# Spatial Competition in the Colombian Deposit Market

Sandra Rozo
Dairo Estrada*

## I. Introduction

As Freixas and Rochet (1997) mention, in perfect competition the optimal choice for banks is determined by the point where intermediation margins are equal to operating costs. In this scenario, market equilibrium is not affected by a bank's actions. In contrast, when a bank has market power, it can affect prices, which will lead to higher lending rates and lower deposit rates. In this way, part of the consumer surplus is passed to the banks and efficiency is lost through a reduction in the volume transacted on the market. Therefore, regulations to limit the creation, spread and use of market power are entirely justified.

Nevertheless, the only guides to implementing such regulations in an ideal way are the empirical studies of competition that describe the characteristics of the relevant market, which is why they are so important.

In Colombia, existing empirical literature on the study of competitive conditions in the banking system has, by tradition, followed one of two tendencies. The focus is either on price or volume to explain the way banks behave, ignoring the possibility that banks might consider other types of strategic variables, or the market structure is invariably analyzed from a national standpoint, without asking if the conclusions for the domestic market are applicable on a regional scale.

This summary outlines a competition oligopoly model where banks use other variables, besides price, to compete on the market. Specifically, the relevance of geographic variables, such as the number of branch offices, is analyzed to explain the strategic behavior of banks in Colombia. A two-stage model is

---

* This document is a summary of "Multimarket Spatial Competition in the Colombian Deposit Market" by Estrada and Rozo (2006). The opinions expressed herein imply no commitment on the part of Banco de la República or its Board of Directors. Please contact the author for doubts or clarification. E-mails: destrada@banrep.gov.co, srozovil@banrep.gov.co.

suggested in this scenario, where banks select the optimal interest rate with which they will compete throughout the country during the first period. In the second period, given that interest rate, they select the optimal number of branch offices to be opened in each region.

The proposed model is intended to evaluate the extent of competition in Colombia's regions and departments. More specifically, the working hypothesis suggests that the aggregated measures used traditionally to examine market power in Colombia leave aside certain regional and departmental features. This can lead to erroneous conclusions. In other words, analyzing the market structure in a more disaggregated way can produce more precise results, thereby making it possible to identify the regions where anti-competitive pressures might occur that cannot be detected at the aggregate level

## II. THE MODEL

The model was developed pursuant to the approximations by Canhoto (2004), and Freixas and Rochet (1997). In this context, a static partial equilibrium oligopoly model was suggested where banks operate in the securities, deposit and loan markets. There is product differentiation in the deposit and loan market, but a great deal of elasticity in substitution, which means the bank's demand for deposits and its supply of loans are dependent on its own interest rate and on the vector of the rates charged by its competitors. Moreover, there is separability between the loan and deposit markets, and banks are price-takers in the securities market.[1]

The model is executed in two periods throughout which the banks have two strategic variables: interest rates and the number of branch offices. In this context, each bank chooses the interest rates that maximize its target function in the first period, pursuant to a Bertrand model.[2] In the second period, given the optimal rates selected during the first period, the bank determines the optimal number of branch offices to be established in each region. More specifically, each bank sets the same interest rate for all its branch offices.[3]

---

1 The market separability assumption has been used widely in literature. For example, Chiappori, Perez-Castrillo and Verdier (1993) and Barros (1997) used it to examine the deposit market.

2 The Bertrand model fits this scenario because, as mentioned by Chiappori, Perez-Castrillo and Verdier (1993), prices should be regarded as the bank's primary means of competition.

3 In Colombia, each bank sets a benchmark rate for the deposit market nationwide. Each office or branch may use that rate to establish one that is a bit different. However, there is no information on these margins, which is why the rate is assumed to be the same throughout the country.

