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## Conference Paper

# Spatial interaction models applied to the design of retail trade areas

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# **SPATIAL INTERACTION MODELS APPLIED TO THE DESIGN OF RETAIL TRADE AREAS**

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38<sup>th</sup> Congress of the European Regional Science Association

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## **ABSTRACT**

Intermetropolitan trade areas are geographical zones defined by consumer movements over space -retail flows- from their origin municipalities towards a head town, to do the main shopping. These market areas own an economic sense that do not have other more commonly used territorial divisions, such as towns, provinces or regions.

Since 1992, the Lawrence R. Klein Institute –Autónoma University of Madrid-actualises the Spanish Retail Trade Atlas and determines regional trade areas and sub-areas, using spatial gravity models and survey. The authors' experience in this Project allows them to analyse the different procedures suggested for modelling the consumer store-choice process.

This work focuses on market area delimitation models and presents the estimation process developed by the L.R. Klein Institute in determining intermetropolitan trade areas. A competing destinations logit model combined with a retail saturation index allows us to determine the best location for new shopping centers situated in the Hispano-Lusitanian market areas.

**Key words:** Intermetropolitan trade areas, Retail trade atlas, market area, market sub-area, spatial interaction models.

## **I. INTRODUCTION**

Intermetropolitan trade areas are geographical zones defined by consumer movements over space -retail flows- from their origin municipalities towards a head town, to do the main shopping. These market areas own an economic sense that do not have other more commonly used territorial divisions, such as towns, provinces or regions.

In 1931, Professor Reilly, of Texas University, was the first in tackling the delimitation market problem. Based on the Newtonian law of gravitation, Reilly is the precursor of the “gravity” type of spatial choice models commonly used today. Later, many researchers have followed his discovering, opening an important path in geographical marketing: Christaller (1935), Applebaum (1961), Huff (1963), Jones and Mock (1984), Fotheringham and O’Kelly (1989), Rust and Donthu (1995), etc.

In 1963, the Spanish Chamber of Commerce published the “1963 Spanish Retail Trade Atlas” which divided the national territory into 101 retail areas and 170 retail sub-areas. Since 1992, the **Lawrence R. Klein Institute** –Autónoma University of Madrid- actualises the Spanish Retail Trade Atlas and determines regional trade areas and sub-areas, using spatial gravity models, spatial interaction models and survey. Recently, this Institute has elaborated the “**1998 Spanish Trade Yearbook**”, in which the Spanish retail trade flows are estimated referred to July 1997. At this date, there were 73 retail areas and 207 sub-areas. The authors’ experience in this Project allows them to review the different procedures suggested for modelling the consumer store-choice process.

This work focuses on **market area delimitation models** (Chapter 2) and presents the estimation process developed by the Lawrence R. Klein Institute (LRKI) in determining intermetropolitan trade areas (Chapter 3). A **competing destinations logit model** combined with a **retail saturation index** will determine the best locations for new shopping centers situated in the **Hispano-Lusitanian market areas** (Chapter 4). Recently, LRKI is analysing those Spanish intermetropolitan market areas that have a common border with Portugal, which are actually determined as cut by the frontier, considering this one as a fictitious barrier. In another paper (Chasco and Insa 1998), we have estimated the real dimension of the Spanish market areas situated in the border with Portugal, as a beginning of a possible Hispano-Portuguese Retail Trade Atlas –we consider this work very interesting at a time of expansion of major retail outlets and new means of communication in both neighbour countries. Now we step forward to detect **potential sales points** for new shopping centres.

## **II. RETAILING MARKET AREA DETERMINATION MODELS**

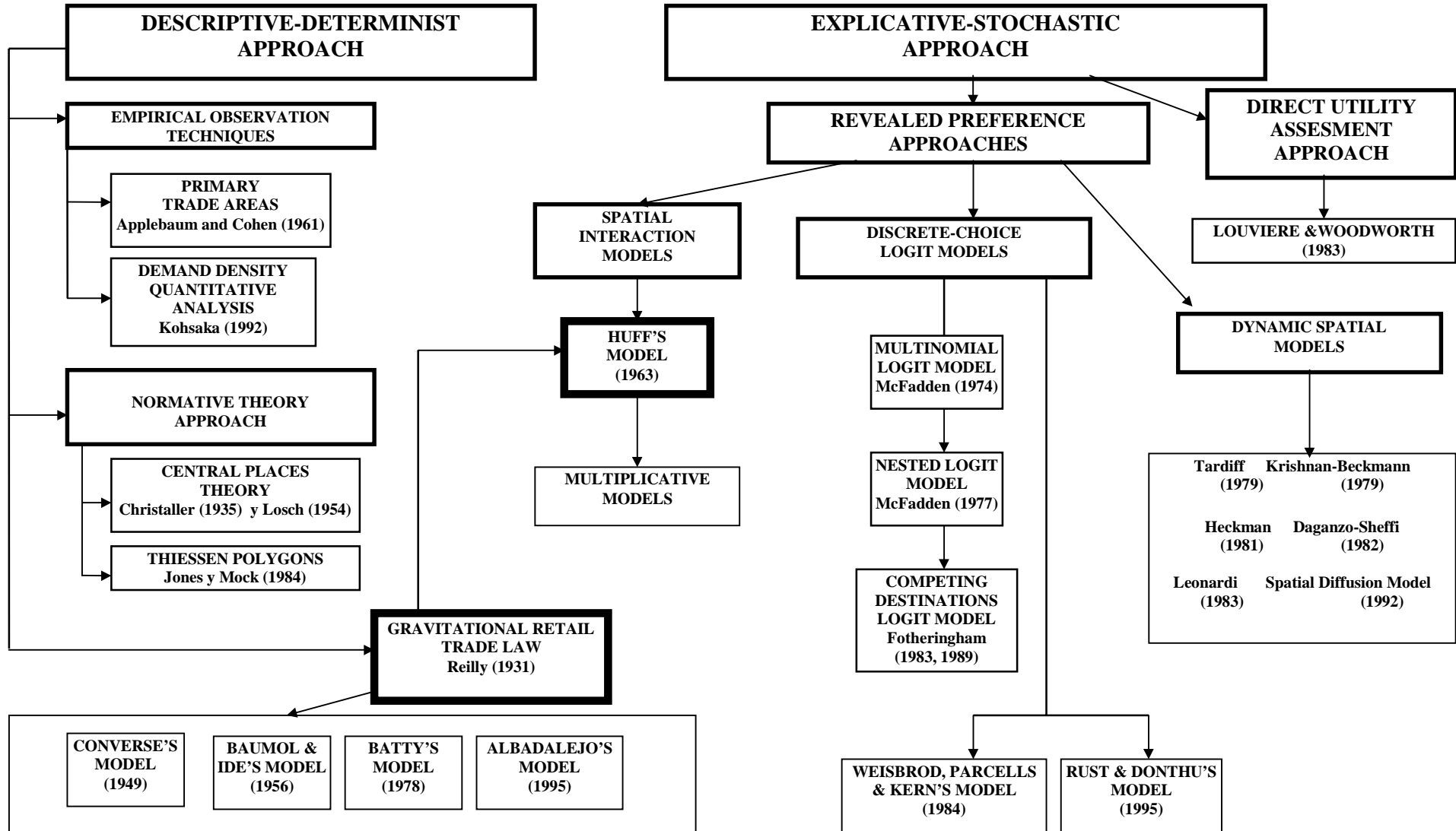
The delimitation of the retailing areas and sub-areas and the study of their competing interaction over territorial space can be realised by some more or less sophisticated techniques and models, ranging from simple rules of thumb to computerized simulation models. These last ones have diverse functional forms and several endogenous and exogenous variables, so that it is possible to distinguish between different groups of ‘families’ of delimitation market areas (Chasco 1997). The intent of this chapter is to discuss and evaluate these methods and illustrate their application in situations relating with intermetropolitan market areas. Therefore, store choice models can be classified into two main groups: descriptive-determinist approach and explicative-stochastic approach (Fig. 1).

