The Independent Submarkets Model: An Application to the Spanish Retail Banking Market

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Abstract

The aim of this paper is to test the predictions of Sutton's independent submarkets model with data on the Spanish retail banking market. The prediction of this model for aggregates of submarkets is that the form of equilibrium outcome must involve some minimal degree of size inequality. However, within each submarket, when three conditions hold, the only form of equilibrium outcome will be an extreme 'fragmented' structure. To test these predictions, firstly I propose methods to identify independent submarkets. Then I analyze the degree of inequality in bank sizes for markets with different levels of aggregation (submarkets, regions and national market). Using concentration by towns' data, I find that in single submarket towns the degree of inequality of the size among banks is zero. Moreover, multimarket towns with a significant degree of concentration are shown to be formed by a different number of independent submarkets where each bank owns one branch. Nonetheless, when the regional and the national bank markets are considered, the degree of inequality in bank sizes becomes high. These results are consistent with the predictions of the theoretical model.

Keywords: independent submarkets, fragmentation, concentration, banks, branches.

JEL Classification: D40;L11;G21;C25

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1. Introduction

The Spanish retail banking sector is formed by a set of banks that show a high degree of asymmetry in the markets they cover: some of them are purely local and others cover nearly every local market. *A priori*, this suggests that the Spanish bank market consists of a large number of independent local markets (i.e., districts, suburbs, towns,...) where branches of different banks[1] compete. It is possible to analyze this market structure using the model of independent submarkets developed by Sutton (see Sutton, 1997, 1998), which represents an idealized setting. This model assumes that a market consists of firms that compete in independent submarkets, and these independent submarkets can be, in particular, geographical. The prediction of the model for the aggregate of submarkets is that the form of equilibrium outcome must involve some minimal degree of size inequality. However, the model also predicts for each submarket that, when three conditions (stated below) hold, the likely form of equilibrium outcome is the extreme 'fragmented' structure, in which all firms have the same 'minimal' size. Sutton (1998) finds empirical evidence of these predictions by analyzing the degree of concentration at different levels of submarkets' aggregation for the U.S. cement industry. Sutton defined, *a priori*, the submarkets in terms of geographical location as individual states of the United States.

This work aims to test the predictions of Sutton's theoretical model with data on Spanish retail banking, a market in which the three special conditions appear to hold. First, we can consider that this market consists of many submarkets (i.e., districts, suburbs, small towns...) in which bank branches serve overlapping areas. Second, as a matter of fact, branches supply the same banking services that therefore can be taken as close substitutes. Third, price competition has been reported to be weak for the long period in which banking was strongly regulated[2]. Liberalization seems not to have produced a dramatic change in this situation. These three conditions will be fundamental in explaining the maximal fragmentation in geographical banking submarkets.

[1] 'Banks' refers to the set of credit or deposit institutions, including savings banks.

[2] For example, Jaumandreu and Lorences (2002) model competition among banks in the loans market from 1983 to 1991, and conclude that there was price coordination or collusion among national banks. Coello (1996) models competition among banks and savings banks in the deposits market from 1985 to 1994, and finds evidence for leadership practices in pricing and competition in branch networks.

The natural strategy for testing the model, applied by Sutton, consists of the study of the actual concentration in markets representative of different levels of aggregation of submarkets. The novelty of this paper relative to the cement industry tests in Sutton (1998) is that I allow the boundaries of the local markets to be determined, to some extent, endogenously.

I focus attention on identifying individual submarkets and examining their submarket structure. I start from the measurement of concentration in almost 5,000 towns, measured in terms of the number of branches held by banks, using commercial data for the year 1996. Big towns, with a high number of branches, are likely to be the aggregates of several submarkets. To analyze concentration by submarkets, I proceed to identify them using two different methods, the regression and cluster analyses. On the one hand, I try to detect single submarket towns and examine concentration in these towns. On the other hand, I try to identify submarkets in multimarket towns and then to decompose the concentration of the town into concentration by submarkets. Finally, I use the same data to construct the Lorenz curve that depicts concentration at regional and at national levels.

Other authors have tested the bound on the inequality of firm size distribution for different industries. Walsh and Whelan (1999, 2001) empirically investigate firm size distribution in Irish food and drink products as they test the predictions of Sutton's bound approach. They focus the analysis on the level of many independent submarkets defined in terms of consumers' tastes. Buzzacchi and Valletti (2000) consider the Italian motor insurance industry, where submarkets are defined in terms of geographical location. This work has many parallels with my paper.

The main empirical results are the following. On the one hand, in 96% of single submarket towns[3] where there are two or more branches, these belong to different entities, hence the degree of size inequality measured by branches is zero. On the other hand, submarkets of multimarket towns tend to show a high degree of fragmentation even when concentration at the town level is significant, i.e., town branches belonging to the same bank tend to be located in different submarkets. In sharp contrast, concentration at the regional and the national levels shows a high degree of inequality in bank sizes. This inequality is heterogeneous, but the Lorenz curves always lie above Sutton's limiting curve.

[3] Town represents a municipality.

The rest of the paper is organized as follows. Section two briefly sets out the theoretical framework. Section three summarizes the reasons why the retail banking sector may be considered an independent submarkets industry. Section four explains the tests applied to check the degree of inequality of size in submarkets as well as regional markets and the national market. Section five presents the empirical results and in section six some concluding remarks are made.

2. The model

The theoretical model is a variant of the independent submarkets model developed in Sutton (1998), in which we consider that firms compete in prices. Sutton's model takes firms as competing across many independent submarkets. I assume that the national retail banking market consists of a large number of local markets. These submarkets arise because there are many different geographical locations throughout the country. Each submarket corresponds to a well-defined market within which products are fairly good substitutes. Every one of these independent submarkets consists of several branches of different banks competing against each other. Submarkets can be taken as independent from the demand side in the sense that cross-price elasticities among submarkets are zero or very small. Zero cross-elasticities are likely to characterize the geographically separated submarkets (small towns, suburbs,...). Small elasticities are likely to be the rule in partially overlapped markets in more important consumer agglomerations (districts of cities).

Under these assumptions, and adopting a 'stage game' approach, banks can be seen to have first made their investments in branches and then to set prices. To obtain the number of branches per submarket, the concept of an *Equilibrium Configuration*[4] defined by Sutton, can be used. In this framework, the prediction of the model for the aggregate of submarkets is that the form of equilibrium outcome must involve some minimal degree of size inequality. However, the model also predicts for each submarket that, when three conditions hold, the only form of equilibrium outcome that we will observe at the submarket level is the extreme 'fragmented' structure, in which all firms have the same 'minimal'

[4] The *Equilibrium Configuration* is a wider concept than the Nash equilibrium in that it only requires satisfying viability and stability conditions, while the Nash equilibrium also requires satisfying optimality.

size. The three conditions are that (i) firms' market areas are overlapping in the sense that each firm in the submarket serves consumers throughout that submarket, (ii) products are close substitutes, and (iii) price competition is weak[5].

