# A Test of the Law of One Price in Retail Banking[♠♥]

**Alfredo Martín Oliver**
**(Banco de España)**

**Vicente Salas Fumás**
**(Universidad de Zaragoza and Banco de España)**

**Jesús Saurina**
**(Banco de España)**

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## Abstract

This paper investigates the level and determinants of retail banking interest rate differences among Spanish banks in the period 1989-2003. We find that interest rates of twenty five different bank loan and deposit products adjust rather rapidly to their long term values in response to external shocks, as the relative version of the Law of One Price predicts, but the evidence runs contrary to the absolute version of the Law. Different credit risk across banks and loan products is an important source of interest rate dispersion in the short and long run that puts limits to banking integration.

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**Key words: Law of One Price, interest rates dispersion, mark up convergence**

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[♥] Address for correspondence: Jesús Saurina; C/Alcalá 48, 28014 Madrid, Spain. Tlf: + 34 91 338 5080; e-mail: jsaurina@bde.es.

## 1. Introduction

This paper uses Spanish retail banking as a case study to investigate the workings of the Law of One Price. Although economic integration and price convergence has been a topic of interest in international economics[1] and there are several country level studies on price differentiation[2], we are not aware of a comprehensive analysis of the Law of One Price in retail banking as the one presented in this paper. Besides the general relevance of investigating price formation in loan and deposit markets, the findings of convergence or divergence in interest rates of banking products within a country member are important to shape expectations about the future banking integration in the Euro area.

We take advantage of a large and unique database: monthly quoted interest rates for 25 different banking products and for each individual commercial and savings bank during the period 1989 to 2003. Thus, we have information about marginal interest rates for both, loan and deposit products. Combining different data sources we are able to obtain credit risk adjusted opportunity costs for each loan product at the bank level, so the convergence in gross profit margins as part of the convergence in interest rates is evaluated after controlling for the credit risk of each individual bank. Banks' products are grouped into loans and deposits. Loans have different maturity, from less than a month to very long term, such as mortgages. Deposits differ in liquidity, from the very liquid sight accounts to the more illiquid two-year deposits. The time period of study starts in 1989 when restrictions to geographic expansion of savings banks, now half of the market, were removed and banking liberalization completed[3]. Between 1994 and 1998 Spain is in a process of nominal convergence to meet the Maastrich criteria in order to become a member of the Euro zone; nominal official interest rates fell from 15% to 3.5%. Over the 1999-2003 period, Spain has been a full member of the Euro zone. Thus, each time period offers a different scenario in terms of monetary and competitive conditions under which banks grant loans and take deposits, which is worthwhile to study separately.

[1] Frankel and Rose (1996) and Taylor (2002) offer general evidence on the workings of the Law of Purchasing Power Parity. Goldberg and Verboven (2001, 2004) study price discrimination and convergence in the European car market.

[2] See, Cecchetti, Nelson and Sonora (2002), Engel and Rogers (2001), andAsplund and Friberg (2001).

Interest rate differences will be evaluated under the absolute and the relative versions of the Law of One Price. The absolute version means that within the boundaries of a market all products offered must be sold at the same price. The Law is violated when products that are close substitutes for the buyers are sold at difference prices in a persistent way. Thus, the study of interest differences across banks and/or product classes in loans and deposits will indicate whether these product/markets are integrated into a single market or not. But persistent interest rate differences can be possible because of, for example, idiosyncratic bank factors that cannot be arbitraged away (i.e. differences in credit risk profiles of banks. Although the Law of One Price dictates that a loan of a given risk will carry the same interest rate across banks, what we observe is the average interest rate of a particular class of loans (i.e. credit lines) granted by each individual bank and in this average there can be idiosyncratic differences across banks, for example, differences in risk aversion across banks.

When the absolute version of the Law of One Price does not hold, market integration can still be evaluated through the relative version of the Law, which focuses on the dynamics of prices, in particular, the speed at which temporary deviations from the long-term across-banks interest rate differences are eliminated. The research question is whether all prices converge or not to long-term levels that can be different across products and/or banks because of idiosyncratic characteristics. The speed and convergence values of prices are interesting by themselves because they are directly related to the degree of market integration and market power of banks, respectively.

The paper is in line with research on convergence of interest rates and evolution of market power in retail banking within EU countries (see Baele et al (2004) for an overview), but with the advantage that we have very disaggregated data for practically the whole industry, and a long period of time. Therefore, we can address questions such as the contribution to interest rate differentiation of time, bank, product and geographic market effects, not explored so far. Second, we can isolate the effects on interest rate

[3] Salas and Saurina (2003) analyses the Spanish banking liberalization process.

dispersion of changes in monetary conditions and changes in marginal opportunity costs of loans and marginal revenues from deposits over time. Third, the test of the relative version of the Law of One Price provides estimates of long-term relative mark ups over the opportunity cost of loans and of the relative mark downs over revenue from deposits. Therefore, the analysis of interest rate dispersion also provides measures of market power of banks and their evolution over time. European banking integration is concerned about price dispersion together with market power, (Bikker and Haaf (2002), Courvoisier and Gropp (2002), Maudos and Fernandez de Guevara (2004), Goddard, Molyneux and Wilson (2004)) and the paper contributes to this literature with a unified methodology and with evidence from product-bank marginal interest rates.

Papers on market power of European banks (for example, Angelini and Cetorelli (2003) for Italy and Maudos and Fernández de Guevara (2004) for European countries) all use bank level aggregated data and estimate margins and profits for loans over the marginal cost of inputs, including the cost of deposits. In this paper we estimate profit margins at the individual bank-product level using current monthly quoted interest rates by each individual bank. Most published research in market power of banks with individual bank-product data has used interest rate of deposits (Berger and Hannan (1989), Hannan and Liang (1993)) and little is known about the effect of credit risk premiums in the interest rates at the product-bank level. This probably owes to the fact that credit risk premium data are difficult to find. Using Banco de España Credit Register database, we are able to obtain at bank and loan product level data on ex post credit risk that is used to estimate the ex ante risk-adjusted opportunity cost of the loans. Therefore, we provide risk-adjusted long term mark up estimates for loans of different maturities[4]. As far as we know, this is new in the literature and turns to be very relevant.

An important result of this analysis is that banks' idiosyncratic effects are a relevant source of interest rate differentiation and they vary across products in both, loans and deposits. Moreover, in several loan products, the relative contribution of bank effects

[4] Jiménez and Saurina (2004) and Jiménez, Salas and Saurina (2005) contain a thorough description of Banco de España Credit Register data.

to differentiation increases over time. If the same pattern can be expected at supra national level, European cross country convergence in loan interest rates may not be the most appropriate benchmark to follow up the process of retail banking integration, unless all banks end up with similar credit risk in their portfolios. Second, we find that the (long-term) Lerner index of loans, a conventional measure of market power, is substantially reduced and is much more stable over time when the marginal cost used in the computation of the index includes the credit risk premium of each bank-loan observation, compared with the values of the non-risk adjusted index, which confirms the relevance of product and bank level variables to explain differences in interest rates.

The rest of the paper is organized as follows. Section 2 contains a description of the data and a preliminary evidence of interest rate differentiation. Section 3 focuses on the absolute version of the Law of One Price through the evaluation of the contribution to dispersion in profit margins of different sources of potential differentiation (Time, Bank, Product and Province). Section 4 presents a test of the relative version the Law of One Price and estimates of the long-term relative difference between interest rates and opportunity costs for each of the bank products. In section 5 we conclude.

## 2. Description of the data and preliminary evidence on interest rate dispersion

### *2.1. Database*

Data on interest rates come from the confidential returns that Commercial and Savings banks send monthly to Banco de España on interest rates for loan and deposit operations made during the previous month. The interest rate reported by a bank on a given product is the weighted average of interest rates set in all operations made in that product during the corresponding month. So, banks report marginal interest rates charged in the transactions. The raw data has been filtered to eliminate inactive banks and to assure a minimum number of annual observations for each bank and product.

Banks with tiny market share (less than 1 over 10,000 in terms of total assets) have been excluded from the analysis. Branches of foreign banks, which concentrate mainly in the wholesale market, are also excluded, since our focus is on retail banking. Only bank-product combinations for which at least eight monthly observations are available within a year are selected in order to reduce the number of missing values from banks that have a reduced number of operations in a given product and year. Finally, to keep a manageable number of observations, monthly interest rates are averaged to quarterly. Thus, we have interest rate data on new loans and deposits made by around 200 different Spanish banks during 58 quarters for 25 different products.

The bank products, loans and deposits of different maturity and liquidity, included in the database are summarized in Table 1. There are five loan and four deposit products, identified in the paper as nine Product Classes. Discounting of Receivables and Credit Lines are loans granted to business firms and individual entrepreneurs, while Personal loans and Mortgages are granted to households. Loans at Variable Interest rate are granted to both. Mortgages have all long-term maturity (above 3 years) but the rest of loan products have different maturities. Loans are grouped by maturity: less than one month, from 1 to 3 months, from 3 months to 1 year, from 1 year to 3 years and more than 3 years. Deposit products include Current accounts (sight deposits with check facilities), Saving accounts (sight deposits with no check facilities), Deposits and Repo type deposits (deposits backed by the bank with a government security). Banks do not report Current and Saving accounts that pay negligible interest rates[5]. Both accounts are considered high liquidity products, while Deposits can be of high, medium or low liquidity depending on the reimbursement period (less than 3 months, from 3 months to 2 years and more than 2 years, respectively). Repo type products can be of medium or high liquidity. Taking into account different maturity/liquidity in loan and deposit Product Classes, the total number of bank products is 25.

[5] The 1st percentile of the distribution of interest rates of these two products takes the value of 0.91%.

The database contains information of commercial and savings banks which, split evenly, hold 95% of the Spanish retail banking market[6]. Banks are also classified according to the geographical scope of their business as National (37% (18%) of deposit share in 2002 (1989)) if they have branches in 90% of the 50 Spanish provinces; Local (16% (28%) of deposit share in 2002 (1989)) if the bank concentrates 90% of the branches in a single province; and Regional, all the rest. In late 1988 the last regulation that limited the geographical expansion of savings banks was removed. Since then, savings banks have been very active in opening branches outside their historical territories and, thus, increasing the number of competitors in local markets. As a consequence, province level market concentration has been stable over time in spite of the mergers of very large banks that have taken place during the period[7]. In the paper merged banks are considered as separated institutions before the merger occurs and as a new bank after it.

