Productivity and economic profits of banks: Implications for interest rates and branching competition

Alfredo Martín-Oliver  
(Universitat de les Illes Balears)

Sonia Ruano  
(Banco de España)

Vicente Salas-Fumás  
(Universidad de Zaragoza)

June 2014

Abstract

This paper models spatial competition in retail banking among bank branches with different productivity level. In the short-term banks compete in interest rates. In the mid-term, banks expand their network of branches until economic profits per branch converge to zero. In equilibrium, banks that are more productive set lower (higher) interest rates of loans (deposits) and their market share increases as a result of both a higher demand of loans and deposits per branch and a larger network of branches. The model fits well the data for Spanish banks over period 1993-2007. The use of the bank-branch as the unit of analysis allows us to explain a situation where the concentration of banks over time is compatible with high industry competition. We find substantial increments in total factor productivity at the industry level during this period and that these gains contribute to lower banking intermediation costs in the form of lower interest rates of loans and higher interest rates of deposits.

JEL classification: E43, G21, L11, O30, R32.

Keywords: banks’ total factor productivity, bank’s economic profits, interest rates, branches dynamics.

*Address for correspondence: Alfredo Martín-Oliver; Universitat de les Illes Balears, Ctra. Valldemossa km. 7.5, 07122 Palma de Mallorca, Islas Baleares, Spain. Tlf: + 34 971 25 99 81; e-mail: alfredo.martin@uib.es.

* This paper is the sole responsibility of its authors and the views represented here do not necessarily reflect those of the Banco de España.
Introduction

Research has shown that distance matters in credit retail banking (Petersen and Rajan, 2002, Degryse and Ongena, 2005, Hauswald and Marquez, 2006, Agarwal and Hauswald, 2010). The reason is that distance affects the transportation costs of borrowers and the information acquisition costs of lenders. This paper models banking competition in interest rates and the expansion of banks’ branches in a spatial market with transportation costs and complete information. The key implication of these assumptions is that the bank-branch is the basic operating and competitive unit on which to build the analysis and we model retail banking around it. We show that total factor productivity (from now on, TFP) affects, in the short-run, the equilibrium of interest rates, volumes of loans and deposits, and profits per branch and, in the long-run, the equilibrium size of the network of branches. The results also highlight the relevance of controlling for banks’ TFP when studying the impact of distance in the performance of the banking sector, under complete and incomplete information conditions.

The paper develops a theoretical model whose implications are tested with data from Spanish banks. In the demand side of the model, the location of branches and the transportation costs differentiate the otherwise homogeneous products for consumers located at different points in the space. In the supply side, bank-branches differ in their operating efficiency, measured in terms of TFP, to produce loans and deposits. Competition is modeled as in Salop (1979), where banks first compete in interest rates and next decide on their network expansion, taking into account the expectations on future profits. The empirical analysis focus on the determinants of the interest rates of loans and deposits, the number of branches, and the economic profits per branch in the Spanish banking industry during period 1993-2007. A key explanatory variable is the estimated TFP of banks, which is obtained from the production function at the branch level with loans and deposits as outputs, and labor, IT capital and physical space as production inputs (Martin-Oliver et al, 2013), using the methodology posited in Levinsohn and Pakes (2003).

Consistently with the theoretical predictions, we find that, in the short-term equilibrium, more productive banks charge lower (higher) interest rates of loans (deposits). For this reason, they also get higher demand for loans and deposits per branch. Profits per bank
branch increase with productivity because, in addition to the higher demand per branch, gross profit margins are increasing with productivity levels. At the industry level, TFP gains over time lower (rise) interest rates of loans (deposits). We interpret these results as evidence that competition is effective in translating productivity gains into lower loan interest rates and higher deposit interest rates. Therefore, as a result of higher bank productivity, intermediation costs have decreased contributing to higher social welfare.

According to the model, banks expand their branch network as long as they expect earning non-negative economic profits. The time-dynamics of bank branches in the Spanish banking industry confirms that banks’ branching decisions respond to the expectations of future economic profit per branch at the industry level. Additionally, the positive correlation between bank-level productivity and the optimal number of branches implies that high-productivity banks expand their branch network at the expense of the low-productivity banks. There is also evidence that the dynamics of bank branches may have been affected by the change in the business model of Spanish banks since Spain joined the Euro zone. During this time period, Spanish banks increased their volume of loans quite above their volume of deposits and issued securities to close the gap.

The dynamics of branches are affected by the economic profits per branch because, according to the evidence, the less productive and profitable banks (particularly, those with negative economic profits) are merged or acquired by others. At the same time, banks that survive until the end of the sample period, earned, on average, a positive but not statistically different from zero long-term idiosyncratic profit. At the bank level, not all the banks have positive or zero estimated idiosyncratic profits. Therefore, our analysis suggests that banks restructuring would have continued in Spain after 2007, even if the financial crisis had not occurred.

The results of the paper add new insights into why distance matters in banking in conditions of complete information, which must be kept in mind when interpreting the effects of distance in the decisions and performance of banks under information asymmetry and uncertainty. The most obvious one is that distance also matters in the competition equilibrium of deposits markets, where information asymmetries are not relevant because deposits are secured. But it also has implications for the equilibrium in the loan market. In this respect, our model predicts that more productive banks will
have higher volume of loans per branch than the less efficient ones, so the average
distance of borrowers to the bank-branch will increase with the productivity level of
individual banks, even under complete information. Therefore, according to these
results average distance between banks and creditors does not depend only on the
incentives to invest in information acquisition (Agarwal and Hauswald, 2010), or on
differences in IT investment (Petersen and Rajan, 2002) in a context of information
asymmetries, but also on differences in TFP across banks. Not controlling for these
differences in productivity may lead to attribute to distance some effects that in fact
should be attributed to in the heterogeneity in productivity. This control would also be
recommended to interpret how distance between borrowers and banks affects the
interest rates of the granted loans (Degryse and Ongena, 2005).

Research on profits of banks has mixed interests. Some papers examine the profitability
of banks to determine whether differences in bank profits respond to i) individual
competitive advantages, such as productive efficiency and lower cost (Berger et al,
2004; Berger and Mester, 2003; Fiordelisi, 2007; Athanasoglou et al, 2008), ii) market
structure conditions (i.e., market concentration; Bourke, 1989, Mirzaei et al, 2013), or
iii) collusive behaviour (Berger and Hannan, 1998). Others view high profitability of
banks as a contribution to systemic financial stability since more profitable banks tend
to be more conservative than less profitable ones (Keeley 1990, Hellmann et al., 2000;
Salas and Saurina, 2003; Jiménez, López and Saurina, 2013). All these findings suggest
the existence of a trade-off. On the one side, more intense competition favours welfare
gains through lower interest rates of loans and higher interest rates on deposits, what
implies lower banks’ profits. On the other side, from a financial stability scope, it may
be desirable that banks earn higher profits because they are able to charge higher
intermediation margins and, thus, they will have a higher cushion to absorb potential
losses ².

Our paper focuses on competition in the short and in the long-term. The research
question is not about financial stability; rather, it is about the transmission of
productivity gains into lower intermediation costs of banks. We posit a new approach to

²Since our model assumes complete information we have no predictions on the relationship between bank
competition and credit risk (Matutes and Vives, 2000; Allen and Gale, 2004; Repullo, 2004; Boyd and De
Nico1o, 2005), and on how operating efficiency influences risk taking in lending (Fiordelisi, et al 2011,
Nemanja et al 2012)
study productivity, competition and intermediation costs of banking. More concretely, we model the banking industry by considering the bank-branch as the basic unit of analysis from which, by aggregating, lessons on firm and industry behaviour and performance can be drawn. One important implication of this approach is that the entry of new competitors in a relevant market is not necessarily in the form of new banks opening branches (Jarayatne and Strahan, 1996, Dick 2006), but it may also be by the expansion of the branch network of the existing banks. In fact, the results of the paper indicate that, even though the number of banks was reduced by 40% during the sample period through mergers and acquisitions, competition in the Spanish banking industry was unaffected because branching competition continued among the remaining banks. Moreover, we notice that in the equilibrium with zero-economic profits, interest rates will still differ from marginal costs of loans and deposits because marginal costs are lower than average costs due to the fixed cost per branch. Price-cost ratios as the Lerner index (Jiménez, López and Saurina, 2013; Fernández de Guevara and Maudos, 2007) can be associated with differences in market power from product differentiation conditions, but not necessarily with banks’ economic profits.

Our paper is also related with the literature on monetary policy transmission mechanism (Kashyap and Stein, 2000; Mojon, 2000; De Bondt, 2005) since the market equilibrium conditions determine a link between the interest rates of loans and deposits and the TFP of banks. The paper examines whether the speed of transmission differs across banks with different TFP and whether productivity affects the speed of transmission in the same way for the interests of loans and deposits or not. Schlüter et al. (2012) perform a similar exercise but only for the loans market relying on an efficiency measure, in contrast with the productivity measure used in this paper. Empirical evidence indicates that TFP has a positive effect on the speed of transmission in the loans market but a negative effect in the speed of transmission in the deposits market.

