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An Assessment of Competition in the Portuguese Banking System in the 1991-2004 Period*

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Abstract

The purpose of the present paper is to assess the competitive behaviour of Portuguese banking groups during the period ranging from 1991 to 2004, using the non-structural test developed by Panzar and Rosse.

The main findings are that the Portuguese banking system has experienced weak competition between 1991 and 1996, underwent a period of restructuring until 2000, and from then until 2004 behaved consistently with perfect competition. Both private and, more markedly, domestic banks, seem to have competed more aggressively on occasions, and no relationship between competitive behaviour and bank size was identified.

Keywords: Banking; Competition; Panzar and Rosse.

JEL: G21; L13; C23

* The views expressed in this article are those of the authors and do not necessarily reflect those of the Banco de Portugal.

1. Introduction

Over the last two decades the Portuguese financial system went through major changes in the competitive environment in which financial intermediaries operate. The first liberalisation steps were taken in the mid 1980's with the opening of domestic markets to private initiative, against the background of an almost fully nationalised banking system. Until the early 1990's, banks remained tightly regulated in many dimensions of their activity. For instance, both prices and quantities in deposit and loan markets were administratively set or severely constrained, while great discretion remained in authorities' hands in what concerns banks' entry (both domestic and foreign) and branching decisions[1]. In this setting, the lack of competitive forces in the 1980's resulted directly from regulatory interference instead of stemming from market players' conduct. In fact, only in the early 1990's banks started to carry out their business in a full market environment, i.e. interest rate setting was free in all operations, while credit ceilings, a system of credit quotas defined at the bank level that was in effect during the 1980's, were abolished. In this way, we defined *a priori* the post-1990 period as the focus of our analysis of competitive conditions prevailing in the Portuguese banking market. This involved the identification of time series patterns in competition and the direct test of regime shift associated to participation in the euro area.

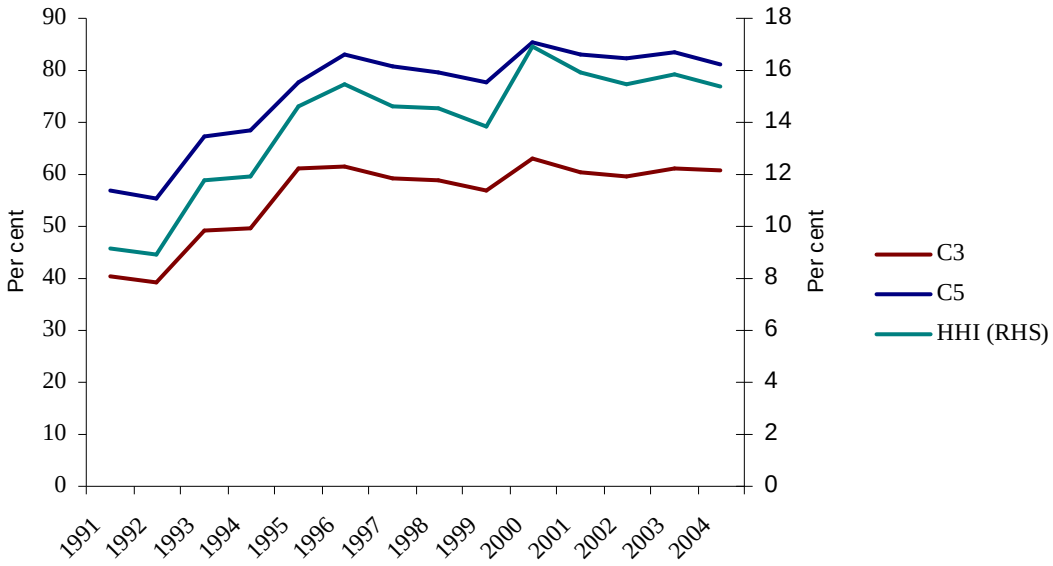
The evolution of concentration in the Portuguese banking industry according to the 3 and 5-bank concentration indices (C_3 and C_5, respectively, on the left scale) and to the Herfindahl-Hirshman Index (HHI, on the right scale), all derived from banks' total assets, is displayed in Graph 1.[2] The three presented indicators show that concentration has increased over time as the deregulation period was followed by a consolidation trend across the market. From Graph 1,

[1] See Ribeiro (2007) for a brief overview of the liberalisation process.

[2] For the *k*-largest banks of a market with *n* banks, $C_k = \sum_{i=1}^{k} s_i$ and $HHI = \sum_{i=1}^{n} s_i^2$, where s_i is the market share of bank *i*. Also note that the unit of observation is the economic banking group, rather than the banking legal entity. For more details on this point, refer to Section 4.

it is observable that over the period comprised between 1991 and 2004 there were two main consolidation waves. Until 1996, as the privatization program progressed, concentration increased almost linearly. Afterwards it remained relatively stable even though deep changes in the shareholding structure and control in some of the largest banks were observed in 2000.

Graph 1. Concentration in the Portuguese banking system



Another relevant development to the national banking sector during the period under scrutiny was the event of privatizations and the increase in the weight of foreign banks, as the market was liberalized. In fact, if there were ten public banking groups operating in 1991, by 1996 there was only one – *Caixa Geral de Depósitos*. Consequently, the market share of public banks in total assets has decreased from close to 60% in 1991 to around 20% since 1996. On the other hand, the number of foreign banks has increased from 1991 to 2004 and so has their market share, which was around 5% in 1991 and slightly over 20% in 2004. The recorded increase in the market share of foreign banks was greater than that observed in the number of active foreign banks. This reflects a major acquisition carried on by a foreign bank during the above mentioned consolidation wave in 2000. In fact, similarly to most other European markets, *de novo* organic growth by foreign players in the Portuguese market was not particularly successful in the retail business.

According to the traditional structure-conduct-performance paradigm (Bain (1951)), an increase in concentration should be linked to a decrease in competition. However, this result contradicts common wisdom and anecdotal evidence regarding the behaviour of the Portuguese banking sector during the period under analysis. This fact, which could be explained both by Baumol's contestability theory (Baumol (1982)) and by the efficiency hypothesis posted by Demestz (1974), motivates the use of the non-structural test described below.

The approach taken to assess the degree of competition consists on specifying tests based on empirical reduced form revenue equations, as stated originally in Panzar and Rosse (1987). Revenues are explained by a vector of input prices and the sum of the corresponding elasticities is a statistic, the so-called *H*-statistic, with useful properties in the inference of competitive behaviour. However, the use of this statistic is not immune to criticism based on the assumptions underlying its use as a measure of competition in banking markets. Hence, the Panzar-Rosse methodology is a non-structural approach, as opposed to estimable specifications rooted on static oligopoly models, which establish testable relationships between market structure, direct measures of strategic behaviour and competition. Further, this methodology carries the crucial hypothesis that banks are essentially producers of a single product in the credit market, while all funding sources, including deposits, are considered inputs in banks' production function. Another controversial issue across most empirical studies is the definition of the appropriate variable to represent banks' revenue: either interest income or total income used in levels or scaled by total assets. These issues as well as the possible ways of overcoming them in the empirical specification are discussed in detail in this paper. Particular attention is dedicated to the definition of the interest revenue variable in order to restrict the analysis to the domestic loan market, the most liable to exhibit market power in the investment side of banks' balance sheet. Similarly, the definition of the cost of funding variable takes due care of the different role of each bank as a provider of immediacy or payment services, in order to control for systematic

differences in the presence of banks in those segments of funding markets where market power is more prone to emerge. Average funding cost is also adjusted to account for the presence of a bank in the interbank market both as a creditor and debtor.