In retail banking, markets are local for most products and services. The information available on interest rates is not disaggregated enough to know the town or city where bank operations are made. Therefore, we do not know the interest rates in different geographic markets, except when the bank concentrates most of its business in a single province. In each province there are local and national banks operating through branches. We assume that a national bank sets the same interest rate of a particular product in all provinces where it operates. With this assumption and the observed interest rates charged by the local banks in the province we can test if Province markets contribute or not to interest rate differentiation.

### 2.2. *Preliminary evidence on interest rate levels and dispersion*

Information on level and dispersion of interest rates is summarized in Table 2. The Interbank rate averages 13.66% in the period 1989-1993 and decreases to 7.35% in 1994-1998 and to 3.61% in 1999-2003. This is a clear evidence of the change in

[6] The other 5% correspond to Credit Cooperatives that do not report interest rates to Banco de España.

monetary conditions for Spanish banks along the time period studied. Table 2 includes for all products, for loans and for deposits, the average absolute difference between the interest rate and the one-day interbank rate both in quarter *t*, and also this average difference relative to the interest rate of the respective loan or deposit. The dispersion measures shown are, on the one hand, the range defined as the average differences between the $90^{th}$ and $10^{th}$ interest rate percentiles in period *t* divided by the average interest rate and, on the other hand, the average coefficient of variation from the distribution of interest rates in each quarter *t*.

Figure 1 shows the evolution of differentials over time for both loan and deposit products. In loan products, the absolute difference between the interest rates charged by banks and the interbank rate has been rather stable, except for Receivable that has been decreasing. In deposits, however, the absolute differentials have been decreasing over time, from rather high levels in 1989-1993, around 4 percentage points (pp), to low levels of 0.81 1999-2003.

Interest rate dispersion increases over time according to range and coefficient of variation). Dispersion is higher in deposits than in loans, and this situation remains over time although in loans dispersion shows an increasing trend. In Mortgages, dispersion stays stable over time since 1993, while for the other three products, Credit Line, Current Accounts and Deposits, interest rate dispersion increases over time (not shown).

Taking all products, interest rate dispersion is also represented by the histograms of Figure 2. The dispersion variable is the range of interest rates. For the whole 1989-2003 time period, 25% of banks' quarterly observations showed a relative range of interest rates above 50%. Dispersion seems to increase over time. In 1989-1993 the relative range of interest rates was above 50% in only 15% of the banks' quarterly observations, rising to 20% in 1994-1998 and to 40% in the last five-year period. The

[7] The Herfindahl index of market concentration in total loans, average across the 50 provinces, has been stable around 0.10.

separated histograms for loans and for deposits (not shown) confirm that dispersion increases over time in both types of bank products.

From this preliminary evidence, including histograms and the summary of Table 2, we conclude the following:

i) There has been a radical change in monetary conditions in Spain from 1989 to 2003. At the same time, the intervals of the average absolute differences between interest rates of loans and deposits with respect to the interbank rate (spreads) are, respectively, 2.98, 3.26, 2.76, and 4.16, 1.40, 0.81 percentage points. Thus, average absolute differences decline substantially more in deposits than in loans, where they remain quite stable over time.

ii) In relative terms, differences with the interbank rate increase over time in both, loans and deposits: from 16.98% in 1989-1993 to 40.17% in 1999-2003 for the former, and from 75.47% to 90.07% for the latter.

iii) Irrespectively of the measure of dispersion used, interest rate dispersion shows increasing trends over time when all bank products are considered. Therefore, no evidence exists that interest rate dispersion decreases after the introduction of the Euro.

iv) Interest rate dispersion is in general higher for deposit than for loan products, especially during the 1989-1993 period, but the increasing trend in dispersion of interest rates of loans implies that differences decrease over time.

## 3. Determinants of interest rate differentiation

### 3.1. *Why can interest rates differ?*

Loan markets are not homogeneous and banks offer different products to respond to different borrower needs and information conditions. In the database we have loans

granted to business, like Receivable and Credit Line, and loans to households, such as Personal and Mortgages. Within each Product Class, loans vary in maturity. Some are secured with external collateral and others with internal collateral; some loans are made at fixed interest rates and others at variable rates, what means a different allocation of risks between borrower and lender. If loan products are different in several dimensions because they respond to different market needs, market equilibrium of bank interest rates can differ across Product Classes and Maturity. However, the demand for one class of loans will not be independent of the interest rates charged on other loans, so the realistic assumption is that the bank faces demand functions for loans which are imperfect substitutes. Little is known about systematic differences observed in actual interest rates charged by banks in each product class and maturity or on the contribution of product class and maturity to total interest rate dispersion in loans.

The former arguments can be extended to deposits. Here, products differ in terms of liquidity and payment facilities. Current Accounts and Saving Accounts are both highly liquid deposits, but the former offers checking facilities while the latter does not. Bank Deposits satisfy the demand for savings, but as they may have different maturities, they can also be classified by liquidity. Liquidity/payment needs and saving needs seem to be very different, so low consumer substitution can be expected among products that satisfy each separate need. But again, little is known about how substitution among deposit products and liquidity translates into systematic interest rate differences.

Individual banks face different competitive market conditions. For instance, their respective local markets may have more or less competitors, have different operating costs and/or credit risk in each product class (loans) or can differ in terms of competitive strategy, low cost or high consumer services. All these are potential sources of ex post observed interest rate differences across banks. Interest rate dispersion can respond to bank heterogeneity which affects loan and deposit products offered by the same bank. One of the concerns in our analysis is to evaluate the contribution of bank fixed effects to the total variance observed in interest rates in different moments of time. It is an open question whether increasing competition, as markets get larger and the number of

competitors increase, reduces or increases interest rate differences attributed to bank effects. To lower competitive pressures, banks can shift towards a differentiation strategy that reduces the own price elasticity of demand and creates price differences in the market (Boot and Thakor (2000)). Second, since banks differ in observed characteristics such as form of ownership (Commercial versus Savings banks), and geographic scope (National versus Regional/Local banks), we can ask for possible systematic differences in interest rates due to these observed characteristics.

Bank idiosyncratic effects can be the same across all Product Classes or differ among them. Bank common credit risk policies would contribute to have common idiosyncratic effects for all loan products but banks' specialization in business or consumer loans could derive into heterogeneous bank effects across loan products. Similar examples of common or different bank effects can be found for deposits. What situation actually occurs is an empirical question that we address in the following section.

Retail banking markets are for the most part local markets as services are provided at the banks' branches. Geographical markets can differ in terms of demand and supply conditions that create interest rate differences across them. Within a geographical market, homogeneous products can sell at different prices because consumers face search costs which create information differentiation (Stigler (1961)). Banking products can be affected by information differentiation that creates interest rate dispersion (Martin, Salas and Saurina (2005)). We cannot observe interest rates at the geographical (province) market level except in the cases where banks are local and have all their activities concentrated in one province. For the rest of banks, heterogeneity in market conditions will be part of the idiosyncratic factors included in the bank effects. Given the characteristics of the database, in this paper the relative importance of Province effects in interest rate dispersion is just an empirical question[8].

[8] The Province is considered also a control variable that accounts for unobserved characteristics of the market such as concentration; Berger and Hannan (1989), Hannan and Liang (1993).

The official interest rate set by Banco de España (from 1999 onwards, by the Eurosystem) and the interbank money market interest rate around it, sets a reference for bank interest rates in retail markets. Since individual banks are price takers in that market, they face a perfectly elastic demand of funds for the money received as deposits, and a perfectly elastic supply of funds for their loans. The interbank interest rate separates deposit from loan markets and interest rates are set in each market independently of the other[9]. Inflation, business cycle, and economic specialization, are also relevant factors that can affect interest rates in retail banking and, in particular, credit availability and the ex ante risk premium charged by banks in their loan products. Our analysis of interest rate differences will isolate time effects common to all banks.

Therefore, there are many reasons to believe that systematic and permanent differences can be expected in interest rates across Bank, Product, Province and Time. Part of them will be differences that respond to product differentiation, as for example between banks that charge different interest rates and offer at the same time different customer service. The Law of One Price dictates the same price for products of equal quality or service and, thus, it should be tested from price data on products that are perfect substitutes from the buyers' point of view. In practice, it is very difficult to find data on identical goods or services to properly test the absolute version of the Law of One Price and for this reason it is necessary to complement this test with the less demanding one posed by the relative version of the Law. The latter takes as given that differences can exist between long term convergence values of interest rates across banks, for example, and investigates how fast transitory shocks to bank interest rates are eliminated. One important parameter in this analysis is the speed of convergence to the long term value of the interest rate, so that higher speed of convergence is interpreted as higher adherence to the Law of One Price. In section 4 we test for the relative version of the Law of One Price.

[9] This result is based on the Monti-Klein model of the banking firm, as surveyed in Freixas and Rochet (1997).

3.2. *Methodology*

The main purpose of this section is to evaluate systematic interest rate differences across Product Class, Maturity, Liquidity, Bank, Province and Time, over the 1989-2003 period. We also want to evaluate the contribution of each source of potential differentiation to the total variance observed in interest rates. The analysis is static in the sense that short-term deviations of interest rates from their long- term levels due to temporary shocks are ignored. We combine regression and analysis of variance. Our data allows us to compute interest rate differences for each product and each peer of banks every quarter, but to work with all bilateral differences is unpractical. One possibility is to evaluate the differences relative to the average of interest rates across all banks for each product. The other is to choose a particular market as a benchmark and explain interest rate spreads with the comparison market. The second alternative is more attractive, especially if the benchmark chosen is considered a highly competitive market. Then, differences in prices with respect to the benchmark can be easily translated into welfare losses. In this paper, the benchmark market and the reference interest rate are the interbank market and the one-day interbank interest rate respectively. When computing differences with respect to the interbank interest rate, we also remove from the interest rates of individual banks and products the common time effects introduced by the evolution of monetary conditions over time[10].

