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Abstract

Recent studies have shown that barriers to entry for large retail establishments in Spain have been increased in the last decade. We exploit a unique dataset derived from an extensive analysis of the location of each large retail establishments in Spain to test whether the entry of large retail establishments was effectively limited by regional regulation. To achieve this aim we merge the literatures on stochastic production frontiers and on barriers to entry by estimating a frontier entry model, which allows us to get market-specific estimates of entry costs. We have found that entry costs have decreased the number of large establishments in a 25%. Most of this inefficiency is explained by legal retail legislation. The existence of significant differences among local markets discourages using regional data to analyze entry cost and barriers to entry.

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1. **Introduction**

A study carried out recently by the Spanish Central Bank (see Llanos and Mora, 2007) showed that barriers to entry for large retail establishments promoted by Spain's autonomous regions have been increased over the last decade. Only a few years prior to that study, the Spanish Competition Authority[1] had warned, in 2003, that regional barriers to entry for large retail establishments had "lowered competition...allowing incumbent firms to be less efficient, which has translated into higher prices" (TDC, 2003, p. 22). This contrasts with the European Single Market Program initiative that was launched more than two decades ago to deregulate markets and lower trade barriers (Nicoletti and Scarpetta, 2003; Chen, 2004) and with the European Union's Services Directive (Directive 2006/123/EC) that aims to facilitate the provision of cross-border services in the Internal Market.[2]

Why have regions decided to create entry barriers against large retail establishments? Why have they then imposed additional barriers to the initial ones? As pointed out by the Spanish Competition Authority in a 1995 report, "the objective of the [Spanish law that regulates the retail sector] is to protect traditional shops with the aim of slowing down the continuous decline in their market share […]. In addition, slowing down the creation of large retail establishments will reinforce the incumbents' market power, as they will not compete with new rivals. In contrast, if the entry of large retail establishments was not limited, retail competition would increase, and supply would thus be higher, with more variety and better prices".

Using an asymmetric model of oligopoly, Hoffmaister (2006) has shown that forcing (low-cost) large retail establishments out of the market changes the composition of the retail industry in favor of traditional shops. In the absence of barriers, (low-cost) large retailers drive prices below the traditional retailers' long-run break-even point thereby forcing the latter out of the market. To the extent that these shops are locally owned and operated, regional governments may thus be seeking to protect and enhance employment in these businesses as well as to shore up electoral constituencies.

In the present paper we try to test one of the Spanish Competition Authority's statements in its 1995 competition report, namely, whether the entry of large retail establishments was effectively limited by regional regulation. As far as we know, this is the first attempt to assessing the impact of restrictive regulation on entry into the Spanish retail industry. To achieve this objective, we estimate a *frontier entry model* where the number of retail establishments in a particular local market is modeled as a function of a measure of regional barriers to entry as well as demand and cost drivers. As far we know this is the first time the literature on stochastic production frontiers is applied to measure entry costs and barriers to entry.

The equation to be estimated relies on a theoretical model where entry is thought of as a two-stage process: a firm incurs an entry cost, which includes the cost of barriers to entry, and then competes for business (see, for instance, Manuszak and Moul, 2008). Since entry costs always reduce the number of firms in all theoretical models of entry and the nature of barriers to entry and other unobserved demand and cost variables is

[1] Before September 2007 the Spanish Competition Authority was called *Tribunal de Defensa de la Competencia (TDC)* and since then it has been called *Comisión Nacional de la Competencia (CNC)*.

[2] Completion of the internal market in services is viewed as a major building block and contributor to higher growth and employment in the European Union, as services account for 60-70 % of economic activity in the EU Member States and about the same percentage of jobs.

quite different, we assume that the effect of entry costs on market structure can be modeled as a non-positive random term. This allows us to capture either observed and non-observed entry costs or barriers to entry, and to get market-specific estimates of entry cost. Since this barriers-to-entry random term is asymmetrically distributed we can apply the stochastic frontier techniques developed in the production literature (Kumbhakar and Lovell, 2000) to estimate an entry efficiency index for each local market by dividing the observed number of stores by the estimated (maximum) number of stores that would survive in case of no entry barriers.

Instead of estimating a simple equation where the number of retail establishments is modeled as a function of regional barriers to entry, demand and cost drivers, previous papers have estimated the *probability* that a local market is supplied by a particular number of firms is modeled. This approach was first used by Bresnahan and Reiss (1991) in order to model the market structure in five different service and retail industries using data on the number of firms and population for a cross-section of geographic markets. They have found that there was a positive correlation between the number of firms and population per firm over the range of approximately one to three firms in the market. They also have developed the insight that, if entry of additional firms into a market compresses the average markup of all firms in operation, then the market size needed to support an additional firm will be larger than if this competitive effect was absent. Mazzeo (2002b) used this approach to model the number of motels located along U.S. interstate highways using data from a cross-section of local markets. Recently, Manuszak and Moul (2008) have applied the same model in order to analyze the market structure for office supply superstores in the US, and Griffith and Harmgart (2008) for the UK grocery retail industry. The authors of the later paper have found that more restrictive planning regulation reduces the number of large retail establishments.

In the present paper we do not estimate the probability that a local market is supplied by a particular number of firms *a-lá* Bresnahan and Reiss because the number of retail establishments in our local markets are larger, compared to the number of competitors in the above mentioned studies. The approach followed by Bresnahan and Reiss (1991) and the other papers allows entry cost to vary with the number of firms, but imposes a common entry cost structure for all markets, that is, two markets supplied by the same number of firms face the same barriers to entry, and hence only an average entry cost can be estimated for all markets. The main contribution of the proposed approach is the way the skewness of the barriers-to-entry random variable is exploited in order to get market-specific estimates of entry cost, separately from the average entry cost.

On the other hand, Griffith and Harmgart (2008) have found that the impact of planning regulation on the number of UK large retail establishments is overestimated if variation in demographic characteristics across markets (i.e. market heterogeneity) is not controlled for. In order to control for market heterogeneity and aggregation errors that might bias our empirical results, in the present study we use a *local market* approach. Following Manuszak and Moul (2008), Gómez-Lobo and González (2007), and Ashenfelter *et. al.* (2004), our geographical markets are commercial areas, formed by the municipality of one of the main Spanish cities and its surrounding municipalities. Previous studies and reports on the Spanish retail market used a *regional* approach where geographical markets were broadly defined as a whole administrative region.[3]

[3] See, for instance, Sánchez *et. al.* (2008).

The local approach of the present paper allows us to examine whether there are significant differences within a particular region in entry cost and, hence, whether a regional approach is appropriate.

The empirical evidence in this study exploits the synthetic indictor of regional retail regulation recently constructed by Llanos and Mora (2007), and a unique dataset derived from an extensive analysis of the location of each large retail establishments in Spain. This analysis allowed us to measure the distance between stores and to identify the stores which are competing directly with other stores in the same commercial area.

2. Theoretical background

The analysis of barriers to entry in this paper is anchored by the Cournot-Nash framework of imperfect competition. Retail services are non-traded so that firms must open a store before generating sales in a specific market. We assume that each market consists of a number of identical establishments maximizing profits by choosing output given other firms' output.

The firm's problem in the m*th* market is given by

$$\max_{q_i} \quad \pi_m(q_i) = (P_m - c_m)q_i - f_m \tag{1}$$

where π, q, c, and f denote profits, output, and marginal and fixed costs for firm i. The fixed costs are taken to be the annual costs of operation associated with regulations in market m, including bureaucratic and accounting requirements. For notational ease we assume that marginal and fixed costs are common to all firms in a particular market. $P_m(Q_m)$ is the m*th* market's (inverse) demand function, and $Q_m = \Sigma_{i=1}^{N_m} q_i$ is the output supplied by all firms in the market.

The first-order profit-maximizing condition that expresses the equality of marginal revenue to marginal cost is the following:

$$P_m + \frac{\partial P}{\partial q_i} q_i = c_m \tag{2}$$

For concreteness, take P_m=D_m-Q_m where D_m positions the m*th* market's (inverse) demand curve, and assume that all firms are identical. The symmetrical Cournot-Nash optimal output can thus be expressed as:

$$q^* = \frac{1}{1+N_m}(D_m - c_m) \tag{3}$$

which depends on the endogenous number of firms, N_m, supplying the market. The zero-profit condition pins down the number of firms in the long run, and thus allows the long-run optimum level of output to be characterized fully. Hence, the long-run equilibrium number of establishments that can be supplying the market is:

$$N_m^*(D_m, c_m, f_m) = \frac{(D_m - c_m)}{\sqrt{f_m}} - 1 \tag{4}$$

This equilibrium represents the pure-strategy subgame-perfect Nash equilibrium, as no firm would change its entry decision given the entry decision of other firms.[4] Using the equation (4) and assuming that c_m=0 and f_m=2, we represent in Figure 1 the number of establishment, $N_m^*(\cdot)$, that can be supplying the market as a function of the market size, D_m. As shown below, it should be noted that this line provides a *maximum* due to the existence of entry costs and barriers to entry might yield an observed number of firms, N_m, less that the maximum.

[Insert Figure 1 here]

Entry barriers can be modeled as an entry cost,[5] much (if not all) of which is likely to be fixed and even sunk. A cost is sunk when it cannot be recovered or reversed by simply stopping the activity that gave rise to it. Sunk costs raise barriers to entry (and exit) by imposing very high penalties for failure on potential competitors: if entry fails, then the entrant, unable to recover sunk costs, incurs greater losses. Therefore, when a new firm decides to enter the possibility of failure becomes a critical factor in that decision because the new firm must be prepared to incur substantial upfront cost and because the firm must be prepared to absorb the entire sunk portion of that cost in the event that it does fail.[6]

In this model, entry can be thought to be a two-stage process: a firm incurs an entry cost, and then competes for business. A firm thus enters whenever profits in the second stage cover the entry cost (i.e. there are neither strategic effects nor first-mover advantage). The profit-maximizing behavior and entry decision imply that barriers to entry reduce the number of firms in the market. Specifically, let b_m denote the *mth* market's barriers to entry; then the relation between barriers and the number of stores can be expressed as:

$$N_m = \frac{(D_m - c_m)}{\sqrt{f_m + b_m}} - 1 = \frac{(D_m - c_m)}{\sqrt{f_m}} \cdot \frac{\sqrt{f_m}}{\sqrt{f_m + b_m}} - 1 = \left[N_m^* + 1\right] \frac{\sqrt{f_m}}{\sqrt{f_m + b_m}} - 1 \quad (5)$$

After some manipulations and taking natural logs we get the following relationship:

$$ln(N_m + 1) = ln(N_m^* + 1) - ln\, F_m \quad (6)$$

where

$$F_m = \frac{\sqrt{f_m + b_m}}{\sqrt{f_m}} \geq 1$$

[4] Note that fixed cost in this equation works as a barrier to entry. This is a technological barrier to entry due to the existence of fixed cost implies that the technology exhibits increasing returns to scale.

[5] The Barker Review (2006) reports that applications for large retail stores cost an average of £70,000. In a recent inquiry conducted on the UK Grocery market, the Competition Commission (2000) reports an average cost of £50,000. The CC also reports that application delays for the major supermarkets could vary from a minimum of 4 months to a maximum of 24 months.

[6] Therefore, a new firm that wishes to enter the market must carefully weigh its chances of surviving in the long run. Cabral and Ross (2007), pointed out, however, that in a strategic context where an incumbent may prey on the entrant, sunk entry costs have a countervailing effect: they may effectively commit the entrant to stay in the market. By providing the entrant with commitment power, sunk investments may soften the reactions of incumbents. The net effect may imply that entry is more profitable when sunk costs are greater.

is a measure of the relative importance of the barriers to entry. If F_m=1, there are not entry barriers. If $F_m \rightarrow \infty$, entry barriers tend to infinity. Note also that if entry costs are mainly formed by sunk costs, F_m can be interpreted as the entire sunk portion of total fixed cost in the event that it does fail.

If we assume that N_m and N_m^* are large enough we can drop the number one inside the parenthesis and get the following relationship between the observed and the maximum number of stores:

$$ln\, N_m = ln\, N_m^* - ln\, F_m \tag{7}$$

As mentioned above, this equation indicates that the existence of barriers to entry (i.e. lnF_m>0) yields an observed number of firms N_m less that the maximum. Therefore, if we have a data set of several markets and the number of establishments that are actually supplying those markets, equation (7) can be interpreted as a frontier that envelops all observations. Given the magnitude of the entry barriers in each market, the picture we observe is the provided by Figure 2, where all observations are below the frontier that indicates the maximum number of potential establishments.