Despite the shortcomings, the simplicity of this methodology explains its popularity in the study of competition in banking markets. For instance, it does not require price and quantity data on the services provided by banks, an issue that can often be problematic in the estimation of empirical structural equations of banks' behaviour, either because they are not available to researchers or due to the fluidity of these services in what concerns establishing a measure of their quantity. Another appealing property of this methodology is the fact that it allows for the inference of the interaction between input price shocks to the cost function and the revenue function, without requiring the estimation of output demand or cost functions. In addition, there is no need to worry about the appropriate relevant market in a geographic sense, as the input price to revenue relationship captures possible local market product differentiation on average, in the aggregate.

In the next section, the relationship between some common competition models and the results of the Panzar and Rosse (P-R) approach are derived. Section 3 presents a brief summary of previous empirical findings on the subject, whereas Section 4 presents the data and empirical methodology employed and results are shown in Section 5. Section 6 concludes.

2. The Panzar-Rosse approach

2.1. Competitive long-run equilibrium

To start with, let us establish the main positive result derived in Panzar-Rosse (1987), concerning the magnitude of the *H*-statistic in long-run perfect competition equilibrium. From duality theory and under some regularity

conditions, for some arbitrary production function $y = f(x_1,...,x_M)$ where x_i are M inputs, there is a function $C(y,w)$, the cost function, which results from the minimization of the total production cost $C = \sum_{i=1}^{M} w_i.x_i$ for each given output level y.

In long-run perfectly competitive equilibrium, price should equal marginal cost and free entry and exit conditions determine zero economic profit. For our purposes it translates into the two following expressions:

(1) $p_0^C - C_y(y_0^C, \mathbf{w}) = 0$

(2) $p_0^C y_0^C - C(y_0^C, \mathbf{w}) = 0$

where the superscript C stands for perfectly competitive equilibrium price and output levels.

Comparative statics in the neighbourhood of the competitive equilibrium can be undertaken taking the total differential of (1) and (2) and applying Cramer's Rule to the resulting system of equations. In particular,

(3) $$\frac{\partial \boldsymbol{y}^{\boldsymbol{C}}}{\partial \boldsymbol{w}_{\boldsymbol{i}}} = \frac{\boldsymbol{C}_{w_i} - \boldsymbol{y}^{\boldsymbol{C}}.\boldsymbol{C}_{w_i y}}{\boldsymbol{y}^{\boldsymbol{C}}\boldsymbol{C}_{yy}}$$

By Shephard's Lemma, the partial derivative of the cost function with respect to each input price is the conditional demand for the input itself, i.e. $\boldsymbol{C}_{w_i} = \boldsymbol{x}_{\boldsymbol{i}}$ and equation (3) simplifies to $$\frac{\partial \boldsymbol{y}^{\boldsymbol{C}}}{\partial \boldsymbol{w}_{\boldsymbol{i}}} = \frac{\boldsymbol{x}_{\boldsymbol{i}}^{\boldsymbol{C}} - \boldsymbol{y}^{\boldsymbol{C}}.\left(\partial \boldsymbol{x}_{\boldsymbol{i}} / \partial \boldsymbol{y}_{\boldsymbol{C}}\right)}{\boldsymbol{y}^{\boldsymbol{C}}\boldsymbol{C}_{yy}}$$

Taking $\boldsymbol{R}_{\boldsymbol{C}}$ as the total receipt $\boldsymbol{p}_{\boldsymbol{C}}\boldsymbol{y}_{\boldsymbol{C}}$ in the competitive equilibrium and using equality (2), in equilibrium, its derivative with respect to each factor price is

(4) $$\frac{\partial \boldsymbol{R}_{\boldsymbol{C}}}{\partial \boldsymbol{w}_{\boldsymbol{i}}} = \frac{\boldsymbol{C}_{y}\left[\boldsymbol{x}_{\boldsymbol{i}}^{\boldsymbol{C}} - \boldsymbol{y}^{\boldsymbol{C}}\frac{\partial \boldsymbol{x}_{\boldsymbol{i}}}{\partial \boldsymbol{y}}\right]}{\boldsymbol{C}_{yy}\boldsymbol{y}} + \boldsymbol{x}_{\boldsymbol{i}}^{\boldsymbol{C}}$$

Taking (4), multiplying by factor prices, aggregating and dividing by total receipt, the resulting figure is the so-called H-statistic, i.e. the sum of factor price elasticities of total revenue such as

(5) $$\boldsymbol{H} = \sum_i \frac{\partial \boldsymbol{R}^C}{\partial \boldsymbol{w}_i} \frac{\boldsymbol{w}_i}{\boldsymbol{R}^C} = \frac{\boldsymbol{C}_y}{\boldsymbol{C}_{yy}} \left\{ \frac{\sum_i \boldsymbol{w}_i \boldsymbol{x}^C_i - \boldsymbol{y}^C \sum_i \boldsymbol{w}_i \left(\partial \boldsymbol{x}^C_i / \partial \boldsymbol{y}^C \right)}{\boldsymbol{R}^C} \right\} + \frac{\sum_i \boldsymbol{w}_i \boldsymbol{x}^C_i}{\boldsymbol{p}^C \boldsymbol{y}^C}.$$

Using the definitions of the cost and marginal cost functions and its equilibrium levels as stated in (1) and (2), it becomes,

(6) $$\boldsymbol{H} = \frac{\boldsymbol{C}_y}{\boldsymbol{C}_{yy}} \left\{ \frac{\boldsymbol{C} - \boldsymbol{y}^C \boldsymbol{C}\boldsymbol{y}}{\boldsymbol{R}^C} \right\} + \frac{\boldsymbol{C}}{\boldsymbol{R}^C} = \frac{\boldsymbol{C}_y}{\boldsymbol{C}_{yy}} \left\{ \frac{\boldsymbol{C} - \boldsymbol{y}^C \boldsymbol{p}^C}{\boldsymbol{R}^C} \right\} + \frac{\boldsymbol{C}}{\boldsymbol{R}^C}$$

It is straightforward from (2) to see that the first term vanishes and the second term is equal to 1.

The mechanics of what's in place in this problem can be explained as follows. Multiplying all factor prices by the same arbitrary proportion *h,* as cost functions are homogeneous of degree 1 in factor prices, we know that $C(y_0^C, h\mathbf{w}) = hC(y_0^C, \mathbf{w})$ and $C_y(y_0^C, h\mathbf{w}) = hC_y(y_0^C, \mathbf{w})$. Multiplying (1) by *h* it is straightforward to see that $\boldsymbol{p}_1^C = \boldsymbol{h}\boldsymbol{p}_0^C$ and $\boldsymbol{y}_1^C = \boldsymbol{y}_0^C$ are solutions of the problem, with $\boldsymbol{w}_1 = \boldsymbol{h}\boldsymbol{w}_0$. Similarly, from homogeneity of degree 1 of the cost function the vector $\left\{ \boldsymbol{p}_1^C, \boldsymbol{y}_1^C \right\}$ that solves condition (1), satisfies also condition (2), so that

$$\boldsymbol{R}_1^C = \boldsymbol{C}_1^C = \boldsymbol{h}\boldsymbol{C}_0^C \Leftrightarrow \frac{\partial \boldsymbol{R}_1^C}{\partial \boldsymbol{w}_i} = \boldsymbol{h}\boldsymbol{x}_{i,0}^C \text{ and } \boldsymbol{H} = \sum_i \frac{\partial \boldsymbol{R}_1^C}{\partial \boldsymbol{w}_i} \frac{\boldsymbol{w}_i}{\boldsymbol{R}_1^C} = \frac{\boldsymbol{h} \sum_i \boldsymbol{w}_i \boldsymbol{x}_{i,0}^C}{\boldsymbol{h}\boldsymbol{C}_o^C} = 1.$$

In looser terms, it means that each bank is facing a perfectly elastic demand schedule which is tangent to the average cost curve at its minimum. Given the homogeneity of degree one in factor prices of both the marginal and average cost functions they shift in the same proportion as a simultaneous shock to all factor prices. The same happens to prices, while each firm's market equilibrium quantity remains unaffected. In this way, shifts in factor prices transmit fully to total revenue. This is a powerful result allowing for the implementation of a direct test of market players' behaviour consistent with price taking behaviour and in which no bank is earning abnormal profits.