The rest of the paper is organized as follows. First, in Section 2, we formalize banks behaviour in a simple model where the relevant business unit is the bank-branch, while the number of branches is determined industry wide by opening and closing decisions. Section 3 describes the data sources and provides the descriptive statistics for the main variables, including the productivity measurement. Section 4 shows the results on the effects of productivity on the interest rates, the demands of loans and deposits and the profit level of banks, as well as the tests on the long-term converge of profits to zero as
a consequence of the banks’ branches dynamics. Finally, the conclusions section summarizes the main results of the paper and their implications.

2.- Production, demand and profit functions

In this section, we present the basic model that will provide the main hypothesis to be tested in the empirical analysis. The model includes the description of the operating technology, the demands and profit functions of banks and the market equilibrium solution for both, the short-run framework, in which the number of branches is constant (static solution), and for the long-run evolution of the number of branches and of the industry profits (dynamic solution).

Production and cost function

The modeling of the production and profit function of banks is based in Martin-Oliver and Salas-Fumás (2008). The representative bank collects deposits \( D \) and grants loans \( L \) deploying physical capital (i.e. branches denoted as \( B \)), IT capital \( IT \) and labor \( N \). Since the bank services attached to loans and deposits are provided at the branch level, we take the branch as the unit of analysis. A bank branch is a physical space where employees meet with the customers and serve their demands with their personal attention and with the support of capital services from information technology assets (IT capital). The fixed physical capacity of the branch is given by \( q \). The variable inputs labor and capital services are represented by the number of employees per branch \( E \) and the IT capital per branch \( IK \). The output per branch is equal to the sum of loans \( L \) and deposits \( D \). The production function for the representative branch of bank \( i \), is given by:

\[
L_i + D_i = \min(q_i, F_i(E_i, IK_i; A_i))
\]

All the variables are defined at the branch level. The production function \( F(\cdot) \) gives the output of the branch as a function of the variable inputs (labor and IT capital services). Parameter \( A \) represents the level of operating efficiency (total factor productivity) of the branch. Function \( F(\cdot) \) is increasing and concave in the variable inputs. Relying on data from Spanish banks, Martin-Oliver and Salas-Fumás (2008) show that the null hypothesis that \( F(\cdot) \) is linear homogeneous (i.e. it exhibits constant returns to scale) cannot be rejected. Thus, this condition will apply for the rest of the exposition.
Taking into account (1) and the linear homogeneity condition, the minimum total variable cost of producing output \((L+D)\) per branch is given by:

\[
C_i(L_i + D_i; w, cc; A_i) = (L_i + D_i) \frac{c_i(w, cc)}{A_i}
\]

The term \(c_i(w, cc)\) is the per-unit variable production cost of bank \(i\); the function \(c_i(w, cc)\) is increasing and linear homogeneous in the input prices of labor, \(w\), and of IT capital services, \(cc\).

The current market price per unit of capacity of the branch is \(p_K\) so the investment in capacity per branch is \(p_i q_i = K_i\). If \(cc_K\) is the user cost of physical branch-capital (equal to interest rate plus the corresponding depreciation rate) the fixed cost of the investment per branch is equal to \(cc_K K_i\).

**The demand functions.**

We consider a spatial market like in Salop (1979) where bank branches are symmetrically located around a circumference of perimeter 1; customers are uniformly located in each point of the circumference so the total size of the market is normalized to 1. The number of branches is initially given and equal to \(N\), so the distance between branches is \(1/N\). Deposits and loans markets are taken to be independent, so there are no bundling decisions on loans and deposits. We will denote by sub indexes \(L\) and \(D\) to loans and deposits, respectively. Therefore, the interest rates of bank-branch \(i\) will be \(r_{iL}, r_{iD}\), for loans and deposits, respectively. The notation for the representative competing bank-branch is, \(r_L, r_D\). A customer in the circumference located at distance \(x_i\) of branch \(i\) will compare the cost of a loan from branch \(i\) with the cost of the loan from the branch of the neighbor competitor. If the cost per unit of distance is \(\tau\), the distance \(x_i\) for which a borrower will be indifferent between the two branches satisfies the condition:

\[
r_{iL} + \tau x_i = r_i + \tau (1/N - x_i)
\]

Customers at a distance less than \(x_i\) from branch \(i\) will prefer buying from this branch and those at distance higher than \(x_i\) will prefer buying from the other branch. Taking
into account the customers at the two sides of the branch, the demand function of branch \( i \) will be, solving (3) and multiplying by 2:

\[
L_{i}(r_{l}, r_{l}) = 2x_{i} = \frac{r_{l} - r_{g} + \tau/N}{\tau},
\]

and for the competing branch,

\[
L_{i}(r_{l}, r_{l}) = 2(1/N - x_{i}) = \frac{r_{g} - r_{l} + \tau/N}{\tau}.
\]

Repeating the calculation for deposits, the resulting demand functions are

\[
D_{i}(r_{d}, r_{d}) = \frac{r_{d} - r_{g} + \tau/N}{\tau},
\]

\[
D_{i}(r_{d}, r_{d}) = \frac{r_{d} - r_{g} + \tau/N}{\tau}.
\]

Banks in our model face the constraint that total investments must be equal to the funds available to finance operations. Loans and fixed assets invested in the branches consume funds while deposits provide funds to finance assets. Additionally, banks have access to financial markets where they can borrow and lend at a given interest rate \( r \). If \( M \) is the amount of market funds per branch lent to or borrowed from the financial markets, then the balance constraint of supply of funds equal to demand is formulated as follows:

\[
L + K = D + M
\]

**Short-term profit maximization**

The profit per branch is equal to the difference between the revenues from loans granted by the branch and the financial and operating costs. The financial costs include the interests paid on deposits and the costs from market finance. The operating costs gather the variable costs associated to labor and IT capital services and the fixed costs from the investment on capacity. Taking into account [8] and after arranging the terms, the respective profit functions per branch of bank \( i \) and of the competing representative bank can be written as:

\[
\Pi_{i} = (r_{d} - r - c_{d})L_{i}(r_{d}, r_{l}) + (r - r_{g} - c_{d})D_{i}(r_{d}, r_{d}) - c_{c}K_{i}
\]
\[ \Pi = (r_L - r - c_i) L_L (r_L, r_d) + (r - r_D - c_D) D_D (r_p, r_d) - cc K \]  

Where \( L(\cdot) \) and \( D(\cdot) \) functions are given by equations [4] to [7] above.

Each bank chooses the interest rates of loans and deposits that maximize profits. The Nash equilibrium solutions for bank \( i \), are given by:

\[
\begin{align*}
  r_i^* &= r + \frac{2}{3} (c_{il} - c_L) + c_L + \tau/N; \\
  L_i^* &= \frac{1}{N} - \frac{1}{3\tau} (c_{il} - c_L)
\end{align*}
\]

and

\[
\begin{align*}
  r_{id}^* &= r - \frac{2}{3} (c_{id} - c_D) - c_D - \tau/N; \\
  D_{id}^* &= \frac{1}{N} - \frac{1}{3\tau} (c_{id} - c_D)
\end{align*}
\]

Equations [11] and [12] provide the interest rates and the volumes of loans and deposits at the short-term market equilibrium, for each bank branch in its local market. Equilibrium interest rates decrease with the number of branches \( N \) and they are positively related with the money market interest rate \( r \), with the unit operating costs of all banks (the own ones, \( c_i \), and those of competitors, \( c \)), with the perceived differentiation \( \tau \). Since the unit costs decrease with the TFP (measured by parameter \( A \)), the higher the productivity of banks, the lower the interest rates of loans and deposits in the equilibrium. The loans and deposits per bank branch in the equilibrium depend on the aggregate number of branches, on the spatial differentiation and on the difference between the operating unit costs of bank \( i \) with respect to its competitors. Therefore, in the equilibrium, more productive banks will have higher demands of loans and deposits.

Substituting the equilibrium values of prices and quantities from [11] and [12] in [9], the maximized volume of profit for bank \( i \) is equal to:

\[
\Pi_i^* = \left( \frac{\tau}{N} \frac{1}{3} (c_{il} - c_L) \right)^2 + \left( \frac{\tau}{N} \frac{1}{3} (c_{id} - c_D) \right)^2 - cc_i K_i. 
\]
Profit of bank-branch $i$ increases with the own productivity relative to that of competing banks (as determinant of unit costs $c$). Productivity gains increases profits through two effects, through the increase of the gross profit margin ($r^g_L - r - c_L$ increases with $A_i$ from [11]) and also because it implies more volume of demand per branch. Profit per branch is higher if the bank operates in markets with higher buyers’ perceived differentiation ($\tau$) and/or in markets with lower number of branches ($N$).

