



Efficiency determinants in retail stores: a Bayesian framework

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ABSTRACT

This paper analyzes the impact of vertical integration, age, geographic expansion, and low price strategy on the cost efficiency of retail stores. We test our hypotheses using the innovative Bayesian frontier methodology. The data involve a sample of Spanish retail stores that operate in a highly competitive and dynamic environment. From the results, it is clear that cost efficiency is higher for stores that have: longer years in business, stronger geographical presence, and lower price offerings. Vertical integration, on the other hand, is negatively related to efficiency. Further discussions of these findings and related managerial implications are provided in the paper.

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1. Introduction

The level of competition in the retail industry has intensified in recent years, driven by several factors such as the decline in household wealth, rising unemployment, tight credit conditions, rapid globalization, unclear economic picture, drop in consumers' confidence index, and increase in merger and acquisition activity. In fact, it is very common today to find several retail stores competing for a slice of market pie that rarely varies in size and often saturated. Consumers have also become extremely price conscious, especially as retailers constantly fight for each dollar by offering substitutable products at lower prices [1,2]. Weekly specials including catalogues and additional marketing are also used intensely to attract consumers and drive sales. While the winner of this price war is the consumer, retailers have to survive with lower profit margin which necessitates a stricter control of productivity and a decrease of operational wastages, especially as the industry is traditionally known to be labour intensive.

In the retail literature, the need for higher productivity has also been highlighted as one of the key issues for future survival. Numerous studies have recently appeared, addressing the performance challenges of several retail markets, such as Portugal, the US, and France [1–4]. The key message from most of these studies is that efficiency measurement is of vital concern at both the store level and the strategic level, since it helps

retailers differentiate themselves from other competitors. Studies dealing with some store-specific characteristics that affect retail performance have also appeared in the literature.

Within the growing importance of performance measurements in retail, more advanced methodologies have also been introduced. In contrast to the traditional literature where simple ratios were the most adopted productivity methods, significant volume of work currently exists in the area of measuring production efficiency by estimating an “efficient frontier” that serves as a benchmark for evaluating performance. The most adopted methods for that purpose include the stochastic frontier (SF) and data envelopment analysis (DEA) methods [5–9]. The advantage of both these methods is that they allow the use of multiple inputs and outputs in the measurement of performance, making them thus more suitable in the retail context. Although the DEA method is a nonparametric, deterministic approach that defines a relationship between multiple spending inputs and outputs by building an efficient frontier, it has been critiqued for not providing fit statistics such as *r*-square or *p*-value that can be used for statistical inferences [10]. The SF method, on the other hand, uses a parametric approach by explicitly taking into account the stochastic properties of the data [1,19].

The aim of this study is driven by all of the above, and the motivation is to extend the existing literature by offering more accurate insights into the performance determinants of retail stores. Specifically, the study focuses on analyzing on the supermarket industry, which is traditionally known to be very competitive. Most supermarkets operate on a high inventory turnover usually with low profit margins, which suggests that retail mark up for each individual product is very low. In most

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countries, supermarkets compete against national, regional, local and independent supermarkets, specialty food stores, club stores, drug stores, convenience stores, discount merchandisers, and other local retailers. They compete on the basis of price, store location, product mix or types of products and brands and services. The industry's small mark up price format indicates that price is extremely significant. In other words, supermarkets rely on low mark up and high sales volumes as opposed to higher mark up and lower volume of sales. In this context, efficiency analysis constitute a useful and interesting tool to improve the profitability of supermarket chains.

Most existing studies in the literature have generally focused on the estimation of efficiency without providing an in-depth analysis to the factors that lead to efficiency variations between retail stores. The sole focus on efficiency makes the study also limited to one sample or one geographic area of analysis. However, as this study focuses on identifying the sources of efficiency, the results can be more applicable to other retail sectors, or even to the same retail sector in other countries. The methodology used in this study also provides an innovation to the existing literature. For the first time, we use the Bayesian methodology that has several advantages over the maximum likelihood (ML) traditionally used to estimate the SF approach. For instance a key advantage of the Bayesian approach is that it allows the inclusion of "prior" information about parameters in inferences. With Bayesian, the results are also usually presented in terms of probability density function (pdfs), making it thus possible to make probability statements about the model parameters.

In testing our hypotheses we use a sample of Spanish retail supermarkets. There are several interesting characteristics of the Spanish retail market that allow us to test our desired hypotheses. In the next section we provide a brief overview of the Spanish retail market. This is followed by the literature review, methodology, data characteristics/hypotheses, discussions, and concluding remarks.

2. Contextual setting

In recent years, the Spanish supermarket industry has been characterized by a series of changes that have affected its structure and performance [11]. Among them, four critical factors deserve special attention.

First, the significant growth of self-service establishments in comparison to traditional stores [12]. Specifically, supermarket chains have become one of the main players in grocery retailing in almost every Spanish city [13] and, in recent years, have earned significant market shares from traditional stores and hypermarkets. In 2007, for instance, supermarkets covered more than of the 73% market share for food products, with the leading supermarket chain –*Mercadona*– having more than 1000 supermarkets. Furthermore, traditional hypermarket operators have developed the supermarket format—for example, *Auchan* (*Alcampo* in Spain) with *Sabeco* Supermarkets; *Carrefour* with *Carrefour Express*; similarly with distribution groups—for example *El Corte Inglés* with *Supercor*.

Second, the Spanish supermarket industry has been characterized in recent years by an increase in market concentration [14,15]. This increase has been the consequence of the growing size of companies, which has been used to gain stronger market power on both sides of the distribution channel. First, in terms of consumers, there could be a negative impact on prices [14] and, second, the relationship between manufacturers and retailers has become more asymmetric. As an example, the market share of the five leading companies (by selling area) has grown from 42.95% in

2001 to 59% in 2007, whereas the participation of the first 10 companies has grown from 62.64% to 74% in 2007. To be precise, companies with the greatest market share in 2007 are the French company *Carrefour*, and the Spanish companies *Mercadona* and *Grupo Eroski*.

Third, it is important to stress the significant increase in inter-type competition among different commercial formats [16]. Although the differences between the services provided by various intermediaries justify the coexistence of several commercial formats (e.g. convenience stores or supermarket chains) [17], the relevant markets of the different commercial formulas in Spain are overlapped as consumers use different formats depending on the type of purchase. This implies strong complementarity and substitutability relationships among commercial formats. It also leads both establishment types to provide the same type of products and to be considered by consumers as competitive alternatives.

Finally, it is also important to highlight the progressive incorporation of new commercial techniques, especially new information and communication technologies (ICTs). These technologies have mainly been introduced by foreign firms operating in Spain (e.g. *Carrefour*) and supported by the continual proliferation of retail associations. The implantation of technological and management innovations (e.g. scanner systems, EDI, ECR, Rack Jobbing, DPP) as sources of competitive advantage towards better customer satisfaction should be particularly stressed. ICTs have changed the production and management structures of supermarkets, allowing more and more complicated real time operations, more efficient stock management as well as the development of new products and services, favouring productivity improvements [18].

3. Literature review

There are two competing scientific methods to analyze efficiency: the stochastic frontier (SF) and the DEA. Several papers exist in the retailing literature using either of these methods or a combination of two. In Table 1, we summarize these papers presenting the models and the inputs and outputs used.

We can observe that most authors have used the DEA method and that there are only few papers using the econometric models. Sellers and Mas [19] estimated a production function of Spanish retailers and compared it with the DEA models. Another European application includes Barros [1] who used a DEA model to analyze the efficiency of Portuguese retail outlets. Productivity at an aggregate level has been analyzed in the USA by Ratchford [2]. The author used a cost function with the associated share equation and concluded that the industry registered a modest degree of growth in total productivity between 1959 and 1995. Betancourt and Malanoski [20] explored the growth in specific types of services offered by a sample of US supermarkets with an econometric simultaneous model. They concluded that there are evidences of constant returns to scale in either output or turnover, but increasing returns to scale with respect to the provision of distribution services. Ofer [21] also found substantial economies of scale in the Israeli retail sector and Oi [22] underlined a positive association between store size and transaction size. The provision of broader and deeper assortments is the reason for larger store size and also the source of scale economies [23].

This brief literature review shows that there are no published papers analyzing the efficiency of supermarket companies with the use of the Bayesian approach. Most studies have adopted the DEA method that suffers from statistical limitations. More importantly, most available studies have focused the analysis on the efficiency of retail stores without providing an in-depth

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