2.2. Monopolistic behaviour in markets for imperfect substitutes

Models of monopolistic behaviour are the most plausible to consider *a priori* in banking as, even if we consider banks as producers of a single product very homogeneous in its intrinsic characteristics, banks differentiate among each other by means of brand advertising and/or branch location. The resulting framework is one in which banks differentiate in quality and are profit maximisers over their own specific perceived demand. For the purpose of studying the *H*-statistic's properties we will consider both the case of a market with a pre-fixed number of banks, which is conceptually similar to perfect monopoly behaviour in each bank's captive demand, and the case of free entry and exit *à la* Chamberlin. In the monopoly case, market players can sustain supra-normal profits, because they do not face the threat of entry, at least in the short-run. In the latter case, market conditions attract to or drive banks away from the market, so that in the long-run equilibrium economic rents cannot be extracted.

2.2.1. Monopoly, perfect cartel or short-run monopolistic competition equilibrium

For simplicity, we consider a market equally shared by a fixed number of banks, in such a way that we can concentrate on some arbitrary representative bank. When choosing its output level, the representative bank ignores the effect that changes of competitors' output have on the industry prevailing price in such a way that each bank can be considered a monopolist in its particular product variety, local market or any other characteristic mapping each bank to a different brand from the consumer perspective. In addition, we consider that a differentiable inverse demand schedule $p_i = p(y_i, n)$ exists for the representative bank such that[3]

$$(7) \qquad \begin{cases} p_y = \partial p_i / \partial y_i < 0, \\ p_n = \partial p_i / \partial n < 0, \\ \partial \gamma / \partial n \geq 0, \end{cases}$$

Where the first condition consists on assuming a standard negatively sloped demand curve, the second condition is a way of stating analytically that the market each bank faces shrinks with the number of competitors and the last condition, where γ stands for the symmetric of demand elasticity, implies that each bank's perceived demand "flattens" with the number of banks. In this class of models, perceived demand elasticity can be mapped into the Lerner index, i.e. the relative price to marginal cost spread, which is a measure of market power.

In such a setting, the representative bank chooses the output level y^M which solves implicitly the first order condition

$$(8) \qquad R_y(y^M, n) = C_y(y^M, \mathbf{w})$$

Differentiating (8) relatively to w_i, applying Shephard's Lemma and rearranging terms yields

$$(9) \quad \frac{\partial y^M}{\partial w_i} = \frac{1}{\partial^2 \pi / \partial y^2} \frac{\partial x_i}{\partial y^M}$$

[3] The following setting borrows directly from Vesala (1995).

Differentiating the revenue function in the neighbourhood of equilibrium output with respect to w_i yields:

$$(10) \qquad \frac{\partial R^M}{\partial w_i} = \frac{\partial R^M}{\partial y^M}\frac{\partial y_M}{\partial w_i} = \frac{\partial R^M}{\partial y^M}\frac{1}{\partial^2 \pi / \partial y^2}\frac{\partial x_i}{\partial y^M}$$

The *H*-statistic is obtained by multiplying (10) by w_i and aggregating over the set of inputs:

$$(11) \qquad \begin{aligned} H &= \sum_i \frac{\partial R^M}{\partial w_i}\frac{w_i}{R^M} = \frac{\partial R^M}{\partial y^M}\frac{1}{\left(\partial^2 \pi / \partial y^2\right) R^M}\sum_i w_i \frac{\partial x_i}{\partial y^M} = \\ &= \left[p\left(y^M, n\right)\left(1 - \frac{1}{\gamma\left(y^M, n\right)}\right)\right] C_y \frac{1}{\left(\partial^2 \pi / \partial y^2\right) R^M} \leq 0 \end{aligned}$$

This expression is clearly non-positive as $\partial^2 \pi / \partial y^2$ is negative by the second order condition of profit maximization and $\gamma(.)$ is higher than one in equilibrium for a profit maximising monopolist. Hence, a negative (or null) value of the *H*-statistic is consistent with a monopoly (n=1), a perfect cartel that replicates monopoly market outcomes and markets with a predetermined number of banks behaving monopolistically. Another interesting result is that *H* is strictly decreasing with respect to the symmetric of the perceived demand elasticity, i.e. higher (less negative) values of *H* can be interpreted as higher effective market power exercised by the monopolist.

2.2.2. Long-run (Chamberlinean) monopolistic competition equilibrium

Considering the number of banks as endogenous and no longer predetermined as in the previous section, the long-run equilibrium is attained when no incentives prevail to bank entry. Positive rents attract new banks to the market shifting the representative bank's demand schedule up to the point where each bank is operating at its economic profit break-even point[4]. Analytically it implies that in addition to the representative bank's first order condition stating that marginal

[4] This concept of long-run equilibrium is usually labelled "Chamberlinian equilibrium" and borrows directly from Chamberlin (1933).

revenues equate marginal costs as in (8), a zero-profit condition has to be imposed, such as:

(12) $R(y^*, n^*) - C(y^*, \mathbf{w}) = 0$, where n^* is the long-run equilibrium number of symmetric banks.

Totally differentiating both conditions with respect to factor prices and the number of banks, solving for $\frac{\partial y^n}{\partial w_i}$, multiplying by factor prices and aggregating over all factors yields:

(13) $$H = 1 + \frac{R_y^*[R_n^* R_y^* - R^* R_{yn}^*]}{R^* \pi_{yy}^* R_n^*}$$

Rewriting the numerator in terms of the inverse demand function it becomes:

(14) $$\Leftrightarrow H = 1 + \frac{R_y^* \left(y^*\right)^3 \left(p_y^*\right)^2}{R^* \pi_{yy}^* R_n^*} \frac{\partial \gamma}{\partial n}$$

As $R_y^* = p_y^* y + p^* = \frac{\gamma - 1}{\gamma} p^*$ and $R_n^* = y_p^* p_n^* p^* + p_n^* y^* = p_n^* (1 - \gamma) y^*$ expression (14) simplifies to

(15) $$H = 1 + \frac{R_y^* \left(y^*\right)^3 \left(p_y^*\right)^2}{R^* \pi_{yy}^* R_n^*} \frac{\partial \gamma}{\partial n} = 1 - \frac{1}{\gamma} \frac{p^* y^* \left(y^*\right)^2 \left(p_y^*\right)^2}{R^* y^* \pi_{yy}^* p_n^*} \frac{\partial \gamma}{\partial n} = 1 - \frac{1}{\gamma^3} \frac{\left(p^*\right)^2}{y^* \pi_{yy}^* p_n^*} \frac{\partial \gamma}{\partial n} \leq 1$$

The second term is clearly positive, given the assumptions in (7). Further, all else constant, the *H*-statistic is increasing in the perceived demand elasticity and converges to 1 as it approaches infinity, replicating the perfect competition outcome derived above.