Sutton derives a 'limiting Lorenz curve' for the aggregate of submarkets under two conditions. The two conditions are a 'symmetry principle' and a 'benchmark case.' The 'symmetry principle' maintains that the strategy of a bank in a submarket only depends on sunk costs and profit opportunities in that submarket. That is, there are no strategic linkages across submarkets. The 'benchmark case' is a situation in which the probability that the next submarket opportunity is filled by a new firm is constant over time (although an increasing probability does not pose a great problem to conclusions). The curve provides an asymptotic 'lower' bound to concentration.

Under these conditions, for any fixed ratio $\frac{k}{N}$, the expression of the 'limiting Lorenz curve,' when the number of the k largest firms and the total number of firms in the market N are high enough, is

$$\underline{C}_{\frac{k}{N}} \geq \frac{k}{N}\left(1 - ln(\frac{k}{N})\right) \qquad (1)$$

where $\underline{C}_{\frac{k}{N}}$ represents the concentration ratio of the k largest firms in the market. In our case, this concentration ratio is defined as the fraction of the number of branches owned by the k largest banks within the market.

Therefore, the model predicts that if the degree of concentration in a market is measured by the Lorenz curve, this curve will lie above the reference curve. On the contrary, if the special conditions on local competition are satisfied (and I will argue that, in the present empirical context, they are) then, in any submarket, the Lorenz curve will lie along (or close to) the diagonal.

It may seem intuitive that 'a bank will not locate two branches in the same retail business area because it will steal customers from itself.' One could also argue that 'it is good for a bank to cluster branches locally in order to create local monopolies.' It can go either way. It is here that the three special conditions are fundamental to specifying when it goes one way rather than the other.

[5] The price competition is weak in the sense that prices set by the firms are far from the competitive price.

To understand how fragmentation can arise at the submarket level, Sutton proposes the following example[6]. Consider a submarket in which the products are differentiated. The sales a new entrant's product achieves will come, in part, at the expense of sales of existing products (the 'business-stealing effect') and in part, from an expansion in total industry sales (the 'market expansion effect'). The decisions of incumbents and new entrants about the introduction of new product varieties will be influenced by the relative size of these effects. And this will depend, in turn, on the degree of substitution among the different product varieties offered and on the toughness of price competition. If products are close substitutes and the toughness of price competition is not very great, the market expansion effect will be small and the fall in price associated with entry will be low. Under these conditions, the firm will prefer to introduce only one product variety within the submarket.

3. Retail banking as a submarkets industry

The core activities of commercial banks are the collection of deposits and the granting of loans (Freixas and Rochet, 1997). Both activities imply the production of services to depositors and borrowers, for which they charge a cost in addition to the rates they set to remunerate deposits or charge loans. Most services must be supplied on a geographical basis, and the 'nearness' of the bank has been always considered to be a source of utility for most customers (at least for households and small firms). This is the reason why commercial banks build networks of branches that extend across their territories[7].

Drawing on these facts, retail banking can be taken as an industry in which banks sell slightly differentiated products competing across many independent geographic submarkets[8]. Each submarket can be seen as a place consisting of symmetrically differentiated competitors[9].The number of branches in a

[6] See Sutton (1998), chapter 2.

[7] The distribution of activities across regions, measured by the networks of branches, is very unequal. Some entities cover nearly the whole national territory, others are regional or strictly local.

[8] This vision of the retail banking industry is more or less shared by other works on banking. See, for example, Fuentelsaz and Salas (1992) and Barros (1999). Jaumandreu and Lorences (2002) start from the independent submarkets model, and the symmetric character of local competition, to specify and estimate aggregated demands.

[9] The identity of the competitors can change from submarket to submarket.

given submarket will be considered as the number of varieties of services (or products) offered by banks. Each bank can, in principle, open one or more branches in a given submarket, although we will see that in practice it tends to open only one branch per submarket. Moreover, bank branches and savings bank branches have the same average size[10]. In fact, as a convenient simplification, we will take all branches as being of approximately of the same size.

At a given moment of time, the history of investments across submarkets determines the distribution of branches of a bank. Banks can be seen competing in prices (rates, commissions) given their previous entry decisions. In this context, Sutton's 'symmetry principle' is likely to hold for entry in any geographic submarket. Cross-price effects are at most negligible. Sunk costs and profitability are probably submarket-specific. As such, submarket strategies for two possibly entrant firms have no obvious reason to be different[11]. It could be argued that large entrants (banks with many branches), have a possible advantage, based on consumers' perception of possible network externalities. However, small banks have reacted to this requirement by belonging to some networks (for example, ATM's)[12] and this effect is likely to be small. Moreover, preferences of a fraction of consumers seem to be biased towards entities with strong regional and local contents, which probably balances the situation.

Finally, considering the characteristics stated in the Introduction, retail banking seems to be an industry that consistently meets the three conditions under which we can expect maximally fragmented outcomes, one branch per bank at the submarkets level.

4. Data and testing strategies

The theoretical model shows that we can expect a relationship between the degree of concentration and the level of aggregation of submarkets. That is, local markets will show the minimum level of

[10] Two statistics are used to measure branch size: the average debt per branch and the average number of bank clerks per branch. 2,298 million pesetas and 2,147 million pesetas are the average debt per bank branch and savings bank branch, respectively, for 1996. The average number of bank clerks per bank branch and per savings bank branch in 1996 are 8 and 6, respectively (see *Anuario Estadístico de la Banca en España* and *Anuario Estadístico de las Cajas de Ahorros Confederadas*).

[11] See de Juan (2001), which analyses the entity's decision (potential new entrant or incumbent) to open or close branches in a submarket from 1994-1998, and finds evidence that the entry decisions of potential new entrants are mainly determined by submarket characteristics.

[12] See Matutes and Padilla (1994).

concentration ('maximally fragmented' equilibrium) or, in other words, all firms will be the same size. However, the aggregation of submarkets will bring some level of concentration. Therefore, the strategy for testing the model consists of analyzing concentration at different levels of submarkets' aggregation.

The main data source used in this paper is the *Guía de Banca, Cooperativas de Crédito y Cajas de Ahorros*, which contains commercial information about the number of branches of every bank and savings bank in each Spanish town for the year 1996. This information allows me to measure the degree of concentration in terms of branches in each town. According to this source, there are 4,977 Spanish towns with banking branches (see Appendix A for details). As a complementary source, I have also used the *Anuario Comercial de España*, which supplies socio-economic information for towns with more than 1,000 inhabitants (number of inhabitants, area, per-capita disposable income,...). Therefore, this source can be matched to a subset of the Spanish towns for which I compute concentration.

