Other possible approaches, like those based on macro-economic balance, ad-hoc surveys or fiscal information were rejected because of their incapability to offer high detailed information about origin and destination of flows, their relatively high cost, or their restrictions to statistical secret.

Next we resume the main steps followed in the process of estimation of the interregional trade of products and services.

<sup>7</sup> This section is based in Llano C., 2004; Llano C., 2001

**Table 2: Statistics containing data related to the Spanish Interegional trade**

	ACCOUNTING SISTEM	STATISTICAL SOURCES
TOP-DOWN APPROACH	<b>Macro-economic balance</b> (Alcaide, 1996)	Interregional trade is deduced as a difference between regional Inputs and regional Outputs.
	<b>Input-output Tables Regional Accounts.</b> (Most of the Spanish regional input-output tables)	Information base on <i>direct Survey to producers, and/or consumers</i> : <ul style="list-style-type: none"> <li>• The use of “<i>available official</i>” statistics, such as National Industry, Agricultural or Mining Surveys...(INE)</li> <li>• <i>Surveys designed “ad-hoc”</i> for the elaboration of the input-output table.</li> </ul>
DOWN-TOP APPROACHE	<b>Regional Balance of Payments</b> (Parellada, 1982; Oliver, 2003; Oliver, 1997).	The use of <i>interregional transport flows data</i> , with detailed information about the geographic origin and destination of the flows: <ul style="list-style-type: none"> <li>• The use of regional and national transport statistics in terms of volume.</li> <li>• Estimation of domestic prices using other information to value transport flows.</li> </ul>
	<b>NOT AVAILABLE. STATISTICAL SECRET</b> (Santiso, 2000)	The use of <i>fiscal information</i> about trade relations within Spain: <ul style="list-style-type: none"> <li>• Fiscal declarations of companies and professionals about their transactions with other national agents. (VAT and the E-347 declaration)</li> </ul>

## 4.2. The estimation of the interregional trade of goods

According to Table 2, most of the Spanish experiences on the use of transport data for the estimation of interregional trade corresponds to few studies that focus on the calculation of Regional Balance of Payments (Parellada 1980, 1982; Oliver 1997; Pulido A. et al. 2000, 2002). We find also abroad some precedents using transport data to approximate the interregional trade flows within the context of some multiregional input-output models (Polenske, 1980; Hewings, 1993; Kazumi, 2000). Following these approaches, we combine data on transport flows with additional information related to the output per regions and sectors in order to constrain the interregional transport flows.

### 4.2.1. Statistical information available on interregional transport flows

**Table 3: Transport statistics used in the estimation of Spanish interregional trade**

MODE	DESCRIPTION AND MAIN FEATURES
ROAD	<p><i>Encuesta Permanente de Mercancías por Carretera (Permanent Survey on Road Transport of Goods).</i></p> <p><b>Source:</b> Ministerio de Fomento (Spanish Ministry of Public Works)</p> <p><b>Product Disaggregation:</b> 160 products (class.NST/R-3 digits)</p> <p><b>Available since:</b> 1993-2003</p> <p><b>Observations:</b></p> <ul style="list-style-type: none"> <li>• Permanent survey on the weekly-activity of a large sample of heavy trucks in Spain: each trip includes origin-destination, type of product, volume, distance (km)...</li> <li>• It may include international transit flows moved from ports/airports to final locations.</li> <li>• It is important to notice that the figures obtained surveying truck-drivers may not be consistent with figures on production/purchases from firms and households surveys.</li> </ul>
RAILWAY	<p><i>RENFE statistics on Complete Wagon and Containers flows.</i></p> <p><b>Source:</b> information from the <i>Statistics Department of RENFE</i></p> <p><b>Product Disaggregation:</b> aprox. 40 categories (RENFE's classification)</p> <p><b>Observations:</b> Registration of every domestic flow: High quality, low product detail. No information about the products transported by Containers (30% of rail flows).</p>
SEA	<p><i>Spanish Ports Statistics. (Puertos del Estado)</i></p> <p><i>Indirect estimation of interregional flow matrices using a RAS-like approach using:</i></p> <p>a) <i>Tons loaded/Unloaded by each Spanish Port, kind of flow, and type of product.</i> <b>Source:</b> <b>Statistical Yearbook. Puertos del Estado.</b></p> <ul style="list-style-type: none"> <li>– <b>Data:</b> Annual. 26 Spanish ports.</li> <li>– <b>Product Disaggregation:</b> 40 products (Spanish Ports's classification)</li> </ul> <p>b) <i>Set of Spanish Domestic flow matrices with Ports of Origin and Destination.1989.</i> <b>Source:</b> <b>Domestic maritime flows by Origin and Destination.1989.</b> Puertos del Estado:</p> <ul style="list-style-type: none"> <li>– <b>Data:</b> Annual- by 38 Spanish principal ports.</li> <li>– <b>Product Disaggregation:</b> 52 products (CSTE)</li> </ul>
AIR	<p><i>O/D Matrices of Domestic flows of goods by airport of Origin and Destination 1995. AENA.</i></p> <p><b>Source:</b> AENA&amp;Ministerio de Fomento (Spanish Ministry of Public Works).</p> <p><b>Data:</b> Annual. Main Spanish Airports.</p> <p><b>Product Disaggregation:</b> None</p> <p><b>Observations:</b> No information about sectoral disaggregation of domestic air flows</p>
PIPE	<p><i>O/D matrix of oil flows using pipe 1995</i></p> <p><b>Source:</b> CLH (main oil distributor in the Spanish market). 1993.</p> <p><b>Product Disaggregation:</b> None</p> <p><b>Observations:</b> Indirect estimation using O/D matrix obtained by Department of Public Works&amp;TEMA-Consulting Group from CLH in 1993 and re-scaled to 1995 figures.</p>



#### 4.2.2. Pros and cons of transport data

On the one side, the use of transport data as a proxy of the real interregional trade provide significant contributions to our goals:

- Most of the Spanish transport data are disaggregated by type of products.
- Most of them allow also to take into account the geographic origin and destination of flows that, in general, could be identified respectively with the places where the product is produced or consumed. Some of them offer even higher spatial disaggregation than what is strictly required for our analysis (NUTS-2). This fact will allow further developments and different exercises of data verification (see point 4.2.3-III).