[Insert Figure 2 here]

Once the parameters that define the frontier number of firms are estimated, an *entry efficiency* index can be calculated by dividing the observed number of stores by the estimated (maximum) number of stores that would have in case of no entry cost or entry barriers. By construction, this index can be interpreted as a proxy of the relative importance of the barriers to entry, that is:

$$E_m = \frac{N_m}{N_m^*(\cdot)} \tag{8}$$

3. Empirical Model

Following Manuszak and Moul (2008) the latent profit function for a particular firm in market *m* when it is supplied by N_m can be written as:

$$\pi_m(\cdot) = Z_m\delta - \beta\, ln\, N_m + \xi_m \tag{9}$$

where $Z_m=(D_m,c_m)$ are market-specific demand and cost factors that impact profitability in market *m*, and ξ_m are unobserved factors in that market, and (δ,β) are unknown parameters of the latent profit function. We assume in the latent profit function (9) that firms' profits are decreasing in N_m, so that (9) can be interpreted as the reduced form of the expected present discounted value of profits that result from post-entry competition between firms and that all firms observe. [7] Here we assume a logarithmic relationship between profit and the number of firms like in many theoretical models of imperfect competition where the effect of entry on firms' profits is decreasing.

Regarding the firms' entry decisions, three comments are in order. First, a firm enters whenever profits cover its entry cost. Since we do not observe this entry cost we

[7] One characteristic of this framework is that it ignores the dynamics of the entry process, and that firms are not symmetric (in terms of size, reputation, quality, etc.). Modelling decisions when both entry decisions are discrete and firms are asymmetric is a complex work. Mazzeo (2002a) relaxed this symmetry assumption by introducing different types of products (or firms), conditioning the analysis on the number of entering firms of each type. However, Einav (2007) pointed out that the main restrictions still remains (e.g. all potential entrants are ex-ante identical), and extending Mazzeo's model to more than two or three types is computationally infeasible.

treat entry cost in a particular market m, F_m, as a random variable. Second, we assume that F_m can be modeled as a non-negative random term because entry cost always reduces the number of firms in all theoretical models of entry. And, third, we assume that entry cost in a particular market m is a function of *observed* barriers to entry, b_m. That is:

$$\ln F_m = \ln F_m(b_m, \alpha) \quad , \quad \ln F_m \geq 0 \tag{10}$$

The resulting number of retail competitors supplying the market in the long run can be obtained from the zero-profit condition once the entry cost is accounted for. Assuming that all retail outlets are identical, the equilibrium number of firms in market m is characterized by the following equation:

$$Z_m\delta - \beta \ln N_m + \xi_m = \ln F_m(b_m, \alpha) \tag{11}$$

Rearranging (11), we get that the endogenous number of firms in market m in the long run can be written as:

$$\ln N_m = Z_m\delta' - u_m + \varepsilon_m \tag{12}$$

where $\delta' = \delta/\beta$, $u_m = \ln F_m(b_m,\alpha)/\beta$ is a random term which measures the effect of entry cost and barriers to entry on market structure (i.e. the number of stores), and $\varepsilon_m = \xi_m/\beta$ is a noise term that captures unobserved demand and cost factors in market m that impact market structure.[8] We expect the data generating processes behind both random terms, u_m and ε_m, are quite different because the nature of entry costs (i.e. barriers to entry) and other unobserved demand and cost variables is quite different.

Note, first, that both random terms refer to two different firm's decisions, and these decisions are made in different periods of time: while u_m affects directly the decision to entry in a particular market, ε_m affects the period-by-period profit maximization, once there is a previous decision on entry. In this sense, the unobserved demand and cost factors captured by ε_m only affect entry decisions indirectly, and hence while the effect of ε_m on market structure is probably uncertain, fuzzy and weak, the effect of barriers to entry is stronger and more certain. Second, while other unobserved demand and cost variables are probably market-driven, entry costs are probably highly determined by regulators due to legal retail regulation in Spain are mainly designed to limit the entry of large retail establishments.[9] And, third, while ε_m may capture unobserved costs that can be recovered in case of exit, u_m may capture sunk costs that cannot be recovered. As mentioned above, sunk costs exaggerate the penalties for failure on potential competitors, reducing the probability of entry.

In summary, since barriers to entry involve substantial sunk costs and their effect on market structure is more direct, stronger and more certain than the effect of ε_m, we expect that u_m is likely negative and asymmetrically distributed. For this reason, while assuming that the noise term is symmetric with zero mean is conventional, we assume

[8] The model (12) that is going to be estimated is called "reduced form" because the number of firms is thought of as derived from the interaction of a demand function with a supply relation that captures both profit-maximizing behavior and entry decisions. As a result, the parameters of a reduced form equation are themselves typically functions of the structural parameters of the underlying economic relationship (Baker and Rubinfeld, 1999).

[9] Note, in this sense, that in theoretically ε_m might capture barriers to entry associated with the degree of firms' scale economies, and hence this term is also determined by the available technology.

that the effect of entry barriers on market structure can be modeled as a non-positive random term, i.e. $u_m \geq 0$. Identification of the barriers-to-entry random term relies on the non-symmetry of u_m. If both right hand side and left hand side tails of the distribution of u_m are symmetric, we cannot get separate estimates of statistical noise and entry cost from estimates of the composed error for each market. In this situation, we cannot also estimate market-specific entry efficiency scores.[10]

If the barriers-to-entry random term is asymmetric, we can apply the stochastic frontier techniques developed in the production literature (see Kumbhakar and Lovell, 2000) in order to estimate (12). Moreover, in this case, we can take advantage of the skewness of the barriers-to-entry term to get market-specific barriers-to-entry scores.

Let's us assume that the barrier-to-entry random term follows a truncated-normal distribution. A general specification including a vector of entry cost's determinants, b_m, can be written as $u_m \rightarrow N^+[\mu(b_m),\sigma(b_m)]$. In this general specification the observed entry barriers determine both the shape and magnitude of the one-sided random term, and their coefficients can only be estimated using maximum likelihood techniques (MLE). The model can also be estimated, however, using a method of moments if u_m satisfies the so-called *scaling property* (see Wang and Schmidt, 2002). In this case, u_m can be written as:

$$u_m \rightarrow g(b_m,\alpha)\cdot\theta_m \quad , \quad \theta_m \rightarrow N^+(\mu,\sigma) \tag{13}$$

where $g(b_m,\alpha)$ *is* a scaling function and θ_m is a random variable that does not depend on b_m. This type of models has a convenient economic interpretation, i.e. while the scaling function $g(\cdot)$ captures the effect on market structure of *observable* barriers to entry (likely common to several markets), θ_m is a random term which captures the effect of *unobserved* barriers to entry and allows entry cost to vary within a particular region. For instance, while $g(\cdot)$ likely includes variables measuring the regional retail regulation that limit the entry of large retail establishments in a particular Autonomous Region, θ_m can be interpreted the degree this entry legislation is enforced by local governments.

Although it is an empirical question whether or not the scaling property should hold, it has some features that we find attractive. The question of whether the effects of the b_m, on market structure are monotonic can be handled easily by the choice of scaling function. If one wishes to impose monotonicity, simply use a monotonic scaling function, such as the exponential scaling function $exp(b_m'\alpha)$. If not, use a non-monotonic scaling function. As noted by Wang and Schmidt (2002), the interpretation of α does not depend on the distribution of θ_m, and simple scaling functions yield simple expressions for the effect of the b_m on the magnitude of entry costs. For example, if we use the exponential scaling function, so that $u_m=exp(b_m'\alpha)\cdot\theta_m$, the market structure equation to be estimated is:

$$ln\, N_m = Z_m\delta' - exp(b_m'\alpha)\cdot\theta_m + \varepsilon_m \tag{14}$$

In this case, the coefficients α are just the derivatives of $ln(u_m)$ with respect to b_m.

[10] Note, however, that in this situation we can estimate the market structure equation (12) and the *average* entry cost for all markets as a constant term due to $E(u_m)>0$.

3. Estimation strategy

In order to estimate (14) we can use two alternative methods: a method of moments approach and MLE.

The method of moments approach involves three stages. In the first stage, least squares is used to generate consistent estimates of all parameters describing the configuration of the market structure equation, apart from the variances of both random terms. This stage is thus independent of distributional assumptions on either error component. In the second stage of the estimation procedure, distributional assumptions are invoked in order to obtain consistent estimates of the parameter(s) describing the structure of the two error components, conditional on the first-stage estimated parameters describing the configuration of the market structure equation. In the third stage, entry efficiency scores are estimated for each market by decomposing the estimated residual into a noise component and a barrier-to-entry component.

The MLE approach uses maximum likelihood techniques to estimate simultaneously both (second-stage) parameters describing the structure of the two error components and parameters describing the configuration of the market structure equation. In this case, the MLE approach merges the two first stages of the method of moments approach into one.[11]

Base on the results of a Monte Carlo experiment, Olson, Schmidt, and Waldman (1980) concluded that the choice of estimator (MLE versus method of moments) depends on the relative values of the variance of both random terms and the sample size. When the sample size is small and the variance of the one-sided error component, compared to the variance of the noise term, is not large the method of moments outperforms MLE in a mean-squared error sense.

3.1. MLE method

This method relies on assuming a specific distribution for the asymmetric barrier-to-entry random term, θ_m. Assume, for instance, that this term can be modelled by allowing θ_m to follow a truncated normal distribution.[12] If we assume that $\theta_m \sim N^+(\mu,\sigma^2)$ then

$$f(\theta_m) = \frac{1}{\sqrt{2\pi}\cdot\sigma}\cdot\Phi^{-1}(\mu/\sigma)\cdot exp\left\{-\frac{(\theta_m-\mu)^2}{2\sigma^2}\right\} \tag{15}$$

In this case the log likelihood function can be derived from Stevenson (1980) with (μ,σ) being replaced with $(\exp(b_m'\alpha)\cdot\mu, \exp(b_m'\alpha)\cdot\sigma)$. This yields the following log likelihood function:

[11] It can be also used to obtain second-stage estimates of the parameter(s) describing the structure of the two error components, conditional on the first-stage estimated parameters, describing the configuration of the market structure equation. It can be also used to estimate simultaneously both types of parameters.

[12] We have chosen this distribution because it is a generalization of the one-parameter half-normal distribution and it is one of the most employed in the production frontier literature.

$$\ln f(\omega_m) = -\ln\Phi(\mu/\sigma) - 0.5\ln\left(\sigma_\varepsilon^2 + \sigma^2 \exp(b_m'\alpha)^2\right)$$
$$+\ln\phi\left[\frac{\ln N_m - z_m'\delta + \mu\exp(b_m'\alpha)}{\sigma_\varepsilon^2 + \sigma^2\exp(b_m'\alpha)^2}\right] \tag{16}$$
$$+\ln\Phi\left(\sigma_\varepsilon^2 + \sigma^2\exp(b_m'\alpha)^2\right)^{1/2}\cdot\left[\frac{\sigma_\varepsilon}{\mu\sigma\exp(b_m'\alpha)} - \frac{\sigma\exp(b_m'\alpha)}{\sigma_\varepsilon}\left(\ln N_m - z_m'\delta\right)\right]$$

where $\omega_m = \varepsilon_m - \exp(b_m'\alpha)\cdot\theta_m$. And so, $\left(\hat{\delta},\hat{\alpha},\hat{\mu},\hat{\sigma}\right) = \arg\min\sum_m \ln f(\omega_m)$.