The analysis will proceed as follows. First of all, I will examine the degree of concentration by town, using the whole sample, ranking towns according to their number of branches. But large towns with a high number of branches may be the aggregate of several submarkets. Therefore, this analysis, which brings together independent submarkets and aggregates of submarkets, cannot go too far. One possibility then is to consider only the smallest towns, arbitrarily setting some number of inhabitants small enough to be sure I isolate independent submarkets (say 1,000 inhabitants). This turns out not to be very informative, because these submarkets usually have few branches (1 or 2). Consequently, in the second place, I will try a slightly different method: to identify the subset of towns with a single submarket irrespective of their number of inhabitants. This will be done by a regression method that is explained below. Then I will analyze concentration in the single submarket towns identified in this way.

I will perform a third exercise. Aggregate markets may be analyzed in order to identify the independent submarkets, and hence examine concentration again at the submarket level. To do so, I propose a geographical cluster analysis. As this method is very time consuming (every branch must be located by its geographic co-ordinates), this analysis will only be applied to a small subset of towns. I choose first to apply it to a set of towns characterized by a number of branches that may imply the existence of submarkets (5 to 10) and by some degree of concentration. The result is expected to show the likelihood of an explanation of this concentration based on the aggregation of fragmented submarkets. Next, I apply the same method to a medium-size town (more than 160,000 inhabitants) with 86 branches in which the first bank owns 16 branches.

Finally, to give the other side of the picture, I will examine the degree of concentration at the highest levels of aggregation: the regional and national levels.

The complementary instruments used to measure concentration are the 'one-bank concentration ratio' C_1 and the Lorenz curve. The one-bank concentration ratio is defined as the fraction of the number of branches owned by the largest bank within the market. And the Lorenz curve shows the fraction of the total of branches in the market accounted for by the biggest k banks as a function of $\frac{k}{N}$, where N is the total number of banks. I will compare C_1 with the minimum level of concentration possible, given the number of branches n, $\frac{1}{n}$. If both coincide, the submarket is maximally fragmented. In terms of the whole distribution of bank sizes, if the submarket is maximally fragmented, the Lorenz curve will lie along the diagonal. When I examine broader markets, I will be interested in comparing the Lorenz curve with the limiting Lorenz curve (equation 1).

The two methods used to count independent submarkets within each town are a regression analysis and a cluster analysis[13]. The first estimates the number of submarkets per town. The second tries to identify the submarkets of a given town.

To estimate the number of submarkets, I propose to decompose the number of branches of each town (n_m) into two components: the average number of branches per submarket (n_m^S) and the number of submarkets (S_m)

$$n_m = n_m^S * S_m \qquad (2)$$

where the subscript $m=1...M$ denotes the town. This breakdown of the number of branches per town can be useful if one accepts that the determinants of both components can be specified separately. The Sutton

[13] Notice that the regression analysis only allows me to identify clearly single submarket towns and to know the number of submarkets per town. The cluster analysis, in contrast, identifies the submarkets in multimarket towns. Therefore, we could use cluster analysis to identify single submarket towns, but not regression analysis to identify submarkets in multimarket towns.

model suggests that the number of branches per submarket is a function of the relative size of the submarket and the sunk costs incurred on entry[14]. Thus, (n_m^S) is likely to vary with the level of demand and population spread. At the same time, for relatively small towns, the main determinant of the number of submarkets is probably the geographical (and perhaps socio-economic) structure. Unfortunately, this structure cannot be measured with the available data. However, for this sort of towns and assuming that the number of branches in a given submarket varies according to some submarket characteristics ('turnover' and 'spatial spread,' for example), we can expect that, controlling for these factors, the number of such submarkets (S_m) can be detected by the role of town size (measured by the number of inhabitants) in explaining the remaining variations in the total number of branches.

The components of expression (2) can be specified as two non-linear functions where the existence of at least one branch and submarket is required. That is, these two non-linear functions guarantee that the estimates of the average number of branches per submarket and the number of submarkets for each town will never be able to take the value zero. One such specification is[15]

$$n_m = exp^{exp(x'_m b)} * exp^{exp(z'_m g)} + m_m \qquad (3)$$

where the vectors x_m and z_m include the set of variables that explain the number of branches per submarket and the number of submarkets, respectively. *â* and *ã* are parameters to be estimated and $ì_m$ is a disturbance term.

Once the parameters *â* and *ã* are estimated, I replace them with their estimates in the two functions to give estimates of the average number of branches and the number of submarkets, respectively, for each of the towns considered.

To try to identify the independent submarkets within a given town, I use a cluster analysis. The details are given in section 5.3.

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[14] See Sutton (1998), chapter 2.

[15] Alternatively, n^S and S could be modelled as the partially unobserved realizations of a bivariate Poisson process.

5. Empirical results

This section analyzes the degree of concentration at different levels of submarket aggregation: towns and districts of towns, regions and the national territory. In subsection 5.1, I carry out a purely descriptive analysis of the degree of concentration by towns in the whole sample (4,977 towns). Next, I try to count the independent submarkets per town through the two alternative methods explained in section 5. In subsection 5.2, I explain the results of estimating equation (3) for the subset of towns with a population of between 1,000 and 5,000, which allows me to predict the number of independent submarkets per town. Then I focus attention on the concentration ratios of the subset of towns with only one independent submarket (single submarket towns). In subsection 5.3, I analyze the dendograms obtained for a subset of towns that have between 5 and 10 branches and show a high degree of concentration and the clustering of branches in one medium-size town. The dendograms allow me to identify the likely number of independent submarkets per town. Then I examine the degree of concentration in these submarkets. In subsection 5.4, I analyze the degree of concentration in the regions and in the national territory.

5.1. Concentration by towns

The sample consists of 4,977 towns. The variable ‘number of branches per town’ has an asymmetric distribution that ranges between 1 and 2,737. The average number of branches per town is 7. More than 85% of towns have a number of branches below this figure.

To examine the degree of concentration at the town level, the one-bank concentration ratios C_1 are calculated and compared with the values of the function $\frac{1}{n}$. Figure 1 shows this comparison graphically[16]. The numbers report the number of towns with the same number of branches and the same one-bank concentration ratio for each point, i.e., there are 965 towns with two branches owned by different banks (C_1 = 0.5) and 38 in which the two branches are owned by the same bank (C_1 = 1). If the concentration

[16] Figure 1 represents 96% of the towns in the sample. The figure corresponding to the rest of towns is not reported because it does not change the results.

ratio C_1 lies along the curve $C_1 = \frac{1}{n}$, the market structure is maximally fragmented. This occurs in 86% of the towns. The points above this bound lie on curves that depict the concentration-number of branches pairs corresponding to the cases in which the largest bank owns more than one branch (2,3,...). Figure 1 clearly shows that the higher the number of branches per town, the higher the proportion of towns in which the largest bank owns a higher number of branches.

FIGURE 1 ABOUT HERE

Another useful way of reading the information in Figure 1 is to analyze the evolution of the probability that the largest bank in the town owns more than one branch according to the number of branches. Figure 2 shows this probability. It looks like a logistic functional form which increases with the number of branches. The probability is higher than 0.5 when there are more than 8 branches in the town, and is equal to unity when there are more than 16 branches in the town. That is, there is no town with more than 16 branches where the largest bank has only one branch.