### **II.1. Descriptive-Determinist Approach**

This approach includes a group of techniques that rely on observation or normative assumptions. Deterministic models were ruled out because they rely on generally unrealistic assumptions regarding consumer spatial behaviour such as consumers patronising the nearest opportunity.

- A. Empirical Observation Techniques** are based on observation and quantification of market areas. It is well-known the ‘analog’ procedure devised by **Applebaum** (1961) for constructing primary trade areas from customers spotted on a location map. The ‘analog’ procedure uses customer surveys to determine the geographical pattern of trade areas. Rather than relying on a priori assumptions regarding consumer travel patterns, actual travel patterns are analysed using ‘customer spotting’. This method is used extensively by many retail firms.
- B. Normative Theory Approach** is founded on certain consumer behaviour assumptions about travel time. It includes the **Central Place Theory** (CPT), which is the best developed normative theory of retail location. First proposed by Christaller (1935) and Lösch (1954), CPT is based on the nearest-centre hypothesis: when consumers are faced with making a choice among similar outlets, they select the one nearest to them. Thus, in this method, the trade area of an outlet is found simply by demarcating the geographic area that is closer to this outlet than any other. CPT examine the complexity of this problem under highly simplify conditions. Recent developments, however, have brought the theory close to actual retail environments –that is the case of **Thiessen Polygons** (Jones and Mock, 1984).

**Figure 1: Spatial models and methods applied to the design of retail trade areas.**



Source: Chasco (1997).

**C. ‘Reilly’s Law of Retail Gravitation’** (Reilly 1931) considers not only distance but also attractiveness of alternative shopping opportunities. The notion that agglomeration tends to increase the attractiveness of stores is key to Reilly’s “law” –stores located in centres with greater populations draw customers from farther distances than those in smaller-order centres. The focus of this model is the intermetropolitan trading area boundaries between neighbouring cities in a region, rather than the trade area boundaries of individual stores. Based on the Newtonian law of planetary attraction, it was the first to explicitly recognize that consumers trade off the cost of travel with the attractiveness of alternate shopping opportunities. Thus it is the precursor of the gravity type of spatial choice models commonly used today.

This deterministic law argues that the proportion of retail trade attracted from intermediate towns by two competing urban areas is in direct proportion to their population and in inverse proportion to the square of the distances from those cities to the intermediate towns (Fig. 2).

**Figure 2: Reilly’s Law of Retail Gravitation.**

$$\frac{R_A}{R_B} = \left( \frac{P_A}{P_B} \right)^1 * \left( \frac{D_B}{D_A} \right)^2$$

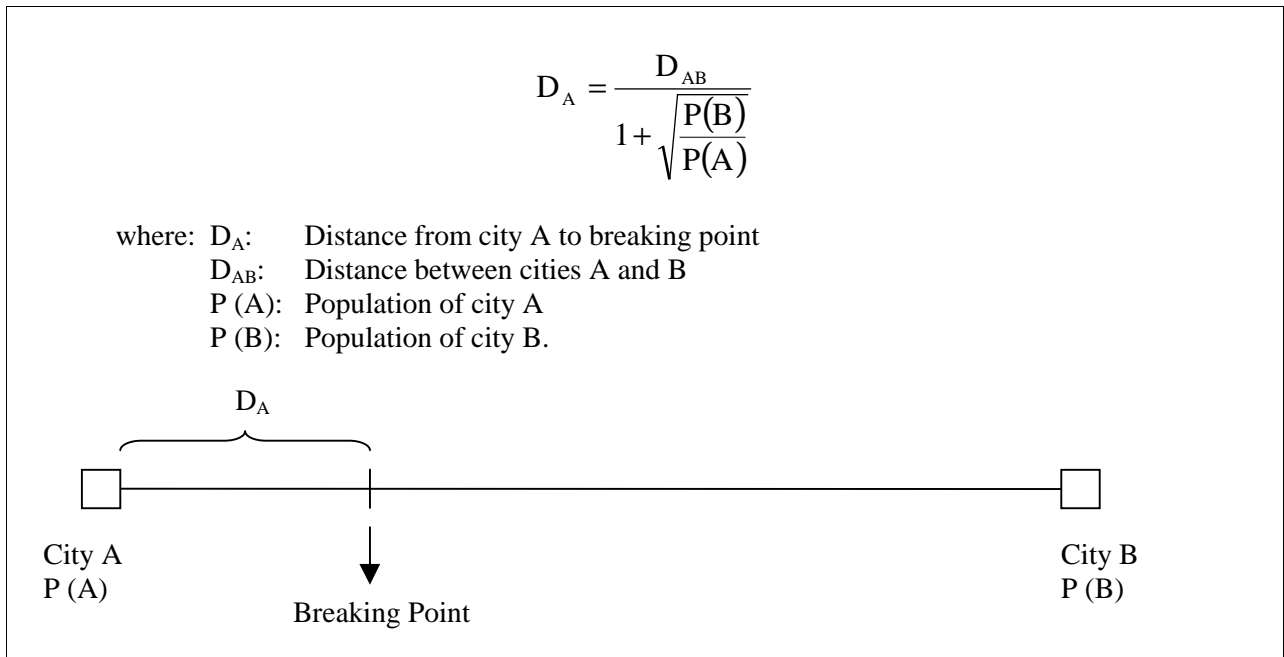
$R_A, R_B$ : proportions of retail trade from an intermediate town attracted by the cities A and B  
 $P_A, P_B$ : Population of the two cities.  
 $D_A, D_B$ : Distancies from the intermediate town to the two cities.