In our empirical analysis, all interest rates are expressed in logs, and, thus, the difference with respect to the benchmark is in percentage or relative terms. The basic models to be estimated for loan and deposit products are formulated as follows

$$\begin{aligned} \ln r_{ijkmt} - \ln r_t &= a + a_{ij} + a_k + a_m + a_t + \varepsilon_{ijkmt} \quad \text{if } i \text{ is a loan} \\ \ln r_t - \ln r_{ijkmt} &= a + a_{ij} + a_k + a_m + a_t + \varepsilon_{ijkmt} \quad \text{if } i \text{ is a deposit} \end{aligned} \tag{1}$$

[10] An alternative possibility is to choose as benchmark interest rates from products of equal maturity to that of the particular loan or deposit product but in this case we would not isolate the dispersion attributed to differences in maturity in loans, and in liquidity in deposits.

where $r_{ijkmt}$ is the interest rate of Product Class *j* charged by Bank *i* with maturity/liquidity *k* in Province *m* and Time (quarter) *t*. $r_t$ is the one day interbank interest rate in quarter *t*. The term $\varepsilon_{ijmt}$ is a random disturbance. The *a* values represent the coefficients of the respective Product Class, Bank, Province and Time dummy variables. The model allows for cross effects between Product Classes and banks, $a_{ij}$, that is, we allow that Bank effects vary across Product Classes in both loans and deposits. In loans we have 15 different products, taking into account Product Classes and Maturity, while in deposits the number of Products is 10. There are 50 provinces, 200 banks and 58 quarters.

*3.3. Dispersion of interest rate differentials*

Table 3 presents evidence on the explanation of interest rate differentials obtained from the estimation of model (1) for loan products. The four columns of the Table refer to different time periods: the entire time period 1989-2003; the period of high nominal interest rates 1989-1993; the period of nominal convergence in interest rates previous to the Euro 1994-1998, and the period when Spain has been member of the Euro zone 1999-2003. Separate estimation for each time period is justified because the null hypothesis of structural stability of model (1) is clearly rejected all cases[11]. Therefore, the first column estimates referred to the whole time period are not too informative of what happened in each period of time. The first part of the table shows the contributions to explained variance of each potential source of variation in interest rates[12], and the bottom part shows the estimated coefficients of the respective dummy variables except Banks. The Product Class values are averages across all banks of the estimated values of $a_{ij.}$ To avoid

[11] The respective F statistics from the Chow tests of model stability are as follows. For loans: Periods 1 and 2, F(301,1106747)=621.9, Periods 1 and 3, F(304,932970)=834.8, Periods 2 and 3, F(253, 960163)=243.19. For deposits: Period 1 and 2, F(296,722361)=177.74, Periods 1 and 3 F(297,669275)=294.85; Periods 2 and 3, F(247,669238)= 284.6.

[12] The measure of contribution to the explained variance for each explanatory variable is calculated as the decrease in the sum of squares of the model if the respective explanatory variable is removed from the model (the so-called partial sum of squares), divided by the sum of squares of the model. That is, $\frac{\Delta SS_{model}}{SS_{model}} = \frac{\Delta SS_{model} / SS_{total}}{SS_{model} / SS_{total}} = \frac{\Delta R^2}{R^2}$. The addition of the marginal contributions to the explained reported in the Table is not 100% because they are obtained keeping all the other explanatory variables in the regression (with replacement).

perfect collineality among the explanatory dummy variables, the one corresponding to loans with *Variable interest rate of less than one month maturity in Madrid by a large bank in the last quarter* of the respective sample has been excluded from the explanatory variables of the regression. Coefficients shown in Table 3 have to be interpreted as differences with respect to this omitted variable (Intercept).

The model explains 73.6% of variation in loans relative interest rate differential in the 14 years period. The main contribution to the explanation comes from the cross effect of Product Class and Bank since the elimination of the cross effect variable from the regression causes a reduction in the explained variance, $R^2$ of the model, of 43%. When the only variable eliminated from the model is Banks (Product Classes) the relative loss in explanatory power of the model is 31.4% (21.3%), so Banks' effects are relatively more important in explaining interest rate differentials than Product Class. Time marginally contributes to the explained variance in 38%, even though time effects from changes in monetary conditions are already controlled for since the dependent variable is interest rate differential with respect to the interbank rate. Other macro economic conditions such as business cycle or changes in competitive or regulatory conditions over time contribute to time dispersion in interest rate differentials in a significant way. Maturity contributes marginally, 1.3%, while Province effects are null.

The explanatory power of the model increases over time from $R^2$ of 65% in the period 1989-1993 to $R^2$ of 76% in 1999-2003. The marginal relative contribution to explained variance of the cross effects Product Class and Banks increases over time (from 57% to 72%). The marginal contribution to explained variance of the variable Banks is higher than the contribution of the variable Product Class in all time periods and increasing from 41% to 53%. Maturity, and partly time, diminish their contribution to explained variance over time.

The bottom part of Table 3 shows the estimated coefficients for the dummy variables of model (1). Table 3 also reports differences in differentials between banks of different ownership form, of different geographic scope and differences in time period

averages (only in the first column). Positive (negative) values of the dummy variable coefficients indicate higher (lower) differential than the differential corresponding to the omitted interest rate whose differential value is measured by the regression intercept. Unless indicated, all coefficients reported are statistically different from 0 at 5% significance level or less. In the period 1989-1993 differentials relative to the intercept are low in all loan products. The intercept increases over time so the differential of the omitted dummy variable shows an increasing trend. Differentials with respect to the omitted dummy variable are also increasing over time, although much less in Mortgages and Variable than in the rest of product classes. For example the interest rate differential of Personal loans is 0.309 (0.272+0.037) in 1989-1993 and 0.757 (0.423+0.334) in 1999-2003. In Mortgages the differential goes from 0.232 in 1989-1993 to 0.396 in 1999-2003.

Relative differences in interest rates with respect to the interbank interest rate also vary systematically with loan maturity. Controlling for Product Classes, the highest average differences appear in intermediate maturity, 1 year to 3 years. The pattern of the average differences is very similar in the second and the third period, which indicates that term structure of interest rates in loans has been quite stable since 1994.

Commercial and Savings banks start practically even in terms of relative differences of their respective interest rates with respect to the interbank interest rate, but at the end of the period the latter have 9.3% higher relative differences, on average, than the former. The geographical expansion and increase in market share of Savings banks during the period 1989 to 2003 coincides with a trend of higher relative interest rates in loan products than Commercial banks[13]. One explanation of this apparently contradicting evidence is that, in their expansion, Savings banks enter market segments of riskier borrowers and have to charge higher interest rates than established Commercial banks. But it could also be the case that in loans, price is not the most determinant factor of market share and Savings banks provide other differentiated services such as accessibility (i.e. higher number of branches) than Commercial banks.

[13] The deposit (credit) share of savings banks raised from 42.4% (35.3%) in 1989 to 52.1% (46%) in 2003.

Differences in interest rate differentials between National and non-National banks show no economic significance in any of the time periods. The final rows of Table 3 provide additional evidence that interest rate differentials in loans increase over time controlling for the rest of sources of variability.

Table 4 presents the result of estimating model (1) for deposit products. The information is displayed in a similar way than Table 3. Now the dummy variable omitted to avoid perfect collineality is *Deposits of high liquidity in Madrid for a large bank in the last quarter of the respective time period* and the results have to be interpreted as differentials with respect to the differential in this particular deposit product. From 1989 to 2003 the explanatory power of the model is even higher than in the case of loans ($R^2$= 79%), and also increasing over time ($R^2$= 90% in 1999-2003). The cross effects of Banks and Product Class contribute to explained variance the most so that if the variable is taken out of the model the $R^2$ decreases 41.75%. In deposit products the marginal contribution to explained variance is higher for Product Class (a decrease in $R^2$ of 34.62%) than for Banks (25.58%). Time contributes to explained variance much less in deposits that it did in loans. Liquidity has a very minor contribution to interest rate differentials dispersion and Province no marginal contribution at all.

The pattern of contributions to explained variance remains quite constant over the three periods. The high contribution of Product Class indicates that deposit products are, as loans, imperfect substitutes of each other, probably because some of them satisfy liquidity demands and others saving demands, though the ability to explain the total variation decreases over time. The explanatory power of Bank indicates that a bank succeeds again in differentiating its deposits from those of competing banks, though the importance of this differentiation is smaller than in loans.

To interpret the results of the lower part of Table 4, we have to keep in mind that higher coefficients of the explanatory variables imply relatively lower interest rates on deposits received by the customers of the bank. The estimated coefficient of the intercept increases from a value of 0.271 in the first time period to 0.438 in the last one. Positive

(negative) estimated coefficients indicate higher (lower) differential than that of the excluded dummy variable. Repo operations show a decrease in their interest rate differentials both relative to the intercept (-0.126 in 1989-1993 to -0.399 in 1999-2003) and in absolute terms (0.145 (0.271-0.126) in 1989-1993 to 0.039 (0.438-0.399) in the last period). In Saving and in Current accounts, the overall differential has increased over time (1.249 (0.271+0.978), 1.126, 1.474 for Saving Accounts and 0.413, 0.625, 0.686 for Current Accounts, respectively).

Differences in interest rates vary systematically with Liquidity. Low liquidity, longer term deposits, pay lower interest rates than highly liquid deposits in the first time period (coefficients of Medium and Low liquidity of 0.095 and 0.138, respectively). The results change over time and in 1999-2003 Low liquidity deposits have a differential 8.7% lower than the differential of highly liquid deposits and, thus, the former pay higher interest rate than the later. The structure of interest rates on deposits has changed over time in an economically meaningful direction.

The persistent observed average differentials between Saving and Current accounts (the former pay lower interest than the latter) are more difficult to justify since both provide the same liquidity and the latter offers, in addition, checking facilities to the depositor. One possible explanation is that banks use Saving and Current accounts to better segment the market, offering the latter to more sophisticated consumers and the former to less sophisticated ones.