Once the parameters in (16) are estimated, entry efficiency scores can be estimated for each market by decomposing the estimated residual into a noise component and a barrier-to-entry component. We have estimates of $\omega_m = \varepsilon_m - \tilde{\theta}_m = \varepsilon_m - \exp(b_m'\alpha)\cdot\theta_m$, which obviously contains information on θ_m. The problem is to extract the information that ω_m contains on $\tilde{\theta}_m$, and given $\exp(b_m'\alpha)$, on θ_m. Jondrow *et. al* (1982) face the same problem in the frontier production function literature and propose using the conditional distribution of the one-sided random term (here $\tilde{\theta}_m$) given the composed error term (here ω_m). The conditional distribution f($\tilde{\theta}_m \mid \omega_m$) is given by

$$\ln f(\tilde{\theta}_m \mid \omega_m) = \frac{f(\tilde{\theta}_m,\omega_m)}{f(\omega_m)} = \frac{1}{\sqrt{2\pi}\cdot\sigma_*}\Phi^{-1}\left(\frac{\mu_*}{\sigma_*}\right)\exp\left\{-\frac{\left(\tilde{\theta}_m - \mu_*\right)^2}{2\sigma_*^2}\right\} \tag{17}$$

Note that $f(\tilde{\theta}_m \mid \omega_m)$ is distributed as $N^+(\mu_*,\sigma_*^2)$, where $\mu_* \equiv \left(-\sigma_m^2\omega_m + \mu_m\sigma_\varepsilon^2\right)/\tilde{\sigma}_m$, $\sigma_*^2 \equiv \left(\sigma_m^2\cdot\sigma_\varepsilon^2\right)/\tilde{\sigma}_m^2 = \left(\sigma_m^2\cdot\sigma_\varepsilon^2\right)/\left(\sigma_m^2+\sigma_\varepsilon^2\right), \sigma_m = exp(b_m'\alpha)\cdot\sigma$, $\mu_m = exp(b_m'\alpha)\cdot\mu$, and $\tilde{\sigma}_m^2 = \sigma_\varepsilon^2 + exp(b_m'\alpha)^2\cdot\sigma^2$. Thus the mean of $f(\tilde{\theta}_m \mid \omega_m)$ can be used to get market-specific estimates of $\tilde{\theta}_m$.[13] The mean is given by

$$E(\tilde{\theta}_m \mid \omega_m) = \mu_* + \sigma_*\cdot\frac{\phi(\mu_*/\sigma_*)}{\Phi(\mu_*/\sigma_*)} \tag{18}$$

3.2. Method of Moments method

Now we describe the method of moments approach. Let us first rewrite the market structure equation (14) as:

$$ln N_m = f_m(\delta) - g_m(\alpha)\cdot\bar{\theta} + v_m \tag{19}$$

where $\bar{\theta} = E(\theta_m)$, $f_m(\delta) = Z_m\delta'$, $g_m(\cdot) = exp(b_m'\alpha)$, and $v_m = \varepsilon_m - g_m(\alpha)\cdot\{\theta_m - \bar{\theta}\}$. Models of the form in (19) have been proposed and estimated in the frontier production function literature, measuring of the efficiency and production using the method of moments approach. See, in particular, Simar *et. al* (2004), and the references in Kumbhakar and Lovell (2000).

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[13] The mode of this distribution can also be used as a point estimator for $\tilde{\theta}_m$. However, the mean is, by far, the most employed in the frontier literature.

In the first stage, least squares is used to generate consistent estimates of all parameters describing the configuration of the market structure equation, apart from the variances of both random terms.

The parameters in equation (19) can be estimated by non-linear least squares by means of

$$\left(\hat{\alpha},\hat{\delta},\hat{\bar{\theta}}\right) = arg\,min \sum_{m} \left[y_m - f_m(\delta) + g_m(\alpha) \cdot \bar{\theta} \right]^2 \tag{20}$$

Note that (20) which is estimated in this first stage is equivalent to the traditional specification of a market structure equation where an average entry cost level is estimated altogether with other cost and demand parameters.[14]

Two estimation issues might arise in this first stage. If some regressors are endogenous, a GMM or IV method should be employed in order to get consistent estimates. Second, the resulting parameter estimates are consistent, but not efficient by construction since the v_m's are independently but not identically distributed. Assuming that θ_m and ε_m, are distributed independently of each other, the second moment of the composed error term can be written as:

$$E(v_m^2) = \sigma_{vm}^2 = \sigma_\varepsilon^2 + g_m^2(\alpha) \cdot \sigma_\theta^2 \tag{21}$$

where $E(\varepsilon_m^2) = \sigma_\varepsilon^2$, and $V(\theta_m) = \sigma_\theta^2$. Equation (21) shows that the error in the regression indicated by (19) is heteroskedastic. Therefore generalized least squares would be needed to obtain estimates that are efficient. [15]

In the second stage of the estimation procedure we obtain consistent estimates of the parameter(s) describing the structure of the two error terms. Assuming, as it is customary, that ε_m is symmetrically distributed, the third moment of the composed error term can be written as:

$$E(v_m^3) = -g_m^3(\alpha) \cdot E\left[(\theta_m - \bar{\theta})^3 \right] \tag{22}$$

Equation (18) shows that the third moment of v_m is simply the third moment of the random conduct term, adjusted by $-g_m^3(\alpha)$. Note also that the variance of the noise error term does not appear in (22). That is, while the second moment (21) provides information about the parameter(s) describing the structure of the two error components

[14] If panel data is available, the market structure equation (19) can be extended allowing for market-specific barriers to entry as follows:

$$ln\,N_{mt} = f_{mt}(\delta) - g_{mt}(\alpha) \cdot \bar{\theta}_m + v_{mt}$$

This model assumes that market-specific barriers-to entry parameters are time-invariant and it is only consistent when long panel data sets are available (i.e. as $T \rightarrow \infty$). In addition, the incidental parameter problem appears as $N \rightarrow \infty$.

[15] Efficient parameter estimates can be obtained using weighted least squares by means of

$$\left(\hat{\alpha},\hat{\delta},\hat{\bar{\theta}}\right) = arg\,min \sum_{m} \left[\frac{y_m - f_m(\delta) + g_m(\alpha) \cdot \bar{\theta}}{\sigma_{vm}} \right]^2$$

However, since σ_{vm}^2 is unknown, it is necessary to construct a feasible least squares estimator. This is done in the second stage.

(i.e. σ_ε^2 and σ_θ^2), the third moment (22) only provides information about the asymmetric random conduct term. Now, if we assume a specific distribution for this one-sided random term, we can estimate σ_θ^2 from the third moment of v_m, and then σ_ε^2 from its second moment. As shown below, this provides all the information required to estimate not only and σ_{vm}^2 but also to get firm-specific market power scores.

If we assume that the barriers-to-entry random term, θ_m, follows a truncated normal distribution, i.e. $\theta_m \sim N^+(\mu,\sigma^2)$, the first three moments of θ_m can be written as (see Jawitz, 2004):

$$E(\theta_m) = \bar{\theta} = \mu + \frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)} \cdot \sigma \tag{23}$$

$$E\left[(\theta_m - \bar{\theta})^2\right] = \sigma_\theta^2 = \sigma^2 - \frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)} \cdot \sigma \cdot \bar{\theta} \tag{24}$$

$$E\left[(\theta_m - \bar{\theta})^3\right] = -\frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)}\sigma^3 + \left[\frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)}\right]^2 \sigma^2 \cdot \bar{\theta} + \frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)} \cdot \sigma \cdot \bar{\theta}^2 \tag{25}$$

Note that, while the first stage is thus independent of distributional assumptions on either error component, in the second stage of the estimation procedure we invoke distributional assumptions in order to obtain consistent estimates of the parameter(s) describing the structure of the two error components, *conditional* on the first-stage estimated parameters describing the configuration of the market structure equation, which includes an estimation of $\bar{\theta}$. Hence, equation (23) can be viewed as a non-linear constraint between μ and σ.

Given the assumed distribution function for θ_m, the second and third moments of the composed error term can be rewritten as:

$$E(v_m^2) = \sigma_{vm}^2 = \sigma_\varepsilon^2 + g_m^2(\alpha) \cdot \left(\sigma^2 - \frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)} \cdot \sigma \cdot \bar{\theta}\right) \tag{26}$$

$$E(v_m^3) = -g_m^3(\alpha) \cdot \left\{-\frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)} \cdot \sigma^3 + \left[\frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)}\right]^2 \cdot \sigma^2 \cdot \bar{\theta} + \frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)} \cdot \sigma \cdot \bar{\theta}^2\right\} \tag{27}$$

Next, using the first-stage residuals, the two equations formed by the non-linear constraint and the third moment of the composed error term

$$\hat{\theta} = \mu + \frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)} \cdot \sigma \tag{28}$$

$$\frac{1}{M}\sum_{m=1}^{M}\left[\frac{\hat{v}_m}{-g_m(\hat{\alpha})}\right]^3 = -\frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)}\sigma^3 + \left[\frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)}\right]^2 \sigma^2 \cdot \hat{\theta} + \frac{\phi(\mu/\sigma)}{\Phi(\mu/\sigma)}\sigma \cdot \hat{\theta}^2 \tag{29}$$

provide estimates of μ and σ, which yield an estimate of $\phi(\mu/\sigma) \cdot \Phi^{-1}(\mu/\sigma)$. Using the second moment of the composed error term, these estimates together yield an estimate of σ_ε^2 by means of

$$\hat{\sigma}_{\varepsilon}^{2}=\frac{1}{M}\sum_{m=1}^{N}\left\{\hat{v}_{m}^{2}-g_{m}^{2}(\hat{\alpha})\cdot\left(\hat{\sigma}^{2}-\frac{\phi(\hat{\mu}/\hat{\sigma})}{\Phi(\hat{\mu}/\hat{\sigma})}\cdot\hat{\sigma}\cdot\hat{\bar{\theta}}\right)\right\} \tag{30}$$

This provides all the information required to estimate σ_{vm}^2 using (26).[16]

Finally, in the third stage, entry efficiency scores are estimated for each market by decomposing the estimated residual into a noise component and a barrier-to-entry component using (18).

4. The market

To measure the effect of entry barriers on the number of large retail establishments it is necessary to define the relevant product and geographical market.

Since legal barriers to entry are more restrictive for large retail establishment than for medium establishments (i.e. supermarkets) and small and specialized stores (like bakeries, butchers, grocers, clotheswear shops, shoe shops, etc.), we will mainly focus our analysis on hypermarkets or shopping centers. The *Spanish Shopping Center Association* defines shopping centers as commercial units of relevant size, with a selling area usually not less than 1,500 m^2, and formed by several individual stores that do not belong to the same brand but which share a common image and a common management. Most of the shopping centers are mainly formed by hypermarkets, i.e. stores with an aggregate selling area not inferior to 2,500 m^2 belonging to a brand where a broad range of products can be acquired through one-stop shopping.

A more critical issue for our analysis is defining the geographical arena in which the large retail establishments compete with each other. In some merger cases in the retail distribution sector the EC has carried out the analysis at the national level, based mainly on the fact that most of the strategic decisions (e.g. advertising campaigns, bargaining with suppliers/producers, client fidelization strategies and selection of the range of products sold) were made at the national level. The overlapping in the catchment area of the stores also favors the nationwide approach.

However, the EC decisions state that the coverage area of a given sales location (supermarket or hypermarket) is limited: 10 to 30 driving minutes are generally mentioned as the radius of coverage of a given store (although this radius may be up to 60 km for the larger stores.[17] On the other hand, several studies have previously established a relationship between prices and concentration in the retailing sector. The fact that local concentration affects prices in many price-concentration studies is an argument in favor of a local market analysis rather than a nation-wide approach when assessing the impact of entry barriers on the number of firms.

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[16] The procedure is much more simple if we assume that θ_m follows a half-normal distribution, that is, θ_m,~$N^+(0,\sigma^2)$. In this case θ_m comes from a truncation below zero of a normal distribution with zero mean. Note that if μ=0, $\phi(\mu/\sigma)\cdot\Phi^{-1}(\mu/\sigma)=(2/\pi)^{1/2}$, $\hat{\sigma}=\hat{\bar{\theta}}\cdot(\pi/2)^{1/2}$, and $\hat{\sigma}_{\theta}^{2}=\hat{\bar{\theta}}\cdot(\hat{\bar{\theta}}\pi/2-1)$. Hence

$$\hat{\sigma}_{\varepsilon}^{2}=\frac{1}{M}\sum_{i=1}^{M}\left\{\hat{v}_{m}^{2}-g_{m}^{2}(\hat{\alpha},\hat{\beta})\cdot\left(\hat{\bar{\theta}}^{2}\cdot(\pi/2)-\hat{\bar{\theta}}\right)\right\}$$

[17] See the Promodes/Carrefour case, Alcosto/Caprabo case, and the Caprabo/Eroski case.