The dynamics of bank branches

The dynamics of the number of branches in a market will be the result of the simultaneous decisions of individual banks about opening and closing branches in that particular market. Each bank will open new branches when its profit expectations are positive and, contrarily, will close them when expectations are negative. These expectations have two components, the profit opportunities that the market offers for all banks, and the profit opportunities of the particular bank in the market, which will depend on its relative competitiveness. We approximate the general profit opportunities by the forecast of economic profits per branch in the market, and the competitiveness of bank $i$ by its relative productivity. The dependent variable of the model is the change in the number of branches of bank $i$ in period $t$. Since banks can open branches anywhere in the country, the profit expectations that affect the opening or closing decisions are defined at the nation-wide market level. Then, we model the branches dynamics for bank $i$ as follows:

$$N_{it} - N_{i,t-1} = \beta_0 + \beta_1 E\left(\frac{\Pi_i}{N_i}\right) + \beta_2 R_A_{i,t-1}$$

[14]

where $N_{it}$ is the number of branches of bank $i$ in year $t$, $E\left(\frac{\Pi_i}{N_i}\right)$ is the expected profit per branch for the whole banking system in year $t$, and $R_A_{it}$ is a measure of relative productivity of bank $i$. It is expected that changes in the number of branches over time will be positively correlated with the general expectations on the economic profits per branch, and with the relative productivity of bank $i$ with respect to rival banks, i.e. we expect $\beta_1 > 0$ and $\beta_2 > 0$.3

3In the Salop type model of spatial competition the equilibrium number of branches in the market with free entry is higher than it should be from welfare maximization criteria; this implies inefficient equilibrium interest rates of loans and deposits too. The socially inefficient number of branches and
The dynamics of industry profits

At the industry level, the total number of branches in period $t$ is the result of the sum of branching decisions made by each individual bank. If there is no collusive coordination of branching decisions by banks, then the dynamics of opening and closing of branches will drive the industry economic profits per branch to zero in the long term. Hence, we formulate the hypothesis of convergence to zero of the economic profits per branch for the whole industry as:

$$\Pi_{M_t} = \alpha_0 + \alpha_1 \Pi_{M_{t-1}} + v_t$$

with $E(\alpha_0)=0$ and $E(\alpha_1)<1$. Equation [15] can be modified to allow for idiosyncratic effects for each bank which will determine whether convergence on bank profits is conditional or unconditional.

Here, we synthesize the hypotheses derived from the model discussed in this section that we will test empirically.

**H1:** The operating efficiency determines the performance of banks:

a) Interest rates of loans (deposits) charged by a bank decrease (increase) with the difference in productivity of the bank with respect to competitors and decrease (increase) with the average productivity in the market.

b) Loans and deposits per branch increase with the relative difference of productivity of the bank with respect to its rivals.

c) In the short-term, profits per bank-branch increase with the relative productivity of banks.

**H2:** The dynamics of branches, [14], is summarized as follows:

a) The number of branches of each bank increases over time with the relative difference in productivity with respect to rivals at the beginning of the period, and with the expectations on future profits of the average branch in the market.

**H3.** The dynamics of industry profits [15]

Interest rates from free entry is not discussed in the paper. See Berger et al (1997) for a different approach to efficient banks’ branches expansion.
a) For the whole banking industry, average economic profit per branch converges towards zero over time.

3. Database and variables

The database refers to Spanish banks over the pre-crisis period of 1993-2007. We use unconsolidated balance sheets and income statement data for each bank and year, with merged banks treated as a new entity. We now describe the calculation of each of the main variables used in the empirical analysis and provide descriptive statistics on each of them.

3.1. Measurement of productivity

The TFP $A_t$ for bank $i$ in year $t$ is estimated as in Martin-Oliver et al (2013). The banking firm is modelled following a production approach where the production function is defined at the branch level according to [1]. Banks deploy labour, IT and physical capital services as inputs to produce a multiple-output that includes the collection of deposits\(^4\), the delivery of loans and the provision of bank services related with them (liquidity provision, payment services, screening applicants, monitoring borrowers, etc). Therefore, the production approach assumes, realistically, that banks must deploy inputs in the form of labour and capital services to produce deposits and related services, as well as to produce loans\(^5\).

The production function for the representative technology at the branch level is estimated with the methodology developed by Levinsohn and Petrin (2003) that corrects for the simultaneity bias in the OLS estimation due to the correlation between the (unobserved) level of productivity and the amount of labour used in production. We compute a “raw” measure of productivity as the difference between the observed and the predicted output taking into account the estimated parameters of the production function, following the methodology posited in Levinsohn and Petrin (2003). Raw productivity may be different among banks for other reasons besides productive

---

\(^4\)Contrarily to the intermediation approach, in which deposits are considered an input, together with labor and capital, to produce loans.

\(^5\)The estimation of production function has different advantages compared with the estimation of the cost function. First, it only requires information on the quantities of input and output variables, whereas the estimation of the cost function also requires information on input prices, which are often difficult to measure (i.e., pricing risk). Moreover, in the intermediation approach the deposit interest rate is taken as an exogenous variable though when banks have market power in the deposits market the interest rate of deposits is determined from the market equilibrium conditions.
efficiency in transforming inputs into outputs. In order to isolate the TFP that more closely measure the operating efficiency of banks Martín-Oliver et al (2013) model the raw productivity as follows:

\[
Raw\ Productivity = A_t + X_{it}'\gamma + A_{it}
\]  

[16]

The TFP of bank \( i \) is separated into two components: the average productivity for the whole banking industry (\( A_t \)), and the differential of the productivity of bank \( i \) in year \( t \) with respect to the industry average (\( A_{it} \)). The vector of control variables (\( X_{it} \)) accounts for other sources of heterogeneity different from operating efficiency. The industry productivity (\( A_t \)) is estimated as the coefficient for the time dummy variable of year \( t \) in [16], while the difference with respect to this mean for bank \( i \) in period \( t \) (\( A_{it} \)) is obtained as the residual of the estimation. Since the “raw” productivity measure is expressed in logs, the industry and the bank operating efficiency variables are also in logs\(^6\).

Figure 1A shows the distribution of the estimated productivity of banks and years for the whole sample period. The distribution is centered on zero because they are the residuals from equation [16]. We observe that productivity is heterogeneous across banks (no degenerated distribution) and that the distribution around the mean is quite symmetric. The estimated coefficients for the time dummy variables in equation [16] that give the time trend in average industry productivity are shown in the last column of Table 2. We observe a steady growth of around 3% a year and an accumulated growth of 45.8% for the 15 years of the sample.

Since the short-term equilibrium solutions and the equation of the dynamics of branches are functions of the bank’s TFP relative to its competitors, we define two dummy variables that classify banks according to their relative level of productivity. The

\(^6\)In the banking literature, the measures of operating efficiency include accounting ratios (such as operating expenses over gross operating margin), and distances to the efficient production frontier obtained through either non-parametric (Data Evolvement Analysis or DEA) or parametric (Stochastic Frontier Estimates or SFE) estimation methodologies. Accounting ratios have severe limitations to be used as a measure of production efficiency since both, the numerator and the denominator, are monetary variables that vary with prices and quantities. The DEA methodology is used in both production and cost functions. The SFE method is most often used to estimate distances to the (dual) cost function and assumes an intermediation approach to the banking firm.
variable $1d(\text{Prod}_i < p25^{\text{th}})$ takes the value of 1 for all banks-years whose level of productivity is lower than the productivity corresponding to the 25th percentile of the distribution of competing banks of competing banks in the same market.

Figure 1. Distributions of productivity (TFP)

A. All Banks

B. Own and Competitors’ TFP

Figure 2.- Evolution of the bank-level distribution of interest rates over time in the banking industry

A. Loan InterestRates

B. DepositInterestRates
given year. The variable \( ld(\text{Prod}_{i,t} > p25^\text{th}) \) takes the value of 1 for banks-years with productivity above the 75\(^{\text{th}}\) percentile of the distribution in the year. The distribution of productivity for the competitors of bank \( i \) is obtained from the estimated productivity of those banks that compete in the relevant market for bank \( i \). We define the relevant market of a bank as all the provinces in which the bank has at least five branches or more. Figure 1B presents the distribution of productivity for the banks that are located below the 25\(^{\text{th}}\) percentile and above the 75\(^{\text{th}}\) percentile of the total distribution of productivity.

### 3.2. Interest rates

The interest rates of loans and deposits for bank \( i \) in year \( t \) (\( r_{\text{L},it} \) and \( r_{\text{D},it} \), respectively) for the empirical analysis are measured with marginal interest rates, that is, interest rates charged by banks in new operations. The interest of loans is the weighted average of the interest rates charged in the different types of loans (i.e. business, consumer and mortgage loans), using as weights the volume of the operations. Similarly, the interest rates of deposits are the weighted average of the interest rates paid on current and
saving deposits\textsuperscript{7}. Since the data of marginal interest rates has a monthly basis, we take averages of the twelve monthly values available for each year to obtain yearly data.