National banks pay marginally lower interest rates than local and regional banks in the period 1989-1993, around 2%, but higher in 1999-2003. The pattern of average interest rate differentials by type of banks is fairly similar in deposits than it was in loans, with Savings banks being able to pay lower interest in deposits than Commercial banks, while increasing their market share in the deposit market over time. Interest rate differentials for deposit products show their lower average values in 1994-1998, 10% lower than the previous five-year period while in 1999-2003 differentials are in average lower than in 1989-1993, but only 5% lower.

## 4. Dynamic analysis

The previous section has dealt with the absolute version of the Law of One Price. Interest rate differences are evaluated in this section under the relative version of the Law of One Price, which focuses on the speed at which transitory deviations from the across-banks long-term interest rate differentials are eliminated. In this dynamic framework we explain the interest rate gap of each product (i. e. the difference in the interest rate of one bank product versus the corresponding benchmark) by the previous period interest rate gap, and Bank specific and Time dummy variables. The methodology is based on estimating a partial adjustment model for each bank product, controlling for bank specific effects and for common time varying external shocks. The inverse of the estimated coefficient of the lagged gap explanatory variable denotes the speed of convergence. If the speed of convergence increases over time, it indicates that price differentials from external shocks will last a shorter period of time. The intercept allows us to obtain a long term average differential that can be used as an estimate of the long term market power of banks. Therefore, we present evidence on across-bank long-term interest rate differentials and their evolution in the three time periods.

Speed of interest rate adjustment and long-term interest rate differential are estimated using two different benchmarks, the one-day interbank interest rate and the estimated marginal opportunity cost/revenue for each bank and product. If bank products are homogeneous from the point of view of the buyer, perfect competition implies that differences in marginal costs across banks will not affect the selling price of the product, which will be necessarily the same for all banks. Long term convergence values of the interest rates should be close to the interbank rate. When products are differentiated across banks and, in general, when individual banks have market power, each bank faces an inelastic demand as in monopolistic competition, so differences in marginal costs are translated into additional differences in price. In such a case, the reference rate that banks take into account to price their products is their own marginal cost. Long term

convergence values of differentials with respect to the marginal cost can be significant as they will be a measure of the long term market power of the bank.

Marginal cost of loans includes a risk free interest rate of equal maturity than the respective loan product plus an estimated risk premium that accounts for the credit risk of the bank and product. The risk premium is estimated for each bank, loan product and year using data on defaults. For deposits, we substitute the one day interbank interest rate by the interest rate of a risk free investment opportunity for the bank of equal maturity than the respective deposit.

4.1. *Speed of adjustment and long-term interest rate differential*

First, we test the hypothesis of convergence to the relative version of the Law of One Price taking as benchmark the one-day interbank interest rate. Our concern is, first, the speed of convergence in response to external shocks due to changes in monetary conditions common to all banks in each time period and, second, the long-term limit values of the relative interest rate differentials. The model to be estimated is formulated for each of the 25 bank Products as follows,

$$y_{jt} = \delta + \alpha\, y_{jt-1} + \gamma_1\, D_1\, y_{jt-1} + \gamma_2\, D_2\, y_{jt-1} + TIME\ DUMMIES + \eta_j + \varepsilon_{jt} \qquad (2)$$

where $\eta_j \sim$ iid $(0, \sigma_j)$ $\quad \varepsilon_{jt} \sim$ iid $(0, \sigma)$

$$y_{jt} = \begin{cases} \ln r_{jt} - \ln r_t & \textit{if the product is a loan} \\ \ln r_t - \ln r_{jt} & \textit{if the product is a deposit} \end{cases}$$

Sub-index *j* refers to the bank *j* and sub-index *t* refers to the time period. Explanatory variables are the one-period lagged dependent variable, bank specific fixed effects, $\eta_j$, and time dummy variables. Bank specific effects control for differences in costs, policies, and ownership preferences of banks that can be treated as stable over time. Time dummies account for other external shocks common to all banks and products beyond those accounted for by the interbank rate. The formulation of the model allows

for different values of the coefficient on the lagged dependent variable in each time period. To do so, the lagged dependent variable is multiplied by the dummy variables $D_1$ and $D_2$ that take value 1 if the observation belongs to period 1994-1998 or 1999-2003, and 0 otherwise, respectively. The model is specified at the product level to allow for the maximum flexibility in the estimation of the parameters. We assume that each bank product is a separate market, consistent with the evidence of Table 3 and 4 where we find that cross effects of Bank and Product Class appear highly significant.

The value of $\beta = \alpha - 1$ is the Beta-convergence estimate of a Product Class, that can be directly related, in absolute value, to the speed of convergence. A lower estimated $\alpha$ imply a faster Beta convergence, that is, a higher speed in the process by which transitory shocks to interest rates disappear and interest rate differentials return to their long term values. The estimated value of the coefficient $\alpha$ provides the beta-convergence value for 1989-1993. The $\beta$ convergence values of the other two five-year periods are given by $(\alpha+\gamma_1-1)$ and $(\alpha+\gamma_2-1)$, respectively. Negative (positive) $\gamma_1$ and/or $\gamma_2$ coefficients will indicate that convergence is faster (slower) in the respective five-year periods than in the first period (1989-1993). In other words, that interest rate adheres more (less) intensively to the relative version of the Law of One Price than in the first period.

Long-term relative interest rate differentials across banks for each product can be obtained by solving the equation of model (2) when dependent variables have reached their long-term value, $y_t = y_{t-1} = \bar{y}$ Solving the model under this condition the long-term value of the interest rate differential is equal to $\delta/(1-\alpha)$. Since we allow for different $\alpha$'s across time periods, the long-term values towards which interest rate differentials converge over the period $t$ are equal to $\delta/(1-\alpha_t)$.

Model (2) will be estimated in first differences (to eliminate bank specific effects that are correlated with the lagged dependent variable) with instrumental variables using Arellano and Bond (1991) panel data estimation technique, which chooses as instruments lags of the dependent variable uncorrelated with the error term. The first differences eliminate the bank specific effects ($\eta_j$) but also the intercept ($\delta$) of the model, so in order

to compute the long term values of the differentials, we will have to recover them *ex-post* (i.e. analyzing the differences between the observed and the predicted values).

The first part of Table 5 (i.e. the benchmark is the interbank rate) reports the estimated values of $\alpha$, $\gamma_1$ and $\gamma_2$ for each of the 25 different products, which correspond to the test of the relative version of the Law of One Price[14].The null hypothesis of no beta-convergence is rejected, as the values of $\alpha$ are significantly lower than 1. So, deviations from long term differentials due to external shocks seem to generate a process of convergence back to long term values. Estimated coefficients of the cross effect variables, $\gamma_1$ and $\gamma_2$, are sometimes non-significant, sometimes positive and sometimes negative (Table 5), so that no clear conclusion is reached on whether the adherence to the relative version of the Law of One Price has changed over time.

Table 5 also reports the p-value of the test of the null hypothesis of no second order autocorrelation in the residuals (first-order autocorrelation is expected because the model is estimated with variables in first differences). The high *p* values especially in loan products imply that second order autocorrelation cannot be discarded with high probability and, thus, the coefficient estimates in the first part of Table 5 are likely to be inconsistent estimates of the true parameters of the model. The estimated convergence model is not a proper specification of the true model underlying the observed interest rate data. Robustness checks of the model with alternative specifications, including lagged values of the dependent variable among the explanatory variables and variations in the number of instruments, did not improve the specification tests. We then proceed to estimate dynamics of differentials with respect to marginal costs of banks.

[14] Alternative estimations with pooled data for loans, deposits, loans (deposits) of given maturity (liquidity) were disregarded because all tests of equal coefficients across pooled products rejected the null hypothesis at high levels of statistical significance. Besides, second order autocorrelation increased compared with that shown in Table 5.

4.2. *Explaining differences in interest rate differentials: Convergence in mark-ups*

The hypothesis now is that banks have market power and each one set prices taking into account marginal costs (revenues) and its own price elasticity of demand (supply). The need to introduce this hypothesis comes from the empirical evidence shown in the first part of Table 5, mentioned above, where observed second order autocorrelation, especially among loan products, suggests evidence of model miss specification with the assumption that idiosyncratic factors of banks do not affect the dynamics of the adjustment process. We assume that loan and deposit markets are separated and banks maximize profits in each of them. In the loan market, profits are equal to the interest rate charged in loans less the opportunity cost of lending the funds, which is the credit risk adjusted interest rate of a secured investment of the same maturity than the loan. For deposits, profit is given by the risk free investments of equal maturity, minus the interest rate paid to the deposits. Each bank faces an inelastic demand for each loan product and an inelastic supply of each deposit product.

Bank products are matched with other investment opportunities and costs as follows. Loans and deposits with maturity until three months are matched with the one-day interbank rate; loans and deposits from 3 months to 1 year, with the 3 to 6 month interbank interest rate; loans and deposits between 1 to 3 years, with the 12 month interbank interest rate; loans and deposits with maturity above 3 years, with interest rates on 3-year government bonds; while Mortgages are matched with the one-year Euribor interest rate since most of them are at variable interest rates indexed to it.

Define $i$ as the risk-free interest rate of a given maturity; $PD$ as the probability that the loan will default and $LGD$ as the loss given default, the amount of the loan that the bank will never recover. The opportunity cost of the loan is the interest rate $i_l$ that solves the equation,

$$(1+i_l)(1-PD)+PD(1-LGD)(1+i_l)=1+i$$

Solving the equation we obtain the opportunity cost for each bank and product,

$$i_l = \frac{i + PD \cdot LGD}{1 - PD \cdot LGD} \tag{3}$$

For each of the five loan classes and for each individual bank and year, the *PD* is estimated from the Credit Register database as the proportion of bank loans in default of the bank at the end of the year in the respective product class. The *LGD* are taken from BCBS (2004) as follows: 25% for Mortgages and credit at Variable interest rate, 45% for Credit Line and Receivables and 85% for Personal loans[15].