On the other side, Spanish transport statistics are usually designed not with economic purposes but with the aim of covering the needs from engineers and transport planners. As a consequence, they do not satisfy all our requirements:

- As transport flows are expressed in physical units (Tn, Km.\*Tn...) rather than in monetary ones, they should be valued using some kind of “value/volume” relations.
- Information for each transport mode (truck, rail,...) is collected by different institutions, with different strategies, classifications and methodologies. This fact make difficult to assure the conciliation of different sources, both between them (each transport mode with the others) and as regards to the rest of the model (input-output Tables, National and Regional Accounts,...).
- We find also problems in the capability to identify and analyse multi-modal flows: due to the proliferation of multi-modal combinations in logistics, the inattentive use of transport statistics could introduce wrong assignments of origin and destinations and inducing problems of double-counting.
- Additionally, some other errors could arise from the complex strategies that are currently displayed on logistic. For instance, the existence of “purchase centres”, “dry ports” and “transport platforms” could induce over-estimations of imports and exports in big markets, and infra-estimation in peripheral ones.
- Another important limitation comes from the technical features of road statistics, that accounts up to the 90% of total transport flows in Spain: although the survey is reliable in general terms, it may induce several mistakes when it is used with low levels of aggregation in relation to the “space” and “type of product”. In fact, we checked the existence of important incoherencies between some flows of product “x” from region “r” and the economic information on the available resources (production+imports) of such products in this region. This fact forced us to introduce a process for data debugging that is briefly described in point 4.2.3.-VIII.

### 4.2.3. Method for the estimation of the Spanish interregional trade flows of goods

- I. Harmonisation of physical transport flows from different sources.
- II. Estimation of non-available data:
  - Sectoral disaggregation of the O/D matrix of containers flows by railway. Container flows were split in product categories using the sectoral structure of railway flows that used “complete wagon” and have the same region of origin (some products are excluded since they are not transported in containers).
  - Estimation of O/D matrices of interregional transport flows by sea: due to the absence of an up-dated set of Inter-port matrices of sea domestic flows, we estimate 40 matrices O/D, one for each kind of product, applying RAS-like method (Allen et al, 1975; Dijkman H. 1994; Polenske et al, 1987) to the most modern O/D information available (*Domestic maritime flows by Origin and Destination.1989*. Puertos del Estado) using more recent information about loaded/unloaded tons by port and product (1995 Statistical Yearbook. Puertos del Estado)
  - Sectoral disaggregation of total domestic O/D matrix flows by air. Surprisingly, there is no information about sectoral disaggregation of domestic air flows in Spain. Therefore, product disaggregation of the unique matrix available of total domestic flows is deduced using the product specialisation of international flights (available) per each airport of origin in 1995. Through this estimation, it is assumed that if a region have interregional exports of goods shipped by plane, the product structure of this movements will be the same that the one observed in international exports from the same region.
  - Treatment of pipe-flows of oil product. Due to the singular distribution process in oil products, where pipe is often used to “approach the product” to the final markets (airports, oil stations, industrial areas...) from distant refineries, the pipe information was used just for the allocation of the road and rail flows of oil products that appear as loaded in regions without refinery, but really come from other regions (with refinery) using the pipe. Apart from this conceptual issue, there are also an important scarcity of information on O/D flows after 1993 (sector liberalisation). We have obtain a 1995 O/D pipe flows by the re-estimation of a 1993 O/D matrix calculated by THEMA-Consulting Group and the Ministry of Public Works and based on data from CLH (main Spanish oil distributor).

### III. First debugging procedure for transport flows in physical units (Tons):

**Figure 4: Example of how transit flows may be detected**



Identification of international trade in transition along the Spanish roads: the EPTMC survey allows the identification of detailed road flows (split by 160 types of products) between the 17 regions and the municipalities where the main maritime ports are located. Then, this flows were compared with additional information about production and logistics practice of Spanish exporters and importers (detailed information on international goods loaded/unloaded into/from ships in each port; output per regions and products; "distribution-paths" of Spanish exports and imports (Ministerio de Obras Públicas, 1993, Ministerio de Fomento, 1995). Following this item-by-item approach, we detect a number of international transit flows that must to be removed from the interregional database.

Allocation of multi-modal flows: following a similar approach, we identify and allocate possible interregional flows that use ships and trucks complementarily. This procedure will lead to a more accurate treatment of interregional trade between the Spanish peninsula and the Islands (Canarias and Baleares).

### IV. Estimation of value/weight relations from International trade statistics.

Due to the absence of statistics containing detailed domestic prices for every kind of product in terms of "value/weight" relations, we have to deduced them indirectly from alternative information. Following previous works on the estimation of regional balance of payments (Oliver, 2003, 1997), we use value/weight relations deduced

from very detailed statistics on International Trade (exports) split by value and weight, region of origin, and about 1300 types of products (NC-4 digits). In that way, by contrast to other previous works that used just two price vectors (one for valuing exports and another for imports), we estimate 19 different vectors of export prices (one for each of the Spanish regions +Ceuta&Melilla +Extraregio) with the purpose of capturing price differences among regions derived from their specialisation in high-low quality standards within the same product.

Being aware of the rough method used to translate transport flows in tons into monetary trade flows in euros, we try to minimize errors using the widest disaggregation available for both pieces of information –transport flows and international prices. More specifically, since each type of transport uses its own product classifications, we have to work separately with each type of transport, estimating 19 sets of 4 vector prices. For instance, Andalusia has 4 different export price vectors, one for each transport mode (road, railway, sea, air).

