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ESSAYS ON BANKING

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Declaration

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Abstract

This thesis is concerned with banking market imperfections, most especially real resources costs and imperfect competition. A special focus is made on the empirical estimation of the importance of such imperfections in the Portuguese market. The thesis is organised in three different essays, being the first focused on real resources costs, the second on market power and price and non-price competition and the third chapter discusses the impact of such imperfections on the measurement of interest rate risk.

The first chapter is an empirical study on real resources operating costs in Portuguese banking. The approach followed is the stochastic cost frontier, because this methodology allows the simultaneous estimation of measures of economies of scale and scope as well as production efficiency and input substitutability estimates. The theoretical framework developed differs from existing literature on the explicit inclusion of the balance sheet constraint on the cost minimisation problem, being concluded that deposits should be handled as an output. Results show a clear evidence for the existence of economies of scale for the smaller banks and some costs advantages for the larger ones associated with high productivity of their branching networks. Economies of scope between deposits and loans were found for all but the larger banks. Portuguese banks were found to be particularly cost inefficient.

The second chapter studies the evolution of market power on the Portuguese deposits market under the current deregulation process. Using panel data, three equations were estimated representing optimality conditions for deposit rates, advertising expenditures and branches. An important conclusion is that interest rate and entry deregulation were associated with an increase in both price and non-price competition. The small banks were found to have virtually no market power on deposits, being the situation especially unpleasant for the foreign institutions following growth strategies. On the other hand, significant market power was detected for banks with market shares for above 5%. However, above that level, we didn´t detect a positive relationship between the two variables. Thus, mergers between large banks will not directly increase market power for the participating firms, although will create a favourable situation for the overall industry, trough the price-concentration relationship.

The third chapter analyses the problem of measurement of interest rate risk exposure of a financial intermediary operating under imperfect competition. A solution proposed by Dermine (1985) is criticised since it doesn't take in consideration the optimising behaviour of such an intermediary. It is also shown that unlike in Dermine´s article, imperfect competition also affects exposure through durations of assets and liabilities, and not only through goodwill. Another consequence of this modelling approach is that other imperfections like required cash reserves and operating costs (responsible for an operating leverage effect) seem to influence exposure. An important conclusion is that duration gap analysis is biased and inappropriate to measure exposure, being concluded that net worth immunization requires that assets have different duration than liabilities, rather than equal.

Introduction

This thesis is focused on banking market imperfections, i.e., real resources transactions costs and imperfect competition, with a special emphasis on the Portuguese market. It is organised according to the "three essay" format on which three separated chapters correspond to essays related to the thesis main topic.

Financial intermediation is still characterised by two aspects that make it considerably different from capital markets transactions: the level of real resources transaction costs and the importance of market structure on competitive imperfections. The first may not only result from the technological process of bank lending, which is much more resource-consuming than the issue of bonds, but also from pure waste, i.e., productive inefficiency. The second is associated with the potential imperfect nature of banking markets which may lead to the use of market power by some of the banks at the expense of the borrowers and depositors.

All chapters in this thesis are based on a "theory of the firm model of the banking firm", on which credit risk is ignored (i.e. different variables are handled on a certainty equivalent basis) in order to allow a focus on both cost and market structures. We start with a constrained optimisation problem of maximising profits subject to a balance-sheet constraint. It is shown that under this framework deposits must be regarded as outputs, rather as inputs as in Sealey and Lindley (1977) and most banking literature. Therefore, we study the impact of both cost and market structures considering the existence of two banking markets: loans and deposits.

The first chapter is devoted to the cost structure and productive efficiency. A standard translog function is estimated for Portuguese banks using capital and labour as inputs and deposits and loans as outputs. Instead of using the traditional econometric approach, we used a stochastic frontier formulation. The combination of these two options allows the simultaneous determination of three important aspects of banking costs: economies of scale, economies of scope and productive efficiency.

The second chapter is concerned with the impact of deregulation on both price and non-price competition in the Portuguese deposits market. The focus on deposits lies on the existence of quantitative credit ceilings for most of the past decade (they were abolished only in 1991) which suppressed competition in the loans market. However, the deposits market experienced a more progressive deregulation process, which may be traced to 1986, and therefore allows the possibility to evaluate how market power was affected by such deregulation. An empirical model of the banking market in which firms compete by interest rate, branches and advertising is estimated using panel data. The model relates competition to market concentration, market share and other firm characteristics like ownership and age. In this study the individual marginal costs estimated in chapter one for each observation are employed to detect the interaction between prices and costs.