## A. First Period

Under the assumptions noted earlier, each bank chooses the interest rate that maximizes its profits during the first period. The profit function of bank *i* in this period would be provided by:

$$(1) \quad \pi_i = r_i^l + (r^s(1 - p) + mp - r_i^d)D_i - C_i(D_i, L_i, S_i, n_i)$$

where $L_i$, $S_i$ and $D_i$ represent, respectively, the amount of loans, the stock of securities and the volume of deposits received by bank *i*; *r* is the interest rate in each market; *p* is the reserve requirement rate; *m* is the return on the amount in reserve; $n_i$ is the number of offices bank *i* has throughout the country; and $C_i$ represents the cost function of bank *i*, where the assumption of separability allows for the conclusion that variable costs are also separable for each activity.

The assumption of separability between the deposit and loan markets allows us to specify the supply of deposits for bank *i* as:

$$(2) \quad D_i = D_i(r_i^d, r_{-i}^d, Z_i)$$

*where* $r_{-i}^d$ is the vector of deposit rates set by rival banks in the market and $Z_i$ represents the other exogenous variables that affect the deposit supply for bank *i*. In this context, the deposit supply for each bank is determined by the interest rates of all its rival banks. This, in itself, is a complicated problem. We simplify it by using Canhoto's method (2004), which replaces the vector of the competitors' interest rates with a weighted average of those rates, so that:

$$(3) \quad r_{Ri}^d = \sum_{j \neq i} \left[ \frac{D_j}{\sum_{j \neq i} D_j} \right] * r_j$$

Given this definition, theory says that the amount of deposits supplied to bank *i* by the public will increase if its own interest rate goes up, and will decline with a reduction in the weighted average of its competitors' rates. Based on these specifications for the deposit supply and the profit function, the first order condition for bank *i* with respect to the interest rate would be given by:

$$(4) \quad r_i^{*d} = \left( r^s(1 - p) + mp - \frac{\partial C_i(D_i)}{\partial D_i} \right) - D_i\lambda$$

where $\lambda$ can be written as:

$$(5) \quad \lambda = \left(\frac{\partial r_i}{\partial D_i}\right) = \frac{1}{\left[\left(\frac{\partial D_i}{\partial r_i^d}\right) + \left(\frac{\partial D_i}{\partial r_{Ri}^d}\right)\left(\frac{\partial r_{Ri}^d}{\partial r_i^d}\right)\right]} = \frac{1}{\left[\left(\frac{\partial D_i}{\partial r_i^d}\right) + \left(\frac{\partial D_i}{\partial r_{Ri}^d}\right)\gamma\right]}$$

In this expression, $\gamma = \left(\frac{\partial r_{Ri}^d}{\partial r_i^d}\right)$ represents the firm's conjectural parameter, which is defined as the change in the other firms' interest rates, anticipated by firm *i* as the response to an initial change in its own interest rate. As illustrated by equations (4) and (5), *ceteris paribus*, the value of this parameter defines if the interest rates are higher or lower by determining the value of $\lambda$. Accordingly, in a competitive market, one would expect bank i to pay higher deposit rates as a way of attracting more customers. By the same token, in a less competitive market, the bank would be expected to do just the opposite, given its market power. In this way, $\gamma$ allows us to measure the amount of competition in the market by identify the interest rate value. More specifically, the case where $\gamma = 0$ represent Nash equilibrium is a scenario where the representative bank is not acting in response to the actions of its competitors. [4] If $\gamma$ is negative, the interest rate will be higher than when $\gamma = 0$, in which case we would find a more competitive scenario than Nash equilibrium. If the opposite occurs, and $\gamma$ is positive and greater than 1, the deposit rate will be less than when $\gamma = 0$ and we would find a more collusive scenario than Nash equilibrium.[5] For the sake of simplicity, for $\gamma$ values such as $0 \leq \gamma \leq 1$, we will contrast the value of the interest rate for Nash equilibrium ($\gamma = 0$) with the value of the interest rate obtained with the estimated $\gamma$ value, and determine, on the basis of that comparison, if the scenario is more or less competitive than Nash equilibrium.