Most of the shopping centers in Spain are located in or around the main Spanish cities. Most of these cities are the capital of one of the 50 Spanish provinces. For a hypermarket or a shopping center, the boundaries of their market do not coincide with the boundaries of the municipalities where they are located. The reason is that in urban areas many people commute daily from their town of residence, enlarging the geographical market in which consumers shop.[18]

Given these considerations, our local markets are defined as the commercial areas formed by the municipality of one of the main Spanish cities and its surrounding municipalities.[19] On the other hand, it is important to note that these commercial areas can be viewed roughly as independent commercial markets due to the fact that the main Spanish cities (which form the main or "lead" municipality of the commercial areas) are, in general, quite far away from each other, and no other significant towns are located between them.

In order to measure the number of large retail establishments in each of these commercial areas, we follow the radius approach (or isochrones approach) used by the Competition authorities, and assume that a given store in the lead municipality of a commercial area competes directly with all other stores in the same location, and other stores placed in locations which, using the fastest road, are within less than 30 kms away from the lead of the commercial area. Since the Competition authorities mention that the radius may be up to 60 km for the larger stores and stores bordered by large rural areas, we also carry out our estimations with a broader definition of the geographical market by adding other stores which are a bit farther than 30 kms from the main city.

5. Data set

As mentioned above we explain market structure variation using demand and cost drivers to capture differences across commercial areas where retail outlets are located, in addition to an indicator of regional regulation. This section summarizes the data we used.

Most of the explanatory variables are obtained from the *Anuario Económico de España 2007*, a dataset elaborated by *La Caixa*, a Spanish savings bank.[20] This dataset includes demographic, economic and commercial information on all Spanish municipalities with more than 1000 inhabitants in January 2006. More significantly, this database also includes several variables that have been elaborated with the aim of measuring the demand for retail products in a particular municipality and in a particular commercial area. These commercial areas were defined in turn using gravity models, based on commercial flows between municipalities, and surveys filled in by the municipal authorities.

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[18] Claycombe (2000) used commuting variables to estimate a price-concentration model. He found that concentration has a strong positive correlation with furniture and clothing prices in the US Metropolitan Statistical Areas.

[19] This is the approach followed, for instance, by Manuszak and Moul (2008), and the FTC to define the relevant geographical market in the Staples/Office Depot merger case. The FTC concluded using confidential documents from the parties that metropolitan areas and regions arguably outside of a metropolitan area formed the relevant market. See also Claycombe (2000).

[20] See www.anuarieco.lacaixa.comunicacions.com/java/X?cgi=caixa.le_menuGeneral.pattern for more details on this database.

In our empirical application we analyze the determinants of retail market structure in 62 local markets, corresponding to the 62 main commercial areas defined in the *Anuario*. Given our definition of commercial areas, some local market variables refer to the main or lead municipality, while other variables refer to the overall commercial area.

To capture differences in demand size across local markets we have used LPOPCA, i.e. the population of the commercial area (measured in logs). This variable includes the population registered in January 2006 in the main municipality of the commercial area plus the population in the surrounding municipalities. We expect a positive value for the parameters associated with LPOPCA.

The number of competitors in a particular market depends on operating costs and fixed costs. Following Bresnahan and Reiss (1991) and de Juan (2006) we model these costs as a function of the characteristics of the local markets. To capture differences in retails costs across commercial areas, we have included three variables in our estimations. The first variable is the occupation rate (in percentage terms) in the main municipality, OCRATE. This variable is chosen as a proxy for labor wages and other labor expenses. Hence, we expect a negative effect of OCRATE on the number of retail outlets. The second variable is the real estate price, RESTAPR. This variable was obtained from the Spanish Ministry of Housing, and it is measured at the province level. Hence, it takes the same value for all commercial areas located in the same province. This variable is used in order to measure differences in fixed costs, so we expect a negative effect on the number of retail establishments.[21]

The variable OTHERS is the number of medium establishments (i.e. supermarkets) and small, traditional, and specialized stores (such as bakeries, butchers, grocers, clothes wear shops, shoe shops, etc.) normalized by the population located in the main municipality and it is included in order to check the one-stop vs. top-up model of shopping behavior. In accordance with this model of consumer behavior, consumers acquire the bulk of their demand in a one-stop shopping trip in large often out-of-town hypermarkets and shopping centers; they subsequently top-up with additional items that were forgotten or unexpectedly needed in small in-town supermarkets and other traditional specialized stores.[22] In this model of consumer behavior, the demand from one-stop shopping is unaffected by the demand from top-up shopping, and hence the number of large stores is independent of the number of small stores and traditional shops.[23]

[21] In order to capture the fixed costs associated with the opening of new establishments in some industries, Bresnahan and Reiss (1991) used the price of the cultivated land. De Juan (2006) also used the housing price as a proxy for the fixed cost of bank branches.

[22] Smith (2006) named these as secondary stores and defined primary stores as those where the consumer spends the greatest weekly amount. Different store formats arise because of consumer preferences and shopping habits. For the one-stop shopping trip consumers prefer a large variety of different goods and therefore prefer a large store format. For the top-up shopping, on the other hand, a small convenient store that is in close proximity is preferred. For this reason the EC view these stores as complements, rather than substitute formats.

[23] From a theoretically point of view this assumption implies that the number of small supermarkets and traditional shops has not be included as an explanatory variable in the model. From an empirical view, this assumption also implies that the number of small supermarket and traditional shops is an endogenous variable due to these firms compete over residual demand after one-stop shopping, and thus their number depends in turn on the number of large stores. Since the reduction in large stores attributed to a higher regional regulation yields an increase in the number of small stores (see the entry models we estimate for small stores), the inclusion of this endogenous variable will capture part of the negative impact of

In order to capture also differences among local markets (i.e. market heterogeneity) we have included the population density of the main municipality, POPDEN, the proportion of population living outside of the main municipality, OUTSIDE, and VEHKM, i.e. the number of vehicles divided by the extension of the main municipality (in Km^2).

As a determinant of entry costs we have included two variables associated with the barriers created by regional legislation that limit entry of new large retail establishments. In order to capture this legal entry barrier we include the retail market regulation indicator developed by Llanos and Mora (2007) as an explanatory variable. We show the level of entry barriers in each region in Table 1. The dispersion of barriers to entry across Spain's autonomous regions is high, reflecting the high degree of regional autonomy in raising barriers to entry.

[Insert Table 1 here]

Since regulation has increased over time we include both a variable measuring the regulation level in 1997, REG97, and the difference between 2007 and 1997 of this indicator, DIFREG.[24] This indicator is measured at the autonomous region level, so both REG97 and DIFREG take the same value for all commercial areas located in the same autonomous region. We expect a negative parameter for both variables. If these parameters are statistically significant we can conclude that legal entry barriers have effectively deterred the creations of new hypermarkets and shopping centers. We also expect a different effect of REG97 and DIFREG because the additional regulation might have a lower deterrence effect than previous regulation; the increase in the regulation indicator captures different entry barriers than those captured in REG97; and the effect on entry of the barriers promulgated in the last years is not completely observed.

The dependent variable in our empirical models is the number of large retail establishments, i.e. hypermarkets and shopping centers. As mentioned in the previous section, we include the stores located in and nearby the main municipality of a particular commercial area. The locations of all hypermarkets and shopping centers are obtained from the list of all the shopping centers in Spain in 2006 (*Directorio de Centros Comerciales*) included in the *Anuario* elaborated by *La Caixa*. This directory provides information on the location of each shopping center (namely the municipality and town each store belongs to), the store selling area, and other facilities.

Using the *Guía Campsa* web page (www.guiacampsa.com), we calculated the distance, using the fastest road, between each outlet located in a particular province. This allows us to count the number of establishments located in the main municipality of a particular commercial area and those located within a radius of a certain number of kilometers. We construct two dependent variables using this information. For the first dependent variable, NUM1, we used the 30 kms criteria to count the number of competitors in a commercial area.

Since competition authorities often point out that the radius may be larger than 30 kms, we have also used a second dependent variable, NUM2, in other to analyze the robustness of our results to the definition of the geographical market. We have

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regional regulation on the number of large retail stores. However, even thought parameters are likely biased, both regulation variables are still negative and statistically significant when the number of small supermarkets and traditional stores is included in the model.

[24] Llanos and Mora (2007) only provide these two values for their regulation indicator.

constructed NUM2 by adding stores which are farther than 30 kms from the main municipality of the commercial area, but given that the duration of the journey is still reasonable, they might be included in the same local market than other outlets, which are closer to the main municipality. We also added stores that, although they are located 20-30 kms from the main municipality of the commercial area, they were initially not included in NUM1 due to their geographical location cast doubts about the appropriateness of their inclusion in NUM1.[25]

Finally, we have estimated several models using the aggregate selling area of all the large retail establishments belonging to the same commercial area as the dependent variable in order to know whether the barriers to entry in the retail local markets also reduced the aggregate supply (variety) of retail products. Using the two abovementioned criteria, we have worked with the aggregate surface of shopping centers and hypermarkets, SUR1 and SUR2.

A summary of the descriptive statistics for the above variables are shown in Table 2. This table describes the demographic characteristics and market structures that we observe in our 62 local markets.

[Insert Table 2 here]

6. Results

The market structure of equation (14) was estimated using MLE for both numbers of competitors, NUM1 and NUM2, and both surfaces, SUR1 and SUR2. In the four specifications we used a half-normal distribution (i.e. we have imposed the restriction $\mu=0$) due to the existence of convergence problems, likely associated to the small size of our sample. The results are presented in Table 3.

[Insert Table 3 here]

The market structure equation (19) was also estimated using the method of moments. Again due to the existence of convergence problems this equation was estimated by imposing the restriction $\overline{\theta} = E(\theta_m) = 1$, like in Simar *et. al* (1994). The parameter estimates we have got using this method are shown in Table 4.

[Insert Table 4 here]

We arrive at similar conclusions using both the method of moments and the MLE method. The parameters estimates we have got using both methods are quite robust if the broader number of firms, NUM2 is employed as dependent variable instead of NUM1. Similar comments deserve the substitution of SUR1 by SUR2. This indicates that our geographical market definition is quite accurate and does not affect the empirical results.

[25] For instance, in Santander's commercial area, we now include two stores located in Torrelavega that before were not included because other stores belonging to the same brand are already located in Santander, and both stores in Torrelavega are located 26 kms away from Santander, while the remainder stores are located in Santander, except one store which is less than 7 kms away from Santander. For similar reasons, NUM2 includes two stores located 20-30 kms from Oviedo that, however, do not likely attract consumers from Oviedo city and surrounding municipalities because they are located in two coal mining valleys, which are far away from the main routes. On the contrary, inhabitants of these two valleys are attracted by stores located near to Oviedo.

The demand driver, LPOPCA, in all estimated models has a significant and positive effect on the number of large retail stores, indicating that market size reflected in population is clearly an important determinant of market structure (see, for instance, Manuszak and Moul, 2008). However, while an increase of 1% in population yields roughly a 0.8% increase in the number of large establishments, this increase in population yields a 1.16 increase in the surface of this store format. This indicates that the average size of large establishments increases with population.

Using both the MLE and the method of moments estimator, the occupation rate in the main municipality, OCRATE, has, as expected, a negative effect on the number of competitors in a particular market. Remember that this variable is chosen as a proxy for labor wages and other labor expenses. Hence, this result indicates that the number of stores depends on this type of costs. The effect in terms of surface is, however, not statistically significant. This might indicate that the nature of these costs is quite fixed because they do not depend on the size of the establishments. The second cost variable is the real estate price, RESTAPR. We were not able to find any negative effect because its effect on both the number of establishments and their aggregate surface is not statistically significant.

The number of small and medium establishments, OTHERS, is not statistically significant in any of the estimated models, indicating that the number of large stores is independent of the number of small stores and traditional shops. Hence, this result supports the one-stop vs. top-up hypothesis of shopping behavior that suggests that consumers acquire the bulk of their demand in a one-stop shopping trip in large hypermarkets and shopping centers, and then they top-up with additional items in other small stores.

In order to capture other differences among local markets we have included three control variables that allow us to control for market heterogeneity. The proportion of population living outside of the main municipality, OUTSIDE, has in all models a negative and significant effect on both the number of large establishments and their aggregate surface. This result might be capturing congestion costs or higher ground prices when the surroundings of the main municipality are more inhabited. The population density, POPDEN, has a positive effect on the number of large stores, but does not have a significant coefficient when we analyze the aggregate surface of large establishments. Finally, the number of vehicles per Km^2 of the main municipality, VEHKM, does not have any significant effect on both the number and the surface of large stores.