It should be borne in mind, however, that this concept of equilibrium is built up on assumptions of individual firm profit maximisation, taking all other firms' actions as constant. This assumption implies no strategic interaction of market players, arguably a too naïve description of market players' behaviour in an oligopoly (for e.g., see Kreps (1990) for a particularly sanguine sceptical discussion of this model).

Anyway, the non-acceptance of both the null hypothesis of $\boldsymbol{H} \leq 0$ and $\boldsymbol{H} = 1$ has been interpreted in previous empirical applications as resulting from a market environment which is not consistent with either long-run perfectly competitive equilibrium or perfect tacit collusive behaviour. Instead, it must contain elements that are akin to both monopoly and perfect competition, representing some intermediate position, as it is the case in the monopolistic competition equilibrium (see, e.g., Henderson *et al.* (1980), page 193).

3. Previous empirical findings

Most studies applying the Panzar and Rosse methodology reject both the hypothesis of monopoly (or perfect cartel) behaviour and that of perfect competition. In a cross-country analysis for the EU-15 for the period between 1997 and 2003, Casu and Girardone (2006) find a value for the *H*-statistic between zero and one, thus rejecting both monopoly and perfect competition, at EU-15 level, as well as for most countries individually, including Portugal.[5] Koutsomanoli-Fillipaki and Staikouras (2004) also reject both monopoly and perfect competition, for a period ranging from 1998 to 2002. However, in this study, rather than being estimated individually for Portugal, the *H*-statistic is estimated for the EU-15 as a whole. Bikker *et al.* (2006) present a cross-country study where competitive conditions are estimated for 101 countries between 1986 and 2005. Since this paper intends to make a methodological point, several different specifications are estimated, and the results obtained for Portugal range from monopoly, in their preferred specifications, to perfect competition in the models they consider misspecified.[6] In general, available results for Portugal are similar to those found for other countries. For a more complete summary of results obtained in recent applications of the Panzar and Rosse methodology, refer to Table 1 in Casu and Girardone (2006) and to Table 1 in Bikker *et al.* (2006).

[5] Perfect competition was not rejected for Finland and monopoly was not rejected for Greece. However, the authors note that inference for these two countries was based on a small number of observations.

[6] See the next Section for a discussion on their methodological point.

4. Data and empirical methodology

The dataset used in this study was obtained from banks' financial statements reported to Banco de Portugal. The database comprises an unbalanced panel of yearly data for all active banks operating in Portugal from 1991 to 2004. Since detailed consolidated accounting data is available only for the most recent period, data on individual basis was used instead. However, since interest lies in comparing the behaviour of different economic units rather than legal entities, data for banks belonging to the same economic group were aggregated into one decision making unit.

All banks operating in Portugal are required to report financial statements to Banco de Portugal. However, there is a large number of small banks that mostly operate in investment banking and are thus likely to behave differently from most commercial or universal banks. Hence, in order to obtain a sample of reasonably homogenous banks, observations for institutions with less than 15 branches or 15 employees were eliminated. Banks that do not take any deposits from customers were also eliminated, and it was checked that positive values for total assets and equity were reported for all observations in the sample. The first two years of activity of new banks were also eliminated, as it seems reasonable to assume that during early stages banks may behave differently than once their activity is stabilized. 25 banking groups and a total of 197 observations survived this process. For each year, the final sample includes no less than 92% of loans granted to customers, 94% of customer deposits held and 92% of total assets of the Portuguese banking system. All money variables were deflated using the GDP deflator.

The definition of banks' outputs and inputs is by no means simple. On the one hand, the "production approach" to bank modelling regards banks as firms producing services which are related to loans and deposit accounts, thus measuring output by the number of deposit accounts serviced and the number

of loans originated and input by labour and physical capital. On the other hand, according to the "intermediation approach" (Sealey and Lindley (1977)), banks' main activity is granting loans and investing in securities and other assets using funds obtained through deposits, purchased funds and equity.[7] Hence, while both approaches agree in classifying labour and physical capital as inputs, they present a conflicting view as to whether deposits should be classified as an output or as an input. Since economic theory does not give clear guidance as to which modelling approach best describes the behaviour of the banking firm, it is somewhat reassuring to note that estimated cost functions appear relatively insensitive to which approach is followed (Humphrey (1990)). On the other hand, there is empirical evidence suggesting that deposits overall behave primarily as inputs (examples are Gilligan and Smirlock (1984), Hughes and Mester (1993), Shaffer (1994) and Hughes, Mester and Moon (2000)). The Panzar and Rosse methodology used in this study follows the intermediation approach. Hence banks are modelled as firms that use labour, physical capital and funds in order to produce loans.

There has been considerable debate in the literature as to whether the dependent variable used to estimate empirical P-R equations should consider total or only interest revenue. On the one hand, the fact that the P-R method considers loans as banks' main output, suggests interest revenue should be used. On the other hand, the increase in the relative importance of commissions and fees in banks' total revenue should not be neglected. Hence, in the baseline specification, we choose to use interest revenue as the dependent variable and include the ratio of other income to interest income as a regressor, thus accounting for changes in income structure. Nonetheless, in order to check for the sensitivity of results, models where the dependent variable includes both interest and commission and fee income were also estimated.[8]

[7] See Freixas and Rochet (1998), pp. 77-79, on the production and intermediation approach.

[8] The choice to include the ratio of other revenue to interest revenue is particularly interesting since $\ln TR = \ln(IR + OR) \approx \ln IR + (OR / IR)$, as put forward in Bikker *et al.* (2006). Note, however, that *OR/IR* may not be exogenous in the regression, and so we do not test whether its

A third matter of discussion is whether banks' size should be controlled for. Since it seems overly simplistic to assume banks' size is uncorrelated with input prices, it is likely that the exclusion of a scaling variable could bias the estimates for the elasticities of factor prices. On the other hand, Bikker *et al.* (2006) point out that the use of a scaling variable (either as a regressor or by defining the dependent variable as the ratio of revenue to total assets rather than the absolute value of revenue) effectively turns the revenue equation into a price equation, and the sum of the elasticities of the output's price with respect to input prices is positive by definition, and independent of the industry's degree of competition. Hence, including a scaling factor in the estimated equation could introduce a positive bias the estimate of *H*. The possible presence of "errors-in-variables" due to the approximation of input prices should, however, act in the opposite direction, as it should bias the estimated coefficients downwards, whether a scaling factor is used or not.

The baseline specification for the empirical reduced form revenue equation stemming from log-linear marginal revenue and cost functions is presented below[9]:

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coefficient equals minus one (in which case the regression would be equivalent to one where the dependent variable is total inccome) or zero (in which case the regression would in turn be equivalent to one where the dependent variable is interest income and other income is not controlled for). Nonetheless, estimation results where *OR/IR* is not considered and the dependent variable is either total income (see Table 3) or interest income (not shown but available upon request) have yielded similar estimates for the *H*-statistic to those obtained with the baseline specification.

[9] The use of the loglinear form is widespread among studies applying the P-R methodology, as it typically improves the regression's goodness of fit and may reduce simultaneity bias (De Bandt and Davies 2000). Furthermore, Molyneux *et al.* (1996) found that a loglinear revenue equation yielded similar results as a more flexible translog equation.