Chapter three studies the impact of both cost structure and market power on interest rate risk. These two effects have so far been completely ignored in the banking interest rate risk literature, which are based on measures developed for mutual funds operating in perfectly competitive markets without intermediation costs. Although based on Dermine's (1985) model of bank interest rate risk under imperfect competition we try to go much farther in the evaluation of such exposure. First, we argue that unlike the implicit assumption on most duration-gap models, banking markets are not perfectly competitive and marginal costs are relevant, thus demanding the adoption of an imperfect competition model of the banking firm. Second, unlike in Dermine's (1985) model and most interest rate risk literature, we use a profit maximisation approach, rather than a purely mathematical one. This approach leads to a result in which both market imperfections play an important role, thus breaking with the currently existing literature.

The Portuguese market constitutes a particularly interesting case-study. Ten years ago (1984) it was one of the most regulated western European markets. Strict international capital controls together with an absolute barrier to entry in the banking sector make it virtually protected against any external threat. All banks but three small foreign-owned institutions were owned by the Government which accounted by more than 95% of the market with just 11 individual institutions. Until 1990 all banks were subject to a (binding) quantitative credit ceiling which was computed by the *Banco de Portugal* according to each bank's liability base. Interest rate regulation persisted until the 1990's, with the administrative imposition of a minimum rate on time deposits (to encourage savings) which was progressively reduced and later removed, a maximum rate on demand deposits (to protect the less efficient institutions) and a maximum rate on loans (to prevent "usury" associated with the excess demand resulting from the credit ceilings).

Entry in this market was banned until the approval of the Constitutional Amendment of 1984. Nevertheless, several barriers to entry persisted and the new banks took some time to be approved. In 1985 one finance institution was changed to bank status and in 1986 only three new Portuguese private banks were authorised. New foreign banks were progressively authorised but remained small. By mid 1989 the Government was still the owner of banks representing 90% of the market. In 1989 the (slow) privatisation process was initiated which combined with the growing agressivity of some private banks led the Government's market share to fall to about 45% in 1993. During most of this time it was not only the banking charter that was subject to strict restrictions since branching was highly regulated. Until 1986 all new branches depended on the central bank's authorisation, which was somewhat automatic within the "4+1 rule", i.e., for every four new branches a bank had to open a fifth one in one of the alternative locations in less-favoured regions indicated by *Banco de Portugal*. In September 1990 a new original scheme was created: each bank had to buy (at par) bad loans from the older nationalised institutions for each new branch opened. Alternatively, they could buy shares of Finangest, a finance company whose assets were only that type of loans. This scheme was also applied to the authorisation of new banks during that period.

All these restrictions were abolished in December 1992. On that date, a new banking law implementing the Second Banking Directive was passed and at the 31th of that month, all banks had to comply with the 8% risk-asset solvency ratio. In a few words, these banks, which lived under a highly regulated framework which allowed the existence of a virtual cartel where inefficiency was not punished, banks held substantial amounts of bad loans and excessive staff was a recurring problem among the older institutions, suddenly found themselves operating under the same rules of all other European banks. Thus, in less than ten years they evolved from a highly protected framework to their complete integration in the single European market for financial services.

The empirical studies in this thesis use panel data for 1986-1992. This way, we expect to detect with the extent to which the deregulation process was accompanied by a reduction in the mentioned market imperfections that flourished during the more protective days. Thus, we expect to detect how much inefficiency is responsible for the current level of banking costs and if there is any special trend on technological evolution, together with the possible impact of deregulation on market power. The combined effect of these two factors is responsible for the evolution of banks' prices. If they are too attractive that constitutes an entry incentive to foreign banks, who may be more competitive than the locals unless technical progress is evident and inefficiency is reduced. It is this context which we believe makes this country's case a particularly interesting one, which deserves to be studied.

The combined results of chapters one and two are particularly relevant for merger policy in Portuguese banking. They show that small banks are in a difficult situation, which may only be solved via internal growth or mergers, since they have very high marginal costs and are not able to exercise market power. On the other hand, mergers between large banks seem not to result in increased market power for the participating institutions. This conclusion results from the estimated constant returns to scale and a positive relationship between market power and dimension, which seems to become exhausted above certain small levels of market share.