In a first attempt, 19 sets of 4 vectors of regional export prices were estimated from the very detailed international trade data. After several comparisons between the prices obtained, we found high disparities along regions in the prices of some products that could not be explained in the light of sectoral or quality differences among regions. As a consequence, we developed a methodology to re-estimate 19 different vectors of exports prices but eluding the observed discrepancies:

- First we estimate a unique debugged-export-prices-vector containing the statistical median for the 19 different original prices (one for each region) and each of the 1300 items (NC4), excluding extreme values.
- Then we deduce 19 sets of 4 definitive-export-prices-vectors (one for each mode of transport and region) by means of a “weighted mean” of “debugged-price-vector” using the amount of tons exported for each product and region as “weights”:

$$PRICE_{T}^{Region} = \left( \frac{Exports(Tns)_i^R}{\sum_{i=1}^{i=n} Exports(Tns)_i^R} * Price_i^{Debugged} \right) + \dots + \left( \frac{Exports(Tns)_n^R}{\sum_{i=1}^{i=n} Exports(Tns)_i^R} * Price_n^{Debugged} \right) \quad [11]$$

Ei: Pricing a flow of product "I" with origin in "R" and transport mode "road"

<p>PRICE of product "I" (Road NST/R class) with origin in region "R".</p> <p>I= ranges from i=1 to n (NC class)</p> <p>R= ranges from 1 to 19 regions</p>	=	<p>"Weighted mean" of the "single-debugged price" for each "i" NC-category included in the "I" NST-category, weighted by the ratio between Tons exported by region R of product "i", and the sum of Tons of "I" NST-category exported by the same region</p>
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## V. Translation of O/D debugged matrices in Tons into Monetary Units.

The objective of this step 19 sets of price vectors estimated in the previous step. Before doing that, we have compared this prices with those deduced from other statistics (Survey of Agricultural Production, Industrial Products Survey-SNIS), with the purpose of validating the accuracy of international “value/weight relations” being used as proxies of interregional prices.

## VI. Aggregation of O/D-matrices of goods.

Then, all the O/D-matrices (one per type of product and type of transport mode) already valued in current Euros, are aggregated according to the common classification used for the whole model, with 26 activities (16 for primary products and manufactures and 10 more for services).

## VII. Final screening of the 16 O/D matrices of Goods in Euros:

Although we have observed significant correspondence between our total exports and imports and those published in regional input-output tables for some regions, we have also detected some remarkable divergences:

- In general, interregional trade flows deduced exclusively from transport flows (without any constraint from regional/sectoral production) appear overvalued.
- Coincidence between this data and other sources like Regional IO Tables and Industrial Enterprises Surveys increases, both from export and import sides, when the interregional exports directly obtained from previous steps are constrained to additional information from the output of this sector in that region.

At this stage we have applied two different approaches:

1. According to the needs of our multiregional input-output model the set of trade matrices obtained were incorporated to the rest of the IO databank, and therefore, constrained by the figures deduced in *Step 1.II.e and Step 4 from section 3.2*. In fact, once that the 26 matrices were estimated and incorporated to the model they were used just as distribution coefficients for the allocation of “Imports from the Rest of the Country” obtained in section 3.2.
2. By contrast, with the purpose of analysing the interregional trade database outside the model (without the restrictions imposed by the rest of the IO data of the model) we followed another alternative:
  - Per each of the 15 O/D trade matrices corresponding to industrial activities, the “sum along rows of all the off-diagonal elements” (interregional exports) were harmonised with the “*Sales to the Rest of Spain*” published for all the regions and industries (2-NACE93) by the **1995 Industrial Enterprises – Survey (SNIS)**. As a consequence, any activity of any region will not be able to export to other regions more than what this survey establishes as “*Production in the region and sold to the Rest of Spain*” for this region/

activity. Due to the lack of information about the “amount of products consumed”, no constraints were established for the “sums along columns”.

- In relation to the O/D trade matrix of products from Agriculture, Fishing and Forestry, the constraint was established for the sum of intra+interregional flows using the information available about production and international exports of such products in each region, i.e: all the Spanish regions together could not sell (intra+inter) more tons of agricultural products than their output plus their net imports to foreign countries of this products.

### 4.3. Interregional trade of services

The estimation of the interregional trade in relation to the “building” and “services” sectors was –as always– even more complicated. The complete absence of direct statistics on this kind of flows and the difficulty to use proxy variables as in the case of goods, forced as to adopt an a-priori indirect approach using a **gravity-like model**:

$$D_{rs}^i = X_{rs} * \frac{(VA^i pb_r / POP_r)}{(VA^i pb_s / POP_s)} \quad [12]$$

$$F_{rs}^i = D_{rs}^i / \sum_r \sum_s D_{rs}^i \quad [13]$$

**The bilateral flow (standardised) of service  $i$  ( $F_{rs}^i$ )** is related to the intensity of interregional trade flows of goods between each pair of regions ( $X_{rs}$ ), and the relation between the size of both spots in terms of Population and VA on this service  $i$ . As it has been tasted, since ( $X_{rs}$ ) behave following the gravity model (Llano C., 2001, 2004) there is no need for an explicitly consideration of “distance” (somehow, implicitly included in  $X_{rs}$ ). In other words, ( $X_{rs}$ ) could be interpreted as a measure of the “economic proximity” (somehow, the inverse of “physical distance”) of any pair of regions.

Although as it has been stayed there was no indirect data to be used as proxies of interregional trade of services (10 sectors), before estimating the pure non-survey approach described above, we analysed different possibilities such as the use of O/D matrices of “passengers by plane”, “O/D matrices of Mailbox matrices” and even “O/D matrices of telephone calls” (unavailable) as indirect measures of “interconnection” of regions in terms of services. Finally, due to the bad results obtained using this approaches, we proceed to the application of the non-survey one.

#### 4. DATA ANALYSIS

In the following section we analyse the most outstanding results observed in a first exploration of the interregional trade matrices. We start by identifying the main ratios deduced from the total interregional trade matrix analysed outside the model, so that exports have been already harmonised with the figures on interregional trade from Agricultural and Industrial official statistics (4.2.3.VII-2).