FIGURE 2 ABOUT HERE

The probability of single submarket towns is higher for towns with a smaller number of branches. These results are consistent with the hypothesis that submarkets are maximally fragmented and concentration emerges mainly as a result of the aggregation of submarkets.

5.2. Identifying single submarket towns

I apply the regression analysis with the aim of identifying the number of independent submarkets in a subset of small towns (1,000 to 5,000 inhabitants) and then isolate the single submarket towns. The subset consists of 1,768 towns[17], which represents roughly 36% of the sample. Towns with less than 1,000 inhabitants are ruled out because my sources do not provide socio-economic data for these, and towns with more than 5,000 inhabitants are discarded to avoid the excessive weight they would have in

[17] The variable number of branches per town has an asymmetric distribution that ranges between 1 and 12 branches. The average number of branches per town is 3. The distribution of the number of branches per town shows that 77.8% of towns have less than 4 branches and 99.5% have less than 9.

estimation. I estimate equation (3) using nonlinear least squares. The vector that explains the average number of branches per submarket (x_m) includes the following set of variables: a set of dummy variables representing intervals of per-capita disposable income (*Y's*) and population density (*Density*). (*Y's*) measures the level of demand in the town. (*Density*) measures the relative size of the market. In modelling of the number of branches per submarket, I expect to find positive effects of the level of demand and negative effects of population density[18]. The vector that explains the number of submarkets per town (z_m) includes the size of the town (*Population*). The number of inhabitants measures the town's size. I expect a positive relationship between the town's size and the number of submarkets per town. Details about the variables are given in Appendix A.

Table 1 reports the results of the regression. The coefficients for the set of explanatory variables are significant and show plausible signs. There is a positive highly non-linear relationship between the number of inhabitants and the number of submarkets. There is a positive relationship between the per-capita disposable income[19] and the number of branches per submarket and, the relationship between population density and the number of branches per submarket is negative and non-linear[20].

TABLE 1 ABOUT HERE

Predictions on the number of submarkets and branches per submarket are obtained by replacing the parameters with the estimated coefficients in the respective non-linear expressions. Table 2 shows the cross-tabulation of the predicted number of submarkets and branches per submarket[21]. In each cell, horizontal percentages are reported in brackets. First of all, the distribution of the number of submarkets shows that 67% of towns with a population of between 1,000 and 5,000 can be taken as independent

[18] Consider two submarkets A and B with the same number of inhabitants. In submarket A, the population is concentrated (high population density) whereas in submarket B, the population is scattered (low population density). Therefore, we will expect that the number of branches established in submarket A will be less than the number of branches established in submarket B.

[19] Notice that we observe this positive relationship although the sign for dummies *Y2*, *Y3* and *Y4* is negative. This is possible because the function specified to the average number of branches per submarket is doubly exponential.

[20] The non-linear relationship between the number of inhabitants and the number of submarkets and the non-linear relationship between population density and the number of branches per submarket are reported graphically in de Juan (1998).

[21] It is important to remark that the predicted number of submarkets and the average number of branches per submarket have been rounded to the nearest lower integer.

submarkets (1,189 towns) and that the rest would have two independent submarkets. The distribution of the average number of branches per submarket shows that 19% of towns (333 towns) have one branch, 67% (1,190 towns) have two branches, 13% (232 towns) have three branches and only 1% have more than 3.

TABLE 2 ABOUT HERE

Furthermore, notice that two or more branches compete in more than 80% of the towns that can be considered single submarket towns. Moreover, the distribution of the average number of branches per submarket is very similar when there are one or two submarkets, although the fact that the probability of one branch per bank increases somewhat with the number of submarkets could be interpreted as a sign of some misspecification.

Once the single submarket towns have been identified, I analyze their degree of concentration. The degree of concentration of 1,189 single submarket towns, measured by their one-bank concentration ratio C_1, can be compared with the minimum level of concentration $\frac{1}{n}$. This is done graphically by regions in 17 panels, one for each Spanish autonomous community, but they are not reported here due to space limitations (see de Juan, 1998). One of these diagrams (Community of Aragón) is presented in the first panel of Figure 3.

In the first panel of Figure 3, I depict the curve $C_1 = \frac{1}{n}$ and the concentration ratios C_1 corresponding to the different single submarket towns. Recall that when both coincide, the submarket is maximally fragmented. It occurs in most of the single submarket towns of Aragón (96%). Notice that this first panel drawn in the (C_1,n) space can be seen as equivalent to Lorenz curves drawn in a $(C_1,\frac{1}{n})$ space. The second panel depicts in the $(C_1,\frac{1}{n})$ space the diagonal $C_1 = \frac{1}{n}$, the concentration ratios C_1 corresponding to the different submarket-towns, and the limiting curve $\underline{C}_1 \geq \frac{1}{n}\left(1 - ln(\frac{1}{n})\right)$.

FIGURE 3 ABOUT HERE

The concentration ratios C_1 of the single submarket towns will tend to be located in the area bound by the diagonal $C_1 = \frac{1}{n}$ and the limiting curve $\underline{C}_1$. Recall that when the C_1 lie on the diagonal, the submarkets are maximally fragmented.

When all the autonomous communities are considered, the result is that 96.3% of the single submarket towns (1,145 towns) are maximally fragmented. Consequently, the isolation of towns with a single submarket greatly increases the number of fragmented outcomes in the sample.

5.3. Identifying independent submarkets in multimarket towns

Now I apply cluster analysis[22] to identify submarkets in multimarket towns. First, I carry out this analysis for a subset of towns which have between 5 and 10 branches and show some degree of concentration; second, I apply it to a medium-size town.

The lack of homogeneity of geographical human agglomerations, together with the targets of 'being where the demand is' and taking advantage of positive externalities derived from common locations[23], suggest that submarkets may be identified by the relative closeness of groups of branches. That is, two branches can be considered to belong to the same submarket if the distance between them is 'small,' while they can be taken as belonging to different submarkets if the distance is 'great.'

The variables used for the cluster formation are the co-ordinates (x,y) of the branches within the town. The method I will use to form clusters is the *agglomerative hierarchical clustering*[24], using as criteria the *average linkage between groups method*[25] and the *centroid method*[26]. In both methods, the distance between cases is measured by means of the *squared Euclidean distance*. I choose these methods

[22] See Chatfield and Collins (1980) and Aldenderfer and Blashfield (1984).

[23] See Tirole (1988).

[24] See the chapter on cluster analysis in SPSS/PC +Statistics 4.0 manual.

[25] The *average linkage between groups method* calculates the distance between two clusters as the average of the distances between all the pairs of cases in which one member of the pair is from each of the clusters.

[26] The *centroid method* calculates the distance between two clusters as the distance between the means of the variables.

because they can be said 'to maintain the nature of the original space'[27] and use more information than other criteria to form the clusters. A way of visualizing the results of the clusters analysis is the *dendogram*. This shows the clusters being combined and the actual distances rescaled to numbers between 0 and 25. More details on the cluster analysis are given in Appendix B.