(16)

$$\ln IR_{it} = h_1 \ln w_{L_{it}} + h_2 \ln w_{K_{it}} + h_3 \ln w_{F_{it}} + \beta_1 (DDEP/TDEP)_{it} + \beta_2 (ML/TL)_{it} +$$
$$+\beta_3 (STL/TL)_{it} + \beta_4 (IBA/CL)_{it} + \beta_5 (OBS/A)_{it} + \beta_6 (A/B)_{it} + \beta_7 (NPL1/CL)_{it} + \beta_8 (E/A)_{it} +$$
$$+\beta_9 (OR/IR)_{it} + \beta_{10} Aqrt25_{it} + \beta_{10} Aqrt50_{it} + \beta_{10} Aqrt75_{it} + \beta_{11} M_{it} + \beta_{12} F_{it} + \beta_{13} P_{it} + \delta + \eta_i + \varepsilon_{it}$$

where Panzar and Rosse's *H*-statistic equals $\sum_{k=1}^{3} h_k$, δ is a constant term, η_i is an unobservable variable that captures idiosyncratic features of each institution that are constant over time and ε_{it} is a random shock.

The dependent variable used in the baseline specification – ln *IR* – is the natural logarithm of interest revenue obtained from loans granted to domestic clients. The option to focus the analysis only on the portion of interest revenue earned on loans rather than including all interest income is explained by the fact that banks are known to have little market power on the remaining interest earning business, such as interbank and securities activities. As such, the analytical interest lies on testing how competitive banks are in customer lending. Hence, a broader specification of the dependent variable would very likely overestimate the competitive conditions in the banking system. This is a novelty feature of this study worth emphasising as, to our knowledge, all previous studies apply this methodology to all interest revenues.

The average price of labour – w_L – is proxied by the ratio of labour costs to the number of employees, whereas the ratio of (tangible and intangible) capital expenditure to (tangible and intangible) fixed assets – w_K – proxies the cost of capital and the ratio of interest paid to interest bearing debt – w_F – measures banks' average funding cost.

The ratio of customer demand deposits to total deposits (*DDEP/TDEP*) and that of market to total liabilities (*ML/TL*) are included to account for banks' funding mix, whereas the ratio of short term loans to total loans (*STL/TL*) and of interbank assets to customer loans (*IBA/CL*), on the other hand, intend to capture the effect of the credit mix. The increasing importance of banks' off

balance sheet activity is controlled for by the inclusion of the ratio of off balance sheet activity to total assets (OBS/A) as a regressor. The ratio of assets to branches (A/B) intends to capture different branching strategies, measuring systematic differences in banks' branch density.

The share of customer loans that have defaulted during each year – *NPL1/CL* – is a credit risk measure that attempts to capture the flow rather than the stock of non performing loans, thus decreasing the *ex-post* character of this variable. In turn, the ratio of equity to assets (*E/A*) should proxy banks' risk aversion once credit risk is controlled for.

The ratio of other revenue – commission and fee income – to interest revenue (*OR/IR*), as discussed above, intends to capture the increasing role of non interest revenue in banks' income. The inclusion of asset quartile dummies in the equation is a compromise solution that intends to address the misspecification described in Bikker *et al.* (2006), while at the same time controlling at least partially for the correlation between banks' size and input prices.[10] Finally, M, F and P are dummy variables equal to one, respectively, when a merger has occurred, if a bank is foreign or if it is public.[11]

Descriptive statistics of the included variables are presented in Table 1 below and the correlation matrix is in Table A4 in the Appendix.

[10] For the sample used in estimation, the simple correlation coefficient between ln A and input prices is 0.35 for the price of labour, -0.08 for the price of capital and -0.24 for the price of funds.

[11] Only domestic public banks are classified as public, since public banks operating abroad are likely to exhibit similar behaviour to that of local private banks. Tables A1 and A2 in the Appendix display which banks are classified as public and as foreign, respectively, for each year.

Table 1. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
IR	197	307.6	340.0	2.5	1445.6
TR	197	348.7	385.0	2.5	1702.3
IR/A	197	4.2	2.0	0.4	10.6
TR/A	197	4.7	2.0	0.8	10.9
W_L (thousnands of euros)	197	21.2	3.9	7.4	31.9
W_K	197	13.3	5.6	4.0	41.9
W_F	197	6.9	4.5	1.1	27.6
DDEP/TDEP	197	35.6	9.5	18.7	65.2
ML/TL	197	44.1	14.6	13.4	88.7
STL/TL	197	46.7	20.8	9.3	93.8
IBA/CL	197	45.2	36.5	0.3	169.7
OBS/A	197	190.1	2365.9	3.4	33228.2
A/B	197	27.3	10.9	4.4	58.7
NPL1/CL	197	1.5	1.3	0.0	7.6
E/A	197	6.9	2.7	1.5	29.8
OR/IR	197	14.6	12.8	1.0	105.6
ROA	197	4.9	5.7	-47.4	25.8
A	197	9295.6	11447.3	70.5	45172.8

NOTE: Money variables are valued in millions of 1991 Euros (unless otherwise stated) and ratios are defined in percentage form.

Equation [16] was first estimated for the whole sample, including domestic and foreign as well as private and state owned banks for the period ranging from 1991 to 2004. However, as discussed in Section 1, this time period is by no means homogenous, since during the early to mid 90's the Portuguese banking system underwent a phase of privatizations, consolidation and liberalization. Hence, we perform a sequential test for differences in the *H*-statistic through time by first estimating an equation using data for the first four years in the sample and checking whether the estimate for the fourth year is statistically different from that obtained for the initial period comprising the first three years. If so, a new period starting on the fourth year would be created; if not 1994 would be pooled with 1991-1993. This process was repeated until 2004, restricting each period to comprise at least three years of data. Due to the limited sample size, cross section equations for each year were not estimated.[12]

In order to test for differences in the competitive behaviour of different types of banks, equations considering only domestic banks and only private banks were estimated. Even though it would be more informative to allow the estimate of the degree of competition to vary across types of banks, this option is not

[12] In fact, De Bandt and Davies (2000) advocate the importance of the time series component as they find variable results for cross section equations even with information for a larger number of banks.

feasible due to the small number of public and foreign banks in the sample. Hence, the statistical significance of the difference in competitive behaviour observed across types of banks is not tested.

As several authors have pointed out (examples are Bikker and Haaf (2002) and Hempel (2002)), small banks may have more market power in local markets, whereas larger banks are generally believed to face greater competition. Note that this argument may not apply directly to Portugal, considering the relatively small size of the national market and the fact that most regions tend to be served by at least one large bank. Nevertheless, the only truly effective way of addressing the misspecification pointed out in Bikker *et al.* (2006) while avoiding the introduction of other sources of bias is to analyse the competitive behaviour of similarly sized banks, thus avoiding the need to use a scaling variable. Hence, the same estimation procedure is applied to small and large banks separately, where *small* and *large* is defined according to whether a bank's total assets are above or below average total assets for each year.[13] We divide the sample in only two groups in order to minimize the loss of degrees of freedom, and the average is chosen over the median as, due to the high concentration in the Portuguese banking market, the group of the 50% largest institutions is very heterogeneous in terms of size. Once again, the small sample size introduces limitations in that it renders unfeasible the estimation of different measures of competition through time when the sample is divided between small and large banks.

The interpretation of the outcome of the P-R approach depends on whether or not banks are in a state of long run equilibrium. In fact, while the result that the sum of factor price elasticities of a monopolist's reduced form revenue function must be nonpositive holds even in the short run, results for models of perfect and monopolistic competition depend on the assumption that the firms are observed in long-run equilibrium (see Panzar and Rosse (1987)). As is common practice in studies applying the Panzar and Rosse methodology

[13] Table A3 in the appendix shows which banks are classified as large for each year.