**Table 4: Intra, interregional and international Spanish trade flows of goods**

MAIN RATIOS FROM THE INTERREGIONAL TRADE MATRICES. GOODS (ITEMS 1-16 FROM INTERTIO CLASSIFICATION). MILLIONS OF EUROS.								
1995	INTRA REGION*	EXPORTS		IMPORTS		BALANCE		OPENESS RATIO***
	(1)	SPAIN (2)*	WORLD (3)**	SPAIN (4)*	WORLD (5)**	SPAIN (6)=(2-4)	WORLD (7)=(3-5)	(2+3+4+5) /(1+2+3)
ANDALUCIA	12.150	12.994	5.918	14.306	6.163	-1.312	-244	127%
ARAGON	3.467	6.952	4.202	10.211	3.386	-3.259	817	169%
ASTURIAS	3.809	3.952	999	4.463	1.022	-511	-24	119%
BALEARES	1.627	558	662	2.750	803	-2.192	-142	168%
CANARIAS	2.950	1.685	653	2.898	2.299	-1.213	-1.646	142%
CANTABRIA	1.110	2.585	797	3.445	1.016	-860	-219	175%
C-LEON	6.268	10.661	4.114	13.236	4.257	-2.575	-142	153%
C-MANCHA	3.033	8.346	895	8.298	1.474	48	-579	155%
CATALUÑA	29.652	31.209	17.582	17.180	25.623	14.029	-8.042	117%
C-VALENCIA	11.050	15.352	9.775	17.278	6.994	-1.926	2.781	137%
EXTREMADURA	1.202	1.766	365	3.023	201	-1.257	164	161%
GALICIA	5.858	9.077	3.386	5.894	3.881	3.184	-495	121%
MADRID	9.693	15.695	6.858	18.174	17.824	-2.479	-10.965	182%
MURCIA	1.682	3.943	1.706	5.233	1.307	-1.290	399	166%
NAVARRA	1.584	5.651	2.818	4.919	1.720	732	1.098	150%
PAIS VASCO	5.549	12.837	6.247	10.923	5.770	1.913	477	145%
LA RIOJA	447	2.487	445	2.398	350	89	96	168%
CEUMEL	1	57	27	1.178	363	-1.121	-336	1915%
<b>TOTAL</b>	101.131	145.807	67.448	145.807	84.451	0	-17.003	
<b>Source: Own calculation based on our Interregional Trade Matrices. 1995</b>								
*Interregional Exports and Imports are deduced from own calculations.								
** Flows with the Rest of the World are obtained from Custom data. 1995								
*** Since data does not include "services", Openess ratio is different than the usual $(X+M)/PIB$ .								

According to our figures we confirm that **most part of the regional trade relations in 1995**, both from the import and the exports sides, **took place among other regions within Spain** rather than with foreign countries. It is also important to notice that the rankings of regions in terms of international trade is similar to that of interregional trade. Just Galicia and Castilla-León seems to be more focused on foreign markets (the presence of big "car industries" in both economies can be behind this phenomenon).

Just six regions register **positive balances in terms of interregional trade** while seven do in the international one. The highest surplus appears in Catalanian's trade relations with the rest of Spain, followed by the positive balance of Galicia and País Vasco.

It is also interesting to notice how in some cases the sign of trade balance with the rest of Spain became the inverse of that with the rest of the world: while some regions -Cataluña, Galicia and Castilla-La Mancha- showed positive balances in the national market and deficits in the international one, others as -Aragón, Valencia, Extremadura and Murcia- registered just the opposite relation.

Another interesting result is that, with the exception of Aragón, the highest openness ratio appeared in the smallest regions in terms of surface: Madrid, La Rioja, Baleares, Navarra, Cantabria.

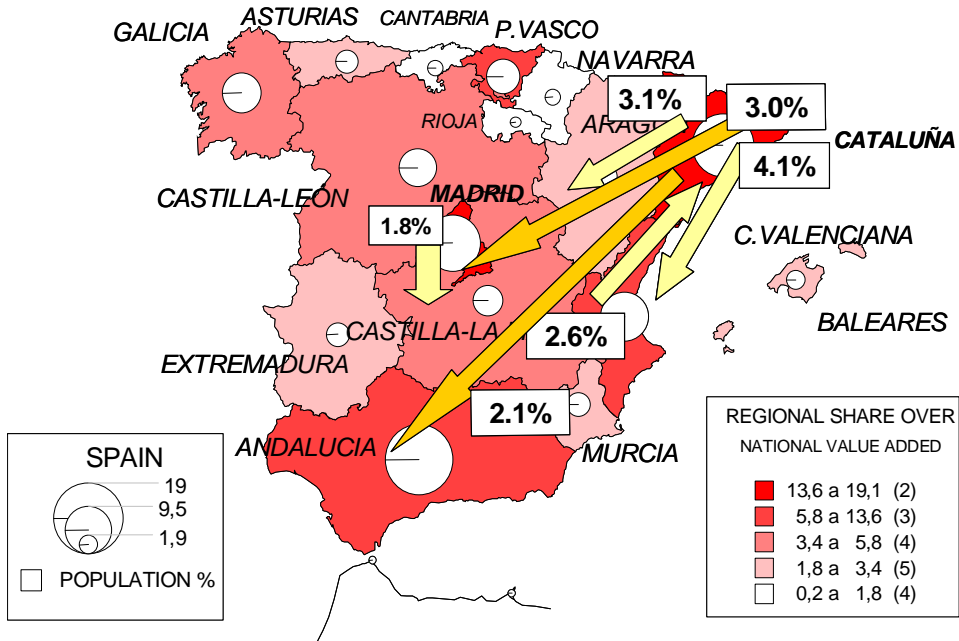
**Table 5: The strongest interregional flows of goods within the Spanish economy**

RANKING OF THE MAIN INTRA-INTER REGIONAL FLOWS ALL GOODS (INDUSTRIES 1-16). % and millions of Euros.					
1995	INTRA		INTERREGIONAL		
	As % of Total Trade		As % of Total Interregional Trade		
	ORIGIN=DESTINATION	%	ORIGIN	DESTINATION	%
1	CATALUÑA	11,3%	CATALUÑA	C.VALENCIA	4,1%
2	C.VALENCIA	5,0%	CATALUÑA	ARAGON	3,1%
3	ANDALUCIA	4,3%	CATALUÑA	MADRID	3,0%
4	MADRID	3,8%	C.VALENCIA	CATALUÑA	2,6%
5	C-LEON	3,1%	CATALUÑA	ANDALUCIA	2,1%
6	GALICIA	2,9%	MADRID	C-MANCHA	1,8%
7	PAIS VASCO	2,2%	ARAGON	CATALUÑA	1,8%
8	C-MANCHA	1,7%	CATALUÑA	PAIS VASCO	1,7%
9	ASTURIAS	1,5%	PAIS VASCO	C-LEON	1,7%
10	ARAGON	1,4%	MADRID	ANDALUCIA	1,7%
INTRA+INTER TOTAL		246.938	INTERREGIONAL TOTAL		145.807
Source: Own calculations based on our interregional trade matrices					