We assume that each bank predicts the expected future PD for a given loan in year *t* using past data on PD available in the records of the bank. The prediction horizon changes depending on the maturity of the loan. If a loan has maturity of less than 1 year we assume that the bank predicts PD for year *t*, the current year; if the loan has maturity of more than 1 year but less than 2, then the PD value used in the calculation is the one predicted for year *t+1*. Finally if maturity is above 2 years then the bank uses PD predicted for *t+2*. The predicted values of PD, not reported, are estimated using standard time series econometric techniques. The estimation uses all information available in the Credit Register that goes back to 1986.

Figure 3 shows the opportunity cost of loans computed according to (3), relative (i.e. divided by) to the interbank interest rate. The profile of the figure reflects the Spanish business cycle, with higher PD in periods of low economic growth, such as the early nineties. Credit line and Personal have the highest ratio between opportunity cost and one-day interbank rate, 1.55 on average for the whole period, with a moderate increase in the 1994-1998 (1.65). In Receivables, Mortgage and Variable the average ratios are 1.25, 1.20 and 1.07, respectively. For Mortgages, the ratio goes from 1.05 in 1989-1993 to 1.32 in 1999-2003.

Profit maximizing banks facing an elastic demand (supply) of loans (deposits), with absolute value $\varepsilon_l$ ($\varepsilon_d$), will set interest rates on loans (deposits) applying a mark up (mark down) $K_l = \varepsilon_l / (\varepsilon_l - 1)$ ($K_2 = \varepsilon_d / (\varepsilon_d + 1)$) to the opportunity cost $i_l$ ($i$)[16]. Substituting the profit maximizing interest rate in the calculation of the relative interest rate differential we obtain,

$$\ln y_{jt} = \ln K_1 + \ln \frac{i + PD \cdot LGD}{r\,(1 - PD \cdot LGD)} \qquad \text{for loans} \tag{4}$$

$$\ln y_{jt} = \ln K_2 + \ln \frac{i}{r} \qquad \text{for deposits}$$

where $\ln y_{jt}$ is the relative interest rate differential computed as in model (2), that is, the differential with respect to the one day interbank rate. Equation (4) indicates that interest rate differentials as defined in the paper are equal to the sum of the log of the mark up (mark down) and the log of the ratio between the marginal cost of the loan (revenue from deposits) and the one-day interbank rate. As long as the relationship between the term structure of risk-free interest rates remains stable over time, interest rate differentials in deposits will change in parallel with changes in the mark down $K_2$. For loans, the interest rate differential depends on the mark up and on the marginal cost which is a function of the ratio between the risk free interest rate of a given maturity and the one-day interbank rate and also of the *PD* and of the *LGD*. If the term structure of interest rates, the mark up and the *PD* all remain stable over time, interest rate differentials of loans will still vary with $r$, the money market interest rate. In periods when $r$ is decreasing, interest rate differentials will increase, even if the rest of terms remain stable over time.

To estimate the new speed of convergence and long term mark up values, model (2) is modified, so that the interest rate differential is now computed with respect to $ln\ i_l$ instead of $ln\ r_t$, that is, the dependent variable is $ln\ r_{jt} - ln\ i_{l\,jt}$ . The explanatory variables are modified accordingly. The estimated slope coefficients for this variation on model

[15] That is, we use supervisors' best estimates of *LGD* as lay out in the Foundation-IRB approach of Basel II framework.
[16] We ignore possible portfolio effects in determining the profit maximizing interest rates of banks.

(2), for each of the 25 products, are presented in the second part of Table 5 (columns under risk-adjusted marginal cost). The null hypothesis of no second order autocorrelation cannot be rejected at p values higher than 10% in all cases, so parameter estimates are now consistent and there are no signs of model miss specification. The differences of results between the first and second part of Table 5 are only in loan products, which indicates that the main specification problem was due to ignoring the credit risk premium in the calculation of the marginal cost of the loan, and not so much to matching maturity in interest rates.

Convergence in mark ups is accepted in all the products (i.e. $\alpha$ is statistically lower than 1[17]). The speed of convergence starts fairly low in the 1989-1993 period, with relatively high values of the slope coefficient, particularly for loan products, but it increases over time since estimated coefficients for the cross variables ($\gamma_1$ and $\gamma_2$) are negative and in many cases statistically significant. The unambiguous negative estimated values of the $\gamma$ coefficients provide evidence in favor of an increase in the speed of adjustment in interest rates over time. However, most of this increase occurs already in 1994-1998, the years of nominal convergence of the Spanish economy in preparation for joining the Euro zone. There is no empirical support for a stronger relative version of the Law of One Price since 1999, when Spain became a member of the Euro zone.

Estimated coefficients shown in the second part of Table 5 are summarized in Table 6 in the form of weighted averages (using as weights the relative number of observations of each product) for selected groupings of bank products: loans and deposits, maturity of loans, liquidity of deposits and Product Class.[18] Lower values of the estimated parameter $\alpha$ shown in Table 6 imply faster long term convergence. If the value

[17] OLS estimators, that establish an upper limit in the value of the adjustment coefficients, are also smaller than 1. Moreover, there is a significant correlation between instruments and the lagged dependent variable that is not present in unit root cases.

[18] Weighted estimates of product by product values of the adjustment parameters have been preferred to estimates using pooled data because pooled estimations showed clear evidence of second order autocorrelation and, therefore, evidence of model miss specification. Probably, bank products are heterogeneous markets and each of them has its own dynamics. This would be consistent with the observed evidence of cross effects between Bank and Product Class detected in Table 3 and 4.

of the parameter increases over time, the speed of convergence is reduced. The speed of convergence is often evaluated in terms of the half-life of price shocks, that is an estimation of the time required for a unit shock to dissipate by one half, –ln2/ln $\alpha$.

Over the 1989-1993 period, the average value of the parameter of the lagged dependent variable, $\alpha$, for the 25 products, is 0.609. This value implies a half-life of interest rate shocks of 1.39 quarters or 0.35 years. The speed decreases up to a half-life interest shock of 0.23 years in the period 1994-1998, and it decreases again in the last period to 0.16 years[19]. The speed of convergence is higher in loans than in deposits in the first period, but the difference is reduced over time. In 1989-1993 the loans' adjustment parameter $\alpha$ is 0.650 with half-life of price shocks of 0.40 years; in 1999-2003 the adjustment parameter is 0.484 (0.609-0.166) and half-life value of 0.24 years. Credit Line show higher speed of adjustment than the rest of loans during the whole time period, with the exception of Mortgages in 1999-2003 whose speed of adjustment is similar to that observed in Credit Line. In Receivables and Personal loans the speed of adjustment is lower, but increasing over time.

For deposits, the respective half-life values are 0.29 in the first period and 0.47 years in the last one, with the highest speed of adjustment in Repo and quite similar in the rest. By maturity, very short term loans, less than one month of maturity, are those with higher increase in speed of adjustment over time, but they are also the products which start at lower speed values in the period 1989-1993[20]. The pattern of speed of adjustment across loans of different maturity (lower among high maturity products) probably reflects the smoothing practice of banks in the transmission to interest rates of loans of changes in costs, consistent with the practice of relational lending (Berger and Udell (1992)).

[19] Goldberg and Verboven (2004) obtain half-life values of 0.7 for car prices in Europe.

[20] We have performed tests of equal weighted averages of speed of adjustment for loans and for deposits products and for loans of low and high maturity (liquidity). The z statistic of the test is computed taking into account the variance covariance matrix of all the estimated coefficients weighted in the comparison. In both cases the null hypothesis of no difference was rejected (z = -2.36 and z = 5.31, respectively).

The last four columns of Table 6 show long-term equilibrium mark ups (in logs)[21]. For the average of all 25 loan and deposit products, long term interest rate mark ups are 0.201 in the period 1989-1993 and 0.263 in the period 1999-2003. In the case of loans, mark ups increase from 0.054 to 0.151. The persistent negative long term values of mark ups in Credit Line over time indicate that banks subsidize this type of loan to firms, maybe because they obtain income from other sources. Mark ups were also negative in loans of maturity above 3 years in 1994-1998, coinciding with a period of high credit risk. The equilibrium mark up in loans is higher in 1999-2003 than in 1989-1993, evidence that suggests an increase in market power of banks in loan products over time[22].

On average, the mark down in deposits is similar in the first and the last periods, around 0.40. During the 1994-1998 period the mark down is lower, implying less market power and presumably higher competition. Current Accounts, and specially Saving Accounts, are the deposit products with higher mark down, suggesting they have the less competitive markets[23].

## 5. Conclusions

Interest rate differentiation is a persistent phenomenon in Spanish retail banking, a situation that has not changed substantially with the introduction of the Euro. Differences in interest rates persist across banks and between product classes in both loans and

[21] Long term differentials are equal to $\frac{\delta}{1-\alpha}$, where $\delta$ and $\alpha$ come from the estimates reported in Table 5: the slope $\alpha$ is the one reported in the Table, while $\delta$ is obtained as the average of the residual $y_{jt} - \alpha y_{jt-1} - \gamma_2 D_1 y_{jt-1} - \gamma_2 D_2 y_{jt-1,}$, as information about the intercept is lost when taking first differences. From the estimated residual we test for statistically different from zero values of the parameter $\delta$ and for statistically significant differences in the average values of $\frac{\delta}{1-\alpha}$ across time periods (one period with respect to the prior one).

[22] The long-term values shown in the final columns of the Table are long term mark ups in logs. The actual mark up is obtained taking the anti-log value of the long-term estimated coefficient. For example in 1999-2003 the mark up in loans is in average 1.16 (exp (0.151)), that is, a Lerner index of 16%. This implies an absolute elasticity of demand of 7 (from $(\varepsilon_l /( \varepsilon_l -1)= 1.15)$.

[23] The actual mark down applied to the risk free interest rate that determines the marginal revenue the bank obtains from deposits, is the inverse of the anti log of the long term value shown in Table 6. For the 0.4 value, the mark down is 0.67 (exp(-0.41)). This implies an elasticity of supply of deposits of 2 and a Lerner index of 50%.

deposits. The evidence found in the paper casts some doubts on whether Spanish retail banking can be considered a single market from the point of view of the absolute version of the Law of One Price, a conclusion that should moderate the expectations about future European banking integration. Dispersion is higher in loans than in deposits, especially due to bank specific effects that reflect heterogeneity in banks' credit policies. Among these policies, relational lending can be the reason why the relative version of the Law of One Price finds stronger support as loan maturity decreases.