Figure 2 characterizes the evolution of the distributions of the banks’ interest rates of loans (panel A) and deposits (panel B). In both cases, we observe a decreasing trend that is parallel to the evolution of the interbank market interest rate, whose time trend has been very much affected by the entrance of Spain into the EMU in 1999. Average and median values of interest rates are similar in loans and deposits although, in the case of loans, the median is slightly smaller than the mean in the years from 2002 to 2007, suggesting a fatter tail of the distribution of interest rates for higher values of the variable. The coefficient of variation shows an upward trend in both, loans and deposits, which indicates that the relative dispersion in banks’ interest rates of loans and of deposits has been increasing over time. Since the standard deviation remains rather stable over time, the time trend observed in the coefficient of variation is due to the decreasing trend in average interest rates. In spite of the level of interest rates having steadily decreased over time, the relative differences with respect the average have become larger.

3.3. Volumes of loans and deposits per branch

The volumes of loans and deposits per branch of bank $i$ in year $t$ ($L_{it}$ and $D_{it}$, respectively) are calculated dividing the respective stocks of loans and deposits at the end of year $t$ by the number of branches of the bank at the end of $t$. The stocks of loans and deposits are valued at constant prices to control for time variations due to pure monetary effects. The calculation of the stocks of loans and deposits at constant prices follows the permanent inventory approach with depreciation equal to zero and price inflation equal to the growth rate of the consumer price index.

The descriptive statistics of the volume of loans and deposits and per branch are shown in Table 1. Both have dramatically increased during the sample period. The average has been multiplied by a factor of 2.3 in the case of loans and by 2.4 in the case of deposits. The representative branch granted 35,850 thousands Euros of loans and collected

\textsuperscript{7}The use of interest rates of loans and deposits for the transactions in year $t$ has advantages over the more usual estimation of average interest rates equal to the interests charged on loans in year $t$ divided by the stock of loans at the beginning of the period. The reason is that operating efficiency is calculated for year $t$ so it is relevant for the transactions performed along that year. The ratio of flows over stocks combines values of the variables in the numerator and the denominator that result from transactions along several years.
27,350 thousands Euros of deposits in 2007. The magnitude of this raise is replicated in all the percentiles of the distribution of loans and deposits (not shown), consistent with a general increment of the volume of loans and deposits per branch that shifts the distributions towards the right.

3.4. Economic profits per branch

Banks make decisions to maximize economic profits. If the decision unit is the bank branch then economic profits are expressed in profits per branch. Although most of the studies on profits measure profits in terms of rates of return (Bourke, 1989; Athanasoglou et al, 2008; Mirzaei et al 2013)\textsuperscript{8} banks do not make decisions to maximize rates of returns but to maximize absolute profits.

\textsuperscript{8}One exception is Albertazzi and Gambacorta (2009) that use accounting profits in levels. Banks maximize profits, not rates of return. In fact the total assets or equity used in the calculations of ROA and ROE are themselves endogenous variables so their determinants will affect the calculated values of rates of return.
Table 1. Descriptive statistics of economic profits, volume of loans and volume of deposits per branch

<table>
<thead>
<tr>
<th>Year</th>
<th>Economic Profit per Branch</th>
<th>Volume of Loans per Branch</th>
<th>Volume of Deposits per Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Median</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>1992</td>
<td>-276.8</td>
<td>-38.12</td>
<td>649.3</td>
</tr>
<tr>
<td>1993</td>
<td>-243.8</td>
<td>-40.95</td>
<td>590.2</td>
</tr>
<tr>
<td>1994</td>
<td>-279.2</td>
<td>-26.19</td>
<td>664.2</td>
</tr>
<tr>
<td>1995</td>
<td>-292.4</td>
<td>-27.62</td>
<td>655.7</td>
</tr>
<tr>
<td>1996</td>
<td>-177.6</td>
<td>-17.65</td>
<td>540.8</td>
</tr>
<tr>
<td>1997</td>
<td>-178.5</td>
<td>4.575</td>
<td>571.3</td>
</tr>
<tr>
<td>1998</td>
<td>-128.6</td>
<td>32.28</td>
<td>601.6</td>
</tr>
<tr>
<td>1999</td>
<td>-146.7</td>
<td>44.02</td>
<td>617.3</td>
</tr>
<tr>
<td>2000</td>
<td>-162.2</td>
<td>28.13</td>
<td>658.8</td>
</tr>
<tr>
<td>2001</td>
<td>-160.3</td>
<td>22.72</td>
<td>661.2</td>
</tr>
<tr>
<td>2002</td>
<td>-134.0</td>
<td>22.63</td>
<td>594.5</td>
</tr>
<tr>
<td>2003</td>
<td>-163.3</td>
<td>15.45</td>
<td>622.7</td>
</tr>
<tr>
<td>2004</td>
<td>-98.96</td>
<td>19.73</td>
<td>547.3</td>
</tr>
<tr>
<td>2005</td>
<td>-51.08</td>
<td>21.53</td>
<td>472.5</td>
</tr>
<tr>
<td>2006</td>
<td>-14.93</td>
<td>34.08</td>
<td>490.5</td>
</tr>
<tr>
<td>2007</td>
<td>40.90</td>
<td>40.94</td>
<td>365.7</td>
</tr>
</tbody>
</table>

Note: All variables expressed in thousands of constant Euros of 1992.
Our estimate of economic profits is calculated from accounting profits with some adjustments. These adjustments consist on excluding expenditures in IT and advertising from the costs of the year and considering them as investment flows that are capitalized and depreciated yearly at depreciation rates proposed in the literature. In addition, the opportunity cost of equity, which is not considered as a financial cost in the calculation of accounting profits, is counted as a cost in the calculation of the economic profit. Economic profits are calculated at the bank level. Then, they are divided by the number of branches of the bank to obtain the branch-level economic profit for every bank-branch and year.

Table 1 shows the evolution of the economic profits per bank during the sample period. Economic profits show a cyclical profile with negative average and median values until 1997 and positive afterwards. Figure 3 shows the frequencies distribution of economic profits per branch for all banks and years in the sample data. Figure 3A corresponds to the economic profits divided by the equity of the bank (relative economic profits) and Figure 3B to the volume of profits per branch. For both variables the mean and the median are centred on zero, as expected in a competitive market in which the dynamics of entry and exit of branches drives the level of profits to zero. On average for the whole time period and all banks, we observe that banks’ net income just compensates for the opportunity cost of equity.

The empirical model about the dynamics of the branches of bank \( i \) in period \( t \) (Equation 14), includes as explanatory variable the “expected” profits per branch for year \( t+1 \) in the relevant market, denoted as \( E\left( \frac{\Pi_{i,t+1}}{N_{i,t+1}} \right) \). Since banks can open new branches in any province of the country and we model the number of branches in the current market and in the potential new ones, the relevant market for the decision of expansion of branches is the whole national market. More particularly, we estimate \( \frac{\Pi_{i,t+1}}{N_{i,t+1}} \) for the average bank of the whole banking industry in the following manner. The expected values of the numerator and of the denominator, \( \Pi_{i,t+1} \) and \( N_{i,t+1} \), are estimated separately for every bank and year using a panel-data model that relates the dependent variable with the lagged dependent variable, the interbank interest rate, the GDP growth

\[1\]For a more detailed description of the calculation of economic profits of banks see Martín-Oliver et al (2007).
Figure 3. Industry distribution of the rate of return and the economic profits per bank-branch

A. Economic profits on equity

B. Economic profits per branch

Note: Units in terms of 1 in the x-axis  
Note: the € in the x-axis

and the inflation rate. Next, by aggregating at the country level the predictions for all the banks in each year, we obtain the series for the average bank in the whole banking industry, \( \bar{\Pi}_{i,t} \) and \( \bar{N}_{i,t} \). In order to assess the impact of the prediction error, we estimate \( \tilde{\Pi}_{i,t} \) and \( \tilde{N}_{i,t} \) using two approaches. First we run the estimations every year using only the information available at \( t \). Second, the estimations at every year are run using all the information of the whole sample period.

Finally, we calculate the average economic profits per branch for the whole banking industry in year \( t \) (\( \Pi_{M_t} \)) dividing the sum of economic profits for all banks at \( t \) by the sum of the number of branches of all banks also at \( t \). The average economic profit per branch for the whole industry is the relevant variable in equation [15].
3.5. Number of branches

The dependent variable in Equation [14] is the first-difference of the number of branches of bank \( i \) at \( t \), \( \Delta N_t \). The variable number of branches for each bank and year is directly taken from the database on banks’ statistics available at the Bank of Spain. Table 2 shows the evolution in the number of banks and some descriptive statistics of the number of branches. The number of banks has decreased over time, giving as a result higher market concentration at the bank level. However, the average number of branches per bank has dramatically increased. This raise in the number of branches affects all percentiles of the distribution, though the growth in larger banks is more acute: banks in the 25\textsuperscript{th} and 50\textsuperscript{th} percentiles of the size distribution present a cumulative growth rate in their number of branches of around 94\%, whereas banks in the 75\textsuperscript{th} percentile have a growth rate of 133\%. The whole pattern of branches expansion reflects the growth of the network of branches triggered by the 1988 regulatory change, which removed all restrictions to the geographical extension of saving banks.