Figure 5

**TOTAL INTERREG TRADE OF GOODS**  
**(1)-THE STRONGEST INTERREGIONAL FLOWS. 1995**



By means of the relative share that each bilateral flow represents overall the interregional Spanish flows, we identify some of the strongest economic transactions in 1995 (see **Table 5**):

- The highest intra-regional flows took place within the regions with the biggest size (Andalucía, Castilla-León), the highest population (Cataluña, Andalucía, Madrid, C. Valenciana) and the highest shares of the economic activity (Cataluña, Madrid, Andalucía).
- Then if we rank the strongest interregional flows of goods we realise that the first 10 positions include at least one of the most industrialised economies, namely Cataluña, Madrid, C.Valenciana, Aragón or País Vasco.
- It is interesting to highlight how the four strongest interregional flows observed in 1995 took place between Catalonia and its two close and strong contiguous economies, Aragón and C. Valenciana. By contrast, it is also remarkable to find that the fifth interregional flow linked Catalanian with Andalusia, the most populous but also the farthest Spanish region.

Table 6: Main clients and suppliers of goods per each Spanish region

RANKING PRINCIPAL SUPPLIERS AND CLIENTS PER REGION				
SPATIAL CONCENTRATION OF INTERREGIONAL FLOWS AS % OVER THE TOTAL INFLOWS/OUTFLOWS OF EACH REGION ALL GOODS (INDUSTRIES 1-16) % Over Millions of EUROS. 1995				
ORIGIN /DESTINATION	DESTINATION (main clients)	%	ORIGIN (main suppliers)	%
ANDALUCIA	MADRID	8,4	CATALUÑA	12,3
	CATALUÑA	7,0	MADRID	9,6
	EXTREMADURA	5,2	C.VALENCIA	6,9
ARAGON	CATALUÑA	23,4	CATALUÑA	33,1
	C.VALENCIA	11,2	NAVARRA	8,5
	PAIS VASCO	6,2	C.VALENCIA	8,4
ASTURIAS	C-LEON	10,3	GALICIA	13,4
	PAIS VASCO	8,3	C-LEON	10,9
	GALICIA	5,3	ANDALUCIA	6,1
BALEARES	CATALUÑA	13,7	CATALUÑA	29,1
	CANARIAS	3,3	C.VALENCIA	18,9
	C.VALENCIA	2,8	ANDALUCIA	5,9
CANARIAS	C.VALENCIA	15,2	ANDALUCIA	16,8
	ANDALUCIA	11,8	CATALUÑA	10,1
	CATALUÑA	4,1	C.VALENCIA	7,3
CANTABRIA	C-LEON	16,4	C-LEON	17,0
	PAIS VASCO	11,7	CATALUÑA	13,5
	MADRID	8,9	PAIS VASCO	13,4
C-LEON	MADRID	9,6	PAIS VASCO	14,1
	PAIS VASCO	8,1	CATALUÑA	12,1
	CATALUÑA	6,8	MADRID	11,3
C-MANCHA	MADRID	18,6	MADRID	23,4
	C.VALENCIA	14,5	C.VALENCIA	14,9
	ANDALUCIA	13,0	ANDALUCIA	10,1

<b>CATALUÑA</b>	C.VALENCIA	10,1	C.VALENCIA	8,2
	MADRID	7,5	ARAGON	5,2
	ARAGON	7,4	MADRID	4,4
<b>C.VALENCIA</b>	CATALUÑA	14,6	CATALUÑA	21,6
	MADRID	6,9	MADRID	6,4
	ANDALUCIA	6,9	C-MANCHA	5,8
<b>EXTREMADURA</b>	ANDALUCIA	12,3	ANDALUCIA	30,7
	C-LEON	9,6	C-MANCHA	8,1
	GALICIA	7,9	C.VALENCIA	5,8
<b>GALICIA</b>	MADRID	13,1	CATALUÑA	11,5
	C-LEON	8,6	C-LEON	8,6
	ASTURIAS	7,4	MADRID	6,9
<b>MADRID</b>	C-MANCHA	10,5	CATALUÑA	16,3
	ANDALUCIA	10,0	C-MANCHA	7,6
	C-LEON	8,7	ANDALUCIA	7,6
<b>MURCIA</b>	C.VALENCIA	26,5	C.VALENCIA	24,2
	ANDALUCIA	15,9	ANDALUCIA	14,4
	MADRID	6,4	CATALUÑA	11,6
<b>NAVARRA</b>	PAIS VASCO	19,7	PAIS VASCO	28,6
	ARAGON	16,0	CATALUÑA	19,1
	CATALUÑA	13,6	ARAGON	6,5
<b>PAIS VASCO</b>	C-LEON	15,0	CATALUÑA	15,5
	NAVARRA	10,1	NAVARRA	8,6
	CATALUÑA	9,6	C-LEON	8,4
<b>LA RIOJA</b>	PAIS VASCO	15,4	CATALUÑA	22,7
	CATALUÑA	13,2	PAIS VASCO	15,5
	NAVARRA	12,6	NAVARRA	11,5
<b>CEUTA/MELILLA</b>	ANDALUCIA	74,4	ANDALUCIA	80,1
	BALEARES	21,3	CATALUÑA	12,4
	CANARIAS	2,0	C.VALENCIA	4,9

Although most of the regions keep trade relations with the others, **Table 6** shows the existence of high levels of concentration in the spatial origin and destination of the interregional imports and exports <sup>8</sup>:

First of all, it is important to realise that most part of the highest export and import shares are registered between **contiguous regions**. Additionally, it is also interesting to highlight that this concentration of interregional trade among pairs of regions could reveal the existence of **important interregional inter-sectoral linkages between them**. In that sense, as soon as this relations were confirmed as stable in time, we would be identifying mechanisms for the transmission of interregional spillovers in terms of growth, prices, productivity...

The spatial distribution of the main interregional flows (see **Figure 2**) and the observed tendency to find the highest exports shares around the contiguous regions (see **Table 6**), remain us once again the importance of distance and proximity that have been highlighted in previous literature about international and interregional trade. Besides the graphical and intuitive approach, the use of a **gravity-based model**<sup>9</sup> help us to understand the relation between the intensity of the interregional Spanish trade taking into account the socio-economic power (approached by means of Population and Value Added) of the two areas interconnected (regions *r* and *s*) as well as the distance (dist) between them:

$$\ln(x_{rs}^p + x_{sr}^p) = a_0 + b_1 \ln(VA_r^p + VA_s^p) + b_2 \ln(POP_r + POP_s) + b_3 \ln(dist_{rs}) + u \quad [14]$$

**Table 7**

<b>Dependent Variable: L(Xij+Xji)</b>				
<b>Method: Least Squares</b>				
<b>Sample: 1 105</b>				
<b>Included observations: 105</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
<b>C</b>	-3.573249	2.371691	-1.506625	0.1350
<b>L(Value Added)</b>	1.290173	0.282891	4.560670	0.0000
<b>L(Population)</b>	0.558684	0.275641	2.026856	0.0453
<b>L(Distance)</b>	-1.304770	0.115770	-11.27036	0.0000
<b>R-squared</b>	0.784140	<b>Mean dependent var</b>		11.89013
<b>Adjusted R-squared</b>	0.777728	<b>S.D. dependent var</b>		1.414740
<b>S.E. of regression</b>	0.666990	<b>Akaike info criterion</b>		2.065266
<b>Sum squared resid</b>	44.93239	<b>Schwarz criterion</b>		2.166369
<b>Log likelihood</b>	-104.4265	<b>F-statistic</b>		122.2984
<b>Durbin-Watson stat</b>	2.081379	<b>Prob(F-statistic)</b>		0.000000

<sup>8</sup> Since % are calculated over the total inflows/outflows (including intra-regional flows), exports and import shares around 20% should be considered very high.

<sup>9</sup> The formulation of the gravity model is based on (Goicolea, et al. 1998)

According to the model estimated in **Equation 14** by OLS, the intensity of interregional flows in logarithms is reasonable well explained ( $R^2: 7,8$ ) by distance and the economic power of the regions. Behind this results, it is important to realised that apart from the role of distance and contiguity in terms of lower transport costs of products, there are a large list of factors such as the existence of better infrastructures or historical inertias of traders. Additionally, it is important to realised that in many cases, the importance of distance in the interregional trade is highly conditioned by the microeconomics of distribution (Llano, C. 2001, 2004; Pulido et al, 2002 and 2001), firm-localization and agglomeration economies (Fujita et al, 2000). In that sense, it is important to remark the existence of different behaviours depending on the type of commodity that is traded (final or intermediate product), the localisation of the region in the territory (coast vs interior) or the sectoral specialisation of the region of origin and destination.

For this reason it would be interesting to reproduce a similar analysis with the aim of verifying the accuracy of the gravity model for each of the 16 sectoral matrices of goods. In order to give an intuitive verification of this assertion, we analyse next how was the interregional trade of two specific products that are generated and traded by two high interrelated activities: "Agriculture" and "Food&Beverages Industries".

Table 8

MAIN RATIOS FROM THE INTERREGIONAL TRADE MATRICES. R1. AGRICULTURE, FORESTRY, FISHING. MILLIONS OF EUROS.								
1995	INTRA REGION*	EXPORTS		IMPORTS		BALANCE		OPENESS RATIO***
	(1)	SPAIN (2)*	WORLD (3)**	SPAIN (4)*	WORLD (5)**	SPAIN (6)=(2-4)	WORLD (7)=(3-5)	(2+3+4+5) /(1+2+3)
ANDALUCIA	2.609	1.322	1.360	1.510	719	-188	641	93%
ARAGON	805	947	60	867	143	80	-83	111%
ASTURIAS	1.346	268	2	249	45	18	-43	35%
BALEARES	332	30	7	379	22	-349	-15	119%
CANARIAS	471	312	298	309	222	3	76	106%
CANTABRIA	170	150	10	307	114	-158	-104	176%
C-LEON	2.574	1.377	63	1.084	194	293	-131	68%
C-MANCHA	1.040	1.959	38	888	71	1.071	-33	97%
CATALUÑA	2.837	1.430	356	1.324	1.711	106	-1.355	104%
C-VALENCIA	725	1.004	1.789	1.224	577	-221	1.212	131%
EXTREMADU	492	754	74	217	11	536	63	80%
GALICIA	1.621	299	102	529	324	-231	-221	62%
MADRID	77	274	44	830	441	-556	-397	402%
MURCIA	555	479	777	690	175	-210	602	117%
NAVARRA	247	459	25	333	94	126	-69	125%
PAIS VASCO	131	210	19	572	460	-363	-442	351%
LA RIOJA	111	389	19	288	67	102	-47	147%
CEU/MEL	0	4	0	64	14	-60	-14	2029%
<b>TOTAL</b>	16.143	11.667	5.043	11.667	5.405	0	-362	
<b>Source: Own calculation based on our Interregional Trade Matrices. 1995</b>								
*Interregional Exports and Imports are deduced from own calculations.								
** Flows with the Rest of the World are obtained from Custom data. 1995								
*** Since data does not include "services", Openess ratio is different than the usual (X+M)/PIB.								

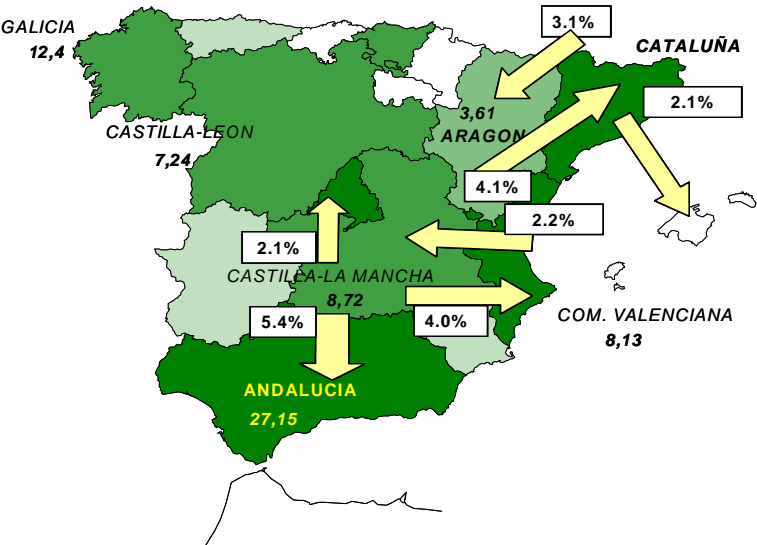
Table 9

RANKING OF THE MAIN INTRA-INTER REGIONAL FLOWS					
R1-AGRICULTURE, FORESTRY AND FISHING. % and millions of Euros.					
1995	INTRA		INTERREGIONAL		
	As % of Total Trade		As % of Total Interregional Trade		
	ORIGIN=DESTINATION	%	ORIGIN	DESTINATION	%
1	CATALUÑA	10,2%	C-MANCHA	ANDALUCIA	5,4%
2	ANDALUCIA	9,4%	ARAGON	CATALUÑA	4,1%
3	C-LEON	9,3%	C-MANCHA	C-VALENCIA	4,0%
4	GALICIA	5,8%	CATALUÑA	ARAGON	3,1%
5	ASTURIAS	4,8%	C-VALENCIA	C-MANCHA	2,2%
6	C-MANCHA	3,7%	CATALUÑA	BALEARES	2,1%
7	C-VALENCIA	2,6%	C-MANCHA	MADRID	2,1%
8	MURCIA	2,0%	C-LEON	CANTABRIA	1,9%
9	EXTREMADURA	1,8%	CATALUÑA	C-VALENCIA	1,9%
10	CANARIAS	1,7%	ANDALUCIA	MURCIA	1,6%
INTRA+INTER TOTAL		27.810	INTERREGIONAL TOTAL		11.667

Source: Own calculations based on our interregional trade matrices

Figure 6<sup>10</sup>

AGRICULTURE, FORESTRY, FISHING...  
(1)-THE STRONGEST INTERREGIONAL FLOWS. 1995



<sup>10</sup> The intensity of the colour express the spatial concentration of population while the numbers are the percentage shares of regions in the Agriculture VA of the Spanish economy. Regional Accounts (INE).

According to the results in **Table 8** and **Table 9**, all the Spanish regions except the Comunidad Valenciana, have higher levels of interregional trade of agricultural products is than the international one.

At the same time, it is interesting to observe that the number of regions with positive balance in their interregional trade is higher than when all goods were considered. Andalucía, C. Valenciana and Murcia share the same trend in their balances: a considerable positive balance in their trade with foreign countries and a slight deficit in the national market. By contrast, Extremadura is the only one region that keeps positive balance in both markets.

In average, the share of intraregional trade of agriculture products appears to be higher than in the case of *all goods*. As it were expected, the strongest intra flows are located in the regions that capture the highest shares of the Spanish production in the sector.

Now, the most intense interregional flows take place among regions with hard specialisation in the production of agricultural products (as origins) and regions with strong levels of final or intermediate consumption as a consequence of their level of population or/and an important presence of transforming industries (as destination).

Notice that, in this case, all of the strongest interregional flows take place between **neighbour economies**. Probably, this fact could be partially explained by the location of those industries that use agricultural as intermediate inputs as well as the presence of centralised markets of agricultural products in the main cities of each region (see Pulido et al, 2002, 2000 for a brief explanation on the impact of distribution strategies in the outcome of interregional trade of Madrid estimated through transport data).

**Table 10**

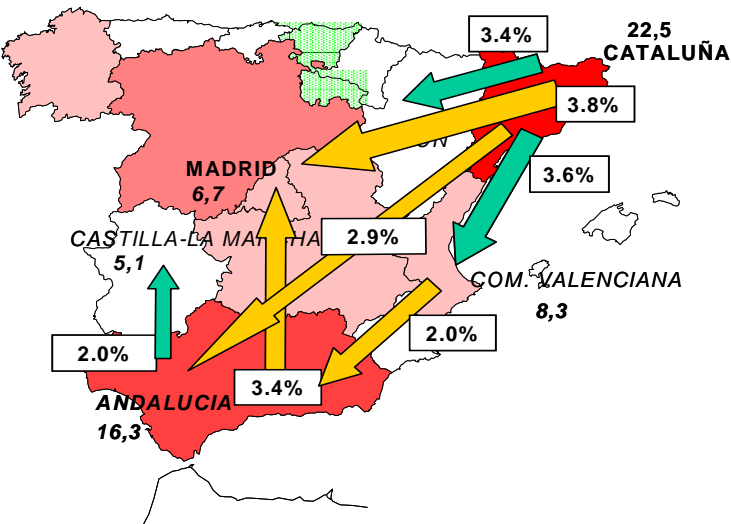
MAIN RATIOS FROM THE INTERREGIONAL TRADE MATRICES. R3-FOOD&BEVERAGES. MILLIONS OF EUROS.								
1995	INTRA REGION*	EXPORTS		IMPORTS		BALANCE		OPENESS RATIO***
	(1)	SPAIN (2)*	WORLD (3)**	SPAIN (4)*	WORLD (5)**	SPAIN (6)=(2-4)	WORLD (7)=(3-5)	(2+3+4+5) /(1+2+3)
ANDALUCIA	3.683	4.889	1.152	4.058	695	831	457	111%
ARAGON	445	1.189	170	1.845	76	-656	94	182%
ASTURIAS	331	990	63	1.043	44	-53	19	155%
BALEARES	343	201	27	762	52	-561	-25	182%
CANARIAS	923	356	86	787	637	-431	-551	137%
CANTABRIA	142	780	89	525	61	255	28	144%
C-LEON	1.319	3.078	302	2.346	243	732	59	127%
C-MANCHA	742	2.029	205	1.914	157	116	48	145%
CATALUÑA	5.086	5.990	1.412	2.962	2.302	3.027	-890	101%
C.VALENCIA	1.552	2.678	480	2.908	627	-230	-147	142%
EXTREMADU	283	509	161	1.059	46	-550	116	186%
GALICIA	1.374	1.829	590	1.182	746	647	-156	115%
MADRID	1.607	1.815	300	4.698	1.048	-2.882	-748	211%
MURCIA	350	1.093	495	1.191	166	-98	329	152%
NAVARRA	404	815	122	447	157	368	-34	115%
PAIS VASCO	634	1.108	216	1.567	340	-459	-125	165%
LA RIOJA	79	946	156	567	46	379	109	145%
CEU/MEL	1	8	15	439	47	-431	-33	2144%
<b>TOTAL</b>	19.298	30.302	6.040	30.302	7.489	0	-1.449	
<b>Source: Own calculation based on our Interregional Trade Matrices. 1995</b> *Interregional Exports and Imports are deduced from own calculations. ** Flows with the Rest of the World are obtained from Custom data.1995 *** Since data does not include "services", Openess ratio is different than the usual (X+M)/PIB.								