The test of the relative version of the Law of One Price provides evidence about the speed of adjustment of interest rates differentials with respect to interbank rate. It also shows that, in the case of loans, the dynamics of interest rates are not well captured by the dynamics of the interbank rate as the hypothesis of perfect competition would predict (the estimated empirical model shows clear evidences of second order autocorrelation). In addition, the speed of adjustment does not change in any clear pattern over time. When the dynamics of interest rates are modeled by the dynamics of the mark up over marginal cost (obtained as a function of risk-free interest rates of loans and of predicted probability of defaults for each bank, product and time period) then the second order autocorrelation disappears and the parameter that measures the speed of adjustment changes over time in a way consistent with higher speed of adjustment, higher adherence to the Law of One Price. However, if interest rates of individual banks respond to marginal costs of the bank, the market power of the bank goes against the absolute version of the Law of One Price, since differences in marginal costs across banks will be an additional source of price differentiation.

Another relevant result of the paper is that conventional measures of market power such as relative profit margins or the Lerner index increase over time in all loan products and remain stable in deposits with the exception of Repo type deposits, for which it decreases. Other than by the decline in interest rates and absolute profit margins during the period of study, the evidence does not support that market power of Spanish banks has decreased in a significant way. This conclusion is reached even when margins are computed over credit risk adjusted opportunity costs of loans. In any case, market

power of banks appears to be quite different across products. For example, in 1999-2003 the relative long term mark up goes from -4.8% in Credit Line to 29% in Mortgages, and from 28.1% in Deposits to 153% in Saving accounts.

Some caveats are however in order. First of all, increasing mark ups in loans may just reflect the fact that the marginal operating cost of lending is not declining at the same pace as the interbank interest rate during the period. Higher relative gross margins in loans are needed to compensate for the trend in marginal operating costs. Data does not allow us to compute separate marginal operating costs for each loan or deposit product, but the very high increase in demand of credit, especially mortgages, during the period of study lead us to believe that marginal operating costs of loans has decreased over time. Secondly, consumers of banking services have benefited from important improvements in quality of services during the period of study, which have to be accounted for to evaluate their welfare. Third, and specially important, increasing competition and loose monetary policies have forced banks to improve credit risk management and to eliminate cross subsidization of products. There is evidence that in 1989-1993, with high money market interest rates, banks had very high profit margins in deposits that compensated for negative profit margins (after credit risk) in personal and business loans. When money market interest rates went down and competition increased within a full liberalization of the retail banking markets, subsidization became no longer possible and banks adjusted the interest on bank products to their respective marginal cost (loans) or marginal revenues (deposits).

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## Table 1. Banking products by maturity and liquidity.

| LOANS | | | | | DEPOSITS | | | |
|---|---|---|---|---|---|---|---|---|
| | Maturity | | | | | Liquidity | | |
| | < 3 m | 3m - 1y | 1y - 3y | > 3 y | | Low | Medium | High |
| Receivable | x | x | x | | Current | | | x |
| Credit Line | x | x | x | x | Saving | | | x |
| Personal | x | x | x | x | Deposit | x | x | x |
| Mortgage | | | | x | Repo | | x | x |
| Variable | x | x | | | | | | |

Note: There are some cells to which we have assigned more than one single product. On the loan side, Loans at variable interest rate of less than 1 month and from 1 to 3 months are grouped under the maturity label of "< 3 m". On the deposit side, Deposits from 3 to 6 months, 6 months to 1 year, 1 year to 2 years and Repo operations from 3 months to 6 months and 6 months to 1 year are grouped under the "Medium" liquidity label.

**Table 2. Interest rate dispersion for all bank products, for loans and for deposits. Summary statistics.**

*Interbank* refers to the one-day interest in the interbank market. The *Differential with the Interbank rate* panel shows the average difference between the interest rate of the Loan/Deposit and the one-day interbank rate in percent points (Absolute) and the average of differences divided by the respective interest rate of Loan/Deposit (Relative). Dispersion includes 90th - 10th (what we call Range), the average difference between the interest rate of the 90th and the 10th percentiles of the distribution of interest rates divided by the average interest rate of the product. Coefficient of Variation is the ratio between standard deviation and the mean of the distribution of interest rates across banks and products.

| | | 1989-2003 | 1989-1993 | 1994-1998 | 1999-2003 |
|---|---|---|---|---|---|
| **Interbank (%)** | | 8.72 | 13.66 | 7.35 | 3.61 |
| **Differential with Interbank** | | | | | |
| All products | Absolute (p.p) | 2.74 | 3.47 | 2.46 | 1.92 |
| | Relative (%) | 45.42 | 41.38 | 38.57 | 61.72 |
| Loan products | Absolute (p.p) | 3.02 | 2.98 | 3.26 | 2.76 |
| | Relative (%) | 27.04 | 16.98 | 29.60 | 40.17 |
| Deposit products | Absolute (p.p) | 2.34 | 4.16 | 1.40 | 0.81 |
| | Relative (%) | 70.44 | 75.47 | 50.68 | 90.07 |
| **Dispersion measures** | | | | | |
| All products | Range ($90^{th}$ - $10^{th}$(%)) | 42.01 | 34.56 | 40.90 | 55.71 |
| | Coefficient of Variation (%) | 17.40 | 13.82 | 17.12 | 23.63 |
| Loan products | Range ($90^{th}$ - $10^{th}$(%)) | 36.07 | 23.59 | 39.22 | 52.43 |
| | Coefficient of Variation (%) | 15.19 | 9.80 | 16.66 | 22.10 |
| Deposit products | Range ($90^{th}$ - $10^{th}$(%)) | 50.09 | 49.90 | 43.18 | 60.03 |
| | Coefficient of Variation (%) | 20.41 | 19.45 | 17.74 | 25.64 |

**Table 3. Determinants of interest rate differential and contribution to explained variance of Time, Product Class, Maturity, Bank and Province in selected time periods. Loans.**

The dependent variable is ln $r_{ijmt}$ - ln $r_t$, where $r_{ijmt}$ stands for the interest rate of Bank *j* on Product *i* at Time *t* in province *m*. $r_t$ is the one-day interbank interest rate at Time *t*.

| | 1989-2003 | 1989-1993 | 1994-1998 | 1999-2003 |
|---|---|---|---|---|
| **Contribution to explained variance[a,c]** | | | | |
| Time | 37.97% | 23.46% | 9.80% | 17.85% |
| Product class | 21.32% | 32.92% | 37.46% | 37.28% |
| Maturity | 1.30% | 6.78% | 2.41% | 0.60% |
| Bank | 31.39% | 41.60% | 51.55% | 53.17% |
| Province | 0.00% | 0.00%* | 0.00%* | 0.00%* |
| Product class * Bank | 43.04% | 57.71% | 73.81% | 71.90% |
| **Intercept[a,b]** | 0.408 | 0.272 | 0.370 | 0.423 |
| **Product Class[a]** | | | | |
| Receivables | 0.218 | 0.048 | 0.189 | 0.158 |
| Credit Lines | 0.166 | -0.035 | 0.118 | 0.197 |
| Personal Loans | 0.254 | 0.037 | 0.218 | 0.334 |
| Mortgages | 0.017 | -0.040 | -0.020 | -0.027 |
| Variable | 0.057 | -0.073 | -0.029 | -0.008 |
| **Maturity[a]** | | | | |
| 1 to 3 Months | 0.005 | -0.013 | 0.010 | 0.022 |
| 3 Months to 1 Year | 0.040 | 0.022 | 0.050 | 0.048 |
| 1 to 3 Years | 0.075 | 0.070 | 0.086 | 0.062 |
| More than 3 Years | 0.004 | 0.011 | 0.007 | -0.001 |
| **Differences by type of bank** | | | | |
| Saving Banks-Commercial Banks[a] | 0.056 | -0.005 | 0.078 | 0.093 |
| Non National Banks - National Banks[a] | 0.005 | -0.013 | 0.016 | 0.011 |
| **Differences in average relative differentials in time periods[a]** | | | | |
| Period 94-98=Period 99-03 (P-value) | 0.000 | | | |
| Period 94-98 - Period 89-93 | 0.154 | | | |
| Period 99-03 - Period 89-93 | 0.336 | | | |
| **$R^2$** | 73.56% | 65.41% | 70.98% | 76.32% |
| **Number of observations** | 1.455.798 | 495129 | 522220 | 438449 |

[a] Unless specified with (*), all p-values from the F-tests for statistical lack of significance of coefficients are less or equal to 1%

[b] Intercept estimates refer to credit with variable interest rate and with maturity below 1month in Madrid for a large bank.

[c] We show the relative fall in the $R^2$ of the model when the group under study is withdrawn from the regression.