The market equilibrium conditions in interest rates of loans and deposits and in volumes of loans and deposits per branch depend on the number of branches in the relevant market. As indicated above, we define the relevant market for a bank as the sum of all the provinces where it has at least 5 branches. However the number of bank branches in each province is endogenous according to the model, since banks decide opening or closing branches in each province. To reduce the possible estimation biases we substitute the total number of branches from all banks in the relevant market, by an estimate of the size of the relevant market, equal to the sum of GDPs of each province that belongs to the relevant market of bank \( i \), \( GDP_{Market} \).
Table 2. Number of banks, number of branches and time varying explanatory variables

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of banks</th>
<th>Number of Branches</th>
<th>LLP/Assets (x100)</th>
<th>GDP Market (m€)</th>
<th>Real Interbank</th>
<th>GDPG</th>
<th>Inflation</th>
<th>Industry Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>143</td>
<td>223.0</td>
<td>0.744</td>
<td>108,666</td>
<td>7.38%</td>
<td>0.9%</td>
<td>3.54%</td>
<td>7.457</td>
</tr>
<tr>
<td>1993</td>
<td>141</td>
<td>221.9</td>
<td>0.899</td>
<td>117,501</td>
<td>6.34%</td>
<td>-1.0%</td>
<td>5.92%</td>
<td>7.526</td>
</tr>
<tr>
<td>1994</td>
<td>137</td>
<td>231.8</td>
<td>0.794</td>
<td>132,704</td>
<td>3.73%</td>
<td>2.4%</td>
<td>4.57%</td>
<td>7.485</td>
</tr>
<tr>
<td>1995</td>
<td>138</td>
<td>236.5</td>
<td>0.450</td>
<td>152,969</td>
<td>5.32%</td>
<td>2.8%</td>
<td>4.72%</td>
<td>7.510</td>
</tr>
<tr>
<td>1996</td>
<td>133</td>
<td>250.6</td>
<td>0.327</td>
<td>170,017</td>
<td>3.80%</td>
<td>2.4%</td>
<td>4.67%</td>
<td>7.533</td>
</tr>
<tr>
<td>1997</td>
<td>131</td>
<td>260.3</td>
<td>0.214</td>
<td>185,808</td>
<td>3.23%</td>
<td>3.9%</td>
<td>3.56%</td>
<td>7.606</td>
</tr>
<tr>
<td>1998</td>
<td>125</td>
<td>280.0</td>
<td>0.183</td>
<td>222,033</td>
<td>2.17%</td>
<td>4.5%</td>
<td>1.97%</td>
<td>7.607</td>
</tr>
<tr>
<td>1999</td>
<td>121</td>
<td>290.6</td>
<td>0.307</td>
<td>250,224</td>
<td>0.84%</td>
<td>4.7%</td>
<td>1.83%</td>
<td>7.598</td>
</tr>
<tr>
<td>2000</td>
<td>113</td>
<td>309.7</td>
<td>0.320</td>
<td>284,424</td>
<td>1.33%</td>
<td>5.0%</td>
<td>2.31%</td>
<td>7.682</td>
</tr>
<tr>
<td>2001</td>
<td>108</td>
<td>319.1</td>
<td>0.366</td>
<td>323,247</td>
<td>0.48%</td>
<td>3.6%</td>
<td>3.43%</td>
<td>7.669</td>
</tr>
<tr>
<td>2002</td>
<td>103</td>
<td>332.4</td>
<td>0.391</td>
<td>369,641</td>
<td>0.42%</td>
<td>2.7%</td>
<td>3.59%</td>
<td>7.729</td>
</tr>
<tr>
<td>2003</td>
<td>97</td>
<td>353.4</td>
<td>0.474</td>
<td>411,952</td>
<td>-0.69%</td>
<td>3.1%</td>
<td>3.07%</td>
<td>7.704</td>
</tr>
<tr>
<td>2004</td>
<td>94</td>
<td>377.6</td>
<td>0.330</td>
<td>451,631</td>
<td>-0.73%</td>
<td>3.3%</td>
<td>3.04%</td>
<td>7.728</td>
</tr>
<tr>
<td>2005</td>
<td>93</td>
<td>395.4</td>
<td>0.303</td>
<td>529,902</td>
<td>-1.03%</td>
<td>3.6%</td>
<td>3.01%</td>
<td>7.784</td>
</tr>
<tr>
<td>2006</td>
<td>92</td>
<td>416.2</td>
<td>0.305</td>
<td>614,128</td>
<td>-0.08%</td>
<td>3.9%</td>
<td>3.37%</td>
<td>7.886</td>
</tr>
<tr>
<td>2007</td>
<td>90</td>
<td>443.1</td>
<td>0.376</td>
<td>706,662</td>
<td>1.66%</td>
<td>3.8%</td>
<td>3.52%</td>
<td>7.914</td>
</tr>
</tbody>
</table>
3.6 Other explanatory variables

Banks may differ in their willingness to take credit risks. To control for this source of heterogeneity among banks we add the variable ratio of loan loss provisions over total assets (i.e. $LLP/Assets$) among the explanatory variables in the models of determinants of interest rates of loans and volume of loans per branch. If this ex-post measure of credit risk is a good proxy of the perceived risk at the time the loan is granted, then the interest rates of loans is expected to increase with the credit risk proxy. Other sources of heterogeneity among banks that are unobservable and time invariant are captured in the empirical model by time invariant fixed effects.

In the empirical model, we assume that the banks’ differentiation perceived by consumers (parameter $\tau$) is the same across markets and, thus, it is excluded from the list of the explanatory variables for interest rates and volumes of demand.

In some cases, the time dummy variables will be replaced by macro and other time-varying variables common to all banks. These include variables such as interbank interest rates, price inflation and GDP growth of the Spanish economy and the estimates of average operating efficiency for the banking industry, $A_i$ in [16].

4. Empirical model and results

4.1. Empirical models

The first group of empirical models correspond to the econometric formulation of equations [11], [12], [13], [14] and [15] that explain interest rates of loans and deposits, volume of loans and deposits per branch and economic profits per branch.

The empirical model on the determinants of interest rates is formulated as follows:

$$y_{it} = \gamma_0 + \gamma_1 Id(Prodv. < 25^{th})_{u-1} + \gamma_2 Id(Prodv. > 75^{th})_{u-1} + \gamma_3 A_i +$$

$$+ \gamma_4 \ln GDPMarket_{u-1} + \gamma_5 CV_t + \eta^L_t + \nu^L_t$$  \[17\]

The variable $A_i$ is the average TFP of the industry at year $t$ defined above; the size of the market $GDPMarket$ replaces the number of branches in the relevant market to avoid endogeneity problems; the $CV_t$ is a vector of time varying control variables. The control variables include the ex-post credit risk of bank $i$ in year $t$ calculated as the ratio of loan
loss provisions over total loans $\frac{LLP_{i,t-1}}{Assets_{i,t-1}}$ (only for the interest of loans), and time varying variables such as the Interbank interest rate, the GDP growth rate and the consumer price index (Inflation). We expect that the coefficients of the variables that capture the relative efficiency levels of bank $i$ will have signs $\gamma_1 > 0$ and $\gamma_2 < 0$ for interest on loans and just the opposite signs for interest on deposits. The model also predicts a negative (positive) association between industry efficiency and interest rates of loans (deposits): $\gamma_3 < 0$ (>0). Closer distance between branches in larger markets implies more intense competition, so we expect $\gamma_4 < 0$ (>0) in the equation of determinants of interest rates of loans (deposits). The effective transmission of monetary policy implies a coefficient of one for the interbank interest variable. For robustness purposes, equation [17] will be estimated replacing time varying variables by time dummy variables.

The empirical econometric model on the determinants of volumes of loans, deposits and economic profits per branch, is formulated as follows:

$$z_{it} = \delta_0 + \delta_1 ld(Prodv. < 25^{th})_{i,t-1} + \delta_2 ld(Prodv. > 75^{th})_{i,t-1} + \delta_3 \ln GDPMarket_{i,t-1} + D_i + \eta_i + \nu_{it} \quad [18]$$

From the theory we expect $\delta_1 < 0$, $\delta_2 > 0$ and $\delta_3 < 0$ for all dependent variables. When the dependent variable is volume of loans per branch, we also include the variable $\frac{LLP_{i,t-1}}{Assets_{i,t-1}}$ in [18]. The coefficient of this variable could be positive, if banks reduce their credit standards and grant more loans per branch when risk increases, or negative, if banks grant fewer loans to riskier borrowers. The answer of this question will be answered empirically.