Market power on deposits was found to be very dependent on several specific firm characteristics other than size. Among those are the banks "age", i.e., banks operating before the revolution benefit from higher margins, while new private retail banks show a much higher price and non-price aggressivity. Therefore, the previously nationalised banks, although slightly less efficient, are, in fact, in a favourable competitive situation vis a a vis their new competitors. This result is particularly important because the authorities always have protected the "old" banks (and in some cases still own them) using the argument that they are unable to compete with the new more cost efficient institutions.

Because of deposit insurance, regulators should also be interested in the impact of this progressive liberalisation on banking profitability and individual institutions ability to survive. Deregulation appears to be contributing to an increasing competitiveness of the market. The extent on which this may affect the survival of some institutions is difficult to assess, since it mainly depends on bank managers' ability to solve the current high inefficiency levels in the industry. Although, theoretically, important cost savings may be achieved, so far only a small trend was detected (1% increase per year). Results do also indicate that one particular aspect of this liberalisation trend, privatisations, seems to be giving a positive contribution to efficiency. This may be an indication that the Government´s banking groups (which account for more than 45% of the market) should also be privatised as a way to achieve a more cost efficient banking system.

The significant market power found for the larger institutions, combined with the high marginal operating costs and inefficiency suggest that the Portuguese economy is paying a high price for financial intermediation. Although the first of these aspects seems to be decreasing as a result of progressive liberalisation, the second is more difficult to control. Bank managers should be aware of the burden they are imposing and realise that progressive liberalisation and freedom of entry and exit are creating a framework on which cost-efficiency will be a critical success factor for survival.

Results derived in chapter three do also show that in cost-inefficient markets the measure of interest rate risk exposure should not be conducted using the traditional measures. This will become particularly important when the BIS proposal in this field becomes effective. By using this measures, which are biased in one direction, we may end up in a situation on which banks may be forced to support the costs of inappropriately measured exposures, while effectively exposed banks will be exempted from equity coverage. Therefore, banking supervisors should be particularly careful on the adoption of such measures for exposure measurement.

Chapter One:

Economies of Scale and Scope and Productive Efficiency in Portuguese Banking:

A Stochastic Cost Frontier Approach

1.1. Introduction

For more than a decade, Portuguese banks operated under a highly regulated oligopoly, where the Government owned all but three institutions (more than 90% of the market), interest rates for deposits and loans were set by the authorities and entry was simply banned. In 1985 a progressive deregulation process was began and today, only nine years later, these previously highly protected companies are now competing against new institutions which were born under a more competitive framework and they are all now part of a progressively integrated European market for financial services.

This protectionist background, where all competition was virtually banned, may have resulted in low productivity and lack of a marketing approach by the older banks. Although there is some anecdotal evidence on this, there are so far no studies on the productive efficiency of Portuguese banks. Therefore, questions such as "are public banks less efficient than the new private ones?" and "did privatisations increase efficiency?" still remain to be answered.

Portuguese banks have generally been considered to be very cost inefficient. Following a financial analysts perspective, Alpalhão and Pinho (1990) found that operating costs measured as percentages of assets or operating revenues, clearly exceed typical values for OECD banks published by that organization's reports in *Bank Profitability*. This fact combined with the current progressive reduction of market concentration and the entry effects of the second banking directive, leads to the question of the ability of the country's banks to survive. In fact, this combination of high costs and fierce competition may lead to losses and the need for a restructuring process within the sector through possible mergers and / or alliances.

The Single European Market on financial services is leading to a wave of mergers in European banking. In Spain, such a wave was actively promoted and encouraged by the authorities, while the Portuguese Government has apparently adopted the opposite policy. With this study we try to evaluate the extent to which mergers may increase both scale and productive efficiency in Portuguese banking. To assess the first issue, the measurement of economies of scale is essential. In this chapter we concentrate on scale effects on the cost side of the income statement. "Revenue scale economies" are addressed in Chapter Two in the context of measuring market power. In order to separate both effects, economies of scale and productive efficiency must be estimated simultaneously. Also of interest is a note regarding the cost effects of growth driven by the creation of new branches (firm scale economies) versus growth effects of mergers (via plant scale economies).

Currently, one major debate within the industry revolves around the advantages of mergers against alliances between autonomous specialised companies. If economies of scale and scope do exist, then mergers may increase the bank´s competitiveness. If, on the contrary, no such economies are detected, alliances between separated specialised companies are the correct choice to be made. To address this question, an empirical evaluation of economies of scale and scope in Portuguese banking is, therefore, essential.