Regarding the barriers to entry variables, for each of the dependent variables used in Table 3 and Table 4 the estimations show that regional regulation in 1997 has affected the number of large establishments located in a particular local retail market.[26] That is, REG97 has a negative and statistically significant coefficient in all models, indicating that legal entry restrictions in 1997 have effectively deterred the creation of

[26] One might think that both regulation variables can be endogenous if the decision to introduce regulation depends on the presence of hypermarkets and shopping centers. However, we expect that this issue is not quite relevant in this application due to regulation variables are defined at a regional level, and each region includes several local markets. That is, unobserved demand and cost shocks that affect the number of large establishments located in a particular local market do not necessarily determine the regional regulation variables.

new hypermarkets and shopping centers.[27] The results using the selling area as dependent variable are very similar. The parameter estimates of REG97 using both the short and the broader definition of the relevant geographic market were statistically significant at the standard levels of confidence, indicating that the reduced number of large retail establishments has implied a reduction in the aggregate selling area of hypermarkets and shopping centers, reducing the variety of product offered by these establishments.

The coefficient of DIFREG is, on the other hand, also positive, but only statistically significant for the number of establishments using the method of moments estimator. In this case we can conclude that the increase of regional barriers to entry for large retail establishments promoted in the last decade by Spain's autonomous regions have also deterred the creation of new establishments. It is worthy to note that the additional regulation had, on average, a lower deterrence effect than the regulation in 1997 because the estimated coefficient of REG97 is approximately four times the estimated coefficient of DIFREG.

In summary, the above results corroborate the Spanish Competition Authority's statement that the entry of large retail establishments was effectively deterred by regional regulation. This reduced number of large retail establishments is likely to have harmed consumers' welfare due to the reduced variety of retail products and the higher prices they probably pay for the products they purchase from nearby hypermarkets compared to those they would have paid with free entry.

Once we have examined the estimated coefficients of the market structure equation, entry efficiency scores can be estimated for each market by decomposing the estimated residual into a noise component and a barriers-to-entry component. For the MLE estimates we apply the Jondrow *et al.* formula using the parameter estimates of Table 3. Regarding the method of moments, we show in Table 5 the second stage estimates, assuming that the barriers-to-entry term θ_m follows a half-normal distribution (i.e. assuming μ=0) or a truncated-normal distribution. The calculated variances of the pre and post-truncated barriers-to-entry random term and the overall variance are positive, as expected. However, we have got a negative value for the variance of the random noise, which is obtained residually. This result, which is likely a consequence of imposing the restriction $\overline{\theta} = E(\theta_m) = 1$, precludes us to calculate market-specific entry efficiency scores using the method of moments approach.

The MLE entry efficiency scores classified by regions are showed in Table 6.

[Insert Table 6 here]

Figures 3 and 4 suggest that scores are quite robust if a broader or a short market definition is used, indicating that our geographical market definition does not affect the magnitude of the entry efficiency scores.

[Insert Figure 3 here]

[Insert Figure 4 here]

[27] Note that entry barriers enter in the equation with a negative sign. Hence a positive coefficient indicates that any regulation variable has a negative effect on the number of establishments or in their aggregate selling area.

The average efficiency scores using both numbers of competitors, NUM1 and NUM2, is about 75%. The regions with the highest entry efficiency scores using NUM1 are Madrid, Castilla-La Mancha and Cantabria, with scores close to or higher than 80%. On the other hand, the regions with the lowest entry efficiency scores are Cataluña, Canary Islands and Valencia with scores between 65% and 70%. The average efficiency score descends to 71% when we use the selling area, i.e. SUR1 and SUR2, indicating that barriers to entry in the retail local markets have a special effect on the aggregate supply (variety) of retail products, measured by the establishments' selling area. It is worthy to note that Figure 5 suggests that both efficiency scores (i.e. using the number of competitors and their aggregated selling area) are positively related, but there are also important differences in some of the local markets.

[Insert Figure 5 here]

In Table 7 we decompose the average entry efficiency scores into two components using the following expression:

$$\ln E_m = [g(\alpha) - g_{\min}(\alpha)] \cdot \ln E_m^* + g_{\min}(\alpha) \cdot \ln E_m^* \quad , \quad \ln E_m^* = -\theta_m \qquad (31)$$

The first term measures the effect of (observed) legal barriers to entry created by regional governments. This component is defined in relative terms in the sense that it collapses to zero when the level of legal regulation is time-invariant and equal to the minimum level of legal barriers in 1997. The second component measures the effect of unobserved barriers to entry that we can partially attribute to the degree this entry legislation is enforced by local (i.e. municipality) governments.

The average efficiency scores attributed to legal legislation is less than 90% using NUM1 and NUM2. This indicates that regional regulation has decreases the number of large establishment in the local markets more than a 10%. The average efficiency scores attributed to enforcement or other unobserved barriers to entry is less than those obtained for legal legislation. This suggests that enforcement or other unobserved barriers to entry explain more than half of the estimated reduction in the number of large establishments.

In Figure 6 we show the efficiency scores we have got for each local market, grouped by regions. The dispersion of the efficiency scores is often high within a particular region, indicating that there are significant within-differences in entry costs among local markets and, hence, that a regional approach is not appropriate when measuring entry costs and barriers to entry. On the other hand, since the observed barriers to entry are constructed at regional levels, the differences in a particular region reflect differences in unobserved barriers to entry or differences in enforcement of regional entry restrictions by local governments. This figure might suggest that regional legal entry restrictions were enforced with differences degrees in each local market, and that in some local markets differences in enforcement have notably aggravated the entry restrictions imposed by regional legislators.

[Insert Figure 6 here]

The average efficiency score attributed to legal legislation descends to 78% when we use the selling area. Unlike the results we got using the number of establishments, the average efficiency scores in terms of surface attributed to enforcement or other unobserved barriers to entry is quite high. This outcome indicates that most of the estimated reduction in the large establishments' selling area is explained by legal retail legislation and that local enforcement has aggravated moderately the already established regional entry restrictions.

7. Conclusions

Recent studies have shown that barriers to entry for large retail establishments promoted by Spain's autonomous regions have been increased in the last decade. In this study we try to test whether the entry of large retail establishments was effectively limited by regional regulation, and whether a regional approach is appropriate when measuring entry costs and barriers to entry.

We have found that entry cost have decreased the number of large establishments in a 25%. This percentage increases up to 29% if we use aggregate selling area as a dependent variable. Since most of this inefficiency is explained by legal retail legislation, our results corroborate the Spanish Competition Authority's statement that the entry of large retail establishments was effectively deterred by regional regulation. In addition, we have found that the entry restrictions imposed by regional legislators were enforced with differences degrees in each local market. The notable within-region dispersion of the estimated efficiency scores suggests the existence of significant differences in entry costs among local markets, suggesting in turn not using a regional approaches to analyze entry cost and barriers to entry in the Spanish retail industry.

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Table 1. Retail market regulation level by region

Region	1997	2007	Rate of growth (%)
Andalucía	35	53	51.4
Aragón	41	56	36.6
Asturias	35	62	77.1
Baleares	40	51	27.5
Canarias	45	56	24.4
Cantabria	33	47	42.4
Castilla y León	38	51	34.2
Castilla-La Mancha	33	41	24.2
Cataluña	41	54	31.7
Comunidad Valenciana	46	44	-4.3
Extremadura	33	58	75.8
Galicia	41	33	-19.5
Madrid	32	42	31.3
Murcia	35	53	51.4
Navarra	39	63	61.5
Rioja	40	38	-5.0

Source: Llanos and Mora (2007)
Note: They do not provide the score for País Vasco due to its inclusion made the factorial analysis worse, and changed significantly the other scores.

Table 2. Descriptive statistics

Variable	Mean	Std	Min	Max
NUM1	6	14	1	105
NUM2	7	15	1	119
SUR1	138408	306648	5982	2291109
SUR2	151674	348873	5982	2608252
REG97	37.7	3.9	32.0	46.0
DIFREG	11.8	9.7	-8.0	27.0
LPOPCA	13.0523	0.9099	11.4029	15.7472
OCRATE	85.3	4.9	71.6	92.3
RESTAPR	222.0	109.2	66.2	488.7
OUTSIDE	66.2	9.8	38.4	87.6
OTHERS	21.4	4.6	10.2	30.9
POPDEN	0.113	0.135	0.009	0.749
VEHKM	1.14	1.58	0.03	9.38

Table 3. MLE estimates

Dependent variable:	NUM1		NUM2		SUR1		SUR2	
Parameters	Estimates	Est./s.e.	Estimates	Est./s.e.	Estimates	Est./s.e.	Estimates	Est./s.e.
CONST	1.675	23.022	1.755	23.887	11.384	93.367	11.429	95.492
LPOPCA	0.796	10.710	0.774	10.728	1.167	11.205	1.165	11.890
OCRATE	-0.019	-1.689	-0.022	-2.109	-0.005	-0.342	-0.009	-0.555
RESTAPR	-0.001	-1.271	0.000	-0.589	0.000	0.078	0.000	0.371
OUTSIDE	-0.025	-4.281	-0.021	-4.039	-0.040	-5.606	-0.037	-5.256
OTHERS	0.006	0.499	0.007	0.564	0.017	0.935	0.018	0.983
POPDEN	1.505	2.911	1.621	3.151	-0.107	-0.142	0.007	0.019
VEHKM	0.007	0.155	0.013	0.305	0.036	0.629	0.036	0.664
REG97	0.061	1.532	0.097	2.334	0.111	1.623	0.131	1.825
DIFREG	0.009	0.645	0.008	0.593	0.040	1.426	0.042	1.459
σ	0.548	7.156	0.524	6.962	0.556	5.507	0.546	5.599
$\lambda = \sigma / \sigma_{\varepsilon}$	2.834	2.219	2.753	2.274	1.254	2.029	1.168	2.051
lnLF/obs	-0.366		-0.336		-0.609		-0.614	
Observations	62		62		62		62	

Table 4. First stage Method of Moments estimates

Dependent variable:	NUM1		NUM2		SUR1		SUR2	
Parameters	Estimates	Est./s.e.	Estimates	Est./s.e.	Estimates	Est./s.e.	Estimates	Est./s.e.
CONST	2.269	49.410	2.353	52.537	12.028	203.041	12.085	203.225
LPOPCA	0.786	9.917	0.787	10.205	1.165	11.386	1.159	11.320
OCRATE	-0.032	-2.599	-0.037	-3.084	-0.014	-0.909	-0.017	-1.104
RESTAPR	0.000	-0.263	0.000	-0.083	0.000	-0.123	0.000	0.102
OUTSIDE	-0.032	-5.684	-0.028	-5.166	-0.041	-5.619	-0.038	-5.267
OTHERS	0.010	0.649	0.011	0.767	0.018	0.916	0.020	1.009
POPDEN	1.015	1.633	1.189	1.970	0.047	0.059	0.246	0.307
VEHKM	0.028	0.640	0.031	0.735	0.035	0.621	0.035	0.630
REG97	0.030	1.964	0.042	2.962	0.031	1.596	0.040	2.129
DIFREG	0.012	1.853	0.011	1.795	0.012	1.401	0.012	1.415
Observations	62		62		62		62	

Table 5. Second stage Method of Moments estimates

Dependent variable:	**NUM1**		**NUM2**		**SUR1**		**SUR2**	
Parameters	HN	TN	HN	TN	HN	TN	HN	TN
μ	(0)	0.959	(0)	0.967	(0)	0.949	(0)	0.954
σ	1.253	0.524	1.253	0.506	1.253	0.548	1.253	0.536
σ_{θ}^{2}	0.571	0.234	0.571	0.222	0.571	0.249	0.571	0.242
$\sigma_{vm}^{2} = E(v_m^2)$	0.129	0.129	0.122	0.122	0.215	0.215	0.215	0.215
$\sigma_{\varepsilon}^{2} = \sigma_{vm}^{2} - g_m^2(\alpha)\cdot\sigma_{\theta}^{2}$	-0.455	-0.111	-0.471	-0.109	-0.370	-0.040	-0.376	-0.035