All the previous empirical models contain banks fixed effects to control for the unobserved heterogeneity, $\eta_i$. Finally, $\nu_{it}$ is the stochastic error term. All the variables are lagged one period to capture the effect of “at the beginning of the year” and limit the impact of potential endogeneity. Also, the measures of relative productivity are instrumented with the lagged values of the $25^{th}$, $50^{th}$ and $75^{th}$ percentiles of the distribution of the competitors’ productivity. We expect a high correlation between these instruments and the variables identifying banks of high and low productivity, but none correlation with the residuals from the empirical model of any of the dependent variables.
The empirical model on the short-term evolution of branch opening and closing decisions [14] is formulated as follows:

\[ N_n - N_{n-1} = \beta_1 + \beta_2 \text{Prodv. (< 25th)}_{n-1} + \beta_3 \text{Prodv. (> 75th)}_{n-1} + \beta_4 \text{FPI}_{t+1} + D_t + \eta_n + u_n \]  \[ \text{[19]} \]

This model is estimated with the GMM technique. We consider the relative productivity of the bank and future profits as potentially endogenous and define as exogenous variables the lag \( t-2 \) of total assets, the lags \( t-2 \) and \( t-3 \) of the 25\(^{th}\), 50\(^{th}\) and 75\(^{th}\) percentiles of the productivity distribution and time dummy variables. To assess the validity of the estimates, we provide the \( p \)-value of the test of over-identifying restrictions to test the consistency of the orthogonality conditions. We estimate the model with the two-step procedure computing robust standard errors using the Windmeijer finite-sample correction mechanism. According to the predictions of the model, we expect that banks with relatively lower productivity level will open a lower number of branches (\( \beta_2 < 0 \)) while banks with relatively high productivity level will tend to open more branches (\( \beta_3 > 0 \)). In parallel, the perspectives of higher future profitability will also lead banks to open new branches (\( \beta_4 > 0 \)).

The third block of empirical estimates models the behaviour of the profit per branch of the banking system according to Equation [15]. We use panel data of profits per branch as dependent variable and the lagged dependent variable and time dummy variables as explanatory ones. The model will be estimated using the GMM technique using the \( t-2 \) and \( t-3 \) lags of the dependent variable and the time dummies as instruments. If the zero-profit convergence condition is satisfied then the constant and the coefficients of the time dummy variables should be equal to zero and the coefficient of the lagged dependent variable should be lower than one. Next, we estimate with the Arellano and Bond estimator to account for the banks’ fixed effects and test for conditional convergence.
4.2- Results of the estimation

4.1. Testing Hypothesis H1

*Determinants of interest rates of loans and deposits*

The results of the estimation of different specifications of econometric model [17] on determinants of the interest rates of loans and deposits are shown in Table 3. In column (1), we report the estimated coefficients for the econometric model on loan interest rate. Results are in line with the predictions of the theoretical model (summarized at the end of section 2). First, the interest rates of loans depend on the relative level of productivity of the bank and its competitors: consistent with the theory, banks in the lower tail of the distribution of productivity charge higher interest rates for loans than banks with average productivity. In particular, our estimations indicate that low-efficient bank-branches charge 110 basis points more to the interest rates of loans than the rest of banks. The estimated coefficient of the variable \( Id(Prodv_i > p75^{th}) \) is not statistically significant indicating that banks in the upper tail of the distribution of productivity do not charge lower interest rates than banks with average productivity.

The coefficient of the industry productivity variable \( A_t \) is negative and statistically significant (\( p\text{-value}<1\% \)) as predicted in the theoretical model (equation [11]). The contribution of the industry productivity growth to the dynamics of the interest rates over time is equal to the estimated coefficient of the industry productivity variable multiplied by the observed growth rate in productivity reported in Table 2. Performing these calculations, the industry gains in productivity have resulted in an accumulated decrease of 1.5 percentage points in the interest rate of loans, and an accumulated increase of 0.5 percentage points in the interest rate of deposits during the 15 years of the sample period.

The negative and statistically significant (\( p\text{-value}<1\% \)) coefficient of the size of the relevant market (i.e.\( GDPMarket \)) is also consistent with the theoretical predictions. This result suggests that there is a higher density of branches in larger markets than in
Table 3. Estimation of equations (11) and (12): Determinants of interest rates

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id(Prodv.&lt;P25th)_{t-1}</td>
<td>0.011 **</td>
<td>-0.013 ***</td>
<td>0.009 **</td>
<td>-0.004</td>
<td>0.015 **</td>
<td>-0.018 ***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.002)</td>
<td>(0.007)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Id(Prodv.&gt;P75th)_{t-1}</td>
<td>0.003</td>
<td>-0.006</td>
<td>0.002</td>
<td>0.003 *</td>
<td>0.006</td>
<td>-0.009</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(1.760)</td>
<td>(0.007)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Industry Efficiency</td>
<td>-0.031 ***</td>
<td>0.011 *</td>
<td>-0.033 ***</td>
<td>0.014 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.006)</td>
<td>(0.008)</td>
<td>(0.006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interbank x Id(Prodv.&lt;P25th)_{t-1}</td>
<td>-0.283 **</td>
<td>0.346 ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.141)</td>
<td>(0.118)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interbank x Id(Prodv.&gt;P75th)_{t-1}</td>
<td>-0.190</td>
<td>0.193 *</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.132)</td>
<td>(0.111)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLP / Assets_{t-1}</td>
<td>0.081 *</td>
<td>0.074 *</td>
<td>0.084 *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.046)</td>
<td>(0.045)</td>
<td>(0.044)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In(GDP Market)</td>
<td>-0.004 ***</td>
<td>-0.001</td>
<td>-0.004 ***</td>
<td>0.000</td>
<td>-0.003 ***</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.640)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Interbank rate</td>
<td>0.732 ***</td>
<td>0.667 ***</td>
<td>0.857 ***</td>
<td>0.528 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.024)</td>
<td>(0.075)</td>
<td>(0.061)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP Growth</td>
<td>-0.004 ***</td>
<td>-0.003 ***</td>
<td>-0.005 ***</td>
<td>-0.003 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation</td>
<td>0.745</td>
<td>0.433 ***</td>
<td>0.740 ***</td>
<td>0.437 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td>(0.027)</td>
<td>(0.044)</td>
<td>(0.026)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of obs</td>
<td>1456</td>
<td>1479</td>
<td>1461</td>
<td>1487</td>
<td>1456</td>
<td>1479</td>
</tr>
<tr>
<td>R²</td>
<td>88.74%</td>
<td>88.84%</td>
<td>89.29%</td>
<td>92.95%</td>
<td>88.87%</td>
<td>92.95%</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Time dummies</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

Note: Standard Errors in parentheses. Standard Errors robust to heteroskedasticity and clustered at bank level. Estimation with instrumental variables. Instrumented variables: Identifier of low relative productivity, Id(Prodv.<25th), and identifier of high relative productivity, Id(Prodv.<25th). Instruments: Percentile 25th, 50th and 75th of the distribution of competitors’ productivity. (***)=significant at 1%, (**)=significant at 5%, (*)=significant at 10% level. This implies that the distance between branches in large markets is smaller what, in turn, increases competition and lowers the average interest rates of the relevant loan market. Finally, the interest rates of loans also vary with the risk profile of the bank portfolios captured through the explanatory variable of the (ex post) credit risk ratio (i.e. loan provisions on assets). The estimated coefficient is positive and statistically significant at 10% level. This is the expected result if the ex post credit risk
indicator is positively correlated with the *ex ante* credit risk perceived by banks at the time the loan is granted.

As for the monetary transmission mechanism, the coefficient of the interbank rate is positive and significant (*p*-value<1%). However, the estimated value of the coefficient is lower than 1, suggesting frictions in the transmission process. Finally, interest rates of loans are counter-cyclical as the estimated coefficient of the GDP growth is negative.

Column (2) of Table 3 shows the estimated coefficients for the model on the interest rates of deposits. As in the case of loans, part of the heterogeneity observed in the interest rates reflects differences in productivity across banks. Interests on deposits are 130 basis points lower for low-productivity banks than for the average bank (statistically significant at 1%). Interest rates are positively associated with the average industry productivity, with an estimated positive coefficient of 0.024. Next, the monetary transmission mechanism operates for deposits too (positive estimated coefficient for the interbank interest rate), though the estimated coefficient is lower than in the interest rate of loans, probably due to the heterogeneous composition of deposits (liquidity provision and savings vehicle). The estimated coefficient for the variable size of the relevant market is not significant and interest rates of deposits increase with inflation and decrease with the growth of GDP.

Columns (3) and (4) in Table 3 show the results when the common time varying effects are captured by time-dummy variables. The results are broadly consistent with those of columns (1) and (2), although banks interest rates are less sensitive to differences in productivity among banks. For deposits, the relative differences in productivity among banks are now captured by the dummy of high-productivity banks, which pay an interest rate 30 basis points higher than the average bank.