Although the loan market is not the target of this study, it is important to clarify that banks also choose their lending rate using a demand credit function given by:

$$(6) \quad L_i = L_i\,(r_i^l, r_{Ri}^l, w_i)$$

*where* $w_i$ represents the exogenous variables that affect the demand for credit from bank *i*.

---

[4] In this scenario, given the strategies of their competitors, banks have no incentive to change theirs.

[5] It is important to spell out the difference between Nash equilibrium and competitive equilibrium. The former is a situation where a set of strategies provide no incentive for any one bank to change its strategies as long as the others do not change theirs. Competitive equilibrium describes a vector of prices and quantities that empties out the market. Based on these definitions, the conclusion is that the definition of Nash equilibrium is more consistent with existing circumstances, bearing in mind that it allows for an imperfect result on competition.

## B. Second Period

Once each bank has set an optimal interest rate for the entire country, it decides on the optimal number of branch offices to be opened in region *k* of the geographic area in question.[6] The profit function for bank *i* in region *k* is provided by:

$$(7) \quad \pi_{ik} = r_i^{l*} L_{ik} + (r^s(1 - p) + mp - r_i^{d*}) D_{ik} - C_{ik}(L_{ik}, D_{ik}, S_{ik}, n_{ik})$$

where $r_i^{l*}$ and $r_i^{d*}$ represent the optimal interest rates selected by each bank during the first period, and $n_{ik}$ is the number of offices bank *i* has in region *k*.

Within a particular region, we would expect banks with more offices to take in more deposits, as this would make it easier for the public to conduct transactions or to withdraw funds from the bank. In this sense, the deposit supply for bank *i* would be related positively to the number of branch offices it has, and negatively to the number of branches rival banks have. Accordingly, the deposit supply would be estimated by:

$$(8) \quad D_{ik} = D_i(r_i^{d*}, n_{ik}, n_{-ik}, W_{ik})$$

where $W_{ik}$ represents the exogenous variables that affect the deposit supply for bank *i* in region *k*. The first order condition of bank *i* in region *k* with respect to the number of offices is derived from these equations. It is written as:

$$(9) \quad \left( r^s (1 - p) + mp - r_i^{d*} - \frac{\partial C_{ik}(n_{ik})}{\partial n_{ik}} \right) \psi = \frac{\partial C_{ik}(n_{ik})}{\partial n_{ik}}$$

where $\psi$ can be expressed as:

$$(10) \quad \psi = \left( \frac{\partial D_{ik}}{\partial n_{ik}} \right) + \left( \frac{\partial D_{ik}}{\partial n_{-ik}} \right) \left( \frac{\partial n_{-ik}}{\partial n_{ik}} \right) = \left( \frac{\partial D_{ik}}{\partial n_{ik}} \right) + \left( \frac{\partial D_{ik}}{\partial n_{-ik}} \right) \phi$$

As in the first period, $\phi$ in this expression represents the conjectural parameter of bank *i* in region *k*, which is defined in this period as the change in the number of branch offices operated by the competition, anticipated by firm *i*, in response to an initial change in the number of its own offices. If the value of this parameter is neutral ($\phi = 0$), it would describe a scenario consistent with

---

[6] As illustrated later with the empirical application, the total geographic area is the country and its regions, organized by departments.

Nash equilibrium. A positive reading ($\phi > 0$) would indicate a less competitive scenario than Nash equilibrium. As shown in equations (9) and (10), this would indicate the representative bank can have higher marginal costs per office. Negative values, in contrast, point to a more competitive scenario, with a lower marginal cost per office.

In short, the model presented herein creates two first order conditions, one for each period. These two functions allow us to measure the extent of competition among banks in the regions and, in particular, to identify the regions where the banks have market power by analyzing the value of parameter $\phi$.

## III. EMPIRICAL APPLICATION

### A. Functional Forms

The model is estimated in two stages, one for each period. The empirical application for the first period is quite similar to Canhoto's (2004), where specification of the deposit supply and the marginal cost of deposits is given by:

$$(11) \quad D_i = a_0 + a_1 r_i^d + a_2 r_{Ri}^d + a_3 gdp + a_5 emp_i + e_i$$

$$(12) \quad \left(\frac{\partial C_i(D_i)}{\partial D_i}\right) = MC_i^d = b_0 + b_1 wl_i + b_2 wk_i + b_3 D_i + \varepsilon_i$$

*where gdp* is the gross domestic product (GDP) of the entire geographic area analyzed,[7] *emp* is the total number of employees of bank *i*; *wl* and *wk* represent the price per unit of labor and per unit of physical capital, respectively, and $\varepsilon_i$ and $e_i$ represent the error.[8] Theory says, *ceteris paribus*, that the deposit supply of bank *i* would depend positively on the interest rate and *gdp*. In contrast, it would be inversely related to the average rate of its rivals. The number of employees (*emp*) is an exogenous variable that controls the size of the banks in the market and increases with the amount of deposits from the public.[9] The suggestion is that marginal costs are positively related to the price of capital and labor; therefore, one would expect positive signs for $a_1$ and $a_2$. The sign for $a_3$ would depend of the returns of scale for bank *i*.

The following equations are specified for the second period:

---

7 In this case, the area includes the entire country.

8 It is assumed the stochastic errors are distributed normally.

9 To overcome the industrial organization assumption that the marginal cost is not directly identifiable in the firms' behavior, we will not estimate it independently (See Canhoto (2004) and Bresnahan (1982).

(13) $D_{ik} = c_0 + c_1 r_i^{d*} + c_2 n_{ik} + c_3 n_{-ik} + c_4\, gdp + c_5(pob/km^2) + u_i$

(14) $\left(\frac{\partial C_i(D_i)}{\partial D_i}\right) = MC_{ik}^{\ d} = f_0 + f_1 wl_{ik} + f_2 wk_{ik} + f_3 D_{ik} + v_i$

In the case of the regional deposit supply, the interest rate selected by the bank in the first period is given by the optimal value selected during that same period. Accordingly, we expect $c_1$ to be positive, since the interest rate should be relevant for the regional level as well. Also, as mentioned in the previous section, we expect the volume of deposits to increase with the number of offices, and to decrease if the bank's rivals open more offices in the region. As in the first period, the GDP is included in the estimate, because it explains an important part of individual income and the performance of deposits. The population/square kilometer variable was included to control for regional population density.

The same variables from the first period were included for the functional form of the regional marginal costs of bank *i*, but for a regional dimension. Therefore, the signs for $f_1$ and $f_2$ are expected to be positive.

## B. Data and Estimation

The quarterly figures used to estimate the model cover the period from January 1994 through September 2005. The frequency is quarterly.[10] The sample includes 26 banks, which accounted for 94.4% of all deposits in the Colombian banking system during the period in question.[11]

The model is estimated in two stages: one for each period. The procedure used in Canhoto (2004) was followed for each stage, where a pool is constructed with the data.[12] Aggregate data for the entire country were used for the first period, while two estimates sere done for the second: one for Colombia's regional division and another for its political division. In the first estimate for the second period, the country was divided according to the five traditional geographic regions.[13] Two estimates were developed for the Andean

---

[10] It was obtained from documents published by the Office of the National Superintendent of Financial Institutions, the National Department of Planning (DNP) and Atlas Colombiano, which is published by the Instituto Geográfica Agustín Codazzi.

[11] Proxy variables were constructed for the factor prices. Weights were constructed, then multiplied by the national prices to obtain the regional prices. It is assumed the reserve requirement rate is quite small; that is, m = 0.

[12] The estimate was done with TSP 4.5.

[13] Andean, Caribbean, Orinoquía, Pacific and Amazon.

region in particular: one that included Bogotá (Andean 1) and another that did not (Andean 2). Finally, for the second estimate, the country was divided according to the 32 departments, plus the capital city.

In the first stage, equations (4) and (11) were estimated using with the full information maximum likelihood method (FIML), replacing marginal cost function (12) in the first order condition for the interest rate. Using the same method, equations (9) and (13) were estimated for each of the regions and departments, replacing marginal cost function (14) in the first order condition for the number of offices.

## C. Results

The parameters obtained for the first period are statistically significant and consistent with the theory (Table 1). For the deposit supply, the coefficient that accompanies the banks' own interest rate is positive, while the coefficient that accompanies the weighted average interest rate of its rivals is negative. Moreover, the relation between deposit supply and gross domestic product is positive, and the number of employees, which was used as a proxy of bank size, shows the largest banks have a larger stock of deposits. The results for the marginal cost function also are satisfactory, showing positive signs for $b_1$, $b_2$ and $b_3$.

For this estimate, conjectural parameter rejected the existence of market power in the deposit market, as the estimate for the coefficient is less than zero. These results are consistent with the empirical studies by Estrada (2005) and

TABLE 1

ESTIMATE RESULTS FOR THE FIRST PERIOD

| | Coefficients | Error | *P*-value |
|---|---|---|---|
| $a_o$ | 3.91E+08 | 4.79E+08 | [0.414] |
| $a_1$ | 1.62E+09 | 7.61E+08 | [0.033] |
| $a_2$ | -1.22E+10 | 1.03E+09 | [0.000] |
| $a_3$ | 55.8 | 200.602 | [0.005] |
| $a_4$ | 478833 | 21222.9 | [0.000] |
| $b_0$ | -0.99722 | 0.0892 | [0.000] |
| $b_1$ | 7.83E-03 | 1.76E-03 | [0.000] |
| $b_2$ | 0.016598 | 4.22E-03 | [0.000] |
| $b_3$ | 0.037086 | 4.21E-03 | [0.000] |
| $\lambda$ | -2.6108 | 0.395549 | [0.000] |

Source: cálculos de los autores,

Salamanca (2005), which found evidence of a more competitive market structure than Nash equilibrium.[14]

The second-period estimate, for which the country was divided into five regions, did not show significant results for Amazonas or Orinoquía. This could be explained by the size of the market and by the limited development of those regions. The others, however, did show significant parameters with the expected signs.[15] As to the conjectural parameters ($\phi$), all the regions appeared to have competitive markets.[16] The Caribbean region had the lowest conjectural parameters ($\phi$ = -1,023.81), followed by the Pacific ($\phi$ = -962.381) and Andean region 1 ($\phi$ = -640.028).

For the more disaggregated estimate of the second period, when the country was divided into 32 departments, plus the capital city, the coefficients found for Arauca, Casanare, Guainía, Chocó, Guaviare, Quindío, Sucre, Tolima, Vaupés, Meta, Huila and Putumayo were not significant. For the rest of the departments, the conjectural parameter is significant and the signs are consistent with the theory. In this estimate, some areas show evidence of market power. Specifically, we found that Caquetá ($\phi$ = 2,569), Cauca ($\phi$ = 1,848) and Norte de Santander ($\phi$ = 793) are the least competitive regions of the country.

In short, although the national deposit market was found to be competitive, a more disaggregated analysis revealed the departments where banks have market power. Hence, the recommendation is that regulatory policies be laid out carefully in local markets of this type, so as to avoid more serious problems and, if possible, to resolve them.

These results prove the market structure in extremely large markets is not analyzed properly, because the results are overly general. This can lead to regulatory measures that are erroneous.

## IV. CONCLUSIONS

In this study, a spatial competition oligopoly model was developed where banks compete with prices (interest rates) and geographic variables (number of branch offices). In this scenario, each bank selects the optimal interest rate in the first period. In the second period, depending on that interest rate, each bank selects the optimal number of branches to be opened in each region.

---

[14] In international literature, Bikker and Haaf (2000) also found evidence of competitive behavior in the deposit market for a group of European countries.