Source: Location Strategies for Retail and Service Firms (Ghosh et al., 1987).

To demarcate trade area boundaries, Reilly’s law is often expressed as the **‘breaking point’ formula** popularised by Converse (1949). As illustrate in Figure 3, the breaking point is the town between two cities A and B such that all consumers to the left of the point patronise retail facilities in one city and all consumers to the right patronise facilities in the other. If the nearest-centre principle were being used, the breaking point would simply be halfway between the two cities. However, according to Reilly’s law, the breaking point is where the relative attractiveness of the two cities is equal.

This attractiveness is measured by two kind of variables: a ‘mass’ variable –Population-, which exerts positive attraction over consumers and a ‘friction’ variable –Distance-, which discourage them from moving. Mass attraction variable is expressed by measures of **size** of the towns: **population** –as it was in the original Reilly’s law- or **sales surface** (square metres). L.R. Klein Institute use this last one to apply Reilly’s law to the Retail Trade Atlas.

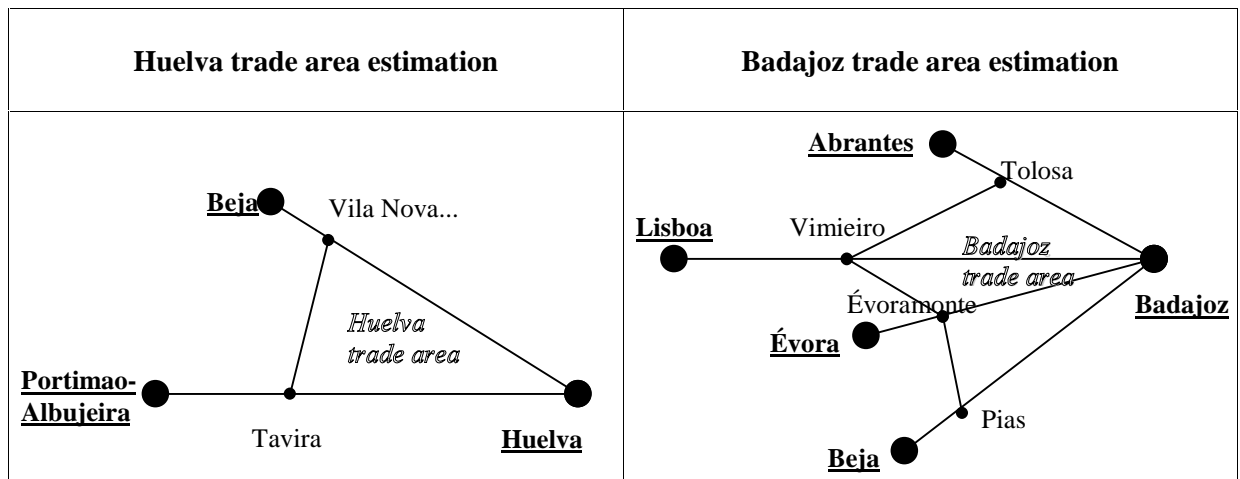
**Figure 3: Illustration of Reilly-Converse's Breaking-Point formula.**



Source: Location Strategies for Retail and Service Firms (Ghosh et al., 1987).

In delineating the entire trading zone of a city, the breaking point between the city and its neighbours **in several directions** must be found as illustrated in Fig. 4.

**Figure 4: Estimating the Huelva and Badajoz trade areas by the breaking point method.**



Source: Self-elaboration.

## II.2. Explicative-Stochastic Approach

This approach uses information revealed by past behaviour to understand the dynamics of retail competition and how consumers choose among alternative shopping opportunities. D. Huff (1963) was the first to use a utility function and introduced the spatial interaction models to

explain consumer behaviour. They argued that consumers rate alternatives based on their evaluation of the total utility of the store and not merely on its location. This big modelling family includes 2 groups of probability compensatory models with an important estatistic-econometrical basis: revealed preference approaches and utility direct evaluation approach.

### **A. Revealed Preference Approaches.**

In this approach we can find 3 groups of models: spatial interaction models, discrete-choice logit models and dynamic spatial models.

#### **A.1. Spatial Interaction Models.**

Based on Reilly's Law, **D. Huff** (1963) was the first to propose a spatial-interaction model for estimating retail trade areas. He argued that when consumers have a number of alternative shopping opportunities, they may visit **several different stores** rather than restrict their patronage to only one outlet. Each store within the geographic area with which the consumer is familiar has some chance of being patronised. Thus, Huff conceived trade areas to be **probabilistic** rather than deterministic, with each store having some probability of being patronised. This one is positively related to the size of the outlet and decreases with distance.