Notes: HN=Half-normal; TN=Truncated Normal

Table 6. Entry efficiency scores by regions

Region	NUM1	NUM2	SUR1	SUR2
Andalucía	77.20	79.59	72.77	73.75
Aragón	70.08	68.11	59.46	58.65
Asturias	77.19	79.30	73.18	73.85
Baleares	74.69	73.25	69.84	68.93
Canarias	66.61	60.79	62.12	59.71
Cantabria	79.51	83.72	80.40	82.31
Castilla-León	75.14	74.98	70.08	69.84
Castilla-La Mancha	81.88	84.29	83.32	84.59
Cataluña	65.80	61.86	52.92	50.92
Comunidad Valenciana	70.07	63.92	67.26	64.18
Extremadura	78.08	81.60	67.46	69.90
Galicia	75.00	72.51	78.86	78.27
Madrid	82.60	85.22	83.06	84.48
Murcia	77.68	79.35	70.91	71.56
Navarra	74.27	73.56	64.54	64.03
La Rioja	72.14	69.52	78.04	77.40
All regions	75.10	74.93	71.01	70.99

Table 7. Entry efficiency decomposition

	NUM1	NUM2	SUR1	SUR2
Overall Ineficiency	75.1	74.9	71.0	71.0
Legal legislation	89.9	86.8	79.3	78.1
Enforcement	83.5	86.3	89.4	90.7

Figure 1. Number of establishments and market size

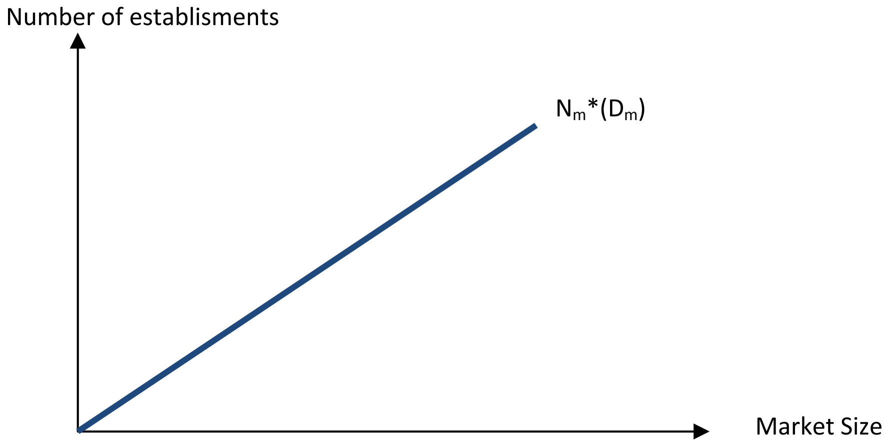


Figure 2. Observed and frontier number of establishments

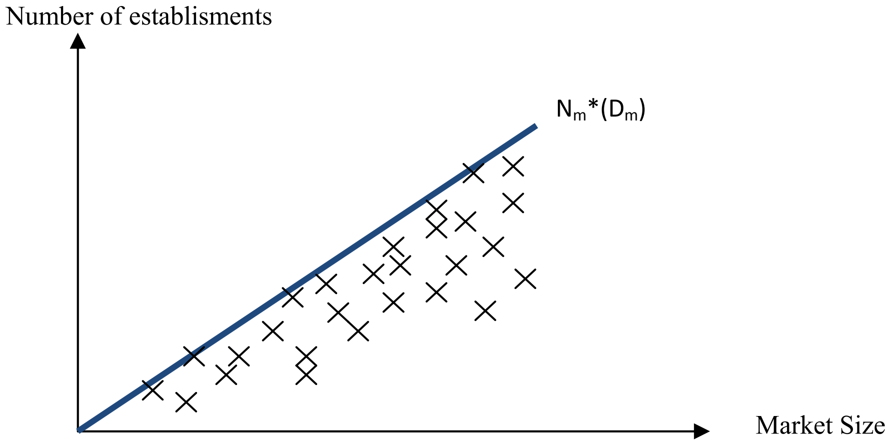


Figure 3. NUM efficiency scores

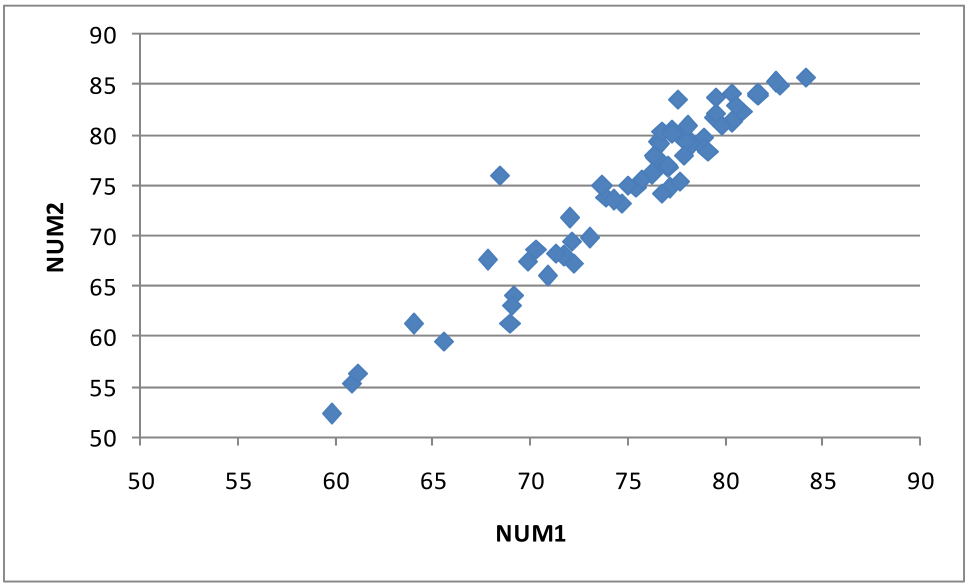


Figure 4. SUR efficiency scores

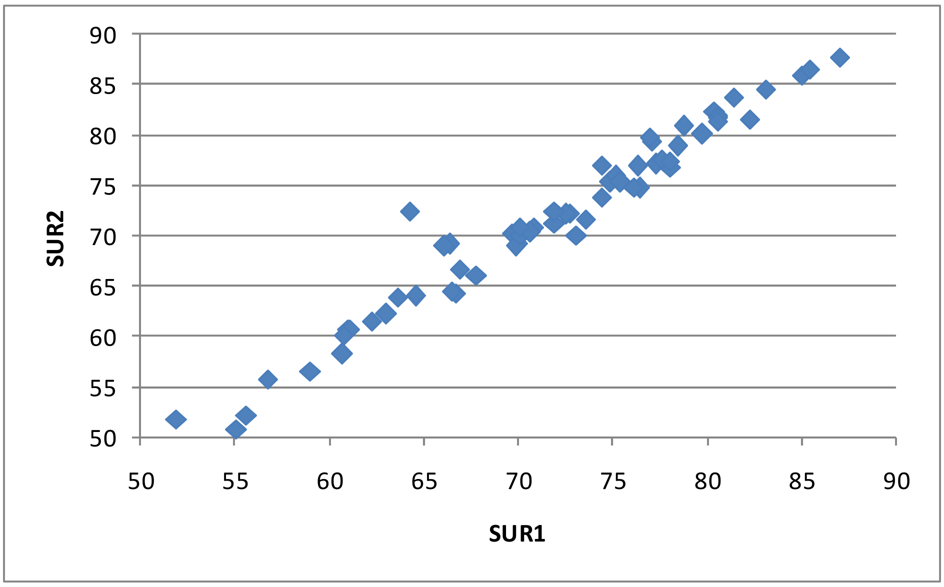
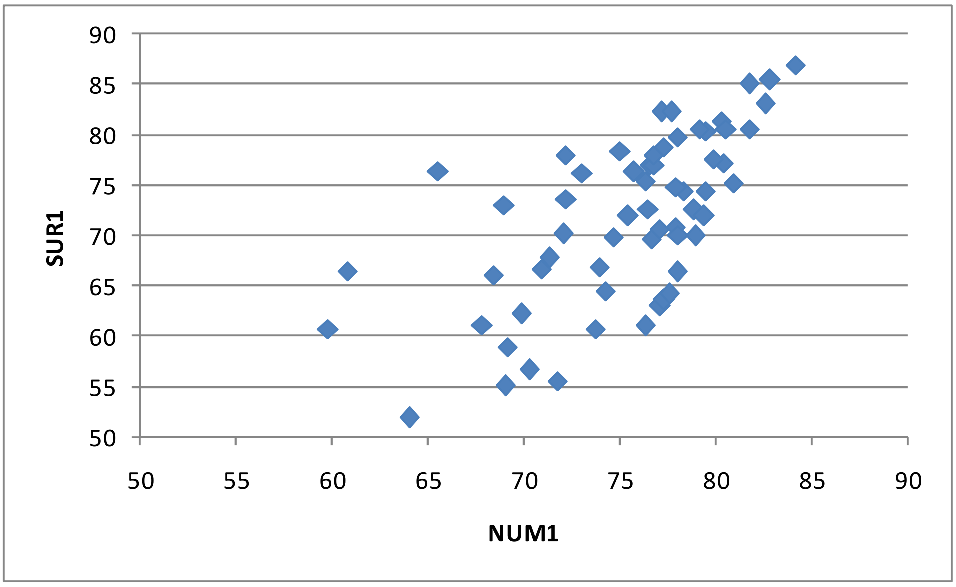


Figure 5. NUM vs. SUR efficiency scores



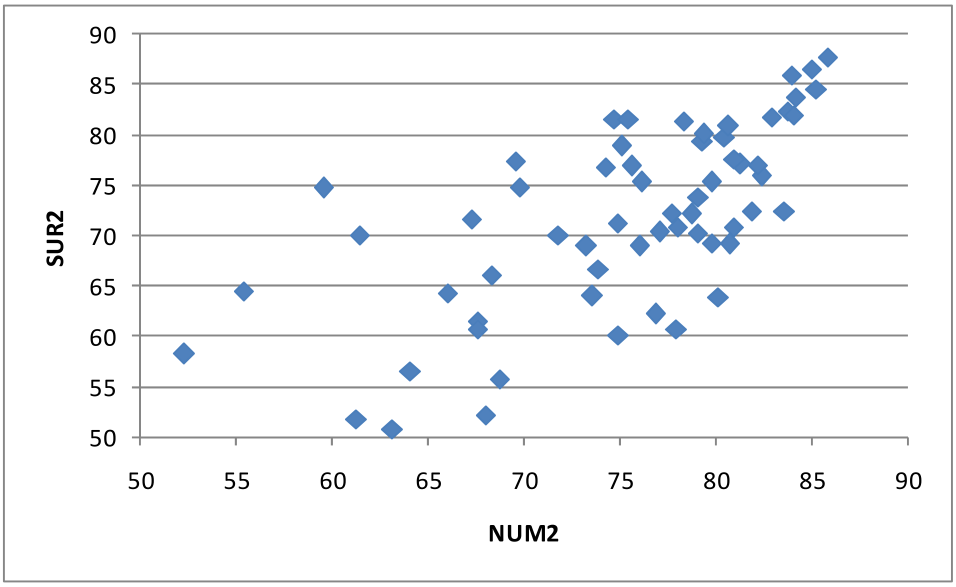
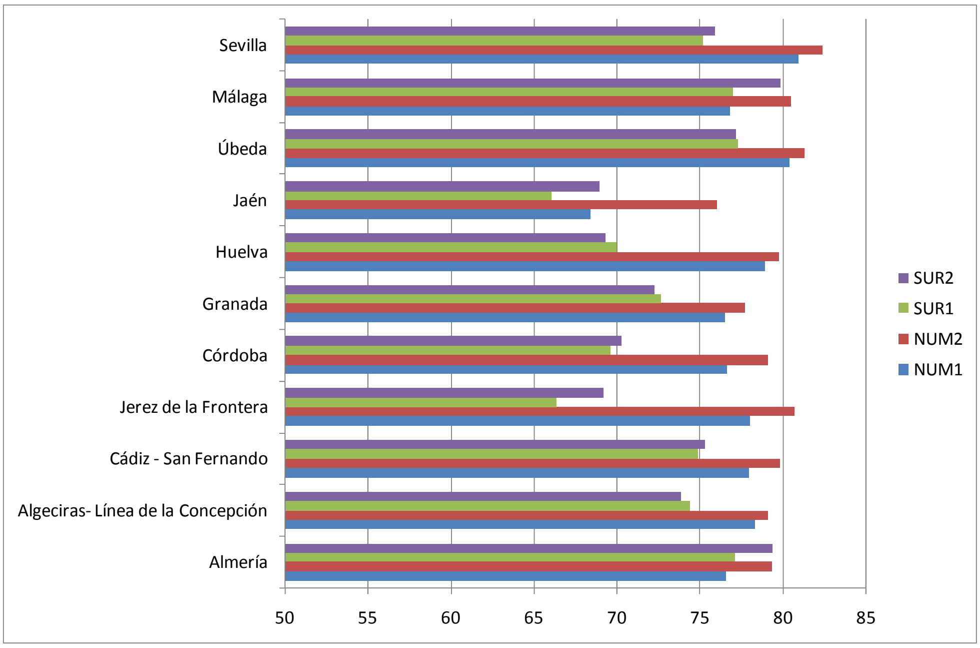
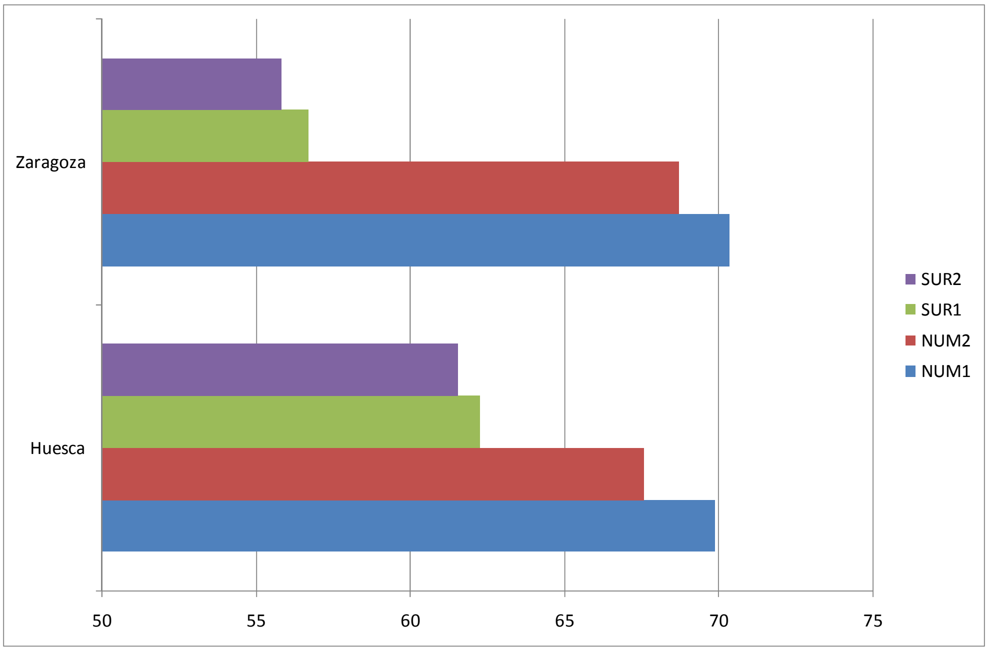


Figure 6. Market-specific entry efficiency scores

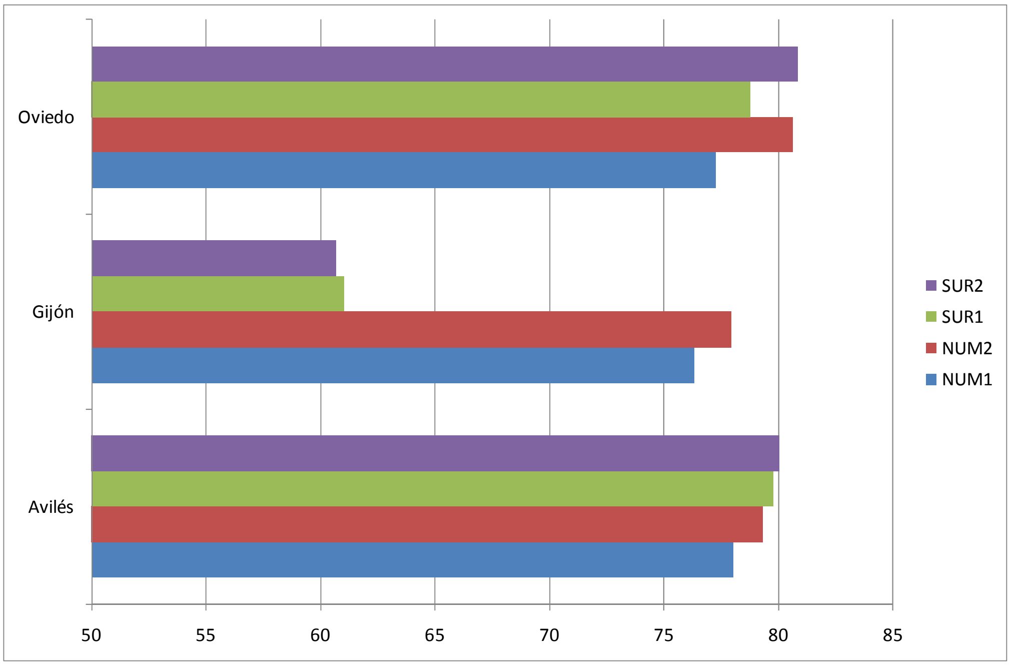
Andalucía



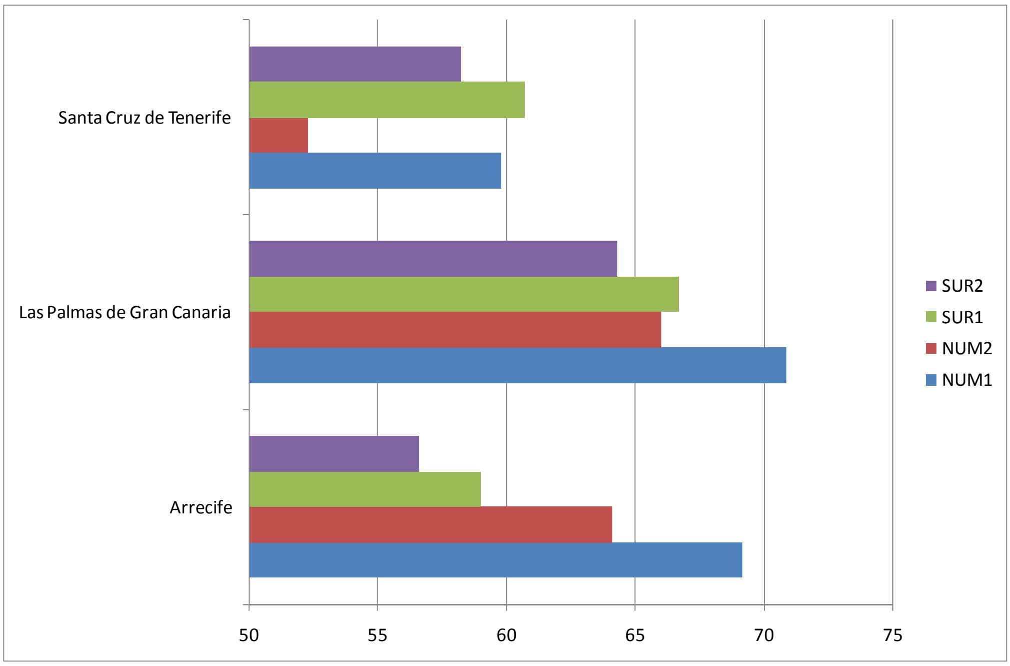
Aragón



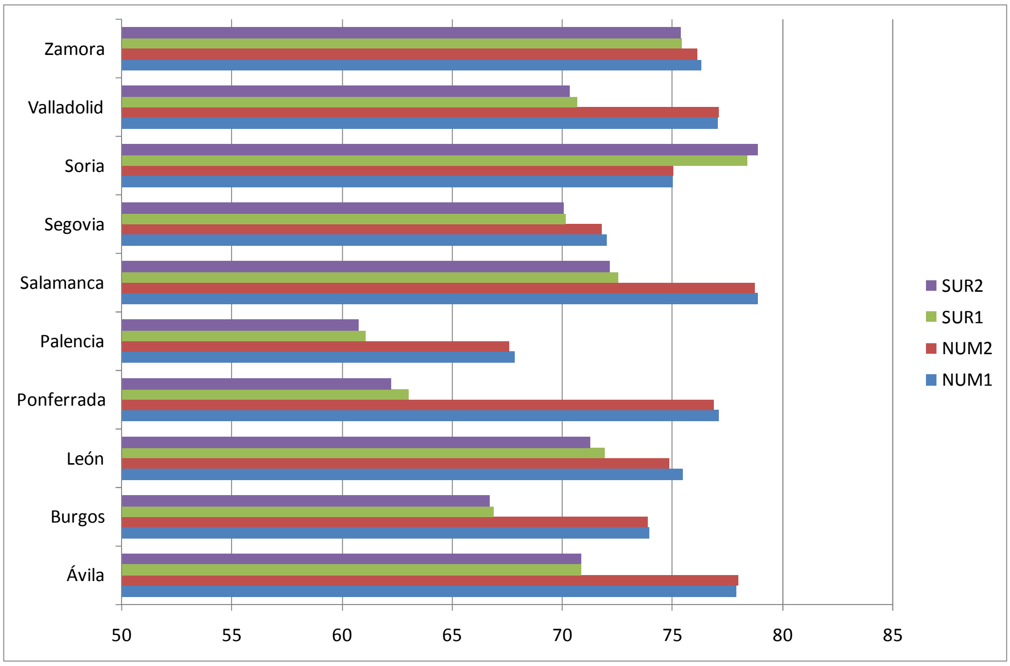
Asturias



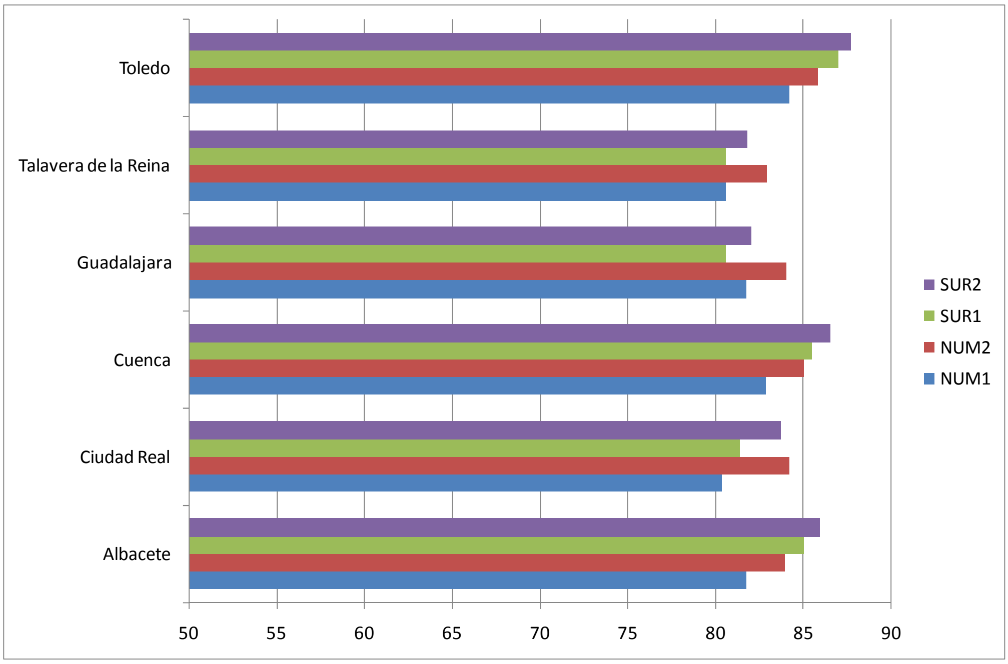
Canarias



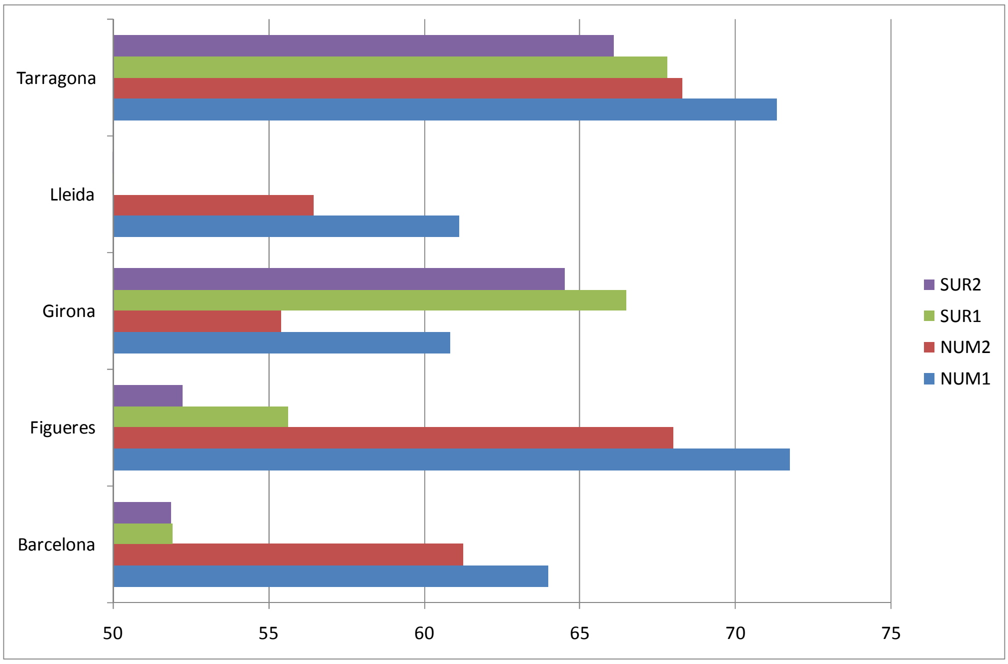
Castilla-León