(examples of which are Shaffer (1982) and Molyneux *et al.* (1994)), we use the fact that in equilibrium risk-adjusted rates of return should be equalised across banks. Thus, banks' Return On Assets (ROA) should be uncorrelated with input prices when the market is in equilibrium. A direct test of equilibrium consists on estimating the P-R equation with ROA as the dependent variable and performing a test for $H = 0$ (equilibrium) against $H < 0$ (disequilibrium), where H is the sum of factor price elasticities with respect to the profitability measures.

To test for the robustness of the results, some alternative specifications were estimated, including the use of total rather than interest income as the dependent variable and using alternative scaling variables, such as the natural logarithm of total assets, scaling income by total assets and not controlling at all for size differences.

In order to account for the existence of non measurable bank specific factors that are invariant through time, the fixed-effects estimator was used, thus allowing for possible correlation between the individual effect and the explanatory variables.

5. Results

Table 2 presents fixed-effects estimation results for equation (16), as well as for the auxiliary regression used to perform the long run equilibrium test. The estimate of the elasticity of interest income with respect to each of the three inputs considered proves to be positive. In fact, the estimate of the *H*-statistic, laying at 0.691, changes only marginally when non significant variables are eliminated from the regression.[14] The test for monopoly performed is a one sided test for $H_0 : H \leq 0$ versus $H_1 : H > 0$, and the null hypothesis is clearly rejected in favour of the alternative under both specifications, thus providing compelling

[14] Results of this more parsimonious regression are not reported but are available from the authors upon request.

evidence against the hypothesis that the Portuguese banking industry has operated as a monopoly or as a perfect cartel on average during the period under scrutiny.[15] If, on the other hand, banks were under perfect competition, the *H*-statistic should equal one. A two sided test for this hypothesis is thus performed and, as shown in Table 2, the corresponding p-value is close to 10%, so that it is not clear whether perfect competition should be rejected or not. Another relevant result reported in Table 2 is that the hypothesis that the sum of the elasticities of profitability (measured by ROA) with respect to factor prices equals zero can not be rejected, which, as argued in the previous section, gives support to the statement that the system was in long run equilibrium during the relevant period. Hence, one may conclude that, on average, in the period ranging from 1991 to 2004, the behaviour of Portuguese banks cannot be assessed as consistent with alternative forms of monopoly-like conduct (such as perfect cartel or monopolistic competition in a market without the threat of entry), and it is not clear whether it is consistent with perfectly competitive behaviour, or whether it is best described as stemming from an intermediate model such as that of long-run free-entry monopolistic competition.

[15] As remarked in Bikker *et al.* (2006), even though a large number of studies applying the Panzar and Rosse methodology have used a two sided test, thus specifying the alternative hypothesis as $H \neq 0$, this is incorrect, as under monopoly the *H*-statistic may assume negative values.

Table 2. Estimation Results

Variable	Model [1] ln (*IR*)		Equilibrium Test *ROA*	
$\ln(w_L)$	0.284	*0.155*	-0.692	*1.795*
$\ln(w_K)$	0.230	*0.076*	-0.492	*0.818*
$\ln(w_F)$	0.177	*0.105*	3.188	*1.911*
DDEP/TDEP	-0.794	*0.709*	3.837	*6.506*
ML/TL	-0.631	*0.582*	-5.729	*6.097*
STL/TL	-1.025	*0.307*	6.617	*3.675*
IBA/CL	-0.460	*0.099*	-3.852	*1.199*
OBS/A	0.004	*0.001*	-0.015	*0.014*
A/B [1]	0.022	*0.006*	0.147	*0.070*
NPL1/CL	1.580	*2.328*	-193.520	*82.798*
E/A	-8.103	*2.616*	39.284	*14.485*
OR/IR	-1.730	*0.416*	8.455	*6.059*
Aqrt(25)	-1.352	*0.206*	-0.671	*1.797*
Aqrt(50)	-1.107	*0.186*	-0.935	*1.520*
Aqrt(75)	-0.271	*0.108*	-0.542	*0.966*
M	0.022	*0.064*	0.119	*0.683*
F	0.491	*0.172*	4.839	*2.482*
P	-0.821	*0.162*	-3.424	*1.841*
δ	14.218	*0.721*	9.812	*8.186*
H-Statistic	**0.691**	*0.184*		
p(*H* ≤*0*)	**0.00**			
p(*H*=*1*)	**0.10**			
Equilibrium Test (p-value)			**0.41**	
R^2	0.63		0.00	
Obs.	197		197	
Banks	25		25	

NOTES: 1) The coefficient on this variable and the corresponding standard error are multiplied by 1000. Heteroskedasticity robust standard errors are reported in italic.

The control variables regarding the funding mix have not shown to be significant, whereas the negative sign on the variable which measures the maturity structure of granted loans suggests that banks for which the weight of short term loans is more important tend to earn less revenue, which is consistent with the fact that credit risk adjusted spreads tend to be lower on short than on long term loans. The same reasoning, i.e. differences in spreads, may be used for the interpretation of the result that banks with a higher ratio of interbank assets to customer loans tend to earn lower interest revenue from customer loans, whereas it seems natural that banks which are more active in the interbank and securities market relatively to the customer loan market, for a given value of total assets, earn less revenue from the latter business. Banks

with more off balance sheet activity seem to earn higher interest revenues, which may be explained by the possibility that this variable is capturing the effect that banks with more off balance sheet activity tend to have a riskier profile. Banks with relatively less, and possibly larger branches tend to earn higher interest income, whereas the measures of credit risk and of risk aversion have the expected signs, even if the former is not statistically significant. As expected, the coefficient on the variable which controls for the ratio of other revenue to total revenue yields a negative sign. Moreover, the estimated coefficients for the dummy variables identifying the quartile of the asset distribution to which each bank belongs indicate that, all else constant, smaller banks tend to earn less revenue. As to what concerns the remaining control variables, mergers do not seem to have a significant impact on interest revenue earned whereas, *ceteris paribus*, foreign banks seem to earn more interest revenue, while the opposite result is found for public banks.

Table 3 shows a series of robustness tests in the form of alternative specifications to Model [1] which illustrate the impact in results of different choices regarding the dependent variable and the scaling variables used.

Table 3. Alternative dependent and scaling variables

	Scaling variable		
Dependent variable	ln (*A*)	*A* qrt.	None
Ln (*IR*)	0.70 0.00 0.04	0.69 0.00 0.10	0.61 0.00 0.06
Ln (*TR*)	0.71 0.00 0.06	0.71 0.00 0.12	0.60 0.00 0.07
Ln *(IR/A)*	———	———	0.71 0.00 0.06
Ln *(TR/A)*	———	———	0.71 0.00 0.07
Obs. Banks	197 25		

NOTES: For each cell, the value in the centre is that of the H-statistic, whereas p-values for the test $H \leq 0$ (left) and $H = 1$ (right) are presented below.
***, ** and * indicate evidence of disequilibrium at the 1%, 5% and 10% confidence level, respectively.

As to what concerns different definitions of the dependent variable, specifications where (the natural logarithm of) total rather than interest income is chosen as the dependent variable are presented. From comparison of the first two and of the last two lines in Table 3, one finds that considering total rather than interest revenue has virtually no impact, either in the point estimate for *H*-statistic or in the tests conducted upon it.

Another relevant robustness test involves checking the sensitivity of results to different scaling variables. From the results presented in Table 3 one finds that, as expected, specifying the dependent variable as the ratio of revenues to assets yields virtually the same results as specifications where the natural logarithm of assets is included as a regressor.[16] If, instead, one controls for the size difference of banks through the use of asset quartile dummies, the estimate for the *H*-statistic decreases slightly when interest income is used as the dependent variable. A more relevant change is the fact that, as reported in Bikker (2006), standard deviations are compressed in "price equations", which might lead to reject perfect competition too often, even if a point estimate that is closer to one is obtained. As shown in the last column of Table 3 above, specifications where no scaling variable is used yield a somewhat lower estimate for the *H*-statistic, whereas results for hypothesis tests remain unchanged relatively to specifications where total assets are considered.

Hence, considering a series of alternative specifications, it remains quite clear that, from 1991 to 2004, the Portuguese banking sector has not operated under monopoly. However there is now greater evidence towards the rejection of perfectly competitive behaviour as well, and so the hypothesis of an intermediate situation, such as that of monopolistic competition, seems more appropriate.

As briefly discussed in the first section of this study, the Portuguese banking system underwent significant changes during the sample period. Hence in order

[16] This was expected since $\ln(X/Y) = \ln(X) - \ln(Y)$.

to investigate whether the process of liberalization and consolidation has had an impact in competitive conditions, the estimated *H*-statistic is allowed to vary over time without any particular functional form being imposed upon it, through the method described in the previous section. Aggregation tests to find homogenous periods were conducted on the specification presented in Model [1]. As a result, three periods were obtained: a first period of consolidation and adjustment to less restrictive regulations – 1991 to 1996; a second period of post-consolidation adjustment, which includes the beginning of euro area participation – 1997 to 2000; and a final period of relative maturity, ending in 2004. Table 4 presents results for fixed-effects estimates of the *H*-statistic for the three periods, as well as for the whole sample, using as scaling variables the natural logarithm of total assets (line 1) and dummy variables for asset quartiles (line 2) as well as using no scaling variable (line 3).

Table 4. Evolution of H for all banks

Scaling variable	1991-1996			1997-2000			2001-2004			1991-2004		
ln *A*	0.41			0.27*			0.88			0.70		
	0.00	0.00	0.43	0.04	0.00	0.00	0.00	0.21		0.00	0.04	
A qrt.	0.07			-0.5*			0.97			0.69		
	0.39	0.00	0.20	0.87	0.00	0.00	0.00	0.90		0.00	0.10	
None	-0.27			-0.63*			0.93			0.61		
	0.81	0.00	0.45	0.90	0.00	0.00	0.00	0.81		0.00	0.06	
Obs.	197											
Banks	25											

NOTES: For each cell, the value in the centre is that of the H-statistic, whereas p-values for the tests $H \leq 0$ (left), $H = 1$ (right) and $H_t = H_{t+1}$ (between periods) are presented below.
***, ** and * indicate evidence of disequilibrium at the 1%, 5% and 10% confidence level, respectively.

During the first period, perfect competition is rejected in all specifications and monopoly is rejected only when the natural logarithm of total assets is used as a scaling variable. For the other specifications, which according to Bikker *et al.* (2006) should be more reliable, the monopoly hypothesis is not rejected and the estimate of the *H*-statistic is either negative or close to zero. Furthermore, during this first period of intense consolidation and privatization, there is no evidence to reject the hypothesis that the Portuguese banking system was

operating in equilibrium. Hence, one concludes that the degree of competition was relatively low during this period. As to what concerns the next period, even if conclusions for the hypothesis tests on the *H*-statistic are the same, there is evidence that the system was not operating under long-run equilibrium. Hence, estimated coefficients constitute no evidence of collusive behaviour, since while the rejection of monopoly in the first specification remains valid in this context, non-rejection of $H \leq 0$ under disequilibrium no longer implies the industry has behaved jointly as a monopoly. In the most recent period, while there is strong evidence to reject perfect monopoly (as well as perfect cartel or short run monopolistic behaviour without threat of entry) in all specifications, perfect competition is no longer rejected under any of the three specifications. Furthermore, differences in the estimate of the *H*-statistic between the intermediate and the most recent period are, both in the magnitude and in the statistical significance of the estimated coefficients, more striking than those found between the first and the second period.

Since foreign banks are likely to behave differently form domestic banks, a replication of the above results while restricting the sample to domestic banks is presented in Table 5. An increase in the estimated value of the *H*-statistic across most periods and specifications is observed.[17] In fact, even if conclusions regarding the first period remain unchanged, perfect competition is only rejected for domestic banks between 1997 and 2000 when the natural logarithm of total assets is included in the regression, which suggests domestic banks have behaved more competitively than the banking system as a whole during this period. Obtained results for the period between 2001 and 2004 when the natural logarithm of total assets is not considered explicitly are consistent with the hypothesis that domestic banks might have behaved too competitively in this period, which may be rationalized under a more complex, dynamic model, where banks aggressively fight for increased market share in order to capitalize on it

[17] Exceptions are the estimates for the *H*-statistic for the first and the last period when the natural logarithm of total assets is used as a scaling variable, which are slightly lower for domestic than for all banks.

with high profits in the future.[18] Furthermore, there is no evidence that domestic banks have not operated under long run equilibrium in the eve of the EMU. Restricting the estimate for the degree of competition exerted by domestic banks to be constant from 1991 to 2004, if one once again concentrates on specifications where the natural logarithm of total assets is not explicitly considered, higher values for the *H*-statistic are obtained when the sample is restricted to domestic banks, and there is no evidence to reject perfect competition. As can be seen by comparison of tables 4 and 5, when the logarithm of assets is included as a scaling variable, results for the relevant hypothesis tests do not change even though the point estimate for H decreases.

Table 5. Evolution of H for domestic banks (FE)

Scaling variable	1991-1996			1997-2000			2001-2004			1991-2004	
ln *A*	0.35			0.59			0.84			0.60	
	0.01	0.00	0.09	0.00	0.01	0.20	0.00	0.36		0.00	0.04
A qrt.	0.17			1.19			1.37			0.98	
	0.27	0.00	0.01	0.00	0.64	0.64	0.00	0.05		0.00	0.92
None	0.12			0.85			1.38			0.95	
	0.36	0.01	0.06	0.02	0.70	0.19	0.00	0.07		0.00	0.84
Obs.	150										
Banks	21										

NOTES: For each cell, the value in the centre is that of the H-statistic, whereas p-values for the tests $H \leq 0$ (left), $H = 1$ (right) and $H_t = H_{t+1}$ (between periods) are presented below.
***, ** and * indicate evidence of disequilibrium at the 1%, 5% and 10% confidence level, respectively.

Table 6 shows the result of similar estimations ran on a sample which includes only private banks. Since the number of public banks in the sample is relatively small, it is not surprising to find that results are quite close to those obtained for all banks. Nevertheless, the degree of competition as inferred by the *H*-statistic is slightly higher for private banks between 1991 and 1997 as well as when the full 1991-2004 period is considered, in which case there is also less compelling evidence towards the rejection of the perfect competition hypothesis when only private banks are considered.

[18] This sort of strategic behaviour may stem from the presence of switching or search costs.

Table 6. Evolution of H for private banks (FE)

Scaling variable	1991-1996			1997-2000			2001-2004			1991-2004		
ln A	0.49			0.29**			0.88			0.75		
	0.00	0.00	0.29	0.05	0.00	0.00	0.00	0.19		0.00	0.05	
A qrt.	0.39			-0.13*			0.80			0.74		
	0.14	0.09	0.26	0.60	0.03	0.08	0.00	0.48		0.00	0.30	
None	0.01			-0.44**			0.88			0.72		
	0.49	0.01	0.38	0.78	0.01	0.03	0.00	0.65		0.00	0.18	
Obs.	162											
Banks	18											

NOTES: For each cell, the value in the centre is that of the H-statistic, whereas p-values for the tests $H \leq 0$ (left), $H = 1$ (right) and $H_t = H_{t+1}$ (between periods) are presented below.
***, ** and * indicate evidence of disequilibrium at the 1%, 5% and 10% confidence level, respectively.