#### **Figure 5: Huff's Model**

$$P_{ij} = \frac{U_{ij}}{\sum_{k=1}^J U_{ik}} = \frac{S_j^\alpha D_{ij}^\beta}{\sum_{k=1}^J S_k^\alpha D_{ik}^\beta}$$

where  $P_{ij}$ : probability of consumer at "i" visiting store j (or town j); J is the set of competing stores (or towns) in the region.  
 $U_{ij}$ : utility of store (or town) j for individual at "i".  
 $S_j$ : size (square metres) of outlet j (or set of outlets of town j)  
 $D_{ij}$ : distance between consumer at "i" and store (or town) j.  
 $\alpha, \beta$ : sensibility parameters; in line with Reilly's Law,  $\alpha = 1$  and  $\beta = -2$ .

Huff suggested (Fig. 5) that the utility of a store depends on its size (S) and distance (D). To determine the probability of a consumer visiting a particular outlet, Huff followed the choice axiom proposed by Luce (1959). Luce's axiom postulates that the probability of a consumer visiting a particular store ( $P_{ij}$ ) is equal to the ratio of the utility of that store ( $U_{ij}$ ) to the sum of utilities of all the stores considered by the consumer.



As an illustration of this model (Fig. 6), we present one example studied in the Hispano-Lusitanian frontier area. Consider an individual living in the municipality of Moura who has the opportunity to shop at three market head towns: Beja, Évora and Badajoz. In view of the sizes of these market heads and their distances from the consumer's home, the probability that the consumer will shop at Badajoz is 0,62. Therefore, 62 in 100 journeys of consumers in Moura, to do the main shopping, take place to the municipality of Badajoz. In the same way, 16 and 22 of 100 journeys take place to the towns of Beja and Évora, respectively.

**Figure 6: Illustration of the application of the original Huff Model.**

Market head	Distance (Km.)	Size (square metres)
Badajoz	133	55.319
Évora	89	8.725
Beja	58	2.628

If  $\alpha = 1$  and  $\beta = -2$ :

Utility of <b>Badajoz</b> head	$55.270 * 133^{-2} = 3,12$
Utility of <b>Évora</b> head	$8.725 * 89^{-2} = 1,10$
Utility of <b>Beja</b> head	$2.628 * 58^{-2} = 0,78$

Based on these utilities, the probabilities that individuals in **Moura** will shop at Badajoz, Évora and Beja market heads of area are:

Probability of buying in <b>Badajoz</b> head	$3,12 / (3,12 + 1,10 + 0,78) = 0,62$
Probability of buying in <b>Évora</b> head	$1,10 / (3,12 + 1,10 + 0,78) = 0,22$
Probability of buying in <b>Beja</b> head	$0,78 / (3,12 + 1,10 + 0,78) = 0,16$
Total	$0,62 + 0,22 + 0,16 = 1$

As well as Reilly's Law, Huff's model has played an important part of development of store choice and retail trade-area estimation models. It was the first to suggest that market areas were complex, continuous and probabilistic rather than the nonoverlapping geometrical areas of CPT (Craig, Ghosh and McLafferty 1984). Most empirical studies support the usefulness of the Huff model in predicting with reasonable accuracy the market share of shopping centres, however some authors argued that **additional variables** should be included in the utility function. This suggestion have originated Multiplicative Models as **MCI** –Multiplicative Competitive Interaction Model (Nakanishi and Cooper 1974)- or **Gautschi's Model** (Gautschi 1981), in which the inclusion of additional distance factors improve the model's predictive performance.

## A.2. Discrete-Choice Logit Models.

Huff's model can be considered as a particular case of the discrete-choice models known as **multinomial logit** (McFadden, 1974). In this model, the probability that an individual located at place  $y$  selects store  $j$  out of a set of  $J$  stores to do his/her major grocery shopping is given by the expression in Fig. 7.

**Figure 7: McFadden's multinomial logit model**

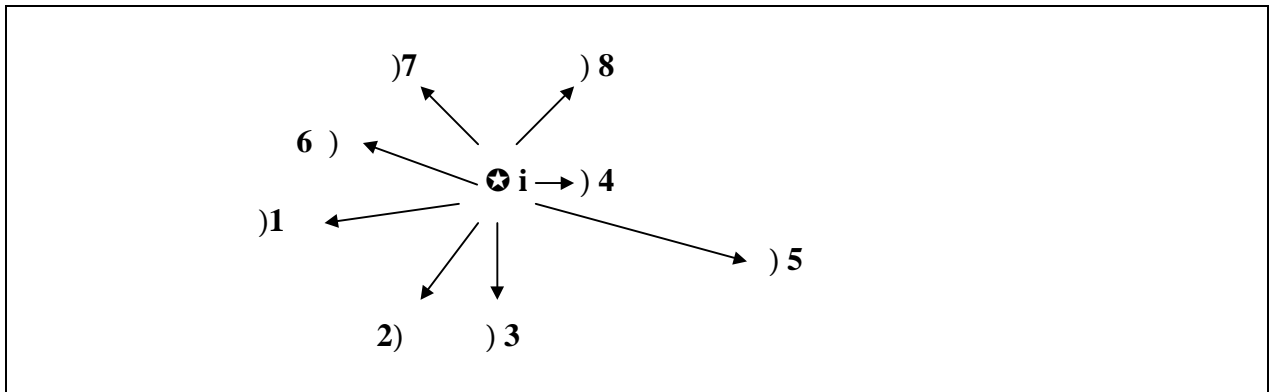
$$P_{ij} = \frac{\exp(V_{ij})}{\sum_{k=1}^J \exp(V_{ik})}$$

where  $V_{ij}$ : represents the observed utility an individual at location  $i$  receives from selecting store  $j$ . According with Lancaster (1966), this utility can be expressed as a linear additive function of stores attributes as perceived by the individual.

Both Huff and McFadden's models satisfies the so-called '**Independence of Irrelevant Alternatives**' (IIA) property, that is, the ratio of the probabilities of an individual selecting two alternatives is unaffected by the addition of a third alternative. While this may be reasonably representative of certain aspatial choice situations, it is very unlikely to occur in spatial choice because of the fixed locations of spatial alternatives. For a better understanding of IIA property, we can consider the retailing system in Fig. 8 with a individual  $i$  faced with making a choice from 8 supermarkets –spatial alternatives.