**Table 4. Determinants of interest rate differential and contribution to explained variance of Time, Product Class, Liquidity, Bank and Province in selected time periods. Deposits.**

The dependent variable is ln $r_t$ - ln $r_{ijmt}$, where $r_{ijmt}$ stands for the interest rate of Bank *j* on Product *i* at Time *t* in province *m*. $r_t$ is the one-day interbank interest rate at Time *t*.

| | 1989-2003 | 1989-1993 | 1994-1998 | 1999-2003 |
|---|---|---|---|---|
| **Contribution to explained variance[a,c]** | | | | |
| Time | 3.41% | 4.62% | 3.36% | 0.57% |
| Product class | 34.62% | 42.25% | 29.31% | 38.61% |
| Liquidity | 0.15% | 1.20% | 0.12% | 0.34% |
| Bank | 25.58% | 28.77% | 24.99% | 31.16% |
| Province | 0.00% | 0.00%* | 0.00%* | 0.00%* |
| Product class * Bank | 41.75% | 49.93% | 38.11% | 46.41% |
| **Intercept[a,b]** | 0.438 | 0.271 | 0.521 | 0.438 |
| **Product Class[a]** | | | | |
| Saving accounts | 0.877 | 0.978 | 0.605 | 1.036 |
| Current accounts | 0.128 | 0.142 | 0.105 | 0.248 |
| Repo operations | -0.283 | -0.126 | -0.399 | -0.399 |
| Deposits | -0.240 | -0.126 | -0.281 | -0.258 |
| **Liquidity[a]** | | | | |
| Medium | 0.041 | 0.095 | 0.024 | 0.006 |
| Low | 0.012 | 0.138 | -0.009 | -0.087 |
| **Differences by type of bank** | | | | |
| Saving Banks-Commercial Banks[a] | 0.082 | 0.093 | 0.068 | 0.098 |
| Non National Banks - National Banks[a] | -0.017 | 0.019 | -0.000* | -0.080 |
| **Differences in average relative differentials in time periods[a]** | | | | |
| Period 94-98=Period 99-03 (P-value) | 0.000 | | | |
| Period 94-98 - Period 89-93 | -0.104 | | | |
| Period 99-03 - Period 89-93 | -0.051 | | | |
| **$R^2$** | 79.02% | 85.65% | 84.07% | 90.32% |
| **Number of observations** | 1.046.277 | 346545 | 376408 | 323324 |

[a] Unless specified with (*), all p-values from the F-tests for statistical lack of significance of coefficients are less or equal to 1%

[b] Intercept estimates refer to deposits with high liquidity in Madrid for a large bank.

[c] We show the relative fall in the $R^2$ of the model when the group under study is withdrawn from the regression.

## Table 5. Estimated slope coefficients from adjustment Model (2) of interest rate differentials.

Dependent variable is ln $r_{ijt}$ - ln $r_t$ for loan products and ln $r_t$ - ln $r_{ijt}$ for deposit products, where $r_{ijt}$ is the interest rate of Bank *j* on Product *i* at Time *t*. $r_t$ is the one-day interbank interest rate for the first four columns and the credit-risk adjusted marginal cost for the last four columns. The estimated equation is $Y_{jt} = \delta + \alpha Y_{ijt-1} + \gamma_1 D_1 Y_{jt-1} + \gamma_2 D_2 Y_{jt-1} + Year\ Dummies + \eta_j + \varepsilon_{ijt}$. Coefficients reported have been obtained applying the Arellano-Bond (1991) estimation technique for each product, using up to four lags of the dependent variable as instruments.

| | COMMON MARGINAL COST= INTERBANK RATE | | | | BANK-SPECIFIC MARGINAL COST=INTERBANK CORRECTED BY RISK | | | |
|---|---|---|---|---|---|---|---|---|
| | $\alpha$ | $\gamma_1$ | $\gamma_2$ | P-values of non-2nd order autocorrelation statistic[a] | $\alpha$ | $\gamma_1$ | $\gamma_2$ | P-values of non-2nd order autocorrelation statistic[a] |
| RECEIVABLEless3months | 0.559 *** | 0.062 ** | 0.085 *** | 0.000 | 0.802 *** | -0.107 ** | -0.144 *** | 0.674 |
| RECEIVABLE3months-1year | 0.568 *** | 0.010 | 0.049 * | 0.000 | 0.672 *** | -0.023 | -0.038 | 0.393 |
| RECEIVABLE1year-3years | 0.403 *** | -0.147 *** | 0.016 | 0.401 | 0.552 *** | -0.192 *** | -0.108 | 0.597 |
| CREDITLINEless3months | 0.491 *** | -0.201 *** | -0.111 ** | 0.085 | 0.329 *** | 0.039 | 0.114 | 0.156 |
| CREDITLINE3months-1year | 0.433 *** | -0.023 | 0.019 | 0.000 | 0.558 *** | -0.038 | -0.172 ** | 0.730 |
| CREDITLINE1year-3years | 0.591 *** | 0.061 *** | 0.113 *** | 0.000 | 0.560 *** | -0.073 | -0.094 | 0.182 |
| CREDITLINEmore3years | 0.462 *** | -0.071 ** | 0.027 | 0.120 | 0.249 *** | 0.035 | 0.150 | 0.879 |
| PERSONALless3months | 0.497 *** | -0.038 | 0.046 | 0.342 | 0.471 *** | -0.063 | -0.064 | 0.566 |
| PERSONAL3months-1year | 0.412 *** | -0.042 | 0.012 | 0.105 | 0.586 *** | -0.150 ** | -0.145 ** | 0.564 |
| PERSONAL1year-3years | 0.562 *** | 0.027 | 0.125 *** | 0.000 | 0.832 *** | -0.234 *** | -0.302 *** | 0.106 |
| PERSONALmore3years | 0.609 *** | 0.023 | 0.179 *** | 0.000 | 0.815 *** | -0.238 ** | -0.263 *** | 0.315 |
| MORTGAGEmore3years | 0.593 *** | 0.074 *** | 0.141 *** | 0.000 | 0.758 *** | -0.310 *** | -0.345 *** | 0.119 |
| VARIABLEless1month | 0.395 *** | 0.043 | 0.132 | 0.121 | 0.784 *** | -0.438 *** | -0.419 *** | 0.125 |
| VARIABLE1month-3months | 0.413 *** | 0.000 | 0.169 ** | 0.007 | 0.788 *** | -0.405 *** | -0.411 *** | 0.131 |
| VARIABLEmore3months | 0.514 *** | 0.025 | 0.245 *** | 0.000 | 0.773 *** | -0.204 *** | -0.203 *** | 0.168 |
| DEPOSITSless3months | 0.616 *** | -0.183 *** | -0.135 ** | 0.686 | 0.616 *** | -0.183 *** | -0.135 ** | 0.686 |
| DEPOSITS3months-6months | 0.576 *** | 0.050 | 0.106 ** | 0.808 | 0.670 *** | -0.247 *** | 0.011 | 0.342 |
| DEPOSITS6months-1year | 0.507 *** | -0.004 | 0.059 | 0.097 | 0.621 *** | -0.281 *** | -0.163 *** | 0.348 |
| DEPOSITS1year-2years | 0.594 *** | -0.132 *** | -0.125 *** | 0.133 | 0.568 *** | -0.010 | 0.062 | 0.107 |
| DEPOSITSmore2years | 0.709 *** | -0.073 | -0.334 *** | 0.153 | 0.455 *** | 0.117 * | -0.131 | 0.860 |
| REPOless3months | 0.511 *** | -0.124 * | -0.013 | 0.624 | 0.511 *** | -0.124 * | -0.013 | 0.624 |
| REPO3months-6months | 0.482 *** | -0.077 | 0.148 ** | 0.180 | 0.435 *** | -0.177 * | -0.095 | 0.515 |
| REPO6months-1year | 0.484 *** | -0.145 ** | -0.058 | 0.687 | 0.424 *** | -0.087 | -0.220 * | 0.998 |
| CURRENT | 0.610 *** | -0.044 | -0.086 | 0.821 | 0.610 *** | -0.044 | -0.086 | 0.821 |
| SAVINGS | 0.562 *** | -0.191 *** | -0.152 *** | 0.880 | 0.562 *** | -0.191 *** | -0.152 *** | 0.880 |

The null hypothesis of $\alpha = 1$ is rejected at p-values of 5% or less in all the products.

[a] The null hypothesis is the absence of second order autocorrelations in the residuals of the regression.

## Table 6. Summary of slope coefficients $\alpha$ and long term mark up of interest rates on loans and deposits.

Slope coefficients are weighted averages of those in Table 5 computed with the specific-marginal cost model. Long term mark up are averages of $\delta/(1-\alpha)$, also from Table 5.