The last two columns of Table 3 allow for differences in the monetary transmission mechanism as a function of the productivity of banks (low-efficiency banks, high-efficiency banks and rest of the banks). For this purpose, we add the interaction of the bank relative productivity dummy variables and the interbank interest rate as explanatory variables. For the loans, the estimated coefficient of the interbank rate is now higher (closer to one) than in column (1) while the coefficient of the interacted variable is negative for the low productivity banks. This means that banks with low productivity reduce the speed for translating changes in the monetary policy to the
pricing of loans, creating market inefficiencies. The opposite occurs with the transmission to the interest of deposits, that is, less productive banks translate changes in the monetary policy to interest rates faster than more productive ones, probably because the former face stronger competition in the deposits markets from more efficient banks.

**Determinants of loans, deposits and economic profits per branch**

The estimations of econometric model [18] on the determinants of loans, deposits and economic profits per branch are presented in Table 4. From column (1), banks in the lower (upper) tail of the distribution of productivity get a lower (higher) volume of loans per branch: the coefficient of \( Id(Prodv < P25^{th}) \) is negative and the coefficient of \( Id(Prodv > P75^{th}) \) is positive, both significant at 1%. The negative estimated coefficient for the proxy of the size of the relevant market is consistent with the prediction that the demand per branch decreases with the intensity of competition (more bank branches in the market). Finally, \textit{ex post} credit risk is positively correlated with the volume of loans per branch, suggesting that some branches relaxed the credit standards to gain market share, compensating the higher risk with higher interest rates.

**Table 4. Estimation of equation (18) for the determinants of the demands of loans and deposits per branch and of the economic profits per branch.**

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>(1) Loans per Branch</th>
<th>(2) Deposits per Branch</th>
<th>(3) Profits per Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id(Prodv.&lt;P25^{th})_{t-1}</td>
<td>-0.584 ***</td>
<td>-0.576 ***</td>
<td>-8.320</td>
</tr>
<tr>
<td>(0.166)</td>
<td>(0.181)</td>
<td>(138.7)</td>
<td></td>
</tr>
<tr>
<td>Id(Prodv.&gt;P75^{th})_{t-1}</td>
<td>0.405 ***</td>
<td>0.114</td>
<td>307.2 ***</td>
</tr>
<tr>
<td>(0.126)</td>
<td>(0.127)</td>
<td>(119.1)</td>
<td></td>
</tr>
<tr>
<td>LLP / Assets_{t-1}</td>
<td>7.953 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3.260)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(GDP Market)</td>
<td>-0.086 **</td>
<td>-0.062 *</td>
<td>-55.612 **</td>
</tr>
<tr>
<td>(0.034)</td>
<td>(0.033)</td>
<td>(26.23)</td>
<td></td>
</tr>
<tr>
<td>No. of obs</td>
<td>1525</td>
<td>1525</td>
<td>1525</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>85.75%</td>
<td>78.96%</td>
<td>61.61%</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Time dummies</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses. Standard errors robust to heteroskedasticity and clustered at bank level. Estimation with instrumental variables. Instrumented variables: Identifier of low relative
productivity, \( \text{Id}(	ext{Prodv}<25^{th}) \), and identifier of high relative productivity, \( \text{Id}(	ext{Prodv}<25^{th}) \). Instruments: Percentile 25\(^{th}\), 50\(^{th}\) and 75\(^{th}\) of the distribution of competitors’ productivity. Time dummy variables represented in Figure 4.A (***)=significant at 1\%, (**)=significant at 5\%, (*)=significant at 10\%.

When the dependent variable is the volume of deposits, column (2), the results show that banks in the lower tail of the distribution of productivity have a lower volume of deposits per branch (\( p \)-value<1\%). The coefficient for the measure of the size of the market is negative and statistically significant (\( p \)-value<10\%).

Finally, the column (3) of Table 4 shows the results for the model of economic profits per branch. The positive and statistically significant coefficient of \( \text{Id}(\text{Prodv}>P75^{th}) \) confirms that higher productivity is rewarded with higher economic profits. The economic profits per branch for high-productivity banks are, on average, 307,200 Euros higher than for the rest of the banks. Profits per branch decrease with the size of the relevant market, again, as expected from the theory.

**Figure 4. Estimated values of coefficients for time dummies**

**A. Time dummies from Table 4: Demand and profits per branch**

**B. Time dummies from Table 5: Growth of branches**
Figure 4A represents graphically the estimated coefficients for the time dummy variables of the three estimations. The values of the estimated coefficients show the time evolution of the volume of loans, deposits and economic profits per branch after controlling for the effects of the other explanatory variables and capture industry and macroeconomic conditions common to all banks. Loans and deposits per branch are in logs and so are the time trend values (left scale). Economic profits per branch are in thousands of Euros. The time trend in loans grows at a relatively constant rate since 1996, when Spain started the nominal convergence to become member of the Euro zone and monetary conditions started to relax, with lower official interest rates. Deposits per branch grew at moderate rates until year 2000 and at higher rates after this year. The time trend of loans is above the trend in deposits from 2003 on, generating a liquidity gap that was financed with funds raised in wholesale markets. The time trend in profits per branch started at negative values and stayed in values around zero from 1996 to 2003, turning positive for the rest of the sample years.

Wrapping up, Tables 3 and 4 support the predictions of Hypothesis 1 of the theoretical model. These results confirm that the productivity of banks affects their interest rates of loans and deposits, as well as their volume of demand per branch. Higher productivity is associated with lower (higher) interest rates of loans (deposits) and higher demand for banking services. Higher productivity is rewarded with higher economic profits per branch. Interest rates of loans (deposits) are lower (higher) in larger markets, i.e. in markets with higher volume of demand for bank services. Demand per branch and economic profits per branch however, are negatively correlated with the size of the relevant market. The positive time trend in loans and deposits per branch over the period of study is consistent with a period of decreasing interest rates and unit margins: as the gross profit margin decreases, the volume of demand per branch must increase to break-even. During 2004-2007, average profits per branch turn positive and with positive growth rate. This could be explained because banks finance the liquidity gap with securitization and wholesale–market financing, which entail low or zero fixed-cost per branch.

4.2. Testing Hypothesis H2

The second set of hypotheses refers to the determinants of the changes in the number of branches of individual banks, as formulated in econometric model [19]. Estimation
results are reported in Table 5. They correspond to two specifications of the basic model, which has been estimated with two-step robust GMM. The specifications differ in the procedure used to estimate the expected industry economic profits per branch in period $t+1$. In column (1) they are estimated using the full sample information while the estimation in column (2) only uses information available at $t-1$. The statistical tests reject the null hypothesis of over-identifying restrictions.

Table 5. Estimation of equation (19) on the growth in the number of branches

<table>
<thead>
<tr>
<th>Dependent Var:</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id(Prodv.&lt;P25$^{th}$)$_{t-1}$</td>
<td>-15.210 ***</td>
<td>-15.223 ***</td>
</tr>
<tr>
<td></td>
<td>(4.447)</td>
<td>(4.464)</td>
</tr>
<tr>
<td>Id(Prodv.&gt;P75$^{th}$)$_{t-1}$</td>
<td>-5.693</td>
<td>-5.510</td>
</tr>
<tr>
<td></td>
<td>(3.514)</td>
<td>(3.360)</td>
</tr>
<tr>
<td>Profit per Branch$_{t+1}$</td>
<td>0.082 ***</td>
<td>0.0690 ***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>Overidentifying restrictions ($p$-value)</td>
<td>0.482</td>
<td>0.751</td>
</tr>
<tr>
<td>Time Dummies</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>No. of obs</td>
<td>1462</td>
<td>1462</td>
</tr>
</tbody>
</table>

Note: Standard Errors in parentheses. Estimation (1): Forecast of profits per branch computed using all the information of the sample. Estimation (2): Forecast for $t+1$ computed with the information available until $t-1$. Estimation with two-step GMM, standard errors robust computing Windmeijer finite-sample correction. List of instruments: log of total assets in $t-2$, productivity from $t-2$ to $t-4$ and time dummy variables (represented in Figure 4B). Instruments: Percentile 25$^{th}$, 50$^{th}$ and 75$^{th}$ of the distribution of competitors’ productivity. ($***$)=significant at 1%, ($**$)=significant at 5%, ($*$)=significant at 10%

Results are very similar in both cases. The estimated coefficient for $Id(Prodv. < p25^{th})$ is negative and significant ($p$-value <1%) and the coefficient for the forecasted economic profits per branch is positive and statistically significant ($p$ value<1%). The empirical results confirm that expectations on industry economic profits per branch drive the expansion of the branch network for all banks and that the less productive banks, on average, expand their network in 15 branches per year less than the rest of banks.