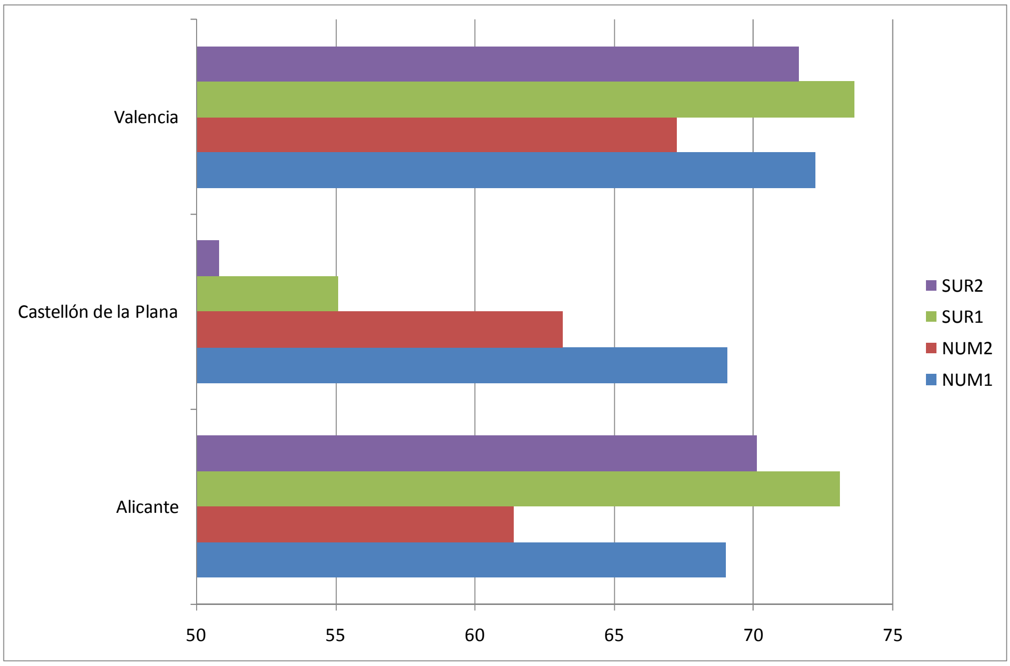
Castilla-La Mancha



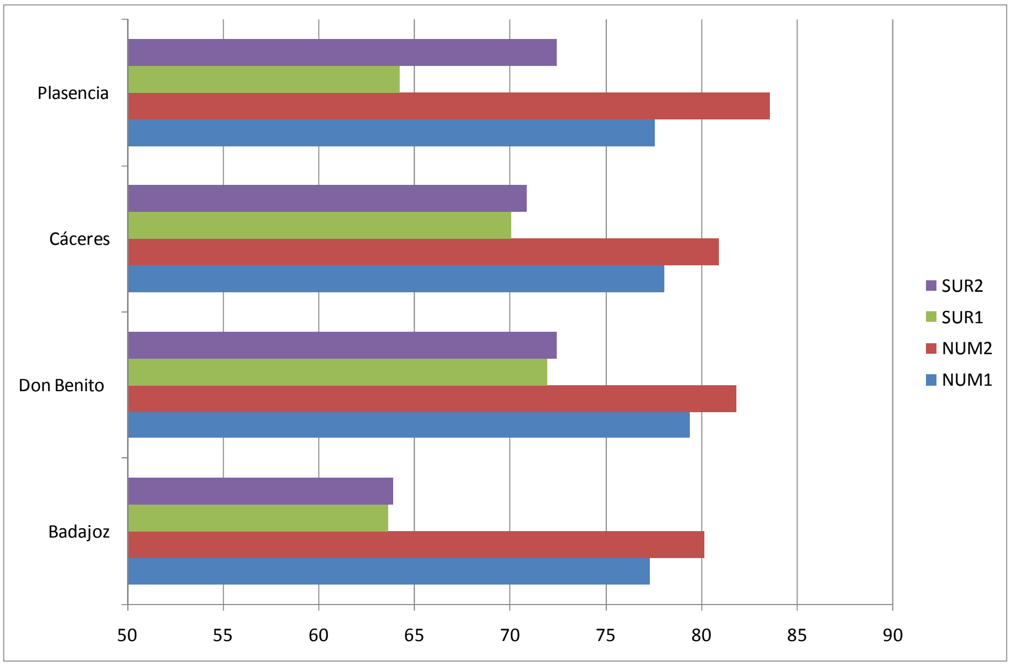
Cataluña



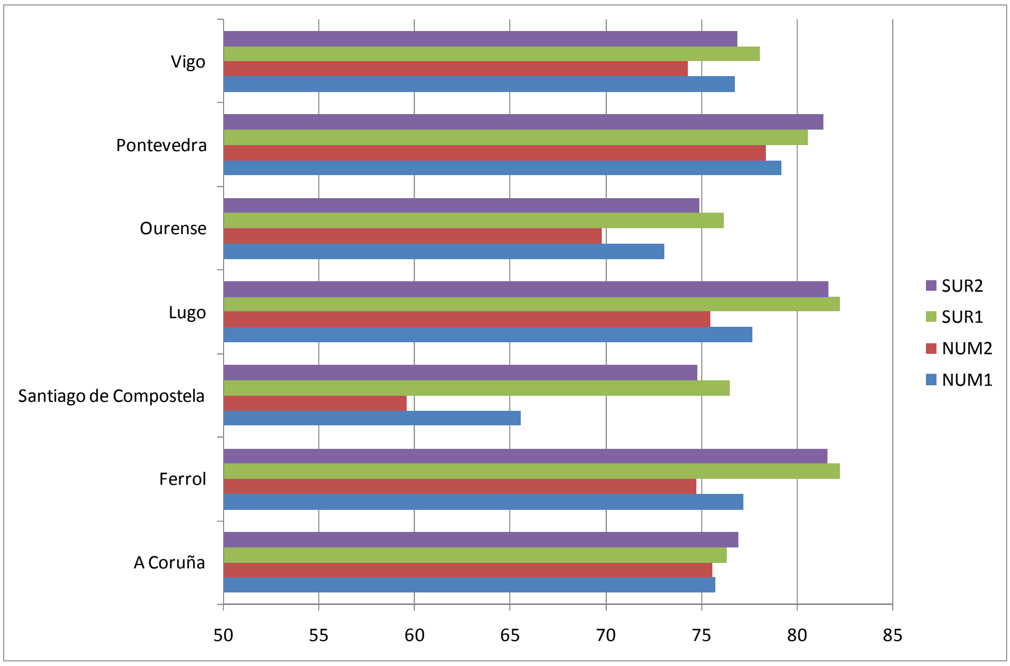
Comunidad Valenciana



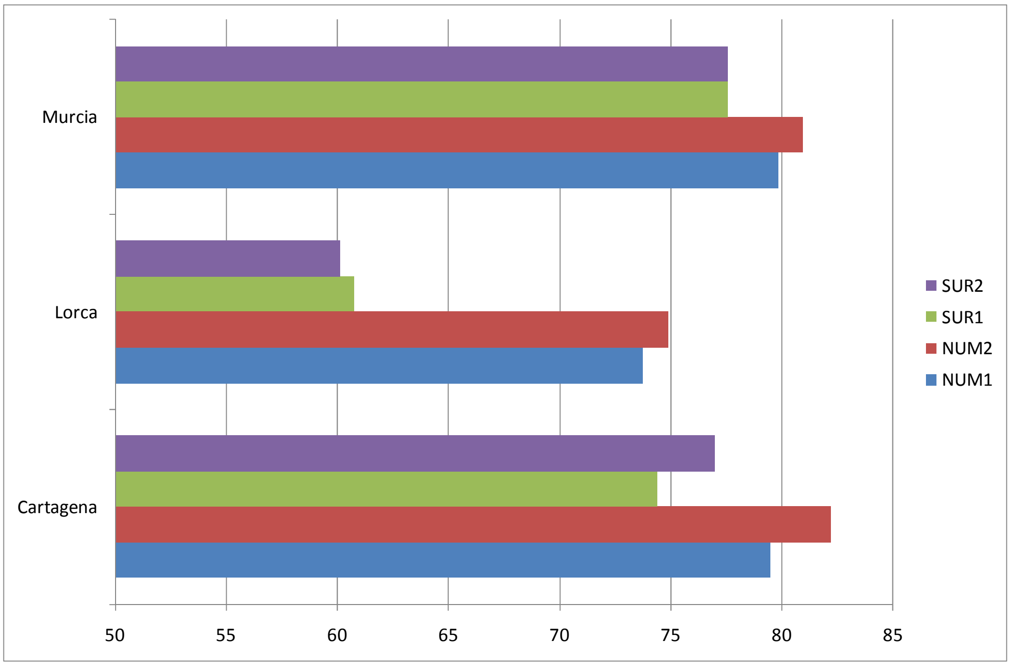
Extremadura



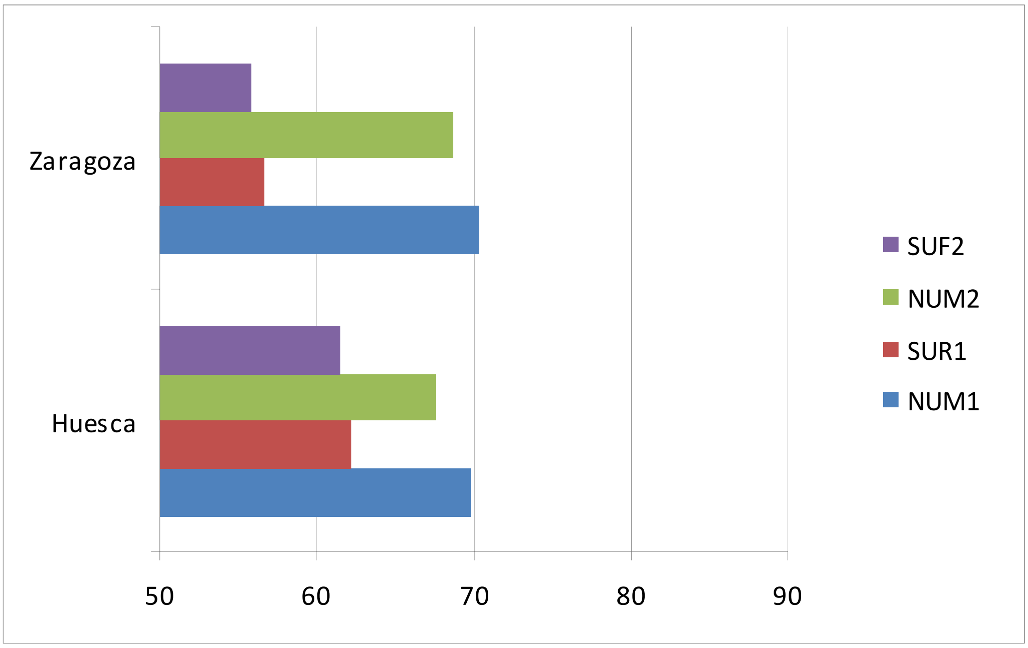
Galicia



Murcia



Zaragoza



Other local markets