[15] There were some problems with the signs of the marginal cost coefficients. However, problems with the incoherence of marginal cost coefficients are common in the literature on conjectural parameters.

[16] Excluding Amazonas and Orinoquía, where the parameter is not significant.

Two estimates were done for the second period. In one, the country was divided by the five traditional regions. In the other, it was divided by the 32 departments, plus the capital city.

The purpose of this study was to analyze competitive conditions in the Colombian deposit market, based on a more disaggregated approach; specifically, one designed to determine if the results obtained in this estimate are consistent or not with those obtained when the national market is analyzed as a whole.

The empirical results for the first period suggest the national deposit market has a more competitive structure than Nash equilibrium. The estimate for the second period, with the country divided into the five traditional regions, showed the Caribbean, Pacific and Andean regions are competitive markets as well. However, the estimate for the second period, with the country was divided by departments, identified three critical markets were banks have market power: Caquetá, Cauca and Norte de Santander.

Accordingly, the suggestion is that regulatory policies in these geographic areas should be administered carefully to avoid more serious problems and, if possible, to resolve them. The results also show the market structure in larger markets is analyzed in a way that is far too superficial. More disaggregated results include certain regional features that allow for a more in-depth analysis of the market. Specifically, the conclusion is that national results are too general and can lead to erroneous regulatory measures.

## BIBLIOGRAPHY


Barros, P. (1997) "Multimarket competition in banking, with an Example from the Portuguese Market," *International Journal of Industrial Organization*. Vol.17, pp. 335-352.

Breshnahan, T. (1982) "The Oligopoly Solution Concept Identified," *Economic Letters*, Vol.10, pp. 87-92.

Bikker J. A., and Haaf, K.(2000) "Competition, Concentration and their Relationship: An Empirical Analysis of the Banking Industry," *Economic Letters*, Vol.10, pp. 87-92.

Canhoto, A.(2004) "Portuguese Banking: A Structural Model of Competition in the Deposit Market," *Review of Financial Economics*. Vol. 13, pp. 41-63.

Chiappori, P. A.; D. Perez-Castrillo; Verdier D., (1993) "Spatial Competition in the Banking System: Localization, Cross Subsidies and the Regulation of Deposit Rates," *European Economic Review*. Vol. 39, pp. 889-918.

Estrada, D. (2005) "Efectos de las fusiones sobre el sector financiero colombiano," *Banco de la República de Colombia*.

Freixas, X.; Rochet, J. (1997) *Microeconomics of Banking*, Cambridge: MIT Press.

Levy, E., and Micco, A. (2003) "Concentration and Foreign Penetration in Latin American Banking Sectors: Impact on Competition and Risk," (Mimeograph), Universidad Torcuatto Di Tella School of Business.

Neven, D.; Roller, L. (1999) "An Aggregate Structural Model of Competition in the European Banking Industry," *International Journal of Industrial Organization*, Vol.17, pp. 1059-1074.

Panzar, J., C.; Rosee, J. N. (1987) "Testing for Monopoly Equilibrium," *Journal of Industrial Economics*, Vol.35, pp. 443-456.

Reyes, C. (2004) "El poder de mercado de la banca privada colombiana," (dissertation for a master's degree), Universidad de los Andes School of Economics.

Salop, S. (1979) "Monopolistic Competition with Outside Goods," *The Bell Journal of Economics*, Vol. 10, No. 1, pp. 141-156.

Schmalensee, R. (1989) "Regulatory Regimes," *Rand Journal of Economics*, Vol. 20, No. 3, pp. 417-436.

Salamanca, D. (2005) "Competencia en los mercados de crédito y depósitos en Colombia: aplicación de un modelo de oligopolio fijador de precios," (dissertation for a master's degree), Universidad de los Andes School of Economics.

Vesala, J. (1995) "Testing Competition in Banking: Behavioral Evidence from Finland," Series J, E1, *Bank of Finland Studies*.