Next, I apply this analysis to a subset of towns. I select a small subsample of towns which possess a number of branches between 5 and 10 and whose one-bank concentration ratios C_1 do not lie along the curve $C_1 = \frac{1}{n}$. In these towns, I locate each branch and measure its co-ordinates (x,y) within the town. Then I obtain the dendograms using the average linkage between groups method. Figure 4 shows only the dendogram corresponding to one small town[28]. The remaining dendograms are not reported due to space limitations (see de Juan, 1998), but the results of these dendograms are summarized in Table 3. The dendograms obtained with the centroid method are very similar. Both methods confirm that natural groupings exist.

FIGURE 4 ABOUT HERE

The nested tree structure of the dendograms suggests that there are many different possible groupings, and the question is where to 'cut' the tree so the most reasonable number of groups is found. Unfortunately this question is still an unsolved problem of cluster analysis, although there are some tests[29]. From the point of view of the present discussion, I am not interested in providing a unique definitive number of submarkets per town; I simply distinguish the several possible groupings in each town according to the distances of the dendogram and I examine concentration through these groupings. In general, the two criteria used to obtain alternative groupings have been cutting the tree in the second and third level, provided that their distances in the dendogram were between 0 and 10[30]. For example, Figure 4 shows the dendogram of one town. If the dendogram is 'cut' at a distance of 2 (second level of

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[27] See Aldenderfer and Blashfield (1984).

[28] The small towns are Pasaia de San Pedro (Guipuzcoa).

[29] See Aldenderfer and Blashfield (1984).

[30] With the exception of Berriozar, Boadilla del Monte and Vila-Seca, in which the second and the third level of the groupings are very similar. Thus, I report the third and fourth level.

the grouping), the number of clusters in this town is 4. Three of the submarkets would be formed by one branch (1,3 and 5) and branches 2 and 4 would integrate the fourth. If the dendogram is 'cut' at a distance between 5 and 10 (third level), the number of clusters is 3. Two of them are formed by one branch (3 and 5), and the third by branches 2, 4 and 1.

Table 3 reports the different groupings per town that I distinguish in the dendograms. This analysis firstly suggests that these towns possess different numbers of submarkets. Moreover, the size of the submarkets of each town measured by the number of branches is not homogeneous. That is, in a given town, different submarkets may have different numbers of branches. Submarkets with the largest number of branches are usually located in the downtown area.

TABLE 3 ABOUT HERE

To analyze the degree of concentration of the submarkets identified in each town, I also report the C_1 of each submarket in Table 3. These ratios show that in most of the submarkets, each bank owns only one branch, and this holds independently of the particular grouping used. Moreover, in those towns where exceptions occur, these exceptions arise in only one submarket in the town. According to these results, the (sometimes high) level of concentration observed in these towns is basically driven by the presence of larger banks having branches spread across several submarkets.

It is important to remark that the regression analysis and cluster analysis[31] yield very similar results for a small subset of submarkets[32]. In this subset of small towns, regression analysis predicted two submarkets and cluster analysis confirms that they are formed by 2 or 3 submarkets according to the distances of the dendogram (see Table 3).

Next, cluster analysis is applied to one medium-size town (Alcalá de Henares, Madrid) with more than 160,000 inhabitants and 86 branches, 16 of which belong to the first bank.

I obtain the dendogram by using the average linkage between groups method. This dendogram suggests that a sensible grouping is 14 clusters (in this case, I report only the second level of the

[31] Notice that the aim of the cluster analysis is to complement the regression analysis applying it to another subset of towns bigger in size. For this reason, I only chose some small towns to check whether the two methods yield the same results.

[32] This small subset of submarkets (Berriozar and Noain) was randomly chosen from towns (1,000 and 5,000 inhabitants) which showed some degree of concentration.

grouping). Table 4 reports the result of this grouping and the degree of concentration per submarket. It can be observed that there are independent submarkets with a high number of branches (10, 12 or 20) that coexist with submarkets with few branches (1, 2 or 3). The submarkets with a large number of branches are located in the downtown area. Once the independent submarkets of Alcalá de Henares have been identified following the method just described, their degree of concentration can be established. Table 4 reflects that the concentration ratios C_1 show fragmentation in all but 4 submarkets. Therefore, this medium-size town may be interpreted as a multimarket town integrated by 14 independent submarkets, most of them maximally fragmented.

TABLE 4 ABOUT HERE

The main conclusion of this subsection is that the majority of independent submarkets identified and examined are maximally fragmented. This result is consistent with the underlying model, given our maintained assumption that the Spanish retail banking market satisfies the three 'special case' assumptions of Sutton (1998) stated earlier.

5.4. Aggregated markets

I check the prediction of the model for the regional markets and the national market using the whole sample of branches of Spanish towns. I construct Lorenz curves for each of the 17 autonomous communities and for the national territory. Then I compare these Lorenz curves with the corresponding 'limiting curve.' The prediction of the model is that the observed Lorenz curve should lie above this reference curve. This comparison is done graphically by regions in 17 panels, one for each Spanish autonomous community, but they are not reported here due to space limitations (see de Juan, 1998). One of them (Community of Aragón) is given in Figure 5.

In Figure 5, I depict the Lorenz curve corresponding to the Community of Aragón and the limiting curve $\underline{C}_{\frac{k}{N}}$. We can observe that the Lorenz curve lies above the limiting curve. The implication is that there is a significant size inequality among banks operating in this community. This contrasts with the image of maximal fragmentation that the individual submarkets give (see Figure 3, which corresponds to the same community).

FIGURE 5 ABOUT HERE

When all the autonomous communities are considered, the result is that all the Lorenz curves lie above the limiting curve. It can also be observed that the degree of inequality in bank sizes is heterogeneous by communities[33].

Figure 6 shows the Lorenz curve and the limiting curve for the national market. The Lorenz curve again lies above the limiting curve. Thus, there is a high degree of inequality in bank size on a national level.

FIGURE 6 ABOUT HERE

Notice that the degree of inequality in bank size on a national (or regional) level is not a simple effect of aggregation of submarkets but the product of the operation of what Sutton calls 'independence effects'[34]. The national market consists of a large number of (maximally fragmented) submarkets, in which branches are treated as having the same size. If all banks were established in the same randomly-determined fraction of submarkets, aggregation would produce no concentration at regional or national levels. The asymmetry with which banks gain submarket opportunities throughout the country determines the concentrated outcomes.

This study has found evidence that once the independent submarkets are identified, the majority of these submarkets are maximally fragmented. Nonetheless, the degree of concentration at regional and at national levels is high, i.e., these markets are concentrated[35]. The degree of inequality in firm size exceeds the minimal level (lower bound) predicted on the basis of the independent submarkets' model.

[33] The communities with the greatest degree of inequality in bank sizes are Aragón, Cataluña and Madrid, while the communities with the lowest degree of inequality in bank sizes are The Canary Islands and Castilla La Mancha.