As to what concerns the comparison of the H-statistic between small and large banks, no robust difference was found. In fact, in addition to results not being robust to slight changes in banks' classification, equality of the estimates obtained for each group is not statistically rejected. Hence, during the period under analysis, there is no evidence that small banks have been able to exert higher market power due to a stronger presence in local markets where competition is less aggressive. The fact that this hypothesis, which has been widely stated and tested for other countries, does not apply to Portugal, should be linked to the smaller size of the national market as compared to those for which the relevant result has been obtained, since in larger countries it is common to find banks which have a strong position in the region where they operate, despite having little weight in the national market as a whole. This fact mitigates the existence of fully distinct local markets in the Portuguese case.

6. Conclusions

The main conclusion to retain from this study is that on average, over the period from 1991 to 2004, Portuguese banks do not seem to have operated either under perfect competition or under perfect monopoly, but rather consistently with long-run monopolistic competition. During this period, both private and domestic banks seem to have competed more aggressively on

average than the banking system as a whole, and perfect competition may not be rejected for these two types of banks.

An investigation of changes in competitive behaviour throughout the period suggests that competition was relatively weak between 1991 and 1996, even though results suggest domestic and especially private banks exhibited slightly higher competitive behaviour. An adjustment period followed between 1997 and 2000, in which behaviour consistent with long run equilibrium is rejected both for the banking system as a whole and for the group of private banks, whereas for domestic banks the hypothesis of behaviour consistent with perfectly competitive long run equilibrium is not rejected. In the more recent period, ranging from 2001 to 2004, strong competition was observed, and it is possible that domestic banks have competed more aggressively than expected in the framework of a static model with no distortions. Hence, the results suggest that the deregulation and liberalization process experienced by the Portuguese banking sector, including euro area participation, catalysed an increase in competition, particularly in what concerns the credit market.

One should, nonetheless, bear in mind the limitations of the non-structural approach employed, particularly regarding the hypotheses implicitly imposed on the underlying model for banks' behaviour. Therefore, obtained results should be compared with those derived using alternative methods in order to draw more general conclusions on the degree of competition in the Portuguese banking sector.

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Table A1. Public banking groups

1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
BCA	BCA	BCA	BCA	BCA	CGD	CGD	CGD	CGD	CGD	CGD	CGD	CGD	CGD
BFB	BCM	BFE	BFE	BFE									
BFE	BFE	BPSM	BPSM	CGD									
BPA	BPA	CGD	CGD										
CGD	BPSM												
CPP	CGD												
UBP	CPP												
	UBP												
7/17	8/19	4/15	4/14	3/15	1/15	1/14	1/14	1/14	1/12	1/12	1/12	1/12	1/12

NOTES: BPSM was not considered in 1991 due to the unavailability of profit and loss account data.
All foreign banks are classified as private.

Table A2. Foreign banking groups

1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS	BARCLAYS
BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA
CLP	CLP	CLP	CLP	CLP	CLP	CLP	SANTANDER	SANTANDER	SANTANDER	SANTANDER	SANTANDER	BNC	BNC
				SANTANDER	SANTANDER	SANTANDER						SANTANDER	SANTANDER
3/17	3/19	3/15	3/14	4/15	4/15	4/14	3/14	3/14	3/12	3/12	3/12	3/12	3/12

Table A3. Large banking groups

1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
BCP	BCP	BCP	BCP	BCP	BCP	BCP	BCP	BCP	BCP	BCP	BCP	BCP	BCP
BFE	BFE	BFE	BPA	BPSM	BPI	BPI	BPI	BPI	BPI	BPI	BPI	BPI	BPI
BPA	BPA	BPA	BTA	CGD	BPSM	BPSM	BPSM	BPSM	CGD	CGD	CGD	CGD	CGD
BTA	BPI	BTA	CGD	GES	CGD	CGD	CGD	CGD	GES	GES	GES	GES	GES
CGD	BPSM	CGD	GES		GES	GES	GES	GES	SANTANDER	SANTANDER	SANTANDER	SANTANDER	SANTANDER
GES	BTA	GES											
	CGD												
	GES												
6/17	8/19	6/15	5/14	4/15	5/15	5/14	5/14	5/14	5/12	5/12	5/12	5/12	5/12

NOTES: BPSM was not considered in 1991 due to the unavailability of profit and loss account data.
Large banks are defined as those with total assets exceeding average total assets for each year. The remaining banks are classified as *small* .

Table A4. Correlation matrix

	ln *IR*	ln *TR*	ln *(IR/A)*	ln *(TR/A)*	ln W_L	ln W_K	ln W_F	*DDEP/TDEP*	*ML/TL*	*STL/TL*	*IBA/CL*	*OBS/A*	*A/B*	*NPL1/CL*	*E/A*	*OR/IR*	*ROE*	*ROA*	ln *A*
ln *IR*	1																		
ln *TR*	1.00	1																	
ln *(IR/A)*	0.05	-0.01	1																
ln *(TR/A)*	0.02	-0.03	0.99	1															
ln W_L	0.22	0.26	-0.37	-0.34	1														
ln W_K	-0.04	-0.05	0.10	0.10	0.17	1													
ln W_F	0.00	-0.04	0.67	0.66	-0.21	0.04	1												
DDEP/TDEP	-0.33	-0.28	-0.49	-0.43	0.41	0.12	-0.33	1											
ML/TL	-0.06	-0.02	-0.71	-0.69	0.53	0.03	-0.39	0.58	1										
STL/TL	-0.38	-0.38	0.05	0.08	0.02	-0.06	0.50	0.30	0.22	1									
IBA/CL	0.07	0.08	-0.43	-0.47	0.27	-0.01	0.14	0.05	0.39	0.25	1								
OBS/A	-0.14	-0.11	-0.14	-0.07	0.06	-0.12	-0.03	0.23	0.09	0.11	0.05	1							
A/B	0.55	0.56	-0.34	-0.37	0.34	-0.11	0.04	-0.06	0.34	-0.04	0.34	-0.08	1						
NPL1/CL	-0.05	-0.08	0.49	0.48	-0.29	-0.11	0.64	-0.38	-0.40	0.30	0.11	-0.06	0.02	1					
E/A	-0.22	-0.25	0.33	0.30	-0.19	0.02	0.33	-0.06	-0.09	0.22	0.02	-0.03	-0.24	0.22	1				
OR/IR	-0.22	-0.14	-0.75	-0.65	0.37	-0.08	-0.48	0.61	0.59	0.12	0.14	0.51	0.13	-0.38	-0.34	1			
ROE	0.30	0.30	0.10	0.10	-0.04	0.01	-0.02	-0.14	-0.08	-0.20	-0.18	-0.01	0.07	-0.12	0.01	-0.05	1		
ROA	0.33	0.32	0.23	0.23	-0.10	-0.02	0.15	-0.18	-0.15	-0.11	-0.19	-0.02	0.12	0.00	0.20	-0.15	0.91	1	
ln *A*	0.93	0.95	-0.31	-0.34	0.35	-0.08	-0.24	-0.13	0.20	-0.38	0.22	-0.08	0.64	-0.22	-0.33	0.07	0.24	0.23	1

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