Figure 4B shows that the estimated coefficients of the time dummy variables in the estimations of columns (1) and (2) of Table 5, which capture the year-industry average change in the number of branches. First, it is decreasing until 1998; then, it stabilizes
around zero, until 2003 and, finally, it increases again until 2007. The comparison of Figure 4B and Figure 4A reveals that the average industry change in the number of branches in Figure 4B is negative during the years of negative economic profits per branch; they are around zero when average profits are also zero; and the average change in the number of branches is positive when average industry economic profits are also positive.

The contraction in the number of branches during the first period when the average industry economic profits are negative just indicates that the number of bank branches was too high and price competition intense. Under this situation, banks reacted reducing the stock of branches until the average profits reached a value close to zero. Then, the situation stabilized for several years, when profits remained around zero and the average change in the number of branches was also around zero. Starting in 2003, the profits per branch and the number of branches increased in parallel. In this period, the volume of deposits was lower than the volume of loans and Spanish banks relied on securitization and wholesale markets finance to close the liquidity gap (Figure 4A). The business model of Spanish banks changed and deposits collected by the branch network no longer were the only source of lending funds. The logic of more branches, more competition and lower profits broke down and economic profits per branch grew at the same time that the network of branches was expanding in an explosive way.

4.3. Testing Hypothesis H3

We now test for the zero-profit condition for the banking industry using bank-level data. The results of the GMM estimation of equation [15] with time dummies and not controlling for banks’ fixed effects are presented in column (1) of Table 6. The null hypothesis that the constant and the coefficients of the time dummy variables are all equal to zero cannot be rejected. In addition, we cannot reject the null hypothesis that the coefficient of the lagged dependent variable is smaller than 1 (p-value<5%). These results can be interpreted as evidence in favor of convergence of economic profits per branch towards zero for the Spanish banking industry. However, the large magnitude of the coefficient of the lagged dependent variable (0.86) implies a slow process of convergence, since it will take up to 7 years (1/(1-0.86)) converging to zero profits.
Table 6. Estimation of (15): Time dynamics of economic profits per branch

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Ec \text{ Profit}_{t-1} )</td>
<td>0.861 ***</td>
<td>0.602 ***</td>
<td>0.600 ***</td>
</tr>
<tr>
<td></td>
<td>(0.060)</td>
<td>(0.093)</td>
<td>(0.097)</td>
</tr>
<tr>
<td>( Id \text{ (year&gt;1999)} \times Ec \text{ Profit}_{t-1} )</td>
<td>-0.130</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.096)</td>
</tr>
<tr>
<td>\text{CONTROL FIXED EFFECTS?}</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>\text{TIME DUMMIES}</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>No. of obs</td>
<td>1690</td>
<td>1527</td>
<td>1527</td>
</tr>
</tbody>
</table>

Note: Standard Errors in parentheses. Estimation (1) and (3) estimated with GMM-panel data techniques without controlling for bank fixed effects. Instruments: dependent variable lagged at \( t-3 \) and \( t-4 \) and time-dummy variables. Estimation (2) controls for fixed-effects using the Arellano and Bond with the lags \( t-3 \) and \( t-4 \) \( (***) \)=significant at 1%, \( (***) \)=significant at 5%, \( (*) \)=significant at 10%

In the specification reported in column (2) that controls for unobserved heterogeneity including banks’ fixed effects, the estimated coefficient for the lagged dependent variable is equal to 0.6, which is lower (p value <5%) than the estimated value in column (1). The magnitude of the difference between these two coefficients supports the hypothesis of conditional convergence. That is, we cannot reject that each bank converges towards an idiosyncratic level of economic profits per branch. The estimated speed of convergence is now faster, 2.5 year \((1/(1-0.6))\). Finally, in column (3), we show the estimation of the model of unconditional convergence allowing for different speed of adjustment in branch profits for the periods before and after the Euro. The estimated coefficient associated to the interaction term is not statistically significant and, thus, there is no evidence of a different speed of convergence between the pre- and the post-Euro years.

The estimated fixed effects in the model of dynamics in economic profits per bank-branch can be interpreted as an estimate of the long-term profits for a particular bank resulting from its unique competitive advantage (or disadvantage). The examination of these fixed effects gives additional insights on the characteristics of the industry dynamics. First, we compare the average value of the fixed effects of banks that survive until 2007 with that of banks that disappear because of M&A during the sample period. Results give an average profit of -100,700 Euros per branch for the banks that disappear and of 33,810 Euros per branch for those that continue in 2007. This difference is statistically significant (p value <1%). Therefore, as expected from the effects of
competitive selection (Wheelock and Wilson, 2000), banks that leave the industry (61 out of 150) are those with negative expectations on long–term profits\(^{10}\).

Second, we find that the average fixed effects of the 89 surviving banks is not statistically different from zero, so industry average profits remain around zero in the long-term. However, differences among continuing banks are not totally random, as we find that the estimated fixed-effects are positively correlated (correlation value of 32.2%, \(p\)-value < 5%) with long-term estimated differences in TFP per branch-bank. Additionally, we find no significant differences between banks and saving banks. According to size categories, we find that, once differences in long-term TFP are controlled for, large banks are only slightly (10,000 Euros per branch) more profitable in the long-run than medium and small banks (\(p\) value <10%). Therefore, the evidence suggests that permanent differences in economic profits per branch-bank are tied to idiosyncratic characteristics of banks, not particularly related to size or ownership, the same that cause permanent differences in operating efficiency. Finally, the fact that some banks that survive in 2007 have estimated fixed effects negative and significant indicates that the survival of these banks is at risk.

**Conclusion**

This paper examines the implications of observed heterogeneity in the TFP of banks in their retail banking activities. Particularly, it examines how differences in productivity affect the decision of banks on interest rates, the dynamics of the banks’ branch network, and the long-run evolution of the economic profits in the banking industry. In this paper, production is measured using a production function approach considering the branch (not the bank firm) as the production unit and assuming that output results from the combined services of labor and IT capital. The paper posits a model of spatial competition for loans and deposits where the branch is the competitive unit and markets are local. Assuming a free-entry condition in the market equilibrium, we derive the determinants of the short-term interest rates, the volumes of loans and deposits and the economic profits per branch for each bank. We also derive the determinants of the

\(^{10}\)Mergers and acquisitions will imply transfers of banking operations from less efficient to more efficient Banks, lowering costs and interest rates, according to the model. Since our operating and competition unit is the bank-branch, mergers and acquisitions are not expected to affect the market power or collusive behavior of banks. Erel (2011) finds evidence that mergers of banks reduce interest rates of loans but only while the cost savings effects dominate the market power effects so market structure also matter as determinant of interest rates of loans.
dynamics in number of branches per bank and of the long-term industry profits. The empirical analysis is based on data from Spanish banks and supports most of the theoretical predictions. Interestingly, the empirical evidence confirms that productivity is an important driver of the performance of banks at the individual and at the industry level. The empirical results also show that high-productivity banks enjoy transitory positive economic profits per branch as the result of their lower operating costs and also because of the spatial differentiation of banks’ products. However, expectations of positive economic profits induce opening of new branches, with less-productive banks losing market share in favor of the more productive ones.

The increase in the number of branches implies lower profits per branch and the convergence of the average economic profits per branch to zero in the banking industry. Along this competition process, intermediation costs, in terms of difference between interest rates of loans and deposits, get lower since the industry gains in TFP are translated into lower interest rates of loans and higher interest rates of deposits. Our results indicate that one point of increase in productivity over time at the industry level implies a reduction (increment) in interest rates of loans (deposits) of 3.1 (1.1) basis points per time period. The estimated average annual growth rate productivity in the banking industry of 3.05% in the period 1992-2007 (Table 2), would be responsible of a reduction of 9.4 basis points in loan interest rates per year (1.41 percentage points over the entire period 1992-2007). For deposits, industry TFP growth results in a yearly increase of 3.48 basis points in the interest rates (an accumulated increase of 0.52 percentage points during the whole sample period). The social gains from lower intermediation costs in the Spanish banking industry occur at the same time that the industry undertakes a process of concentration with a substantial reduction in the number of banks.

After 2007, the Spanish banking industry has experienced a period of low performance mainly due to the impairments of loans to non financial firms granted during the pre-crisis period. The excessive risk taking and social costs that showed up during recent years might be the result of the strong industry competition during the pre-crisis period that we show in the paper, together with the high demand for loans fuelled by the lower interest rates after Spain joined the Euro zone. To assess the net social gains of the performance of banks, we should test whether these costs are compensated by the gains from lower intermediation costs. As preliminary evidence, our results suggest that banks
may have underestimated the ex-post credit risk at the time of granting the loans, although the detailed cost benefit analysis exercise will be an objective of future research. Another extension for future research is on how differences in productivity explain differences in risk taking behavior by banks. This would require extending the model to credit markets with incomplete information in lending transactions. Finally, even though we find evidence that industry productivity gains are translated to interest rates of loans and deposits, we do not know if the smaller number of banks in local markets after the mergers and acquisitions induces collusive behavior so the translation of productivity gains is lower than it could be.
References:


