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The effect of geographic expansion on the productivity of Spanish savings banks*

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Abstract

This article analyzes the effects of geographic expansion of Spanish savings banks on productivity. The study is performed using data from 1992 to 2001, as this is the period when most savings banks expanded geographically. In order to do this, we consider an alternative approach to most multi-stage studies, which use nonparametric methods both to measure productivity growth and to analyze its relationship with branch office expansion. Specifically, we use nonparametric regression techniques and their natural complement, conditional density estimation, which have not been much used by economists. The results—within a context of generalized productivity gains, primarily stemming from shifting the efficiency frontier—indicate that savings banks that expand geographically outside their natural markets experience greater productivity gains. In contrast, those expanding on a nationwide basis, or those that confine their territorial expansions to their traditional markets only experience smaller productivity growth.

Key words: conditional density estimation, geographic expansion, Malmquist productivity index, nonparametric regression, savings bank.

JEL Classification: C14, C30, C61, G21, L5

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1. Introduction

Since 1985, most Western European banking sectors have gone through a turbulent process, characterized mainly by deregulation and liberalization, with many similarities to the wave of changes affecting the U.S. banking industry (see Berger *et al.*, 1995). Since banking industries in Europe faced varying types and degrees of regulation, the deregulation initiatives also differed markedly, and affected firms differently, provoking dissimilar reactions.

Our case, that of Spanish savings banks, constitutes a clear example of a group of banking firms that have shifted from a situation of restrictive regulation, to having to face the intense deregulation that has virtually put them on a par with private commercial banks. These combined factors underline the relevance of study into this area. As an institutional group, not only have savings banks traditionally been subject to higher levels of regulation (in relative terms) than commercial banks, but also Spain's banking industry was originally one of the most heavily regulated in Europe, and consequently has had to go through more intense deregulatory change than its European partners. At present, and as a consequence of deregulation, Spanish savings banks are faced with the same operational regulations as the two other types of existing institutions in Spain—namely, private commercial banks and credit cooperatives. In fact, the only differences that still persist are more closely related to type of ownership.

One of the most transcendent deregulatory initiatives affecting savings banks concerns the removal in 1989 of the restriction that prevented them from branching outside their territory of origin.[1] The consequence of this restriction was that savings banks concentrated their branching networks within their respective regions of origin. Fifteen years after this restriction was lifted there is still a high concentration of branches in their respective territories of origin; however, many savings banks (especially, but not exclusively, the largest) have designed expansive strategies so as to widen their branching networks with the aim of diversifying their territorial network and/or entering new markets. On the other hand, some other savings banks have adopted expansive strategies in their traditional markets. In any case, the convenience or not of one strategy or another in terms of their effects on the efficiency and productivity of banking firms is currently worthy of assessment, now that we have an historical perspective of more than fifteen years.

There are obvious parallels between this deregulatory process and events in the U.S. banking industry following the enactment of the so-called *Riegle-Neal Act* that allowed U.S. banks to branch into states other than those of origin. Several studies analyze the effects of geographic expansion of U.S. banks after this elimination on several aspects of their operational performance: efficiency, productivity, effects on competition, margins, profitability, etc. However, the issue has been explored less intensively in the European context and, more specifically, in the Spanish case which, moreover, offers close similarities to the U.S. case. Indeed, the current dynamism of Spanish savings banks is not only apparent in the geographic expansion policies many of them are taking up, but in many other fields of their operations. For this reason they are generating a great deal of interest, not only in the academic community in

[1] Some exceptions due to historical reasons include Ibercaja in La Rioja, Bancaja in Albacete, or La Caixa in Balears.

general[2] but also in national and international economic and financial press.[3] There is, however, a key difference between the erosion of laws limiting the geographic scope of bank organizations that occurred in the US banking system and that in Spain, namely, restrictions on the equivalent to *intra*state branching in the US were almost nonexistent in Spain.

The lifting of restrictions on the geographic scope of Spanish savings banks may reshape the industry in several ways. Some related research, focused primarily on the U.S. banking industry, has concentrated on the impact on efficiency in commercial banking organizations. Although the effects of deregulation will only be revealed over time, some early results suggest that by preventing the more efficient banks from expanding at the expense of more efficient rivals, the restrictions retarded the "natural" evolution of the banking industry (Jayaratne and Strahan, 1999). Yet even early studies are still awaited for the Spanish case, despite the wishes of banking interests, policymakers, and financial economists to ascertain what the effects of geographic expansion on interbank rivalry and banking market efficiency might have been, or might be.

However, our study does not limit the interest to efficiency, but broadens it out to investigate the extent to which the frontier shifted during the sample period. We follow the contributions of Färe *et al.* (1994), among others, who considered a decomposition of productivity growth into its catching up and technical change components. Therefore, the rationale for the first part of our work is similar to that of Wheelock and Wilson (1999), who found that much of the inefficiency increase in the U.S. banking industry between 1984 and 1993 was attributable to the general failure by most banks to adopt the technological improvements made by a few that shifted the efficient frontier.

Some of the existing studies on efficiency in general and, closer to the point of our study, productivity in the Spanish banking industry, are those by Pastor (1995), Grifell-Tatjé and Lovell (1996, 1997) or, more recently, Kumbhakar *et al.* (2001). Their objectives partly coincide with those tackled here. However, they do not specifically analyze the direct link between territorial expansion and productivity gains, but deal with the general effects of deregulation on the productivity of Spanish savings banks.

In addition, there are also substantial methodological differences between our study and the existing literature, primarily attributable to the use of nonparametric techniques in the second-stage estimation of our study which overcome some of the drawbacks related to the models considered in the two-stage traditional studies. In this way, one of the innovations of the present study is the consistent application of nonparametric techniques, which are used both for measuring productivity gains (which make up the first-stage estimation) and estimating the (likely) relationship between geographic expansion and productivity growth (which would make up the second-stage estimation). In contrast, several contributions adopt a rather inconsistent approach, since efficiency and/or productivity is estimated in the first stage by means of nonparametric techniques, in many cases on the grounds of enhanced flexibility, yet in the second stage they turn to parametric techniques (such as ordinary least squares or censored regression models) which,

[2]See, for example the works of Grifell-Tatjé and Lovell (1996), Lozano-Vivas (1997), Kumbhakar *et al.* (2001), Fuentelsaz *et al.* (2002), Prior (2003), or Crespí *et al.* (2004).

[3]"Spain's savings banks get—and use—muscles", *The Wall Street Journal*, 8 February 2005, referring to the institutions' morphing process "from community supporters to aggressive investors, reflecting changing European business patterns".

in principle, are much more restrictive.

Our study thus partly falls into the category of those broadly known as "two-stage" or, simply, "multi-stage" studies, where the indices of efficiency, or productivity, are estimated in the first stage, whereas the second adds those variables that may affect efficiency and/or productivity to the analysis.[4] This type of study has recently been questioned and criticized both by Daraio and Simar (2005) and Simar and Wilson (2003) for, amongst other issues, its "complicated, unknown serial correlation among the estimated efficiencies".

As suggested above, our investigation contemplates one of the nonparametric instruments most widely employed when measuring productivity growth in banking, namely, the Malmquist productivity index (Caves *et al.*, 1982; Färe *et al.*, 1994; Grosskopf, 2003). Major applications in banking include Grifell-Tatjé and Lovell (1996), Wheelock and Wilson (1999) or Mukherjee *et al.* (2001).[5] In the second-stage estimation, where we attempt to assess the impact of geographic expansion on the productivity of savings banks, we also consider nonparametric techniques. However, as opposed to Daraio and Simar (2005), or Simar and Wilson (2003), we do not use bootstrap methodologies. Alternatively, we consider a simpler method, which also pays dividends in terms of consistency due to its nonparametric flavor, following contributions by Deaton (1989), based on the use of nonparametric regression and bivariate density estimation.

Therefore, we attempt to analyze the effects of geographic expansion on the productivity growth of Spanish savings banks for 1992–2001, as this was the period when most savings banks initiated and established their territorial expansion strategies into other Spanish regions and provinces.[6] However, we pursue our aims by following a little used methodology in the field of efficiency and productivity. Therefore, it may be claimed that our study has a twofold objective, one more substantial, the other more methodological. On the one hand, it aims to fill the existing gap in the literature on Spanish banking regarding the (in)existence of a direct link and/or causal relationship between geographic expansion and productivity growth, efficiency change, and technical change. On the other hand, nonparametric techniques—some of them greatly underused in economics, namely, conditional density estimation—are applied to assess the existing relationship between productivity growth, or decline, and territorial expansion initiatives.

The study is organized in the following way. After this introduction, Section 2 offers a review of what expansion has meant for savings banks in Spain. Section 3 reviews the existing literature on the effects of deregulation in general, and on branching in particular. Sections 4 and 5 describe the sample and methodology used, respectively. Section 6 presents the results for productivity growth for savings banks obtained using activity analysis techniques, as well as those corresponding to the estimation of

[4]Some of these research initiatives, akin to ours, deal with applications to the banking sector. See, for example Dietsch and Weill (1999), Fried *et al.* (1993), Fried *et al.* (1999), Garden and Ralston (1999), Isik and Hassan (2002), Ralston *et al.* (2001) or Mukherjee *et al.* (2001), for a more productivity-centered approach.

[5]Other research studies include those by Avkiran (2000), Berg *et al.* (1992), Casu and Girardone (2004), Devaney and Weber (2000), Fukuyama (1995), Grifell-Tatjé and Lovell (1996), Grifell-Tatjé and Lovell (1997), Isik and Hassan (2003a,b), Noulas (1997), Tsionas *et al.* (2003), Worthington (1999), or Zheng *et al.* (2003).

[6]Spanish regions correspond to what in European terminology are known as NUTS2 (*Nomenclature des Unités Territoriales Statistiques*, or Nomenclature of Territorial Units for Statistics), whereas provinces correspond to NUTS3.

the existing relationship between geographic expansion and productivity gains/losses. Finally, Section 7 offers some discussion and conclusions.

2. On the geographic expansion of Spanish savings banks

After complete deregulation of geographic expansion took place in 1989, some savings banks, and not only the largest, proceeded to increase the number of branches outside what was until then their geographic scope of operation. As commented on above, this deregulation process in Spanish savings banks bore similarities with that in the U.S.. However, there were some significant differences. U.S. deregulation basically refers to the possibility of expansion inside and outside the state itself. This feature prevents us from drawing an exact parallelism with the Spanish case, for several reasons. First, the structure of the industry is very dissimilar; for instance, while Spain does not have any savings banks with just one single branch, the U.S. has thousands of unit-branch banks. This means that in the U.S. the possibility of expanding within the state itself takes on special relevance, i.e. setting up more branches that are different from those already in existence. On the other hand, Spanish regulation has always been more lax in permitting expansion in what could be considered the geographic operational limits of each firm, or "usual" operational boundaries.

In accordance with the Ministerial Order of 7 February, 1975 (*Orden Ministerial del 7 de Febrero de 1975*), this usual operational scope would be defined in juxtaposition to the complementary operational scope, in such a way that the former would consist of the entire provincial territory (coinciding with the physical boundaries of the province itself) in which the headquarters of the analyzed savings bank are located, while the "complementary" label would be attached to those areas situated within the territory of other provinces where the savings bank under analysis was already established (with the proviso that the banking firm had more than three branches in this territory), or the territory of a province where no savings bank had its headquarters.

Thus, regulation previous to the first reform, i.e. the Ministerial Order of 7 February, 1975, only permitted territorial expansion within these geographical limits. The reform of the Ministerial Order of 20 December, 1979 (*Orden Ministerial de 20 de Diciembre de 1979*), broadened the definition of normal, or usual operational scope, by extending it to the regional level. Simultaneously, it provided a new definition for the complementary scope. Lastly, the Royal Decree 1582/1988 (*Real Decreto 1582/1988*) led to the total removal of barriers to geographic expansion up and down the national territory. This was in response to the wishes of some savings banks (especially the largest) to establish their activities throughout the entire national territory in identical conditions to those that private commercial banks had been enjoying since 1974, and in response to the perspective of the Single European Market and, consequently, the threat that European financial institutions could enter the Spanish banking industry.

Accordingly, the aforementioned deregulatory initiatives require a definition of what we understand by geographic expansion which, in turn, means that what might be labeled as the natural market must be defined. In accordance with Fuentelsaz and Gómez (1998), we define a natural market as those provinces where the presence of the savings bank being analyzed allows it to carry out a retail banking activity, for which it must have had at least 5% of the total number of branches located in the province in the first period of the sample (1992).

This concept enables us to define the varying expansion strategies that each firm might have followed. Specifically, one particular savings bank may have chosen an "aggressive" geographic expansion by setting up branch offices in markets other than the natural one or, on the contrary, following a more "defensive" strategy, aimed at consolidating its position in its own market in view of potential entry by competitors, be they national (other savings/commercial banks) or foreign (essentially banking firms from other European Union countries). In turn, expansion may have been nationwide, through branching both in the natural market and in the new markets.

These strategies have meant that private commercial banks and savings banks have experienced very disparate paths in terms of number of branches, employees, or volume of assets, translated finally into gaining market share in the former (savings banks) to the detriment of the latter (commercial banks)—taking the aggregate of savings banks and private commercial banks. However, the relatively recent nature of these tendencies in the banking sector holds the reason as to why so few works analyze how the various expansion policies of each savings bank may have affected the key variables that are considered here.

Therefore, given that expansion strategies have been very different,[7] this study classifies savings banks into groups depending on whether they have carried out a generalized expansion throughout the national territory, or whether expansion was carried out principally in regions where they were already operating. We will analyze whether there is an optimum pattern for geographic expansion that is more advantageous in terms of productivity and/or efficiency using this classification.

This classification will enable us to ascertain how exactly the independent variables are used throughout the study, along with the hypotheses being tested—assuming *a priori* that the dependent variable will be the hypothetical productivity gains and its decomposition into technical change and efficiency change. In particular, the three independent variables considered from the possible strategies outlined above will be:

Expansion in the natural market: variation in the number of branch offices in the natural market.

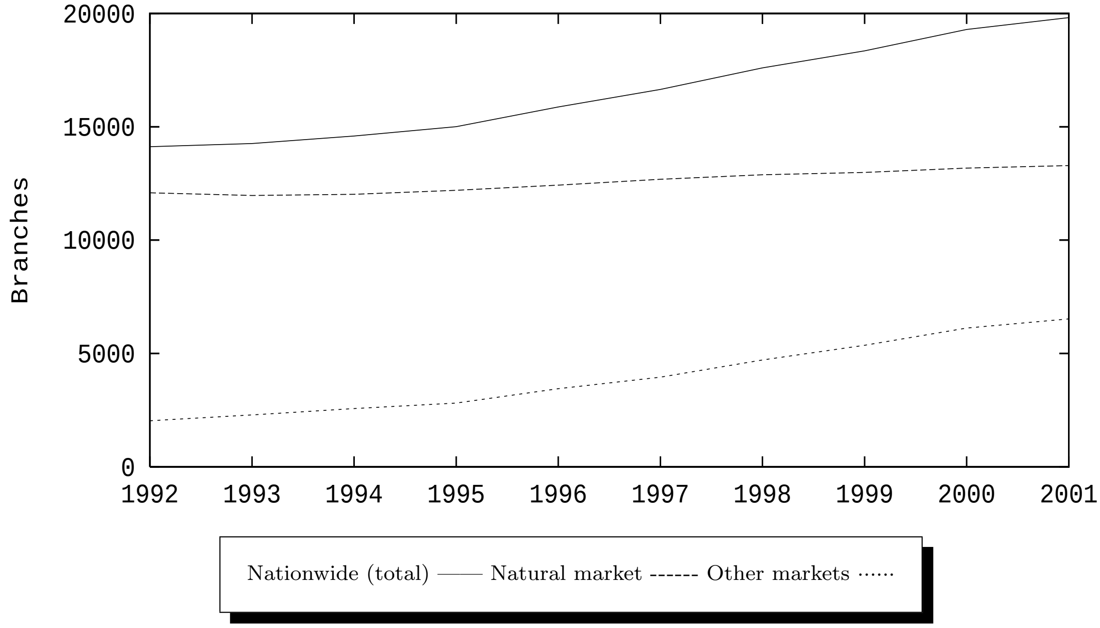
Expansion in other markets: variation in the number of branch offices in markets other than the natural markets.

Nationwide expansion: total variation in the number of branch offices across the country (natural market and other markets).

[7]Fuentelsaz and Gómez (2001) analyze the factors that influence entry and geographic diversification decisions, finding that entry into provincial markets is significantly and positively related to resource availability, firm profitability, and the size of the initial scope of operation. Fuentelsaz *et al.* (2002) analyze the determinants of entry timing decisions. Our focus differs greatly from theirs, since we evaluate how differing geographic expansion policies may affect banking firms' productivity.

Figure 1 shows the development over time of the number of branches in each of the three markets. It can clearly be observed that the increase in the total number of savings bank branches during the considered period stems from expansion in other markets. However, it is also corroborated that this was not the only strategy followed by firms, as the number of branches that savings banks own in their natural market has not declined, but rather has increased, from 12,086 in 1992 to 13,292 in 2001.

Figure 1: Number of branch offices according to geographic location, savings banks (1992–2001)

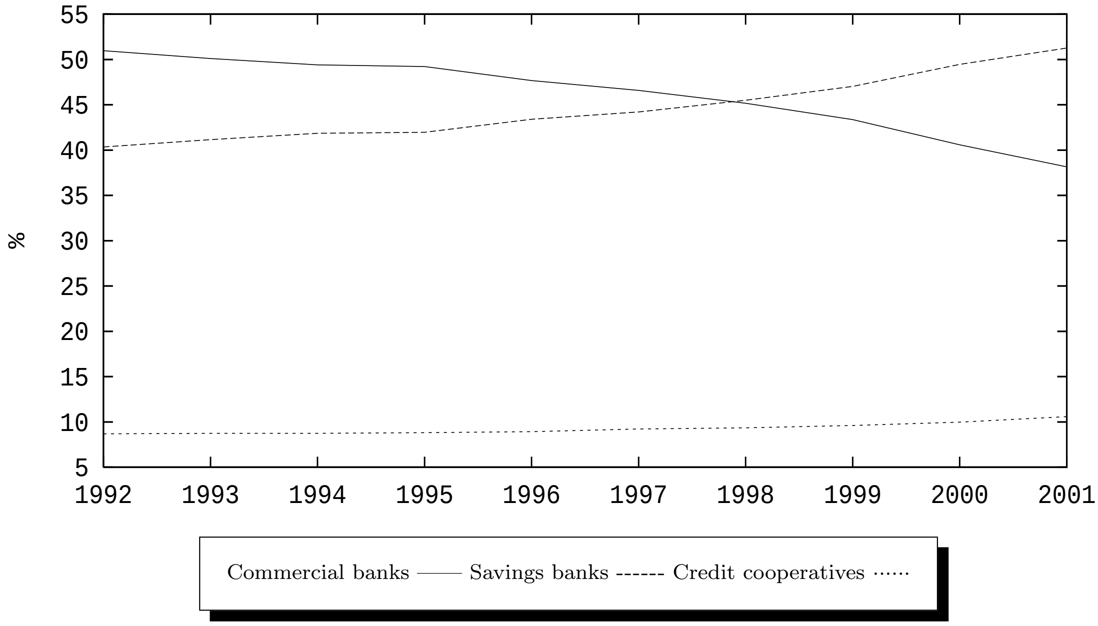


Source: Spanish confederation of savings banks (*Confederación Española de Cajas de Ahorros.*)

These strategies could be defined as offensive, or aggressive, strategies and defensive strategies. They are clearly different strategies, not only in their implementation but also, according to these authors, in their objectives. Thus defensive strategies would be adopted by companies trying to strengthen their market share in their traditional markets. On the other hand, offensive strategies are adopted by savings banks that would be trying to increase their presence in a market in which, previous to 1989, they could not operate (Fuentelsaz and Gómez, 1998; Fuentelsaz *et al.*, 2004). However, these patterns offer a multitude of nuances, as there are firms that have adopted mixed strategies. This is the case of Caja Madrid, for example, which has tried to both strengthen its position in a market as relevant as Madrid and, simultaneously, to expand outside their traditional markets.

In addition, Figure 2 shows that these increasing tendencies do not entirely parallel the case for the other types of financial institutions making up the Spanish banking industry—i.e., commercial banks and credit cooperatives. The nearly 20,000 branches that savings banks own in 2001 (Figure 1) are the result of an increasing tendency which has turned them into the group of firms with the highest percentage of branches—higher than 50% of total branches in the industry. On the other hand, commercial banks' share has been eroded to the benefit of both savings banks and credit cooperatives, to the point that currently they barely account for 40% of the total number of banking branches in Spain.

Figure 2: Percentage of branch offices for each type of firm (1992–2001)



Source: Bank of Spain.

3. The effects of deregulation: brief overview of the literature

3.1. The effects of banking deregulation in general

The literature on the effects of deregulatory processes in banking is vast. Essentially there are two fundamental lines of work that have given rise to this. The first line of research, which is not the aim of this study, focuses on analyzing the effects of deregulation on competition, concentration, structure and market power in banking industries.[8] The second basic line of research is the most important for the aims of the paper, and is devoted to analyze the effects of deregulatory initiatives on the efficiency and productivity of banking firms in different countries.

At the international level, and focussing only on the most recent contributions, we may highlight the study by Avkiran (2000), who analyzes productivity growth for Australian commercial banks in the aftermath of deregulation; that of Canhoto and Dermine (2003), who measure efficiency gains in

[8] Angelini and Cetorelli (2003) analyze the development of competitive conditions in the Italian banking sector after the deregulation period (1983–1997). Bikker and Haaf (2002) investigate how competition and concentration in E.U. banking systems have evolved since deregulation. Corvoisier and Gropp (2002) analyze the recent wave of mergers in the Eurozone as a consequence of deregulation and how the increase in concentration has offset the increase in competition that deregulation in Europe brought with it. DeYoung and Hunter (2002) and Stiroh and Strahan (2003) analyze how deregulation has affected competition and market structure, among other important issues, in U.S. banks, whereas McAndrews and Strahan (2002) analyze whether it has contributed to an increase in market power. Unite and Sullivan (2003) examine the competitive response of Philippine banks when faced with the elimination of entrance barriers to foreign banking. Finally, Wright (2002) analyzes the impact on competition as a consequence of the presence of foreign banks in Australia following the post-deregulation period. These are just but some recent samples of the relevant literature on the effects of deregulation.

Portuguese banking following deregulation; similarly, Gilbert and Wilson (1998) and Hao *et al.* (2001) investigate comparable issues in applications to Korean banks; or Kraft and Tirtiroglu (1998), who analyze bank efficiency in Croatia after liberalization. Isik and Hassan (2003a) also examine related issues, namely, productivity growth, efficiency and technical change in commercial banks in Turkey after deregulation; whereas Maudos and Pastor (2003) analyze the effects of deregulation on productivity and efficiency in Spanish private commercial banks and savings banks, as does Pastor (1999) who introduces in the analysis the role of credit risk.

The attention devoted to the U.S. banking industry overshadows that concerned with any other banking industry in the world. Some recent relevant studies include Berger and Mester (2003), who examine how U.S. banks' technical change efficiency was affected after deregulation; Mukherjee *et al.* (2001) explore productivity growth for a sample of U.S. banks during the post-deregulatory period; Tirtiroglu *et al.* (1998), after controlling for several explanatory variables, explore whether deregulation affected the TFP (Total Factor Productivity) of U.S. commercial banks in the 1946–1995 period; Wheelock and Wilson (1999) analyze the effects of deregulation on the efficiency, productivity, and technical change in U.S. commercial banks and, finally, Worthington (1999), examines productivity growth in U.S. credit cooperatives after deregulation.

With regard to studies that analyze the effects of deregulation on efficiency and productivity in sets of countries in the European Union, we highlight Berger (2003), who analyzes the potential effects on efficiency of creating a single market for financial services in Europe. Maudos *et al.* (2002) examines cost and profit efficiency for European banking systems after deregulation, and Pastor (2002) analyzes how deregulation has affected efficiency in the risk management and credit management of a sample of banks drawn from the most important European banking systems (see also Pastor and Serrano, 2005). Finally, Altunbaş *et al.* (2001) and Casu *et al.* (2004) analyze efficiency and technical change in European banking systems.

After conducting this brief review, one may infer that the effects of deregulation on efficiency and productivity vary a great deal from country to country. Reasons for the dispersion of results might be attributable to the fact not only that regulations across banking industries in different European countries varied widely, but also that deregulatory initiatives in each country also varied a great deal—both in terms of timing and how intensively they were undertaken.

3.2. The effects of deregulation on bank branching and geographic expansion

The literature devoted to the specific analysis of the effects of deregulation on branching and geographic expansion on bank efficiency and productivity is much scarcer—in some cases entirely yet to come. Although some studies[9] deal with the analysis of the effects of bank branch deregulation on productivity, their analyses do not specifically deal with the (likely) links between branch geographic expansion and productivity growth.

[9]See, for example, Kumbhakar *et al.* (2001), or Grifell-Tatjé and Lovell (1996, 1997).

Among the few studies devoted to analyzing the effects of savings banks' geographic expansion, we should highlight Carbó Valverde *et al.* (2003), Fuentelsaz *et al.* (2002) and Fuentelsaz and Gómez (2001). However, none of these deals with the effects of expansion on productivity, nor even efficiency. The first examines its likely effects on competition using the Lerner index, finding a greater intensity of competition in the savings bank sector after nationwide branching was permitted. On the other hand, Fuentelsaz *et al.* (2002) and Fuentelsaz and Gómez (2001) attempt to determine the key variables that explain decisions on geographic expansion.

The scant number of studies analyzing the effects of geographic expansion on productivity in Spanish banking does not parallel the literature at the international level on multiple aspects of bank branching such as, for instance, analyses of the effects of branching deregulation on competition. For example, Kano and Tsutsui (2003) concluded that geographic expansion has promoted increased concurrence and reduced interest rates in Japan. Likewise, Bonaccorsi di Patti and Gobbi (2001) analyze how bank branch deregulation has prompted entry into local markets and intensified the level of competition. Analogously, Calem and Nakamura (1988) and Hannan and Prager (1998) examine the effects on competition via the relationship between geographic expansion and the price of banking products. DeYoung *et al.* (2001) also assesses how branch office deregulation has led to tougher competition and also examine the way in which CAMEL rating reflects the level of risk banks are willing to bear.

A related stem of research deals with the effects of bank branch deregulation on risk. Within this category fall Akhigbe and Whyte (2003), Hughes *et al.* (1996) and Shiers (2002), who analyze banking risk in the U.S. after deregulation brought about by the 1994 Riegle-Neal Act. In a similar way, Emmons *et al.* (2001) analyze the effects of geographic expansion on risk by means of diversification.

A third stem of research consists of studies examining bank branch deregulation effects on mergers. Thus, Avery *et al.* (1999) explore the connections between consolidation and geographic expansion in U.S. banks, while Berger *et al.* (1999) and, more recently, Hart and Apilado (2002) contemplate, amongst other issues, the effects of branch deregulation on the number of mergers and acquisitions. Matasar and Heiney (2000) also analyzed the Riegle-Neal Act effect and concluded that deregulation has produced a reduction in the number of banks. Carow and Heron (1998), Carow and Lee (1997) and Fraser *et al.* (1997) found a positive relation between bank branch deregulation and the average price of banks' shares, indicating that there is a positive wealth effect as a consequence of easing restrictions.

A fourth stem of research includes the studies by Jayaratne and Strahan (1996), Freeman (2002), Strahan (2002) and, more recently, Clarke (2004), who deal primarily with the effects of bank branch deregulation on economic growth, finding a positive effect—i.e., economic growth benefits from deregulation. And last but not least we find studies examining the effects of branching deregulation on a wide variety of other aspects.[10]

[10] Merrett (2002) shows that deregulation allowing Australian banks to operate internationally has boosted their presence in international markets and extended the range and reach of operations and products they offer. Ramírez (2003) finds that restricted branching in the U.S. has been a major cause of bankruptcy. Wall (2004) presents results showing that branch office deregulation tends to deter the creation of companies in some regions and to foster it in others. Cyree *et al.* (2000) analyzes the determinants of bank growth finding that larger banks tend to grow more abroad.

Regarding the research interests pursued here, i.e., that of the effects of savings bank branch deregulation on their productivity, the study by Berger and DeYoung (2001) stands out. They explore the effects of geographic expansion on cost and profit efficiency for a sample of 7,000 U.S. banks over the 1993–1998 period, finding that parent organizations control affiliates and that the greater the distance from the parent organization, the weaker this control will be. Berger *et al.* (2000) examine the causes, consequences and implications of cross-border consolidation as a result of deregulation, finding that domestic banks are more profit efficient than foreign banks. DeYoung *et al.* (1998) investigate the relationship between out-of-state banks entering the state, and the efficiency of local banks, finding that the Riegle-Neal Act enhances both competition and efficiency. Berger and DeYoung (2003) consider certain predictions on the effects of technical progress on geographic expansion, finding that technological progress has prompted geographic expansion. Finally, Jayaratne and Strahan (1999) investigate the effects of branch deregulation on banking costs and efficiency after the Riegle-Neal Interstate Banking and Branching Efficiency Act.

4. Data and variables

Defining and measuring bank inputs and outputs is usually a matter for debate and controversy. There are two alternatives for measuring banking activity, i.e. the production approach and the intermediation approach. The first considers banking institutions as producers of services for their customers.[11] Therefore, the number of accounts or transactions performed would be suitable indicators of bank output, while inputs would include the number of employees and physical capital. On the other hand, the intermediation approach expands the definition of inputs to include deposits (due to the financial cost they generate), and suggests measures for banking output according to the money value, basically in earning assets—although deposits can also play an important role. In connection with this, the asset, user cost and value-added approaches to define bank output differ, amongst other aspects, in the role assigned to different balance sheet items. The asset approach (Sealey and Lindley, 1977) and user cost (Hancock, 1985, 1991) classify inputs and outputs in mutually exclusive ways. The former assumes that banks are only intermediaries between liability holders, and those receiving funds. The user cost approach classifies the different asset and liability items as inputs or outputs depending on their net contribution to the financial institution's revenues. And regarding the value-added approach (Berger *et al.*, 1987), liabilities can have a twofold nature by representing inputs and outputs at the same time; in particular, all categories that generate value-added are classified as outputs.

Most studies defining bank output have tended towards the intermediation approach, partly due to the difficulty of obtaining data that painstakingly reflect the banking production aspect. When defining banking output, the database does not allow us to distinguish between different deposit categories and, ideally, to classify these as outputs, we should have information on the percentage of deposits that

[11] Some applications of this approach are those by Sherman and Gold (1985), Ferrier and Lovell (1990) or Fried *et al.* (1993).

represent “transaction deposits”, since these are the only ones that constitute an adequate proxy for the payment services offered by the bank. Therefore, we adopted an “enlarged” asset approach where we also take into account the role of non-traditional banking activities Rogers (1998).[12] The inputs considered are both physical capital and staff expenses (due to the operative costs they entail), as well as loanable funds (due to the financial costs they generate). Table 1 presents more precise details of the definition, while Table 2 offers some descriptive statistics.

Table 1: Definition of the relevant variables

Variable	Variable name	Definition
Outputs		
y_1	Loans	Cash and balances with the Bank of Spain, interbank loans, loans to firms and households
y_2	Fixed-income securities	Fixed-income securities, public debt
y_3	Other securities	Shares and other equity (quoted shares, unquoted shares, other equity, mutual funds shares)
y_4	Non-traditional output	Non-interest income
Inputs		
x_1	Funding	Interbank deposits, savings deposits, issued securities, subordinated debt.
x_2	Labor	Number of employees
x_3	Capital	Fixed assets

The data comes from the statistical yearbooks of the Spanish banking association (AEB, *Asociación Española de Banca*) and the Spanish confederation of savings banks (CECA, *Confederación Española de Cajas de Ahorros*). This information is currently available on the Internet for the most recent years of the sample.[13]

5. Methodology

This study will use nonparametric techniques to both: (i) estimate the indices of productivity of Spanish savings banks; and (ii) test the existence of a dependent relation between geographic expansion of savings banks and their productivity growth/decline.

5.1. Measuring productivity growth for Spanish savings banks

We use the Malmquist productivity index to measure productivity of Spanish savings banks. Although the index was named after Sten Malmquist, it was Caves *et al.* (1982) who dubbed it a Malmquist productivity index since they constructed an index of productivity change (in the consumer context) based on Malmquist’s 1953 paper. However, we will not focus solely on productivity but also on the relation between efficiency and productivity, i.e., we will define productivity growth as the change in output due to change in efficiency (catching up effect) and technical change. In other words, our approach distinguishes between changes in how far an observation is from the frontier of technology, and the

[12] Other works that highlight the importance of non traditional banking are those by Kaufman (1993), Kaufman and Mote (1994), Edwards and Mishkin (1995), Gorton and Rosen (1995) or Allen and Santomero (1998, 2001).

[13] See `http://www.aebanca.es` and `http://www.ceca.es` for banks and savings banks, respectively.

Table 2: Summary of descriptive statistics, 1992–2001

	# of firms	y_1	y_2	y_3	y_4	x_1	x_2	x_3
		MEAN						
1992	53	516,122.48	172,674.39	14,822.47	3,116.40	670,028.50	1,515.17	29,096.86
1993	51	593,037.65	159,541.57	18,060.34	3,583.59	734,309.58	1,618.02	30,063.54
1994	50	614,914.55	203,084.51	19,392.57	4,303.42	806,394.62	1,675.70	31,958.39
1995	50	637,141.55	210,590.40	22,655.18	4,439.63	835,011.83	1,681.14	32,012.35
1996	49	695,127.57	220,950.19	28,470.58	4,992.08	903,960.27	1,779.24	35,886.32
1997	50	739,140.22	199,260.72	41,126.98	5,949.32	934,967.50	1,801.12	34,422.81
1998	50	846,127.54	186,515.94	47,969.61	6,993.53	1,027,753.24	1,880.94	33,969.88
1999	49	948,284.20	196,297.45	59,190.09	7,873.06	1,136,104.54	1,991.16	33,674.98
2000	47	1,105,411.48	213,075.66	76,330.89	8,762.01	1,322,504.65	2,173.53	33,820.43
2001	45	1,173,224.22	226,035.28	79,005.41	9,121.48	1,396,953.73	2,247.96	33,728.68
		MAXIMUM						
1992	53	5,327,450.09	2,507,897.67	398,464.55	44,482.62	7,680,628.89	10,824.00	349,803.82
1993	51	6,387,764.12	1,905,314.66	435,194.68	49,551.65	8,213,067.74	12,079.00	349,521.69
1994	50	6,091,779.23	2,517,161.60	430,534.82	56,040.01	8,846,417.45	12,130.00	361,456.74
1995	50	5,949,443.93	2,572,690.22	551,752.71	60,601.28	8,823,238.22	12,546.00	374,056.20
1996	49	6,444,835.14	2,503,859.54	648,091.69	68,279.53	9,312,158.80	13,917.00	379,608.23
1997	50	6,339,613.75	2,065,417.40	789,043.59	87,158.01	8,905,037.48	14,499.00	350,993.81
1998	50	7,867,024.54	1,523,554.74	962,283.56	100,827.77	9,717,475.90	16,328.00	360,884.57
1999	49	8,706,187.79	1,531,221.59	1,320,214.45	109,699.67	10,436,981.11	17,870.00	349,334.14
2000	47	9,494,968.25	1,735,326.07	1,489,104.23	112,665.98	11,522,795.98	19,126.00	344,258.20
2001	45	9,650,801.30	1,824,004.36	1,440,098.29	124,540.75	11,654,486.41	20,494.00	343,444.66
		MINIMUM						
1992	53	9,305.99	1,514.96	56.11	38.32	10,469.23	42.00	338.03
1993	51	10,802.89	1,230.58	65.46	41.89	11,605.38	41.00	298.48
1994	50	12,290.77	2,078.08	68.05	39.07	14,048.75	46.00	404.53
1995	50	12,071.02	3,487.64	82.87	50.44	15,227.18	48.00	372.30
1996	49	12,886.52	4,329.54	103.25	37.12	16,995.63	45.00	503.49
1997	50	15,236.30	1,956.98	115.65	43.09	17,158.13	50.00	489.81
1998	50	16,403.24	479.45	313.36	43.18	16,940.27	53.00	581.32
1999	49	19,053.53	513.52	263.57	72.80	20,891.55	55.00	650.15
2000	47	20,551.61	528.24	354.35	76.06	22,776.90	63.00	746.15
2001	45	23,665.41	1,516.44	283.69	83.86	27,729.89	63.00	691.00

In thousands of euros. Converted from year 2001 pesetas (1 euro=166.386 pesetas).

shifts in the production frontier since, as suggested by Grosskopf (1993), the Malmquist-type index of total factor productivity is potentially very useful in calculating productivity growth in presence of inefficiency.[14] Therefore, our approach will be based on the literature pioneered by Färe *et al.* (1992, 1994)—although the distinction had been previously developed for the parametric context by Nishimizu and Page, Jr (1982)—in which ideas on measurement of efficiency from Farrell (1957) and on measurement of productivity by Caves *et al.* (1982) were combined. Recently, Grosskopf (2003) has presented a general view of the Malmquist index, focusing both on its history and its decompositions, as well as suggesting lines for future research.

In our specific setting, the Malmquist index attempts to establish whether a savings bank has experienced productivity growth or decline between periods t and $t+1$. The index is constructed from distance functions, by exploiting the fact that the component distance functions are reciprocal to Farrell measures of technical inefficiency. Following Caves *et al.* (1982), the "distance function in outputs" of an individual in t regarding technology t (F^t) can be expressed as $D_o^t(\mathbf{x}^t, \mathbf{y}^t) = \inf\{\vartheta^{t,t} : (\mathbf{x}^t, \mathbf{y}^t/\vartheta^{t,t}) \in F^t\}$, where $\mathbf{y}^t \in \mathbb{R}_+^M$ is the output vector for firm s ($s = 1, \ldots, S$), $\mathbf{x}^t \in \mathbb{R}_+^N$ is its input vector, and F^t is the technology in period t. This distance function D_o^t is defined as the inverse maximum expansion to which the output vector in t ($\mathbf{y}^t$) must be subject, given the input levels ($\mathbf{x}^t$), in such a way that the observation is on the frontier at period t. From these concepts, the Malmquist productivity index based on outputs to analyze productivity change between periods t and $t+1$ is defined as:

$$M_o^t(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t) = \frac{D_o^t(\mathbf{x}^{t+1}, \mathbf{y}^{t+1})}{D_o^t(\mathbf{x}^t, \mathbf{y}^t)} \tag{1}$$

If $M_o^t > 1$, it indicates that productivity for period $t+1$ is higher than for period t. On the other hand, if $M_o^t < 1$, it indicates that productivity has declined between periods t and $t+1$. However, interpretations would be reversed if we adopted an input-oriented approach. It is reasonable to adopt such an orientation in the banking sector, in which we may assume that firms try to maximize their output.

When the attempts involve an analysis of productivity change for a long time span, using a fixed technology can cause problems as one moves away from the base year. To resolve these problems, two indices are usually calculated based on pairs of consecutive years that take as a base the technology of two periods t and $t+1$ and calculate the geometric mean of both. Rewriting this geometric mean enables us to decompose the Malmquist index of total factor productivity in a catching up—or efficiency change—effect and the effect of technical change:

$$M_o^t(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t) = \underbrace{\frac{D_o^{t+1}(\mathbf{x}^{t+1}, \mathbf{y}^{t+1})}{D_o^t(\mathbf{x}^t, \mathbf{y}^t)}}_{\text{Catching up}} \underbrace{\left[\frac{D_o^t(\mathbf{x}^{t+1}, \mathbf{y}^{t+1})}{D_o^{t+1}(\mathbf{x}^{t+1}, \mathbf{y}^{t+1})} \frac{D_o^t(\mathbf{x}^t, \mathbf{y}^t)}{D_o^{t+1}(\mathbf{x}^t, \mathbf{y}^t)}\right]^{1/2}}_{\text{Technical change}} \tag{2}$$

The catching up effect, or relative change in efficiency in (EC) between periods t and $t+1$, is

[14]Other approaches to measure productivity have been collected in Hulten *et al.* (2001).

represented by the first ratio, which will be greater than one if there has been a increase in efficiency—since we are taking the output oriented approach. In a similar way, the term in square brackets measures technical change (TC), or shifts of the frontier between the two periods.

The aforementioned ideas were implemented using nonparametric linear programming techniques to estimate the distance functions included in the definition of productivity change. In particular, we use Data Envelopment Analysis (DEA), which lies within the broad set of techniques that measure the efficiency of one DMU (Decision Making Unit) imposing a minimum number of assumptions both on the function to estimate (costs, deposits, or profits) and on the distribution of the indices of efficiency, which is why they are usually grouped under the label of nonparametric techniques.

Our data on savings banks consist of a vector of inputs and outputs of S firms at both periods t and $t+1$:

$$\mathcal{Z} = \{(\mathbf{x}_s^t, \mathbf{y}_s^t, \mathbf{x}_s^{t+1}, \mathbf{y}_s^{t+1}), s = 1, \ldots, S\}, \tag{3}$$

where $\mathbf{x}_s^t = (x_{s1}^t, \ldots, x_{sn}^t, \ldots, x_{sN}^t)' \in \mathbb{R}_+^N$ and $\mathbf{y}_s^t = (y_{s1}^t, \ldots, y_{sm}^t, \ldots, y_{sM}^t)' \in \mathbb{R}_+^M$ are the input and output vectors corresponding to firm s, $s = 1, \ldots, S$ in period t, respectively.

Both the production set and the distances we may define from it are unknown. This applies to both period t and period $t+1$. As suggested above, the four distances included in Equation (2) can be computed using linear programming techniques. Following Färe *et al.* (1992), for each s firm ($s = 1, \ldots, S$) we may consider a linear programming model as follows:

$$\begin{aligned}
&[\hat{D}_s^t(\mathbf{x}_s^t, \mathbf{y}_s^t)]^{-1} = \max\ \theta \\
&\text{s.t.} \\
&\quad \theta y_{sm}^t \leq \textstyle\sum_{j=1}^S \lambda_j^t y_{mj}^t, \qquad m = 1\ldots, M, \\
&\quad \textstyle\sum_{j=1}^S \lambda_j^t x_{jn}^t \leq x_{sn}^t, \qquad n = 1, \ldots, N, \\
&\quad \lambda_s^t \geq 0, \qquad s = 1, \ldots, S.
\end{aligned} \tag{4}$$

where $\boldsymbol{\lambda}^t = (\lambda_1^t, \ldots, \lambda_S^t)'$ is a vector of weights forming a convex combination of observed firms relative to which the subject firm's efficiency is evaluated. Linear programming model (4) calculates the distances $\hat{D}_s^t(\mathbf{x}_s^t, \mathbf{y}_s^t)$. Computing $\hat{D}_s^{t+1}(\mathbf{x}_s^{t+1}, \mathbf{y}_s^{t+1})$ is analogous to linear programming problem (4), where $t+1$ is substituted for t.

In order to estimate the mixed-period cases, which combine information of both periods t and $t+1$, two additional linear programming models must be considered. Distance function $\hat{D}_s^t(\mathbf{x}_s^{t+1}, \mathbf{y}_s^{t+1})$ is estimated for each s firm as:

$$\begin{aligned}
&[\hat{D}_s^t(\mathbf{x}_s^{t+1}, \mathbf{y}_s^{t+1})]^{-1} = \max\ \theta \\
&\text{s.t.} \\
&\quad \theta y_{sm}^{t+1} \leq \textstyle\sum_{j=1}^S \lambda_j^t y_{mj}^t, \qquad m = 1\ldots, M, \\
&\quad \textstyle\sum_{j=1}^S \lambda_j^t x_{jn}^t \leq x_{sn}^{t+1}, \qquad n = 1, \ldots, N, \\
&\quad \lambda_s^t \geq 0, \qquad s = 1, \ldots, S.
\end{aligned} \tag{5}$$

Estimating the second mixed-period distance function $\hat{D}_s^{t+1}(\mathbf{x}_s^t, \mathbf{y}_s^t)$ is straightforward—just reverse superscripts t and $t+1$ in (5). This is possible since, as reported by Färe *et al.* (1994), observations involved in (5) are from both period t and $t+1$, and the reference technology relative to which we evaluate $(\mathbf{x}_s^{t+1}, \mathbf{y}_s^{t+1})$ is constructed from observations in t.

5.2. Measuring the effect of geographic expansion on the productivity of savings banks

Several studies identify the variables that explain the disparities observed among efficiency and productivity indices for the decision making units (DMUs) in general, and financial institutions in particular. As mentioned in the introduction, these studies, as a general rule, adopt a multi-stage methodology, although most focus on two stages. The first stage attempts to estimate the indices of efficiency, or productivity, of the financial institutions. The second stage generally consists of regressing these indices on a predetermined set of variables that have an *a priori* theoretical relationship with the efficiency or productivity obtained in the first stage.

Regarding efficiency obtained by nonparametric methods, since they involve constructing a variable whose values lie in the $(0, 1]$ range (or bounded from below at unity when adopting an output orientation), many studies choose censored regression models. However, as in the case when ordinary least squares (OLS) are chosen, censored regression models assume that stochastic errors associated with different observations are independent, and are distributed as normal variables of the same mean and variance.

However, the hypothesis for error independence does not hold up so easily when using DEA to estimate the indices of efficiency or productivity, as each of these indices is obtained from other observations in the sample. This is the core argument underlying the contributions by Daraio and Simar (2005) and Simar and Wilson (2003) who, together with those by Hirschberg and Lloyd (2002) and Harker and Xue (1999), are the only ones that are consistent, i.e., where nonparametric techniques are used in both stages. In particular, they all share bootstrap techniques in the second stage, although Simar and Wilson (2003) criticise the approach of Hirschberg and Lloyd (2002) and Harker and Xue (1999) for resampling without taking into account the peculiar distributions of efficiency scores, or productivity, obtained by linear programming techniques.

On the other hand, we consider some rather simpler, somewhat more intuitive techniques, but which prove to be equally consistent, since we also consider nonparametric techniques in the second stage. In particular, our approach is related to the contribution by Deaton (1989), who uses nonparametric regression and kernel estimation of bivariate density functions to study the relationships between the price of rice and income distribution in Thailand. Our approach goes further in that we combine nonparametric regression with its natural complement, which would not be the kernel estimation of bivariate density functions, but conditional density estimation (Rosenblatt, 1969; Hyndman *et al.*, 1996; Bashtannyk and Hyndman, 2001). Although several studies have made use of nonparametric regression in various fields of economics, conditional density estimation is an instrument that is much less used (Deaton, 1989).

5.2.1. Nonparametric regression

Regression is probably the most popular technique based on data to examine the interaction between variables, especially in cases described as "cause and effect". In general, a linear model is postulated, without accounting too much for the mechanism underlying the relationship being modeled. In some occasions, confining the analysis to a linear model can be satisfactory; however, it usually constitutes a rather preliminary approximation. In fact, in econometrics, the assumption of statistical adequacy, or correct specification of the model has traditionally been a major concern, and an incorrect specification of the functional forms can imply invalid tests for the hypothesis under analysis.

Yet any introductory course to the empirical literature in many fields of economics reveals that most applications use more or less simple parametric approaches, such as OLS or two-stage least squares (2SLS), along with simple descriptive summary statistics. The use of these methods persists despite the recent development of nonparametric techniques in statistics and econometrics (DiNardo and Tobias, 2001).

Nonparametric regression allows one to graphically observe how a certain Y variable, in our case the productivity of savings banks and each of its components, is affected by changes in another variable X, in our case the geographic expansion of their branching networks. Therefore, in order to avoid convoluting notation, the dependent variable Y will be labeled MO,[15] whereas the independent variables will be referred to as Z. The main advantage of this technique, as opposed to others such as linear or polynomial regression, lies in the fact that it does not impose any type of *a priori* relationship between the variables to be analyzed. Therefore, for a set of data $\{(Z_s, MO_s)\}_{s=1}^{S}$, we would estimate the mean response curve m from the relationship:

$$MO_s = m(Z_s) + \varepsilon_s,\ \ s = 1, \ldots, S. \tag{6}$$

In many cases, it is not possible to know the nature of $m(\cdot)$, i.e. it is impossible to know whether the relation is linear, quadratic, growing in Z, etc. It is in these cases where nonparametric regression proves most useful. The basic idea is to obtain the mean of MO conditioned on a certain value of Z, for example Z_s, defining an interval around this value and computing an weighted mean of values MO that correspond to the observations within the interval. It is therefore, a local averaging procedure where the local average is constructed in such a way that it is defined only from observations in a small area around z. Therefore, we could define this procedure as:

$$\widehat{m}(z) = S^{-1} \sum_{s=1}^{S} W_{Ss}(z) MO_s, \tag{7}$$

where $\{W_{Ss}(z)\}_{s=1}^{S}$ would denote the sequence of weights that depends on the total of vector $\{Z_s\}_{s=1}^{S}$, and satisfies a certain set of properties (Härdle, 1990). A possible alternative to define the form of the sequence of weights is to use a kernel function that adjusts the size and shape of the weights near z.

[15] Referring to the Malmquist total factor productivity index. Computations will also be performed for efficiency change and technical change. Thus, we should substitute MO with EC or TC, depending on the component chosen.

Thus, taking the kernel density estimator conceived by Rosenblatt (1956) and Parzen (1962), $\widehat{f}_h$ (which would estimate the marginal density of Z), the sequence would be defined as:

$$W_{Ss}(z) = K_h(z - Z_s)/\widehat{f}_h(z), \tag{8}$$

where

$$\widehat{f}_h(z) = S^{-1}\sum_{s=1}^{S} K_h(z - Z_s), \tag{9}$$

$$K_h(u) = h^{-1}K(u/h) \tag{10}$$

An alternative for (8) is the proposal by Nadaraya (1964) and Watson (1964), hence the name of the estimator, the Nadaraya-Watson estimator:

$$\widehat{m}_h = \frac{S^{-1}\sum_{s=1}^{S} K_h(z - Z_s)MO_s}{S^{-1}\sum_{s=1}^{S} K_h(z - Z_s)} \tag{11}$$

In addition, various alternatives are available when selecting the kernel, K. In our case, for operational reasons, we have chosen the gaussian kernel, i.e., $K(u) = (2\pi)^{-1/2}\exp(-u^2/2)$.

Moreover, the parameter h is known as bandwidth, window width or smoothing parameter. An important stem of literature on nonparametric statistics is devoted to estimating the optimum smoothing parameter. One of the most interesting alternatives are the plug-in methods; in particular, our work uses the parameter proposed by Ruppert *et al.* (1995), available though various statistical packages such as `R`.

5.2.2. Conditional density estimation

Nonparametric regression provides a more or less smoothed curve (depending on the bandwidth h) which links productivity growth to the geographic expansion of savings banks. However, nonparametric regression does not provide information on the statistical significance of the relationship among the variables being analyzed.

In order to draw conclusions on the significance of this relationship, it may be more useful to graphically represent the density function of savings banks' productivity growth, distinguishing between different degrees of geographic expansion of the branch office network. In other words, instead of estimating the expected value of MO conditional on Z, the second step of our methodology is to estimate the density function of MO conditional on Z. These are the aims of conditional density estimation which, in addition, also fits our setting since, in Rosenblatt's (1969) words, "these estimators have a nonparametric flavor." It mingles the tools for nonparametric (Härdle, 1990) regression and bivariate density estimation (Silverman, 1986) presented above, by focusing in the estimation of the conditional density $f(mo|z) = f(z, mo)/g(z)$, where $f(z, mo)$ denotes the joint density of (Z, MO) and $g(z)$ denotes the marginal density of Z.

For this, we follow contributions by Hyndman *et al.* (1996), who point out that conditional density estimation helps to "triangulate" the relationships between nonparametric regression and nonparametric estimation of density functions. On the one hand, nonparametric regression does not allow one to tackle changes in modality. Thus, it would be difficult to know, for instance, whether, underlying a negative hypothetical relationship between productivity growth and geographic expansion there were a group of firms for whom territorial expansion were successful, which would be masked by the negative relationship encountered. This would also remain masked by any type of parametric test. The multi-modality could be detected by nonparametric estimation of density functions; yet it does not allow conditioning by an explanatory variable. Therefore, conditional density estimation represents the natural complement to nonparametric regression or, in other words, its three-dimensional counterpart.

In our particular setting, we estimate the density function of MO, EC and TC, conditional on the level of nationwide, natural markets and other markets expansion (which are represented by the Z variable). Specifically, we use the modified version of the Rosenblatt's (1969) estimator suggested by Hyndman *et al.* (1996). Considering $\|\cdot\|_{mo}$ and $\|\cdot\|_z$ are distance metrics on the spaces of MO and Z respectively, we have:

$$\hat{f}(mo|z) = \frac{1}{b}\sum_{s=1}^{S}\omega_s(z)K\Big(\frac{\|mo - MO_s\|_{mo}}{b}\Big), \tag{12}$$

where

$$\omega_s(x) = \frac{K((\|z - Z_s\|_z)/a)}{\sum_{i=1}^{S} K((\|z - Z_i\|_z)/a)} \tag{13}$$

and $K(\cdot)$ is the Gaussian kernel function (yet other alternatives are also possible), and a and b control for the degree of smoothing applied to the density estimate, i.e., they represent the bandwidths for each co-ordinate direction. These parameters have been estimated according to the bootstrap bandwidth selection approach proposed in Bashtannyk and Hyndman (2001).

6. Results

6.1. General trends in productivity growth: 1992–2001

Estimations for productivity change (MO) and its decomposition into catching up, or efficiency change (EC), and technical change (TC) according to Equation (2) are reported in Table 3.[16] These calculations were performed for each savings bank considered. Indices higher than the unit indicate productivity gains, efficiency gains, and positive technical change (technical progress). Indices lower that the unit indicate productivity decline, efficiency losses, and negative technical change (technical regression).

Table 3 reports annual and accumulated results for the entire 1992–2001 period and subperiods 1992–1996 and 1997–2001, using the geometric mean of the indices to express the evolution of average productivity.

Over the nine years considered, accumulated productivity growth for savings banks is 14.9%, which corresponds to an average growth rate of 1.55%. During the first half of the period (1992–1996), productivity growth was more intense than that in the second period (1997–2001). In fact, an accumulated

[16]To avoid the bias generated when the series are large, these indices are first calculated based on pairs of consecutive years t and $t+1$, and their geometric mean is calculated.

Table 3: Productivity growth, efficiency change, and technical change

Period	Geometric mean		
	MO	*EC*	*TC*
1992–1993	1.022	0.990	1.032
1993–1994	1.008	1.013	0.995
1994–1995	1.011	0.992	1.019
1995–1996	1.020	1.005	1.015
1996–1997	1.029	1.000	1.029
1997–1998	1.008	0.999	1.009
1998–1999	1.026	1.006	1.020
1999–2000	1.007	1.007	1.000
2000–2001	1.009	1.002	1.007
1992–1996	1.062	0.999	1.063
1997–2001	1.050	1.013	1.036
1992–2001	1.149	1.013	1.134
Annual growth (1992–1996)	1.52%	–0.01%	1.54%
Annual growth (1997–2001)	0.99%	0.27%	0.72%
Annual growth (1992–2001)	1.55%	0.14%	1.41%

growth of 6.2% was achieved, compared to 5.0% of accumulated growth in the second subperiod. The average annual rates of growth during the first period were 1.52% annually, compared to 0.99% in the second part.

The decomposition of productivity growth reveals that it is mostly attributable to technical progress, and to a much lesser extent to improvements in efficiency gains. In particular, savings banks have gone through accumulated technical progress of 13.4% (1.41% annually), while accumulated improvements in efficiency hardly reach 1.3% (0.14% annually). In other words, efficiency represents around 2% of gains in productivity, while technical progress is responsible for 98% of these.

The behavior in the two subperiods considered shows some differing features worthy of mention. In the period 1992–1996 total gains in productivity are achieved thanks to technical progress, while efficiency does not contribute to growth in productivity at all. In particular, accumulated technical progress is 6.3% (1.54% annually), while accumulated efficiency gains were negative (−0.1%), representing an annual decrease of −0.01%. On the other hand, for the 1997–2001 period, accumulated gains in productivity associated to technical progress were only 3.6% (0.72% annually), while gains in accumulated efficiency reached 1.3% and 0.27% annually). This means that both for the first and the second periods, productivity growth is almost entirely attributable to technical progress. In general, these results coincide with those obtained by Grifell-Tatjé and Lovell (1997), although their study encompasses a different time horizon in which many savings banks had still not begun their territorial expansion policies.

To discover whether there are differential guidelines depending on size ($SIZE$), Table 4 shows the relationship between growth in productivity and its components with the size of savings banks according to their assets.[17] The savings banks are classified into five size groups according to their assets, so that there is a similar number of savings banks in each interval. The table shows that for the period 1992–2001, there is a clear and regular relationship between size of savings banks and gains in productivity. Thus, the productivity growth experienced in the entire period by the largest savings banks is 3.65%, remarkably higher than that experienced by smaller sized savings banks (0.41%). Analyzing both periods

[17] All intervals have been constructed so as to include the same number of observations.

offers the same results: higher productivity gains for larger savings banks, although the pattern is not as regular as for the entire period.

Analyzing the sources of productivity growth reveals that efficiency did not drive productivity gains for any of the considered sizes, since even for the size category with highest productivity gains, efficiency change only reached 0.34%, and the contribution in the intermediate size category is virtually zero. On the other hand, technical progress was the primary force behind productivity growth, especially for the largest savings banks.

In order to ascertain whether different patterns emerge according to the size of the branch office network ($BRANCH$), Table 5 shows the relationship between productivity growth (and its components) classifying savings banks into five groups according to the number of branches. Here one observes that for the 1992–2001 period, akin to the results obtained with size, there is a clear and regular relationship between branch office network size and productivity gains. Thus, productivity growth experienced in the entire period by savings banks with a network made up of over 402 branches was 2.78%, again much higher than growth experienced by savings banks whose network was less than 107 (0.42%). The results for both subperiods considered exhibit the same pattern: greater productivity gains for savings banks with a larger network, although patterns are not as regular as for the entire period. Indeed, in the first subperiod, the greatest productivity gains occurred for savings banks whose branch office network ranged (on average) between 144 and 199 branches.

Analyzing the sources of productivity growth reveals, once more, that efficiency was not the primary cause for productivity gains for any of the branch office network sizes considered, despite substantial efficiency gains in the 1997–2001 period, especially for savings banks with branch office networks over 402. In a similar way, a positive relationship can in fact be seen between branch network size and efficiency gains and technical progress. In summary, technical progress is confirmed as the main source of productivity growth, regardless of the branch office network size, and there is a positive relationship between branch network size and productivity gains, efficiency gains and technical progress.

However, the main objective of our study is to analyze the success of geographic expansion policies for some savings banks. Table 6 presents the results with savings banks classified according to branch office network growth rate ($BRANCH\_G$) between 1992 and 2001. The results do not allow *a priori* inference of any “regular” differential patterns of productivity gains according to the magnitude of the network expansion. The only consistent feature is that again—regardless of the group considered—technical progress is the main source of productivity growth.

Tables 7 and 8 report the results of considering the decomposition between expansion in natural markets—$BRANCH\_G(n)$—and expansion into other markets, i.e., those which firms have not traditionally operated—$BRANCH\_G(o)$. Results show that there is a negative relationship between branch network growth in the natural market and productivity gains whereas, on the other hand, the relation is positive in the case of branch network growth in other markets. In other words, the greater the network expansion in markets other than traditional ones, the greater the productivity gains, whereas the greater the branch network expansion in the natural market, the lower the productivity gains. In

Table 4: Productivity growth, efficiency change, technical change and size (assets), 1992–2001

	Productivity growth			Efficiency change			Technical change		
	1992–1996	1997–2001	1992–2001	1992–1996	1997–2001	1992–2001	1992–1996	1997–2001	1992–2001
$SIZE < 184828.89$	0.9982	1.0078	1.0041	0.9955	1.0044	1.0010	1.0027	1.0034	1.0030
$184,828.89 \leq SIZE < 352,555.29$	1.0155	1.0040	1.0090	1.0007	1.0064	1.0034	1.0148	0.9976	1.0056
$352,555.29 \leq SIZE < 521,892.03$	1.0110	1.0186	1.0152	0.9968	1.0028	1.0001	1.0142	1.0158	1.0151
$521,892.03 \leq SIZE < 1,041,665.87$	1.0186	1.0026	1.0097	1.0017	1.0019	1.0018	1.0169	1.0007	1.0078
$1,041,665.87 \leq SIZE$	1.0295	1.0421	1.0365	1.0008	1.0024	1.0017	1.0287	1.0396	1.0347

Table 5: Productivity growth, efficiency change, technical change and branch office network, 1992–2001

	Productivity growth			Efficiency change			Technical change		
	1992–1996	1997–2001	1992–2001	1992–1996	1997–01	1992–01	1992–96	1997–01	1992–01
$BRANCH < 107$	1.0009	1.0065	1.0042	0.9968	1.0019	1.0002	1.0040	1.0045	1.0040
$107 \leq BRANCH < 144$	1.0129	1.0230	1.0178	0.9992	1.0101	1.0045	1.0138	1.0127	1.0132
$144 \leq BRANCH < 199$	1.0248	1.0068	1.0148	0.9971	1.0031	1.0004	1.0278	1.0037	1.0144
$199 \leq BRANCH < 402$	1.0125	1.0106	1.0115	1.0013	1.0006	1.0009	1.0112	1.0100	1.0106
$402 \leq BRANCH$	1.0208	1.0333	1.0278	1.0008	1.0031	1.0021	1.0200	1.0302	1.0256

particular, savings banks whose office network in the natural market has gone through highest growth (over 3.78%) experienced average productivity gains of 0.44% throughout the entire period, whereas those whose branch office network has not increased in their traditional market (less than 0.03%) experienced gains of 1.98%. In contrast, savings banks whose office network in other markets showed the highest growth (over 23.14%) experienced productivity gains of 2.25% throughout the period, while those that have experienced the least network growth (less than 3.27%) experienced gains of only 0.64%. This "regular" relationship between intensity of expansion in their own markets and other markets is also present with a certain regularity in both subperiods considered.

Therefore, results based on a preliminary, descriptive, analysis seem to suggest that defensive strategies (expansion in traditional markets) are much less successful in terms of productivity growth than other offensive, or aggressive, strategies aimed at entering other new markets.

6.2. On the (nonparametric) relationship between productivity and geographic expansion

Figures 3.a–11.c show the relation between productivity and geographic expansion in the three markets considered using nonparametric regression techniques presented in Section 5.2.1. These regressions do not only look at contemporary relations, i.e. whether expansion between period t and $t+1$ has resulted in changes in productivity, efficiency and technology between t and $t+1$, but also whether the effect has accumulated and periods $t+3$ and $t+5$ also reflect these changes.[18] This might be relevant since, as suggested by DeYoung *et al.* (1998), "whatever the competitive impact of nationwide banking and branching, however, it is likely to occur slowly", and that "recent experience in states which have already opted-in to the Riegle-Neal Act suggests a slow structural adjustment to nationwide branching". Thus, Figures 3.a–5.c would show the contemporary relation, while Figures 6.a–8.c would reflect the relation between expansion from t to $t+1$ and productivity growth between t and $t+3$, and so on. In this way, we have considered a maximum of 4 lags, i.e. Figures 9.a–11.c report the relationship between expansion between t and $t+1$ regarding an increase in accumulated productivity between t and $t+5$. Although it is a subjective choice, we believe that it is a reasonable period of time for firms to adequately assess the results of their expansion policies.

The tendencies obtained would vary depending on the considered variable (productivity, efficiency change, or technical change), with the geographic scope of expansion in question and with an established time horizon. Thus, the global growth strategy, both in the natural market and in other markets (nationwide expansion) does not seem to positively affect productivity, although the patterns are not entirely regular, as shown in Figure 6.a—according to which the tendency could be reversed for sufficiently high values of the independent variable, although it turns negative again for high values of nationwide expansion. However, the general negative relationship pattern is robust regardless of the lag considered (Figures 3.a, 6.a and 9.a). This result reflects the relatively low technical progress experienced by firms whose office network has grown most, as seen in Figures 3.c, 6.c, and 9.c. Yet these companies experienced

[18]Similar information is also available for one and three period lags, but is not provided because of space restrictions.

Table 6: Productivity growth, efficiency change, technical change and branch office network growth, 1992–2001

	Productivity growth			Efficiency change			Technical change		
	1992–1996	1997–2001	1992–2001	1992–1996	1997–2001	1992–2001	1992–1996	1997–2001	1992–2001
$BRANCH\_G < 1.0214$	1.0182	1.0276	1.0230	1.0006	1.0042	1.0031	1.0175	1.0234	1.0198
$1.0214 \leq BRANCH\_G < 1.0292$	1.0107	1.0058	1.0075	0.9974	1.0075	1.0021	1.0133	0.9983	1.0054
$1.0292 \leq BRANCH\_G < 1.0382$	1.0074	1.0188	1.0138	0.9995	1.0004	1.0004	1.0079	1.0184	1.0134
$1.0382 \leq BRANCH\_G < 1.0517$	1.0102	1.0216	1.0166	1.0023	1.0022	1.0023	1.0079	1.0193	1.0142
$1.0517 \leq BRANCH\_G$	1.0269	1.0058	1.0151	0.9954	1.0031	0.9997	1.0317	1.0027	1.0155

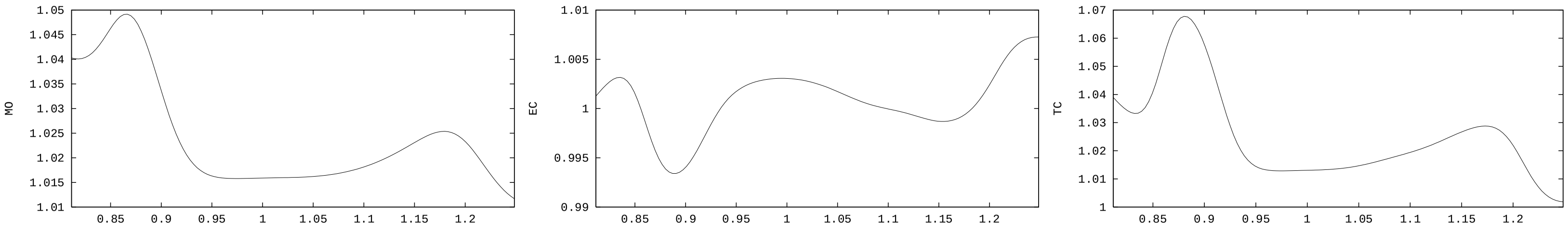
Table 7: Productivity growth, efficiency change, technical change and branch office network growth in the natural market, 1992–2001

	Productivity growth			Efficiency change			Technical change		
	1992–1996	1997–2001	1992–2001	1992–1996	1997–2001	1992–2001	1992–1996	1997–2001	1992–2001
$BRANCH\_G(n) < 1.0030$	1.0167	1.0223	1.0198	0.9985	1.0043	1.0017	1.0183	1.0179	1.0180
$1.0030 \leq BRANCH\_G(n) < 1.0148$	1.0123	1.0228	1.0177	1.0001	1.0061	1.0025	1.0122	1.0166	1.0152
$1.0148 \leq BRANCH\_G(n) < 1.0228$	1.0220	1.0262	1.0240	1.0043	1.0004	1.0029	1.0176	1.0258	1.0210
$1.0228 \leq BRANCH\_G(n) < 1.0378$	1.0053	1.0149	1.0106	0.9995	1.0016	1.0007	1.0058	1.0133	1.0100
$1.0378 \leq BRANCH\_G(n)$	1.0171	0.9939	1.0044	0.9930	1.0045	0.9999	1.0243	0.9894	1.0045

Table 8: Productivity growth, efficiency change, technical change and branch office network growth in other markets, 1992–2001

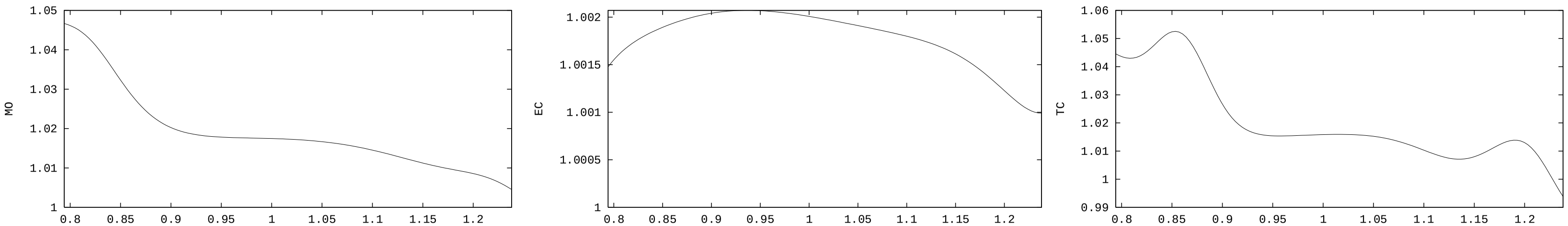
	Productivity growth			Efficiency change			Technical change		
	1992–1996	1997–2001	1992–2001	1992–1996	1997–2001	1992–2001	1992–1996	1997–2001	1992–2001
$BRANCH\_G(o) < 1.0327$	1.0033	1.0076	1.0064	0.9983	1.0020	1.0015	1.0049	1.0055	1.0050
$1.0327 \leq BRANCH\_G(o) < 1.0860$	1.0068	1.0152	1.0112	0.9914	1.0088	1.0006	1.0155	1.0064	1.0106
$1.0860 \leq BRANCH\_G(o) < 1.1411$	1.0141	1.0162	1.0151	1.0034	1.0026	1.0025	1.0107	1.0136	1.0126
$1.1411 \leq BRANCH\_G(o) < 1.2314$	1.0365	1.0114	1.0225	1.0013	0.9993	1.0002	1.0352	1.0122	1.0223
$1.2314 \leq BRANCH\_G(o)$	1.0144	1.0291	1.0225	1.0009	1.0047	1.0030	1.0134	1.0242	1.0194

Figure 3: Productivity growth determinants, nationwide (total) expansion, nonparametric regression (Nadaraya-Watson)



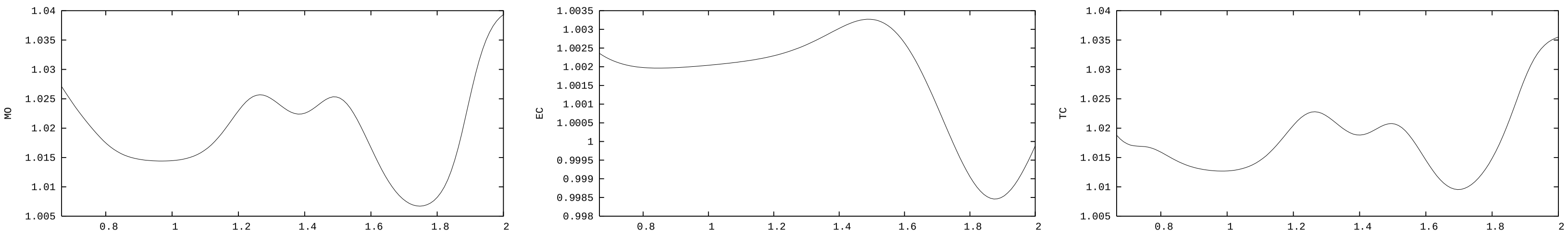
a) Productivity growth b) Catching up c) Technical change

Figure 4: Productivity growth determinants, natural market expansion, nonparametric regression (Nadaraya-Watson)



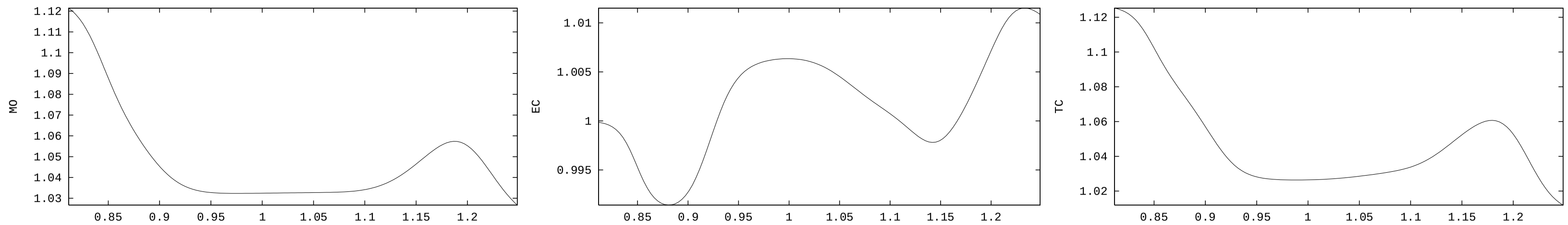
a) Productivity growth b) Catching up c) Technical change

Figure 5: Productivity growth determinants, other markets expansion, nonparametric regression (Nadaraya-Watson)



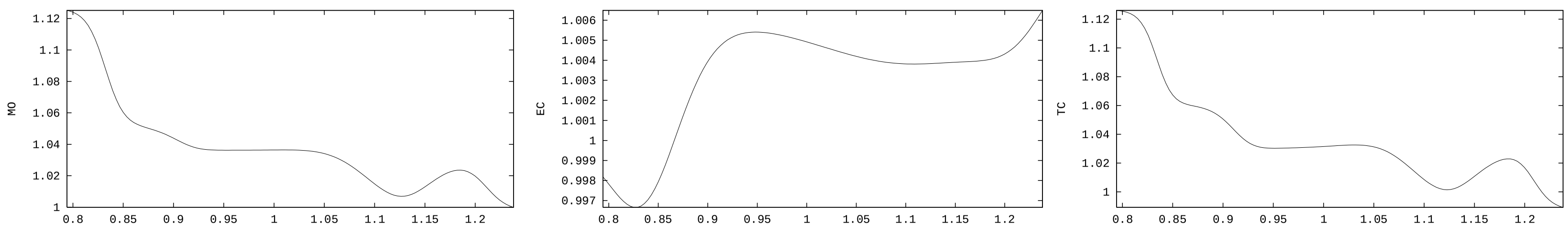
a) Productivity growth b) Catching up c) Technical change