Table 11

RANKING OF THE MAIN INTRA-INTER REGIONAL FLOWS R3-FOOD&BEVERAGES. % and Millions of Euros.					
1995	INTRA <i>As % of Total Trade</i>		INTERREGIONAL <i>As % of Total Interregional Trade</i>		
	ORIGIN-DESTINATION	%	ORIGIN	DESTINATION	%
1	CATALUÑA	10,3%	CATALUÑA	MADRID	3,8%
2	ANDALUCIA	7,4%	CATALUÑA	C.VALENCIA	3,6%
3	MADRID	3,2%	ANDALUCIA	MADRID	3,4%
4	C.VALENCIA	3,1%	CATALUÑA	ARAGON	3,4%
5	GALICIA	2,8%	CATALUÑA	ANDALUCIA	2,9%
6	C-LEON	2,7%	ANDALUCIA	EXTREMADURA	2,0%
7	CANARIAS	1,9%	C.VALENCIA	ANDALUCIA	2,0%
8	C-MANCHA	1,5%	ANDALUCIA	CANARIAS	1,9%
9	PAIS VASCO	1,3%	C.VALENCIA	C-MANCHA	1,7%
10	ARAGON	0,9%	C-LEON	MADRID	1,7%
INTRA+INTER TOTAL		49.600	INTERREGIONAL TOTAL		30.302
Source: Own calculations based on our interregional trade matrices					

Figure 7<sup>11</sup>

FOOD AND BEVERAGES  
(1)-THE STRONGEST INTERREGIONAL FLOWS. 1995



<sup>11</sup> The numbers and the intensity of the colour in the map express the spatial concentration of the Food&Beverages industry output calculated according to the National Industry Survey (SNIS, 1995).



In the case of the Food and Beverages Industry, the amount of regions with positive figures in both sides of the balance increases up to five. It is also remarkable the clear contrast observed between the high positive balance of Catalonia in the national market and the negative balance registered in the international one.

Taking into account the economic nature of this products, it seems logical that the strongest intrar-regional flows appear in those regions with the largest shares of final consumption induced by their high levels of population: Catalonia, Madrid, Andalusia and C. Valenciana.

Catalonia, with about the 22% of the Spanish food industry output, appears as the main origin of interregional exports toward their neighbour regions and even further. It is interesting to observe that in this case the strongest interregional flows links the most powerful regions rather than the closest ones. Probably, as it has been said before, this fact should be explained not just by the distance and the cost of transport, but as a consequence of the strategies of distribution and localization of this particular industry.

## 5. CONCLUSION

In this paper we have described the main steps followed in the construction of this first version of a Multiregional-Multisectoral model for the Spanish economy. Apart from a quick review of the interregional input-output framework and a brief description of the construction method used for the model, the article described pieces of information that are worthy in and of themselves.

We have specially focused on the strategy followed for the estimation of a complete set of interregional trade matrices, using transport flows and value/weight relations indirectly deduced from detailed international trade statistics. In that sense, the paper offers a complementary view of the model, giving a general perspective about the quality and utility of the interregional data that interconnect each of the 19 one-region input-output tables within the interregional framework.

On the other hand, the paper introduces an interesting overview about the spatial structure of trade flows of the Spanish economy with the identification of the highest intra and interregional trade flows in 1995. Finally, as an example, we conclude the analysis with a brief insight into the interregional flows of two specific sectors – Agricultural Products and Food&Beverage Industry- with the purpose of highlighting the possibilities offered by the interregional trade database even when it is used outside the input-output model.

Trough this analysis, we have confirmed the expected primacy of interregional trade relations in comparison to the international ones. We have also checked the validity –in general- of the gravity model for the interregional trade in Spain: the relation between the intensity of the flow and the distance, the population and the output of the regions of origin and destination, and the prevalence of interregional trade relations

among neighbours. In that way, in line with the results obtained by other authors in the field of spatial econometrics (Moreno R. et al 1999, López-Bazo et al. 1998; Vayá E. et al 1998 y 1999) and gravity models (Shen 1994; Batten D.F. 1983; Wilson 1970a, 1970b, 1973), our data confirms the importance of distance and the economic power of regions as explaining variables of the intensity of interregional trade among Spanish regions, and therefore, their level of interdependence and integration.

At the same time, through the analysis of the spatial structure of trade and the identification of strongest interregional flows for the total and two specific sectors, we have also detected how the natural trend towards “trading with neighbours” varies across regions and sectors, depending probably on a large list of variables. Additionally, by means of “spatial concentration coefficients” of interregional flows, we have also identify, the ranking of main suppliers and clients of each region and, as a consequence, the strongest dependence relations among the others.

After this first insight on the 1995 interregional trade database, we expect to offer soon more detailed analysis about 1995 figures and new information about how the interregional economic relations have evolved since 1995 up to date.

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The first part of this paper briefly describes the work developed by the team involved in the **Project of INTERTIO**. The estimation and analysis of the interregional trade is based in my Doctoral thesis (Llano, C. 2004). An special mention corresponds to Antonio Pulido, who has guided the whole project, and to Emilio Fontela and Geoffrey Hewings for their comments on an earlier draft. I would also like to thank all the people and Institutions that have supplied the required statistics.

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