It is supposed that the probability of an individual  $i$  selecting supermarket 4 is three times greater than the probability of choosing supermarket 6. If a new supermarket was opened immediately adjacent to the store 4 then, because of the competition differential effects, it would be logical to think that the new outlet would reduce the probability of choosing supermarket 4 to a greater extent than supermarket 6. Nevertheless, the model is incapable of translating this effect because of the IIA property. In fact, in non-spatial models the introduction of new retail alternatives will grow the denominator and consequently will diminish the final probability of each of the  $j$  retail outlets initially considered in the same proportion. In spatial situations, due to the relative spatial location of the choosing alternatives, the introduction of new outlets affects in a different way to the others depending on the place in which it is going to be situated. Whether it is affected positively or negatively is an empirical question, as it is going to be demonstrated further.

**Figure 8: The spatial choice problem.**



Source: Fotheringham and O'Kelly 1989.

The **Competing Destinations Model (CDM)** proposed by Fotheringham (1983) and derived from purely spatial considerations, provides a way of overcoming some problems with the logit and nested logit models that arise from the transference of essentially aspatial theory to the spatial realm. (Fig. 9).

**Figure 9: Competing destinations model.**

$$P_{ij} = \frac{C_j^\theta \exp(V_{ij})}{C_j^\theta \sum_{j=1}^J \exp(V_{ij})}$$

where:  $\theta$ : sensibility parameter  
 $C_j$ : measure of centrality. According to Borgers and Timmermans (1987) suggestion:

$$C_j = \frac{\sum_{j \neq i} d_{ij}}{J-1}$$

This model make the assumption that there is a limit to an individual's ability to process large amounts of information, therefore spatial choice is likely to result from a **hierarchical information-processing** strategy whereby a cluster of alternatives is first selected. One approach considers that the likelihood of a particular alternative being in the restrictive choice set is a function of the **dissimilarity** of that alternative to all others. The rationale for this approach is that the degree to which an alternative possesses distinctive properties affects its chances of being included in this selection. When the CDM is calibrated and an estimate of  $\theta$  obtained:

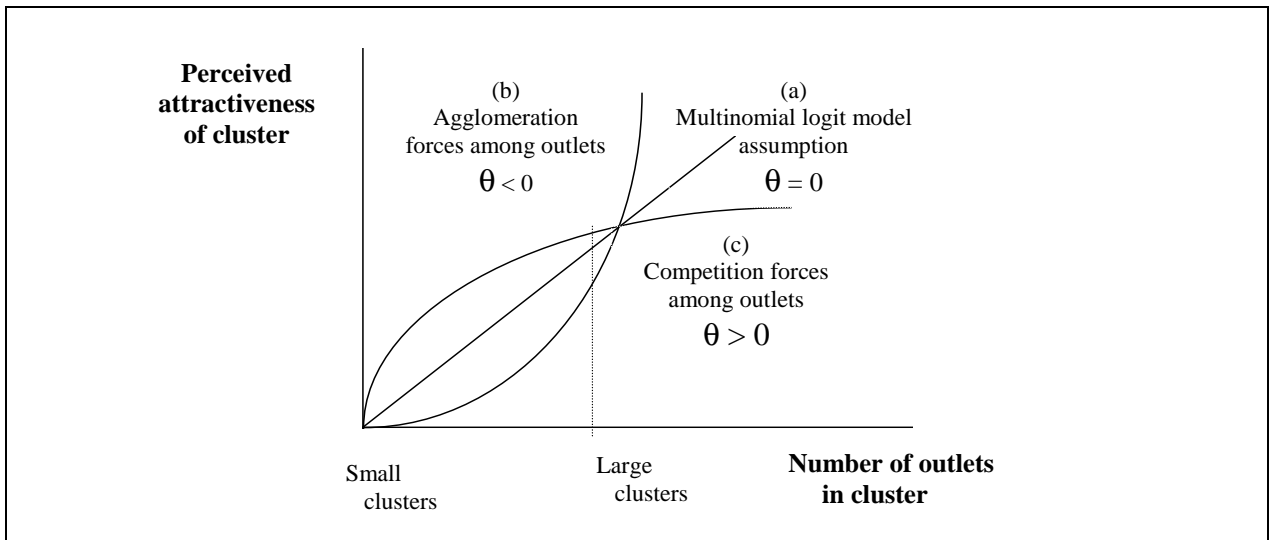
- . If  $\theta > 0$ , outlets will increase their market share by being isolated from their competitors and **competition forces** are said to exist.

. If  $\theta < 0$ , outlets will increase their market share by locating in close proximity to other outlets and **agglomeration forces** are said to exist.

. If  $\theta = 0$ , it is clear that the CDM is equivalent to the logit formulation indicating that **all alternatives are evaluated simultaneously**.

In an intermetropolitan market areas context, a cluster of outlets can be the sum of the retailing establishments located in a municipality or a town. As presented in Fig. 10, if the attraction of a cluster increases exponentially as the number of alternatives in it increases,  $\theta$  will be negative, reflecting some sort of agglomeration and relationship whereby the closer is  $j'$  to other alternatives, the more likely is to be selected. Conversely, if the attraction of a cluster increases logarithmically with its size,  $\theta$  will be positive reflecting some sort of competition relationship whereby alternatives in close proximity to others are less likely to be selected than peripheral ones. Finally when the parameter  $\theta = 0$ , consumers evaluate only individual outlets without regard to their spatial clustering and the attractiveness of a spatial cluster of outlets is merely the sum of the attractions of its individual outlets.

**Figure 10: Relationships between the perceived attractiveness of an outlet cluster and the size of the cluster.**



Source: Fotheringham (1988).

For example, the addition of one store to a cluster of 100 stores probably does not add as much to the perceived attractiveness of the cluster as does the addition of the same store to a cluster of 25. Alternatively, a cluster of 25 stores may be perceived as being more than 25 times as attractive as an individual store. In either case, such relationships cannot be modelled with the

multinomial logit model where the relationship between perceived attractiveness and size is described by slope (a).