[34] See Sutton (1998), pp. 597-602.

[35] This conclusion is consistent with the results presented in previous papers (see Cebrián and Iglesias, 1992; Cebrián, 1997).

6. Concluding remarks

This work proposes to test the predictions of the independent submarkets model with data on the Spanish bank market. To carry out the investigation, I have identified the submarkets in some towns through a regression analysis and a cluster analysis. Firstly, I have identified the submarkets in the towns with a population of between 1,000 and 5,000 for the year 1996 (36% of the towns) through the estimation of a non-linear equation explanatory of the number of branches. With this exercise I have isolated the towns that can be considered a single submarket. Secondly, I have selected a subset of towns which have between 5 and 10 branches and whose one-bank concentration ratios C_1 do not lie along the curve $C_1 = \frac{1}{n}$ and for one medium-size town (more than 160,000 inhabitants). Then, I have identified their submarkets through cluster analysis. Afterwards, I analyzed the degree of concentration in markets with different levels of aggregation (single submarkets, communities and national markets).

The main empirical results are the following. Firstly, more than 67% of the towns with a population of between 1,000 and 5,000 can be considered independent submarkets. 80% of these submarkets are served by two or more branches. Secondly, in 96.3% of these submarkets, the degree of size inequality among banks, as measured by the number of branches, is zero. That is, nearly all the banks of these independent submarkets have only one branch. Thirdly, more than 65% of the subset of towns with between 5 and 10 branches are formed by a different number of submarkets where banks only own one branch. In the rest of the towns, only one of their submarkets is concentrated. Moreover, 71% of the independent submarkets of the medium-size town are maximally fragmented. But fourthly, when the regional markets are considered, the degree of inequality in bank sizes becomes high and heterogeneous. That is, the number of branches opened in each regional market varies widely from bank to bank. Finally, when the national bank market is considered, the degree of inequality in bank sizes is also high. These results are fully consistent with the predictions of Sutton's theoretical model.

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Appendix A. The data

The main data source used in this paper is the *Guía de Banca, Cooperativas de Crédito y Cajas de Ahorros*, which contains commercial information about branches of every bank, savings bank and credit co-operative in each Spanish town. As a complementary source, I have also used the *Anuario Comercial de España*, which supplies socio-economic information for towns with more than 1,000 inhabitants (number of inhabitants, area, per capita disposable income,...). This source can be matched to a subset of Spanish towns. The data refers to the year 1996.

The initial sample of the *Guía* consists of 40,574 records, of which 40,477 remain after eliminating records with missing information. These observations are distributed among 5,401 towns. From this sample, I have firstly discarded 3,321 observations belonging to 'credit co-operatives,' which are mostly located in very small towns and cannot be taken as standard banking institutions.

Then I have applied two filters, one in order to remove duplications (due to the special administrative role played by the same branches) and the other to retain exclusively standard retail branches. The first filter eliminates 867 observations corresponding to central departments[36] located in retail branches. The second filter eliminates 2,649 observations corresponding to a list of special types of branches. 33,640 observations remain, distributed among 4,977 towns that we will take as the population of retail branches.

The *Anuario Comercial* contains information about 3,196 Spanish towns with more than 1,000 inhabitants. I drop the towns in which there are only credit co-operatives and 3,061 towns remain. The intersection of the two data sources gives a sample of 2,864 towns[37] for which we have detailed information about branches and socio-economic data. In the regression analysis, I will use the subset of 1,768 towns whose size is between 1,000 and 5,000 inhabitants.

In 1996, the number of banks was 165, and the number of savings banks 51. The two institutions are now equivalent and must be taken together in considering the banking industry (on this relationship, see Coello, 1996). The size distribution of banks is more skewed than the size distribution of savings banks,

[36] Central departments do not render external services.

[37] There are 197 towns in the *Anuario Comercial* that cannot be matched with the ones in the *Guía* sample due mainly to the fact that the information published in both sources does not coincide. These towns always have between 1,000 and 3,000 inhabitants and there are always less than two branches.

including many entities with insignificant retail activities (most foreign banks among others). In 1996, banks owned 17,674 branches and savings banks 16,094. 56% of bank branches belong to the six largest banks[38], and 38% of savings bank branches belong to the five largest savings banks[39].

In what follows, I specify the definitions of the explanatory variables that constitute the vectors x_m and z_m of equation (3) (Table A.1 summarizes the variables and gives some statistics).

n_m: number of branches per town as of the 31st December 1996.

Vector x_m consists of the following variables:

$Density_m$: population density, measured by the number of inhabitants per square kilometer.

Y_m: set of dummies representing the different per-capita disposable income levels. The levels are the following

Levels	Per-capita disposable income (thousands of pesetas)	nº of towns
1	Up to 900	88
2	900-1,000	247
3	1,000-1,125	371
4	1,125-1,250	265
5	1,250-1,400	247
6	1,400-1,600	371
7	1,600-1,800	141
8	1,800-2,000	18
9	2,000-2,200	18
10	More than 2,200	2

Vector z_m consists of the variable:

$Population_m$: *De jure* population of each town.

TABLE A.1 ABOUT HERE

[38] The six largest banks at the time were: Bilbao Vizcaya, Central Hispano, Español de Crédito, Exterior de España, Popular Español and Santander (see *Anuario Estadístico de la Banca en España*).

[39] The five largest saving banks, ranked according to total resources, at the time were: C.A. y pensiones de Barcelona, C.A. y M.P. de Madrid, C.A. de Cataluña, Bilbao Bizcaia Kutxa and Bancaja (see *Anuario Estadístico Cajas de Ahorros Confederadas*).

Appendix B. Cluster Analysis

'Cluster Analysis' is the generic name for a wide variety of procedures that can be used to create a classification. The aim of these procedures is to form 'clusters' or groups of highly similar cases or entities. More formally, a clustering method is a multivariate statistical procedure that allows me to reorganize the sample of entities into homogeneous groups in terms of some characteristics[40]. For example, cluster analysis is used to classify animals or plants in biology, and to identify diseases and their stages in medicine.

In cluster analysis, distance is a generic measure of how far apart two objects are. There are many different definitions of distance. The choice between the measures depends on which characteristics of the data are important for your particular application. The most used distance measure between two entities is the *squared Euclidean distance*, computed from the vectors of values of their characteristics.

In cluster analysis, the selection of variables determines the caracteristics used to identify subgroups. In this paper, I apply this analysis for the identification of submarkets in multimarket towns. Consequently, the variables used for cluster formation are the co-ordinates (x,y) of the branches within the town. Therefore, distance measures the relative physical closeness of groups of branches.

There are many methods for forming clusters. The most used are the *agglomerative hierarchical clustering*, or the *divisive hierarchical clustering*[41]. In *agglomerative hierarchical clustering*, the clusters are formed by grouping cases, starting with groups of just one entity and ending up with all entities gathered into a single group. In *divisive hierarchical clustering*, the clusters are formed by splitting clusters, starting with all entities gathered into a single group and ending up with as many groups as there are entities.

Under *agglomerative hierarchical clustering*, there are many criteria for deciding which clusters should be combined at each step, but these criteria are invariably based on a matrix of distances. They differ in how the distances between clusters at successive stages are estimated. In general, clustering methods are the following: *linkage methods* (e.g., the *average linkage between groups method* that I

[40] See Aldenderfer and Blashfield (1984).

[41] See, for example, the chapter on cluster analysis in SPSS/PC +Statistics 4.0 manual.

employ in this study), *error sums of squares* or *variance methods* and *centroid methods* (e.g., the *centroid method* that I also employ in this study).

Just as there are many methods for calculating distances and for combining objects into clusters, there are many ways of visualizing the results of cluster analysis (e.g., icicle plot, agglomeration schedule, dendogram). In this study, I employ the dendogram that shows the clusters being combined, and the actual distances rescaled to numbers between 0 and 25.

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Table 1
The determination of the total number of branches per town

DEPENDENT VARIABLE: Number of branches

Number of observations: 1,768

	NLSQ	
Variables	Coefficients	t-ratios
cte	-10.55	(-16.91)
Population	7.72	(12.78)
Population^2	-1.99	(-10.11)
Population^3	0.17	(8.91)
Y2	-0.95	(-6.11)
Y3	-0.47	(-6.82)
Y4	-0.10	(-2.08)
Y5	0.09	(2.13)
Y6	0.01	(0.38)
Y7	0.14	(2.95)
Y8	0.47	(8.07)
Y9	0.56	(7.68)
Y10	0.65	(4.90)
Density	-6.17	(-9.01)
Density^2	12.09	(6.08)
Density^3	-6.26	(-3.90)
R^2	0.23	
R^2 (ajusted)	0.23	

Table 2
The joint distribution of submarkets and branches
(predicted numbers, relative frequencies shown in parenthesis)

		Number of branches per submarket					
		1	2	3	4	5	Total
Number of submarkets	1	186	791	200	7	5	1,189
		(15.7)	(66.5)	(16.8)	(0.6)	(0.4)	(100)
	2	147	399	32	1	0	579
		(25.4)	(68.9)	(5.5)	(0.2)	(0)	(100)
	Total	333	1,190	232	8	5	1,768

Table 3
Number of submarkets and degree of concentration per submarket

Town (region)	**Number of branches**	**C_1 (by town)**	**Possible number of submarkets**	**C_1 (by submarkets)**	**Maximally fragmented?**
Berriozar (Navarra)	5	0.4	3	1/2	Y
				1/2	Y
				1/1	Y
			2	1/4	Y
				1/1	Y
Noain (Navarra)	5	0.4	3	1/1	Y
				1/1	Y
				1/3	Y
			2	1/1	Y
				1/4	Y
Pasai de San Pedro (Guipuzcoa)	5	0.6	4	1/1	Y
				1/1	Y
				1/1	Y
				1/2	Y
			3	1/1	Y
				1/1	Y
				1/3	Y
Mejorada del Campo (Madrid)	6	0.33	4	1/1	Y
				1/1	Y
				1/1	Y
				1/3	Y
			2	1/2	Y
				1/4	Y
Montoro (Córdoba)	7	0.43	5	1/1	Y
				1/1	Y
				1/1	Y
				1/2	Y
				1/2	Y
			3	1/1	Y
				1/3	Y
				1/3	Y
Peñarroya (Córdoba)	7	0.43	3	1/1	Y
				1/1	Y
				2/5	N
			2	1/2	Y
				2/5	N
Leioa (Vizcaya)	8	0.5	3	1/1	Y
				1/1	Y
				2/6	N

Maliaño (Cantabria)	8	0.25	2	1/7 1/1	Y Y
Cardona (Barcelona)	8	0.38	3 2	1/1 1/1 2/6 1/2 2/6	Y Y N Y N
Segorbe (Castellón)	9	0.33	5 4	1/2 1/1 1/2 1/3 1/1 1/2 1/3 1/3 1/1	Y Y Y Y Y Y Y Y Y
Boadilla del Monte (Madrid)	10	0.3	5 4	1/1 1/1 1/1 1/2 1/5 1/1 1/1 1/1 1/7	Y Y Y Y Y Y Y Y Y
Vila-Seca (Tarragona)	10	0.4	4 3	1/1 1/1 1/3 1/5 1/1 1/3 2/6	Y Y Y Y Y Y N

Table 4
Number of submarkets in the medium-size town and degree of concentration per submarket

Town (region)	**Number of branches**	**C_1(town)**	**Possible number of submarkets**	**C_1 (by submarkets)**	**Maximally fragmented?**
Alcalá de Henares (Madrid)	86	0.19	14	1/1	Y
				1/1	Y
				1/2	Y
				1/3	Y
				1/3	Y
				1/3	Y
				1/4	Y
				2/4	N
				1/6	Y
				2/6	N
				1/9	Y
				1/10	Y
				2/14	N
				3/20	N

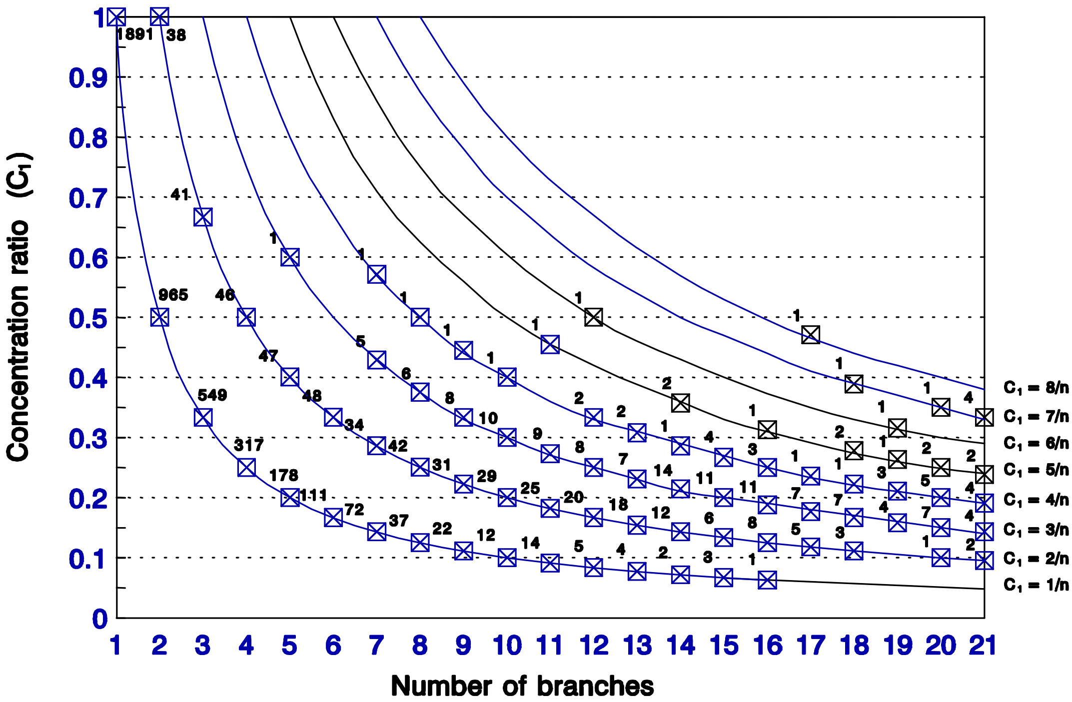
Table A.1
Summary and statistics of the variables employed in regression