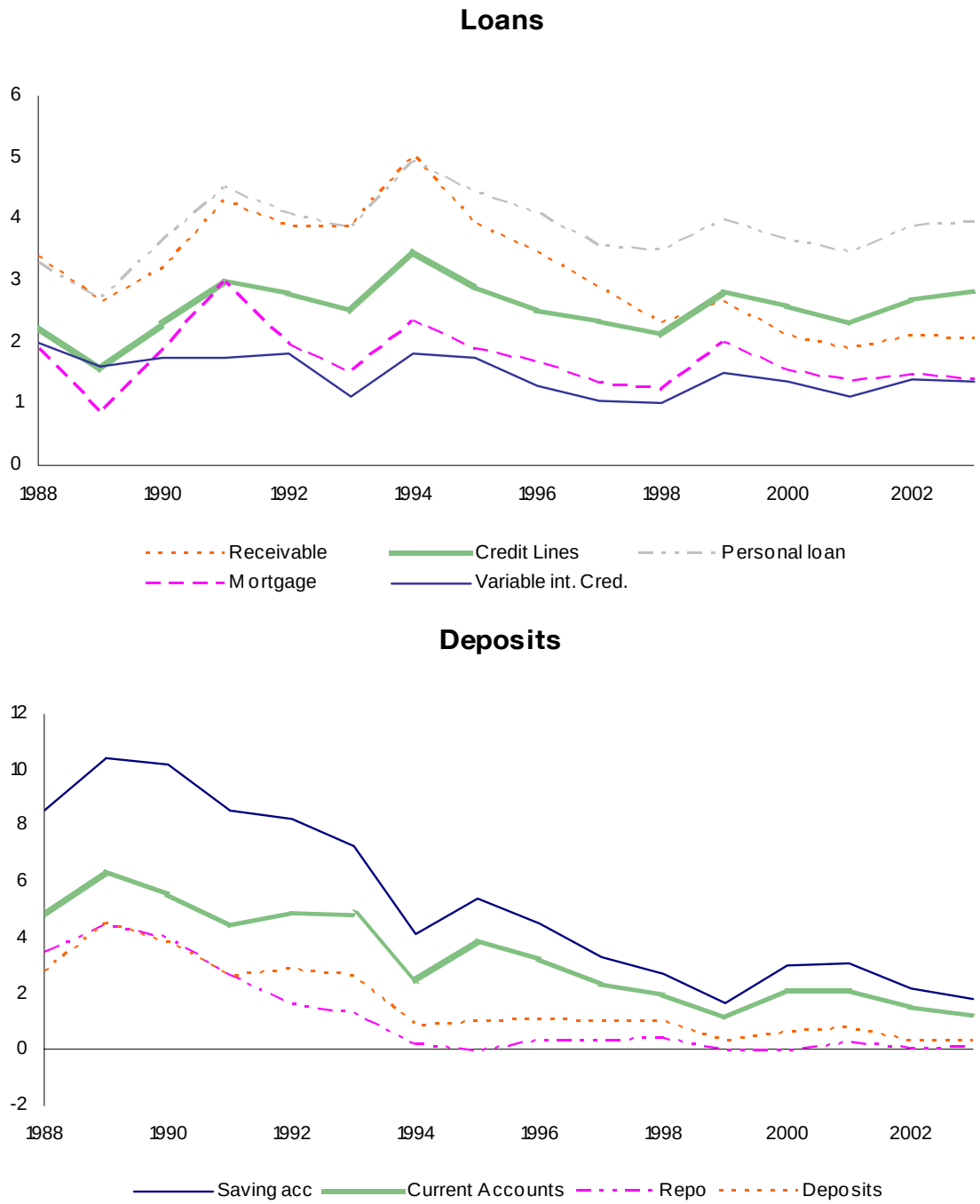
| | | Speed of adjustment | | | Long Term Mark up | | | |
|---|---|---|---|---|---|---|---|---|
| | | $\alpha$ | $\gamma_1$ | $\gamma_2$ | 1989-2003[a] | 1989-1993[a] | 1994-1998[b] | 1999-2003[b] |
| **Pooled regression** | POOL | 0.609 | -0.143 | -0.132 | 0.207 *** | 0.201 *** | 0.174 | 0.263 |
| | | | | | | | (0.000) | (0.000) |
| **By class** | Loans | 0.650 | -0.154 | -0.166 | 0.083 *** | 0.054 *** | 0.067 | 0.151 |
| | | | | | | | (0.001) | (0.000) |
| | Deposits | 0.554 | -0.127 | -0.087 | 0.375 *** | 0.405 *** | 0.319 | 0.410 |
| | | | | | | | (0.000) | (0.000) |
| **By maturity** | More than 3 years | 0.618 | -0.143 | -0.120 | -0.003 | 0.013 * | -0.053 | 0.041 |
| | | | | | | | (0.000) | (0.000) |
| | 1 year - 3 years | 0.659 | -0.164 | -0.175 | 0.071 *** | 0.092 *** | 0.051 | 0.066 |
| | | | | | | | (0.000) | (0.092) |
| | 3 months-1year | 0.644 | -0.102 | -0.137 | 0.088 *** | 0.029 *** | 0.091 | 0.172 |
| | | | | | | | (0.000) | (0.000) |
| | 1month-3 months | 0.612 | -0.125 | -0.123 | 0.081 *** | 0.002 | 0.073 | 0.215 |
| | | | | | | | (0.000) | (0.000) |
| | less than 1 month | 0.784 | -0.438 | -0.419 | 0.047 *** | 0.014 | 0.042 | 0.108 |
| | | | | | | | (0.025) | (0.000) |
| | Very long term (Mortgages) | 0.758 | -0.310 | -0.345 | 0.265 *** | 0.314 *** | 0.198 | 0.290 |
| | | | | | | | (0.000) | (0.001) |
| **By liquidity** | Very high (Sight Accounts) | 0.588 | -0.111 | -0.116 | 0.930 *** | 0.913 *** | 0.831 | 1.091 |
| | | | | | | | (0.000) | (0.000) |
| | Medium | 0.520 | 0.044 | -0.020 | 0.289 *** | 0.285 *** | 0.274 | 0.314 |
| | | | | | | | (0.177) | (0.000) |
| | Low | 0.548 | -0.205 | -0.112 | 0.203 *** | 0.266 *** | 0.145 | 0.188 |
| | | | | | | | (0.000) | (0.000) |
| | High | 0.558 | -0.150 | -0.068 | 0.146 *** | 0.191 *** | 0.109 | 0.137 |
| | | | | | | | (0.000) | (0.000) |
| **By type of product** | Receivable | 0.690 | -0.099 | -0.096 | 0.166 *** | 0.142 *** | 0.186 | 0.179 |
| | | | | | | | (0.000) | (0.350) |
| | Credit Line | 0.459 | -0.021 | -0.033 | -0.088 *** | -0.068 *** | -0.137 | -0.048 |
| | | | | | | | (0.000) | (0.000) |
| | Personal | 0.683 | -0.175 | -0.198 | 0.104 *** | 0.028 *** | 0.097 | 0.237 |
| | | | | | | | (0.000) | (0.000) |
| | Mortgages | 0.758 | -0.310 | -0.345 | 0.265 *** | 0.314 *** | 0.198 | 0.290 |
| | | | | | | | (0.000) | (0.001) |
| | Variable | 0.780 | -0.324 | -0.321 | 0.105 *** | 0.048 *** | 0.097 | 0.184 |
| | | | | | | | (0.000) | (0.000) |
| | Deposit | 0.592 | -0.132 | -0.065 | 0.256 *** | 0.263 *** | 0.231 | 0.281 |
| | | | | | | | (0.000) | (0.000) |
| | Repo | 0.460 | -0.130 | -0.102 | 0.128 *** | 0.237 *** | 0.054 | 0.062 |
| | | | | | | | (0.000) | (0.059) |
| | Current | 0.610 | -0.044 | -0.086 | 0.602 *** | 0.535 *** | 0.585 | 0.721 |
| | | | | | | | (0.000) | (0.000) |
| | Saving | 0.562 | -0.191 | -0.152 | 1.318 *** | 1.351 *** | 1.126 | 1.538 |
| | | | | | | | (0.000) | (0.000) |

Notes.- (***)= Significant at 1%. (**)=Significant at 5%. (*)= Significant at 1%. Standard errors in parentheses.

a The asterisks refer to the test of significance of the first-period average intercept.

b Figures in parentheses are the p-values obtained from the test of equality of the average intercept in the period with respect to that of the previous period.

**Figure 1: Interest Rate Differentials with respect to the Interbank*. Selected Bank Products, 1989-2003. In Percent Points.**




* Differential = $r_{it}$-$r_t$ for loans and $r_t$-$r_{it}$ for deposits, where $r_{it}$ is the average interest rate of product *i* at time *t* and $r_t$ is the interbank interest rate at time *t*.

**Figure 2. Histogram of relative interest rate Range** (difference between the 90th and 10th percentiles divided by the Average Interest rate of the respective Bank Product) **for all bank products.**

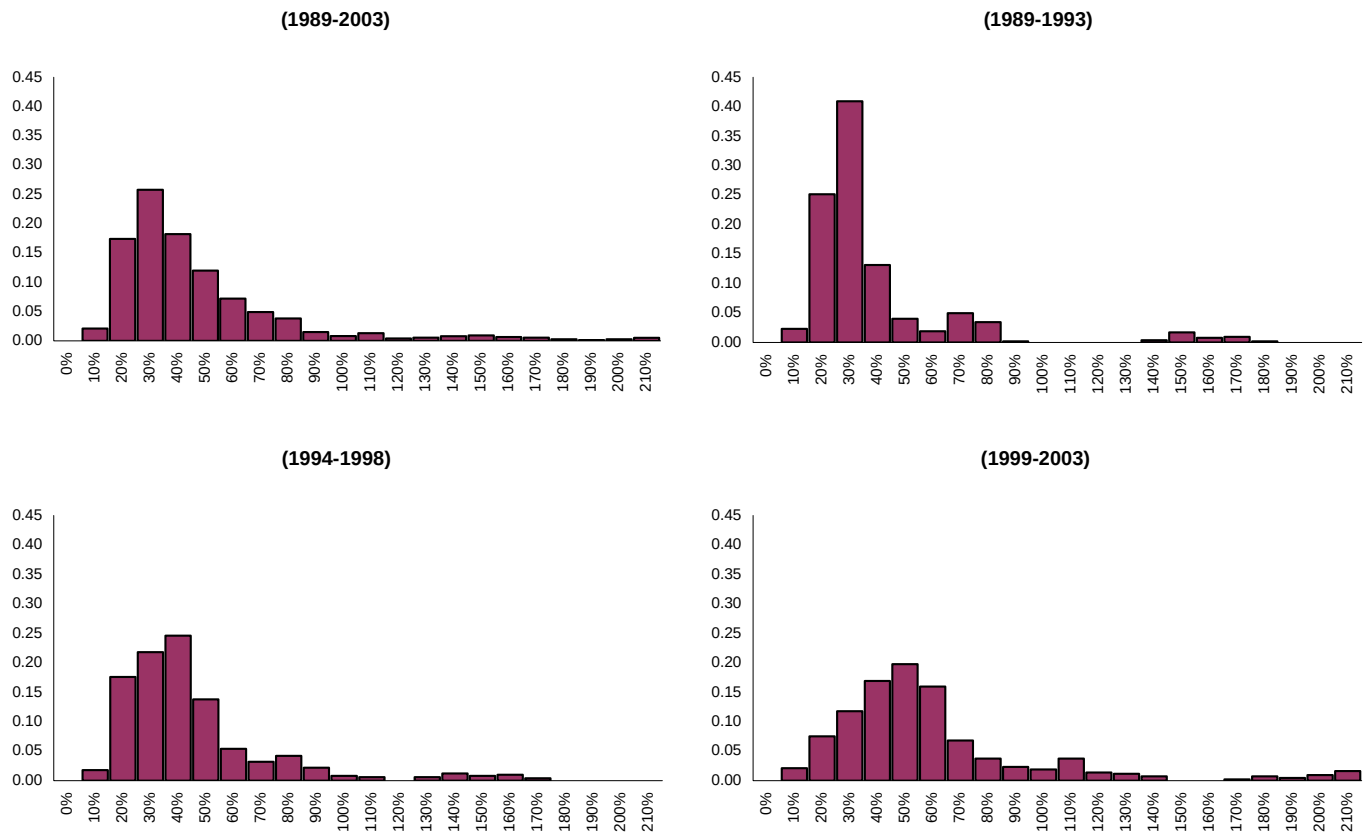


**Figure 3. Opportunity Cost of Loans Relative to One-Day Interbank Interest Rate. 1989-2003.**