### **A.3. Dynamic Spatial Models.**

Finally, the spatial dynamic models constitute the third group in the Revealed Preference Approach. They analyse the market area evolution in time opening new paths in this research area. That is the case of the Allaway's Spatial Diffusion Model (Allaway, Black, Richard and Mason 1992) based on the diffusion theory.

### **B. Direct Utility Assessment.**

This is the second family of models belonging to the Explicative-Stochastic Approach with the Revealed Preference Approach. These models estimate consumer utility functions from simulated choice data using information integration, conjoint or logit techniques (Louviere and Woodworth 1983). Instead of observing past choices (Revealed Preference Approach), these methods use consumer evaluations of hypothetical store descriptions to calibrate the utility function. The advantage of experimental procedures is that since they do not rely on past choices to reveal the utility function, the estimated weights do not reflect the effect of existing spatial structures. So this approach can be very helpful in estimating market shares of **innovative retail institutions** for which past choice data are unavailable (Craig, Ghosh and McLafferty 1984).

## **III. SPATIAL INTERACTION MODELS APPLIED TO MARKET AREA ANALYSIS**

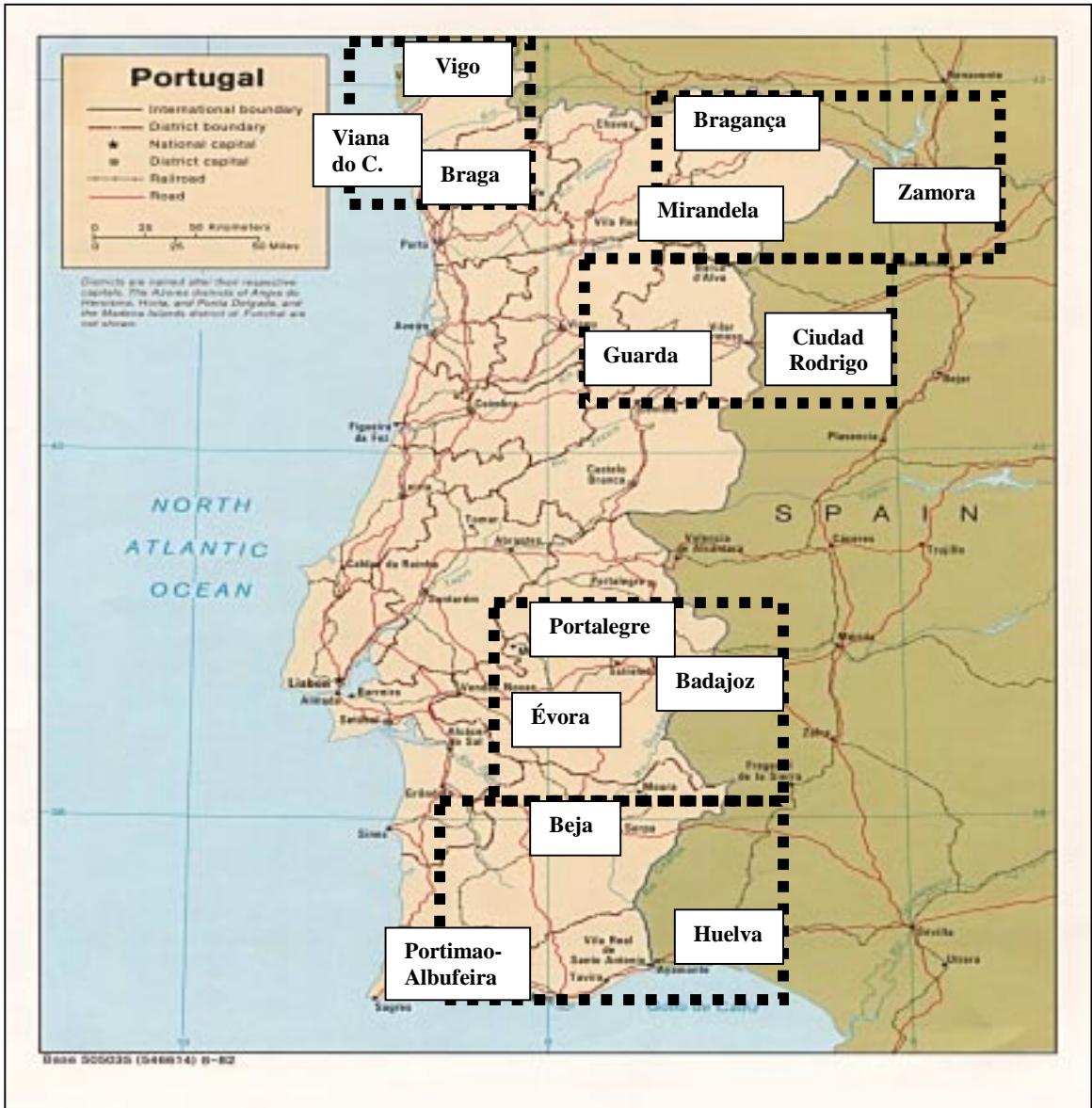
Now we are going to summarise the **L.R. Klein Institute market-area estimation process** in 5 steps. In a first step, certain variables of the study region must be analysed, such as commercial equipment, means of communication, disposable personal income, etc. It is necessary to find out those municipalities that exert some kind of retailing attraction, called "heads of market area".

Once the competing heads of market areas are determined -2<sup>nd</sup> step- some spatial interaction models must be applied in step 3: Reilly's gravity model and Huff's multiplicative model. **Reilly's Law** allows us to know the breaking points drawn by the interacting heads of market area (Fig. 4). Next, as shown in Fig. 6, **Huff's Model** establishes choice probabilities for a sample of municipalities in a study region. The situation described by models is finally outlined by telephone survey -4<sup>th</sup> step- that takes place only in certain zones in doubt. In step 5, it is necessary to decide the shape of the market areas caused by the interacting competing heads, as well as to quantify their magnitude with some statistical measures.

This methodology is being applied to actualise the Spanish retail trade areas and sub-areas, which are published in the Spanish Trade Yearbook. We have also used it to re-estimate the frontier Spanish market areas with Portugal (Chasco and Insa 1998). Now we step forward to detect **potential sales points** for new shopping centres in this area by calibrating the competing destinations logit model in different frontier areas, combined with a retail saturation index.

In this Chapter, we present the **Fotheringham’s Competing Destinations Model** (CDM), usually applied to estimate retail trade areas, as a good method to determine best locations for new retail outlets combined with a Retail Saturation Index (RSI).

**Figure 11: Main Hispano-Portuguese heads of market area in the frontier region.**



Source: self-elaboration.

This methodology is included in a ILRK project research that analyses those Spanish intermetropolitan market areas that have a common border with Portugal (Fig. 11). In the Spanish retail trade atlas, they are actually determined as cut by the frontier, considering this one as a fictitious barrier. This **800-km frontier region** is now considered as a great opportunity for new trade interactions and contacts, specially with the total implementation of Euro area.

It is important to remark the historical **lack of communication** between both countries, also hardly connected by road. Travelling by car is more and more the principal mean of transport used by consumers to do the shopping substituting railway. There is only a two-side motorway border passage, Porto-Vigo road, and we can find two one-side motorway passage: with motorway in Portugal, Faro-Huelva road and with motorway in Spain, Elvas-Badajoz road. Besides, it is possible find some border roads considered as “national roads” (A roads) connecting Beja-Seville, Portalegre-Cáceres, Guarda-Salamanca, Bragança-Zamora and Vila Real-Ourense. In the other side, there is a great deal of B roads and important isolated extensions in an approximately 800 km. frontier line that makes difficult international consumer flows and communication in general.

In this paper, we are going to analyse 3 frontier regions, Huelva-Portimao-Beja, Badajoz-Évora-Portalegre and Vigo-Viana do Castelo-Braga<sup>(1)</sup>, with the objective of determining potential sales points for new shopping centres. This purpose will be covered by 2 steps:

- 1) Determination of **agglomeration/competition market forces** in this area by the calibration of a CDM and the estimation of  $\theta$  centrality parameter.
- 2) Location of municipalities with **low rates of retailing equipment** by the application of a RSI.

### **III.I. Calibration of a CDM<sup>(2)</sup> and determination of agglomeration/competition market forces in the study area.**

After selecting a sample of a set of Hispano-Portuguese municipalities located in each of the previous 3 frontier regions, a CDM has been calibrated to estimate the signification of  $\theta$  centrality parameter through the t-Student test. It has been considered 4 variables:

- . Endogenous variable: **Area97** –a dichotomical variable adopting value 1 when a municipality in the sample is attracted by a considered market area and 0 when it is not attracted.
- . Exogenous variables: **Discab97** –the centrality variable  $\theta$  defined as in Fig. 9.

**Supvta97** –total sales surface (square metres) of the main retail outlets, particularly those that exert a special attraction over consumers: shopping centres, hypermarkets, department stores and big supermarkets.

**Distan97** –distance measured as travel time<sup>(3)</sup>, separating consumers from the municipalities considered as heads of market areas.

As shown in Fig. 12, CDM has been calibrated with three exogenous variables: Discab97 –the centrality one-, Supvta97 and Distan97 –the classical gravitational variables used by Reilly and Huff’s Models.

**Figure 12: The Competing Destinations Model (CDM) applied to the three Hispano-Lusitanian frontier regions in study.**

$$Area_{ij} = \frac{Discab97_j^\theta \exp(Supvta97_j^\alpha Distan97_{ij}^\beta)}{Discab97_j^\theta \sum_{j=1}^J \exp(Supvta97_j^\alpha Distan97_{ij}^\beta)}$$

where:  $Area_{ij} = 1$  if consumers resident in municipality i do the main shopping in the retail outlets located in the municipality head of market area j.  
 $Area_{ij} = 0$  if consumers resident in municipality i do not do the main shopping in the retail outlets located in the municipality head of market area j.

$$Discab97_j = \frac{\sum_{j \neq j} Distan97_{j,j}}{J - 1}$$

Source: self-elaboration.

It is important to remember that our objective is estimating the statistical signification of  $\theta$  parameter and its mathematical sign, to decide the presence of market agglomeration or competition forces. If agglomeration forces were present in a region, the impact of new outlets would be greater if they are located in very close proximity to the existent ones, and vice versa. In Fig. 13, we can see that  $\theta$  parameter is only significant in the third region –**Vigo/Viana do Castelo/Braga** ( $\theta = 3.54$ ). This positive value indicates that there are market competition forces in this area, so new shopping centres must be open as far a possible from the municipalities of Vigo, Viana do Castelo and Braga. In the other cases,  $\theta$  parameter is not statistically significant so new shopping centres will have a priori the same impact proximal or far from the existent heads of market areas.



**Figure 13: Calibration of a CDM in Vigo region and statistical signification of  $\theta$ .**

<b>Vigo/Viana do Castelo/Braga</b>				
Sample: 37 observations.				
Maximum Likelihood Estimates				
Log-Likelihood.....				-7.1316
Restricted (Slopes=0) Log-L.				-40.649
Chi-Squared ( 2).....				67.034
Significance Level.....				.00000
Variable	Coefficient	t-ratio	Prob t >x	
<b>DISCAB97</b>	<b>3.5414</b>	<b>2.032</b>	<b>.05276</b>	
DISTAN97	-.11224	-2.973	.00295	
VR = 1 - (-7.1316/-40.649) = 0.825				

According to this result, the application of a retail saturation index will show those municipalities with limited commercial equipment in which new outlets would be specially necessary. Depending on their geographical situation –isolation or proximity to main roads- it will be possible to decide the best locations for new shopping centres in these frontier regions.

### **III.II. Application of the Retail Saturation Index (RSI)**

LRKI has elaborated a saturation index to determine the relative commercial equipment between different municipalities. The RSI is defined as the total sales surface of main outlets present in a municipality per thousand inhabitants. According with this measure and the previous results, we have selected the best locations for new shopping centres in the three selected areas. In Huelva and Badajoz market areas,  $\theta$  parameter was not statistically significant so new shopping centres will have a priori the same impact proximal or far from the existent heads of market areas. Therefore, we have selected those municipalities with almost one main outlet and low RSI values.

**Figure 14: Best locations for new shopping centres in the selection areas.**

#### **I. Huelva market area:**

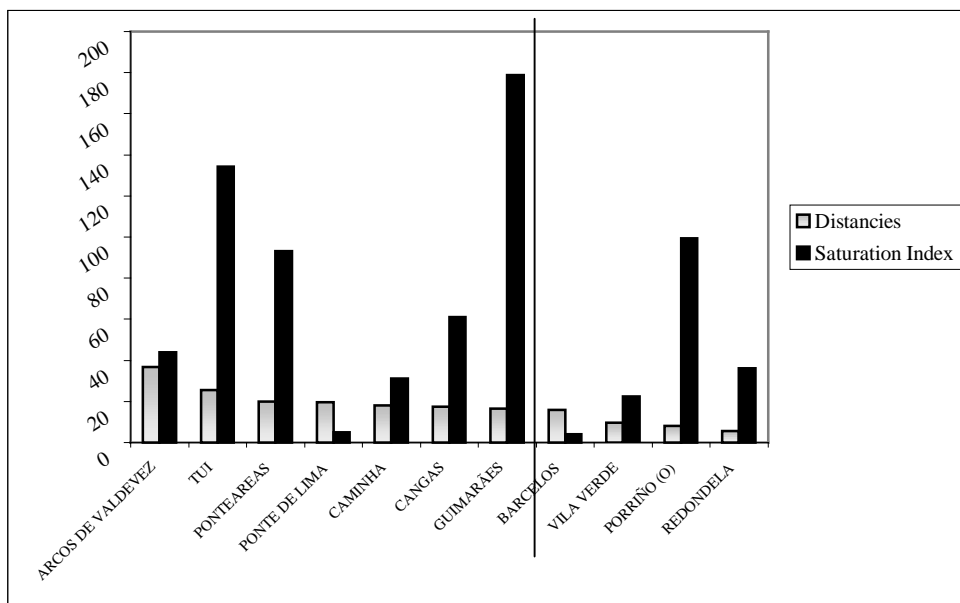
Municipality	Country	Main outlets square metres	Population (5)	RSI
TAVIRA	Portugal	188	24.450	8
OLHÃO	Portugal	1.242	36.970	34
AYAMONTE	Spain	628	17.566	36
VILA REAL DE SANTO ANTÓNIO	Portugal	803	14.010	57
FARO	Portugal	3.354	51.560	65
BEJA	Portugal	2.628	32.940	80

## II. Badajoz market area:

Municipality	Country	Main outlets Square metres	Population (5)	RSI
MONTIJO	Spain	1.200	15.480	78
ESTREMOZ	Portugal	1.407	14.510	97
ELVAS	Portugal	2.593	23.790	109

## III. Vigo market area:

Municipality	Country	Distance Travel time	Main outlets Square metres	Population (5)	RSI
ARCOS DE VALDEVEZ	Portugal	37	1.131	25.790	44
PONTE DE LIMA	Portugal	20	225	44.210	5
CAMINHA	Portugal	18	510	16.430	31



Source: Self-elaboration.

In Huelva market area, all the potential sites are located in very good communicated regions, in the Atlantic Coast, except Beja. Beja, despite its isolated location, is a head of market area as attracts the consumers living in the Portuguese region of the Alentejo. As of municipalities in Badajoz market area, they are well connected with the heads of market areas, specially Estremoz, which is the breaking point between Lisboa and Badajoz.

$\theta$  parameter is only significant in the third region –**Vigo/Viana do Castelo/Braga**. Its positive value indicates that there are market competition forces in this area, so new shopping centres must be open as far a possible from the municipalities of Vigo, Viana do Castelo and Braga. That is why we have taken account two selecting criteria -Distanc97 and RSI. As far is a municipality from its head of market area, as more impact will have the opening of new

shopping centres there, especially if it is not well equipped. There are 3 Portuguese municipalities with these characteristics: Arcos de Valdevez, Ponte de Lima and Caminha. Ponte de Lima is really interesting because it is located next to the motorway Porto-Vigo recently opened.

#### **IV. CONCLUSIONS**

In this work **market area delimitation models** have been quickly revised, especially spatial interaction models. We have pointed out its applications to market area analysis. Reilly and Huff's models are used to forecast intermetropolitan market area dimensions. Besides, we have presented the **competing destinations logit model** as a good instrument to determine best shopping centres locations, if it is combined with a **retail saturation index**. This paper continues the Klein Institute analysis of the Spanish market areas that have a common border with Portugal, as a beginning of a possible Hispano-Portuguese Retail Trade Atlas. Now we step forward to detect **potential sales points** for new shopping centres.

We are conscious of having started a necessary research to complete the Lawrence R. Klein Institute estimations published in the "Trade Year-Book". We think it would be interesting not only for Spanish but also for Portuguese retail enterprises, authorities and researchers, to know the existence of spatial flows and facilitate consumers their shopping journeys with adequate infrastructure.

#### **FOOTNOTES:**

- (1) The frontier region belonging to the Spanish Autonomous Community of Castile and León will be studied with further extension in the future months –Ciudad Rodrigo and Zamora market areas.
- (2) The CDM calibration has been realised with Limdep 6.0 software.
- (3) Distance must be measured as travel time in regions communicated by **different kind of roads**. It is obvious that it is possible to drive at higher speed in A than in B road. On the average, we assign the following speeds: Motorways (120 km/h.), A road (90 km/h.) and B road (70 km/h.).
- (4) Verosimilarity Ratio (VR) –statistical measure similar to the R-Squared (Vicéns 1997) whose value is set in the interval [0,1]: VR = 0: Imperfect adjustment. VR = 1: Perfect adjustment.
- (5) Population de jure: Spanish Census (1.05.96) and Portuguese Census (31.12.96).

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