Figure 6: Productivity growth determinants, nationwide (total) expansion, nonparametric regression (Nadaraya-Watson), 2 period lag



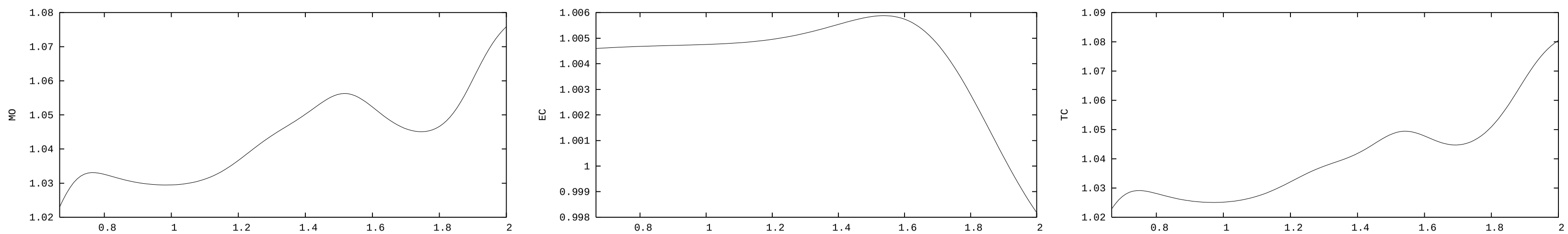
a) Productivity growth   b) Catching up   c) Technical change

Figure 7: Productivity growth determinants, natural market expansion, nonparametric regression (Nadaraya-Watson), 2 period lag



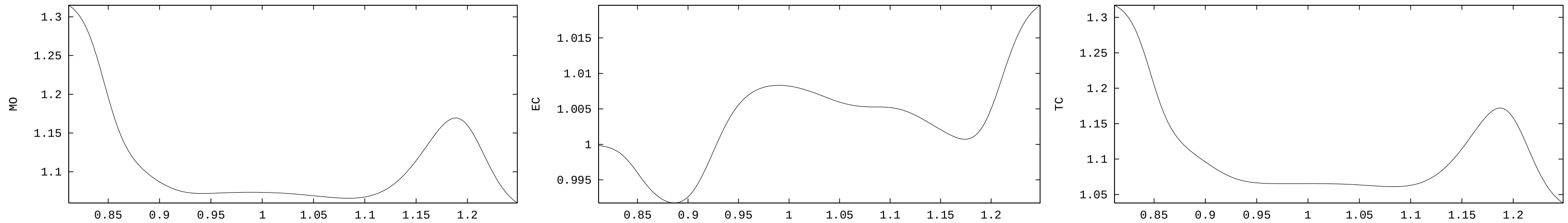
a) Productivity growth   b) Catching up   c) Technical change

Figure 8: Productivity growth determinants, other markets expansion, nonparametric regression (Nadaraya-Watson), 2 period lag



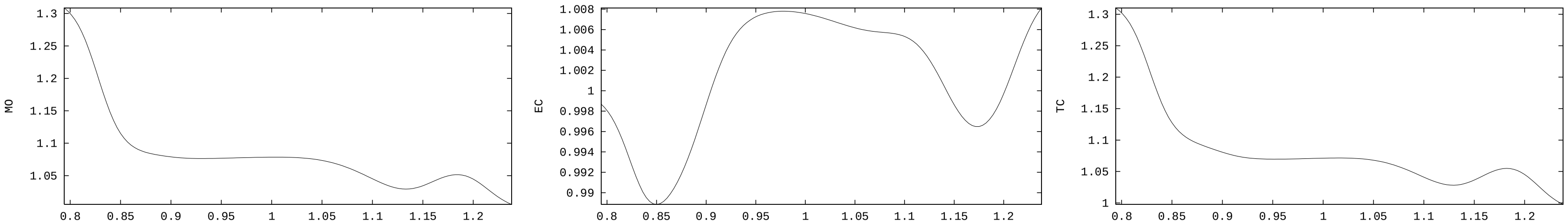
a) Productivity growth   b) Catching up   c) Technical change

Figure 9: Productivity growth determinants, nationwide (total) expansion, nonparametric regression (Nadaraya-Watson), 4 period lag



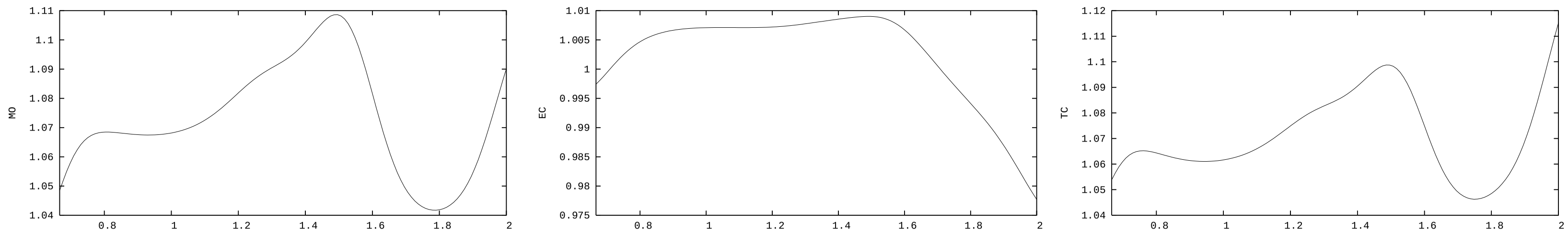
a) Productivity growth b) Catching up c) Technical change

Figure 10: Productivity determinants, natural market expansion, nonparametric regression (Nadaraya-Watson), 4 period lag



a) Productivity growth b) Catching up c) Technical change

Figure 11: Productivity growth determinants, other markets expansion, nonparametric regression (Nadaraya-Watson), 4 period lag



a) Productivity growth b) Catching up c) Technical change

the greatest gains in efficiency, as seen in the relation reported in Figures 3.b, 6.b and 9.b. It must be considered, however, that these effects are limited, since efficiency gains vary within a very narrow range.

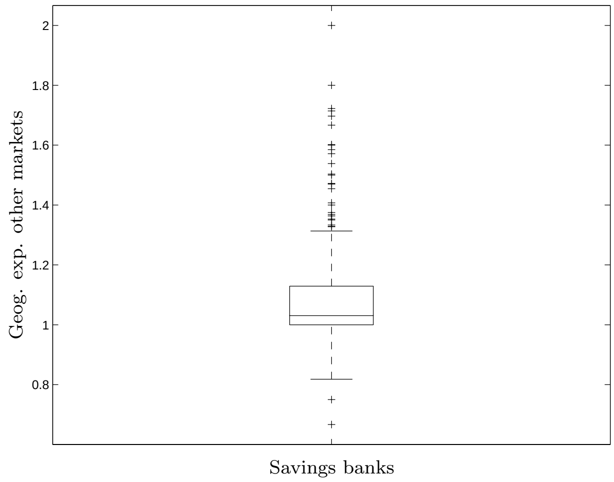
These tendencies do not differ greatly if one considers the defensive expansive strategies within each firm's natural market, as seen in Figures 4.a–4.c, 7.a–7.c and 10.a–10.c. These cases clearly show an inverse relation, which is again due to the low technical progress experienced by those firms focusing on defensive strategies.

Offensive strategies, for which territorial expansion would encompass markets other than the natural, deserve a further comment. Their relation with productivity is quite nonlinear, suggesting that it seems important to adopt a more flexible approach in which no parametric straitjacket is imposed. As suggested by Figures 5.a, 8.a, and 11.a, the links are not as easy to grasp at first sight. As for the contemporaneous affinity (Figure 5.a), we detect that not every strategy reaches a favorable outcome, since for high levels of expansion in other markets the relation is positive, yet for low levels it is negative—with a mixture of results in between. Yet should we draw a conclusion, it would be of a positive relation for most firms, since the behavior at the tails is mostly driven by outliers. This is shown in Figure 12, in which a box plot for the geographic expansion in other markets between consecutive periods (from t to $t+1$, in the 1992–2001 period) is presented. The lower and upper lines of the "box" represent the 25$^{\text{th}}$ and 75$^{\text{th}}$ percentiles of the sample—i.e., the interquartile range. The line in the middle of the box is the sample median; if it is not centered in the box it indicates skewness. The "whiskers" are lines extending above and below the box, showing the extent of the rest of the sample—unless they are outliers. Therefore, they represent the natural bounds of the distribution, i.e., the mean$\pm 1.5 IQR$. If outliers did not exist, the maximum of the sample would be the top of the upper whisker, whereas the minimum would be the bottom of the lower whisker. Figure 12 shows that the upper whisker (i.e., the upper bound of the distribution) is located at about 1.3, suggesting that, indeed, the fuzzier pattern found for high OX axis values in Figure 5.a is mainly driven by outliers. When lags are considered (Figure 8.a and Figure 11.a), a positive relationship is also found. In the case of a four-year lag (Figure 11.a) the link wanders for high values of geographic expansion; once more, this is only due to the presence of extreme observations.

These "skeletal" visions that nonparametric regression provides have a natural complement in conditional density estimation. Although regression provides us with a first approximation to the sign of our relation, and permits us to perceive irregularities in the data that would otherwise remain unnoticed, they are not exempt from certain limitations in themselves. One is that it is impossible to detect the existence of multiple modes. Thus, underlying an apparently negative relation we could find several groups of observations to be located at the upper end of the OX axis. The observed sign could be negative just because a particular mode were bigger than the rest. By concluding that the relation is negative, we would be missing what the sign could be for the remaining observations—i.e., not all expansion policies' success would be correctly evaluated.

Conditional density estimation allows us to control for these facts. To a certain extent it is a graphical indicator of inherent significance to each relation established through Figures 3.a–11.c. Although it is not such an explicit indicator as any type of indicator based on known distributions (t-Student, χ^2,

Figure 12: Boxplots for geographic expansion in other markets, 1992–2001

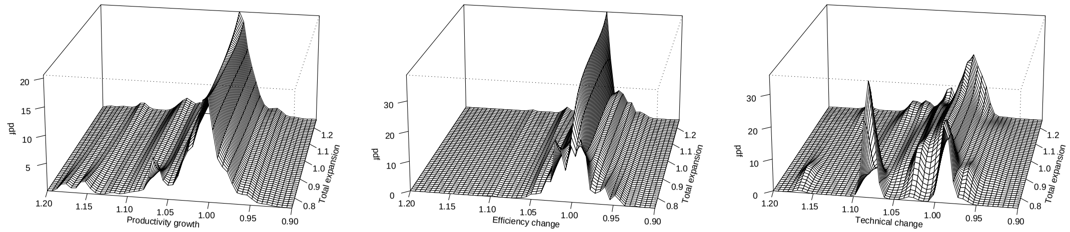


etc.), we should take into account that in this particular case we make no assumption on distributions (hence the nonparametric nature of our instruments) and therefore, that our "graphic" indicators end up being equally valid. These estimations are reported in Figures 13.a–21.c, which are three-dimensional counterparts to the nonparametric regression in Figures 3.a–11.c. In general, they reinforce the tendencies established for nonparametric regression, although there are several particular features of importance that should be mentioned.

Specifically, considering nationwide expansion and expansion in the natural market, the negative relation described in the previous paragraph is confirmed. As shown in Figures 13.a–14.c, 16.a–17.c and 19.a–20.c, the relation has indeed an inverse nature both for productivity and for technical change, as shown by the fact that the probability mass is distributed along the negative slope diagonal underlying each graph. Regarding efficiency change, the tendency is more linear, since it is the productivity change component that has a smallest impact. However, both for productivity and technical change, there is a notable presence of multi-modality, although without masking the general tendency perceived in terms of the negative relation between two variables and geographic expansion in both markets. Again, the role of the smoothing parameter (in this case smoothing parameters, one for each of the variables considered in each three-dimensional graph) plays a crucial role, since it directly affects the amount of smoothing present in each graph. The higher the smoothing parameter, the smoother the graph, whereas a lower parameter provides more bumps and a fuzzier figure. Underlying this trade-off is the traditional balance between bias and variance, as shown by Silverman (1986).

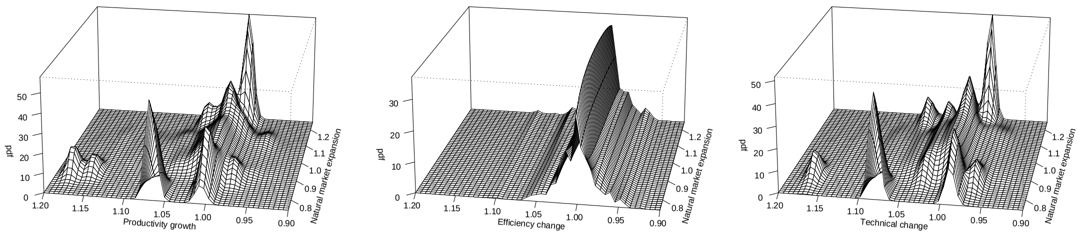
Therefore, the degree of multi-modality found for both nationwide growth and expansion in traditional markets complements, in a natural way, the results obtained for nonparametric regression. The same holds when considering the relation with expansion into other markets (Figures 15.a–15.c, 18.a–18.c and 21.a–21.c). For instance, as shown by Figure 18.a, not all firms which expand most intensively in other markets reach a favorable outcome in productivity: for some of them we even find a decline in productivity. Therefore, firms performing this type of more offensive strategies display a remarkable

Figure 13: Productivity growth determinants, nationwide (total) expansion, conditional density estimation



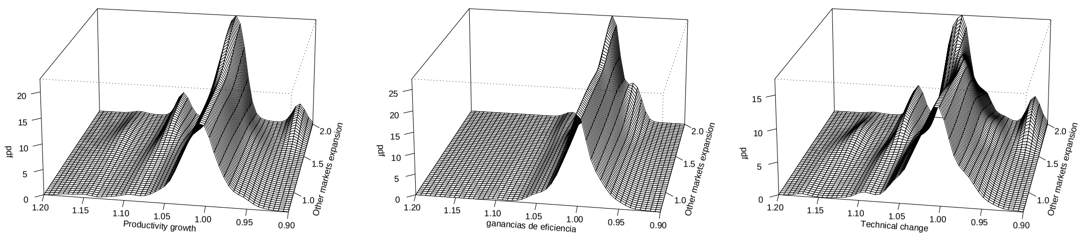
a) Productivity growth b) Catching up c) Technical change

Figure 14: Productivity growth determinants, natural market expansion, conditional density estimation



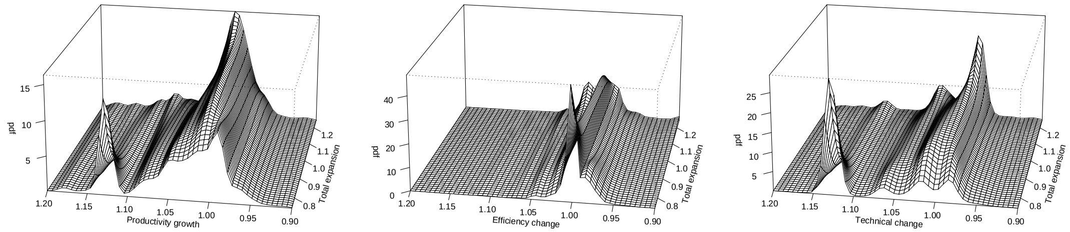
a) Productivity growth b) Catching up c) Technical change

Figure 15: Productivity growth determinants, other markets expansion, conditional density estimation



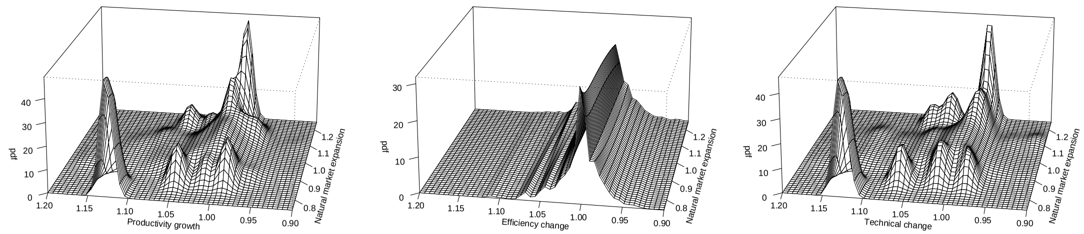
a) Productivity growth b) Catching up c) Technical change

Figure 16: Productivity growth determinants, nationwide (total) expansion, conditional density estimation, 2 period lag



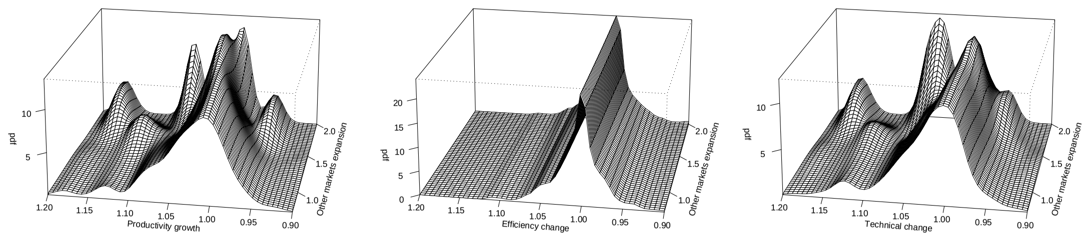
a) Productivity growth b) Catching up c) Technical change

Figure 17: Productivity growth determinants, natural market expansion, conditional density estimation, 2 period lag



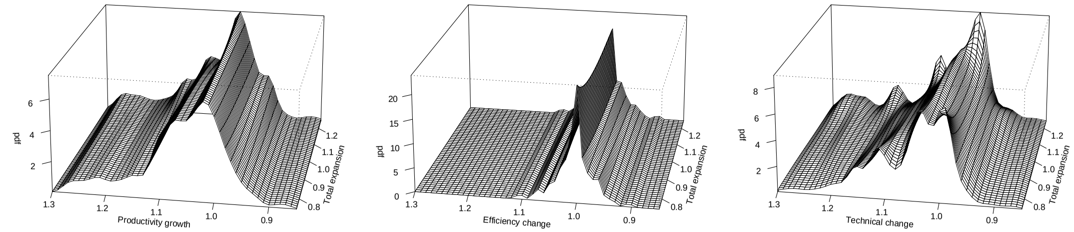
a) Productivity growth b) Catching up c) Technical change

Figure 18: Productivity growth determinants, other markets expansion, conditional density estimation, 2 period lag



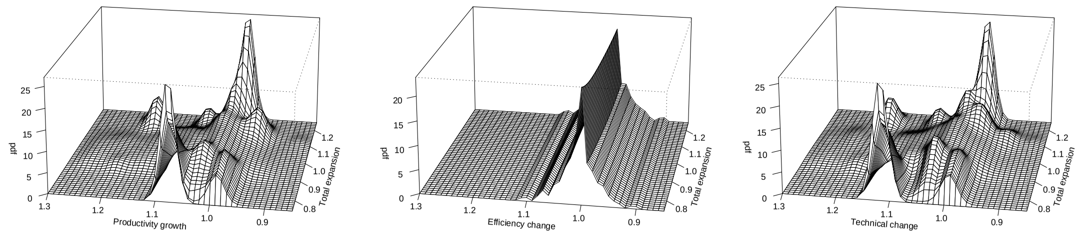
a) Productivity growth b) Catching up c) Technical change

Figure 19: Productivity growth determinants, nationwide (total) expansion, conditional density estimation, 4 period lag



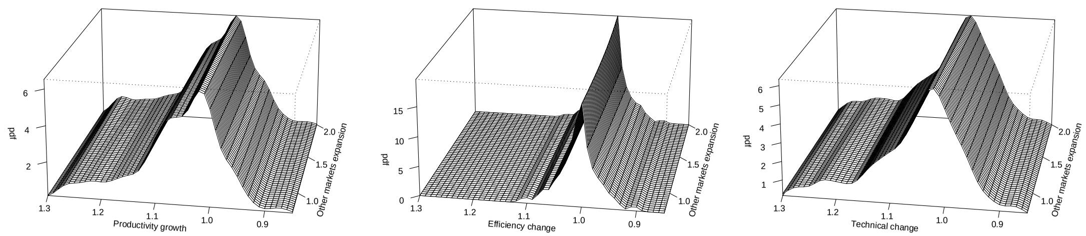
a) Productivity growth b) Catching up c) Technical change

Figure 20: Productivity growth determinants, natural market expansion, conditional density estimation, 4 period lag



a) Productivity growth b) Catching up c) Technical change

Figure 21: Productivity growth determinants, other markets expansion, conditional density estimation, 4 period lag



a) Productivity growth b) Catching up c) Technical change

variety of results. On the other hand, results are more stable, since most firms that do not expand into other markets experience small productivity gains. However, for the last of the lags considered (Figures 21.a–21.c) we find a more uniform relation, yet in this case the smoothing parameter matrix may be encountering difficulties in revealing all features possible hidden by data.

7. Conclusions

This study has analyzed the impact of geographic expansion of Spanish savings banks on their productivity. The relation has been studied, on the one hand, by considering various expansive strategies for each firm (nationwide expansion, expansion in traditional geographic markets, and expansion into other markets) and, on the other, by considering how the different strategies can affect productivity and each of their components: efficiency change (or catching up), and technical change.

Therefore, concerning methodology, the study partly lies with the so-called two-stage efficiency and/or productivity studies, the first of which measures efficiency or, in our case, productivity of decision-making units (in our case, savings banks) to be studied in order to identify, in a second stage, those factors that may be affecting it. However, this type of studies face certain difficulties such as that of being somewhat inconsistent, since they usually employ nonparametric techniques in the first stage, usually in search for greater flexibility (based on the absence of assumptions and/or imposition of functional forms) in order to use, in a second stage, standard econometric techniques such as ordinary minimum squares or logistic regression. However, we consider a different approach by adopting a fully consistent view in which nonparametric techniques are also used in the second stage of the analysis; specifically, we use both nonparametric regression and its natural complement, conditional density estimation.

The results can be summarized in various ways. Global results on productivity indicate that there have been substantial productivity gains in the sector, especially during the first half of the period under study (1992–1996)—despite the fact that many savings banks were still involved in costly mergers. The decomposition of productivity into catching up, or change in efficiency, and technical change reveals that the latter has the deepest impact on the fact that savings banks are currently producing higher quantities of outputs for given levels of inputs. This result partly coincides with previous research studies which, however, did not deal with the post-deregulation era as they were published a relatively long time ago (early and mid-nineties)—i.e., they did not consider the years of greatest savings banks expansion after adapting to the new regulatory environment. Regarding these other works (chiefly Pastor, 1995; Grifell-Tatjé and Lovell, 1996, 1997), we should highlight the homogeneity obtained with respect to efficiency change, which in our study was only slightly responsible for the productive change experienced in the sector.

The general tendencies obtained for the sector are complemented in the second part of the work when analyzing the determinants of productive change. We explicitly analyzed how different expansive strategies that savings banks have opted for have been able to affect their productive change. In order to do this, we did not only consider the possibility that savings banks were allowed to expand into other geographic zones in which their presence was vetoed before 1989, defined as offensive strategies, but we also studied the possibility of more defensive strategies, where firms would try to strengthen their existing position, and even the possibility of mixed strategies, although few firms followed this latter expansion strategy.

Results suggest that more defensive strategies followed by firms that were mainly expanding within their habitual markets of operations (which we defined as natural markets), are negatively related with productivity: the greater the branch office network growth in these markets, the lower the productivity gains. However this does not involve productivity decline for these savings banks, but the opposite. This finding has a robust relation with the number of lags under consideration. On the other hand, companies that have focused their expansive strategies in markets where they had previously not been present offer a variety of results: although in some cases the relation is clearly positive, in others it is negative. In this way, using nonparametric techniques contributes decisively to detecting this diversity in the results. In this case, the result is not entirely robust regarding the number of lags, as it is when one considers four lags, where the relation gives a more positive sign (with the exception of some outliers), i.e. there is a certain lag for expansion that translates into productivity gains. In this sense, one should also take into account that the highest gains in productivity occurred during the 1992–1996 period, whereas the period when savings banks expanded most intensively started precisely around 1996, once the mergers that many of them were involved in had stopped.

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