	Mean	Std.	Min.	Max.
Dependent variables				
Number of branches	2.56	1.54	1	12
Explanatory variables				
To account for the *average number of branches per submarket:*				
Population density[1]	0.09	0.18	0.00	2.91
Income levels:				
Y1	0.05	0.22		
Y2	0.14	0.34		
Y3	0.21	0.41		
Y4	0.15	0.36		
Y5	0.14	0.34		
Y6	0.21	0.41		
Y7	0.08	0.27		
Y8	0.01	0.11		
Y9	0.01	0.09		
Y10	0.00	0.05		
To account for the *number of submarkets:*				
Population[2]	2.30	1.04	1.00	4.97

Notes

1. Thousands of inhabitants per square kilometer.
2. Thousands of inhabitants.

Figure 1
Degree of concentration in towns according to the number of branches



The number on each datapoint reports its corresponding absolute frequency; i.e., there are 965 towns with two branches owned by different banks (C_1 = 0.5) and 38 in which the two branches are owned by the same bank (C_1 = 1).

Figure 2
The probability of being town multibranch for the largest bank

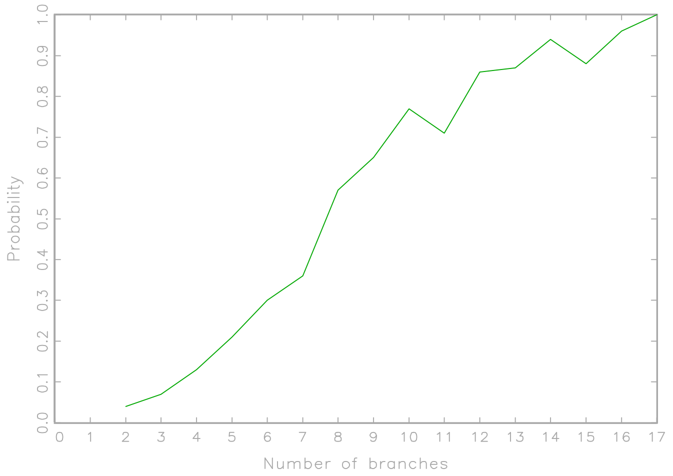


Figure 3
Concentration in individual submarkets. An example.

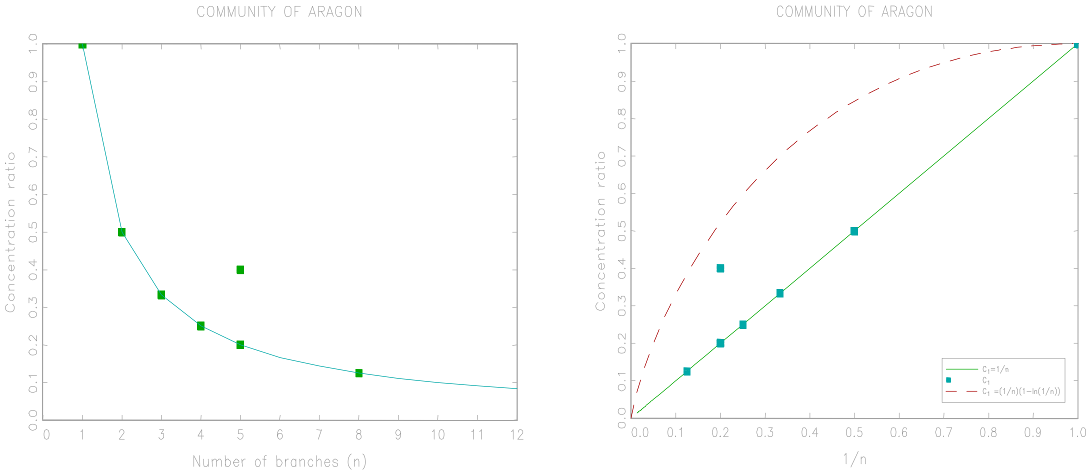
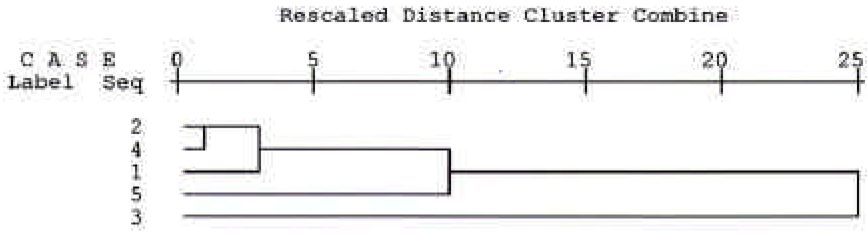


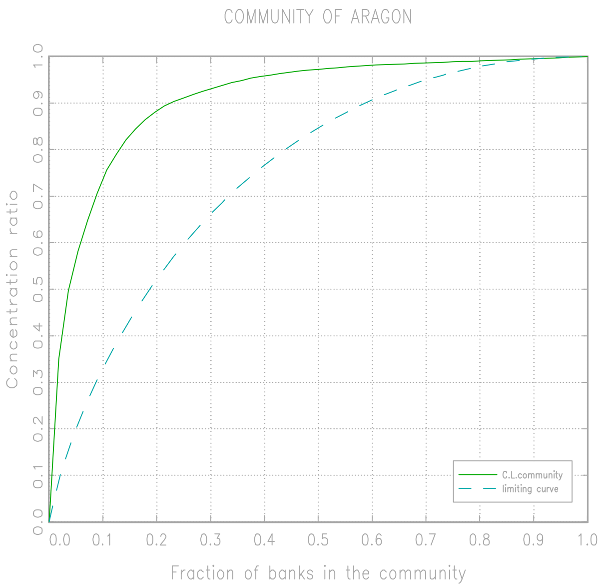
Figure 4
Dendogram using average linkage (between groups)

PASAIA DE SAN PEDRO:



The nested tree structure of this dendogram suggests that there are many different groupings according to the chosen distances. The two extreme cases are the following: If the dendogram is "cut" at a distance of 0 (maximum desaggregated level), the number of clusters is 5. Each of them is formed by one branch. On the contrary, if the dendogram is "cut" at a distance 25 (the higher aggregated level), the number of clusters is 1 which is formed by 5 branches.

Figure 5
Lorenz curve of a community market



The figure relates to the Community of Aragón

Figure 6
Lorenz curve of the national territory