Another potential source of cost savings for Portuguese banks is the banks' capability to increase productive efficiency. If high levels of inefficiency are found, then banks have a considerable potential for cost reductions without the need for changes in scale. By using panel data, it will also be possible to check the extent to which banks are actually reducing their current inefficiency levels.

Most literature on the estimation of banking cost functions follows a multi-product approach to bank production, assuming banks to be economic units that use several inputs to produce different outputs. Generally, the duality between production and cost functions is invoked in order to justify the interpretation of the estimated results of the latter in terms of measures of economies of scale and scope. This approach is commonly used for many other industries, variable cost functions generally being modelled as either Cobb-Douglas or flexible translogs. No effort seems to have been made to adapt it to the specificities of the banking firm. This goes beyond the mere discussion of what the inputs and outputs of financial intermediaries should be.

As the reader may see in Clark (1988), output is generally measured as "earning assets" while deposits are usually seen as inputs, following a seminal article by Sealey and Lindley (1977). This means that, with the exception for labour, the roles of inputs and outputs are assumed by the bank's assets and liabilities[1]. Surprisingly, the equality accounting constraint, which must always be satisfied is ignored by them. Therefore, a re-analysis of the theoretical foundations of these studies has to be made in order to assess how the imposition of the balance sheet constraint affects the definitions of inputs and outputs, as well as other assumptions that have been implicitly made in the literature.

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[1]In some cases, namely Santos (1991), off balance sheet items are also considered as an output.

The analysis of banks' costs may be conducted in three basic ways. One is the "traditional" econometric estimation of some flexible cost function, generally a translog. The other is based on parametric estimation of frontier cost functions, a technique developed by Aigner, Lovell and Schmidt (1977), which has the advantage of allowing the computation of Farrel's (1957) type measures of productive efficiency together with measures of economies of scale and scope. Another, is the determination of non-parametric frontiers based on Data Envelopment Analysis, which is especially useful for measuring efficiency[2]. The three methodologies are compared in Evanoff and Israilevich (1991), and Ferrier and Lovell (1990), in which we can see that the techniques yield different results, continuing the controversy in the literature regarding which of them is more appropriate for measuring efficiency. More recently, surveys by Berger, Hunter and Timme (1993) and Lovell (1993) provide critical and comparative analyses of these alternative approaches.

So far, the only recent study on the subject of economies of scale and scope in the Portuguese banking industry is that of Santos (1991), wherein the author estimated a classical econometric cost function and followed the traditional translog / intermediation approach and found the existence of economies of scale only for the smaller institutions and the complete non-existence of any economies of scope between the several "earning assets" variables, which he classified as outputs[3]. These findings suggest that, unless disposing of significant market power advantage, larger institutions may have chosen an inefficient operative scale. This conclusion is partially corroborated by Barros and Pinho (1994) who, using the "survivor technique", found that banks are moving to a scale between 5% to 10% market shares (measured

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[2]A survey on this approach is provided by Ali and Seyford (1993).

[3]Results for the period 1985-88. Santos also estimates cost functions for more remote periods. Barata (1980) studied the 1970's period.

relatively to total assets), through the growing process of small institutions and the loss of influence of the larger ones.

Given the above, the purposes of the present chapter will be the *development of a* bank production model in which the balance sheet constraint is included, to test it in order to detect possible differences in conclusions with Santos (1991) and to provide measures of technical inefficiency based on the estimation of a parametric cost frontier, using a pooled sample of Portuguese banks for the period 1987/1992.

The chapter is organised as follows. In Section 2 the theoretical foundations of the model to be estimated are evaluated and discussed. In Section 3 the estimation procedure and data are presented. Results are presented and discussed in Section 4. Finally, the paper concludes in Section 5.

1.2. Microeconomic Foundations

1.2.1. Considerations on the Intermediation Approach

Existing studies on banking costs assume either implicitly or explicitly that the bank's technology may be described by a transformation function which uses a vector of inputs to produce a vector of outputs in the most efficient way:

$$F(\mathbf{Y},\mathbf{X}) = 0 \tag{1.1}$$

where **Y** and **X** are vectors of inputs and outputs, respectively.

Using the duality theory between production and costs, we may find a cost function which reflects the technology described by (1.1)[4]:

$$C = C(\mathbf{Y},\mathbf{W}) \tag{1.2}$$

where **W** is the vector of input prices. Provided that C satisfies certain regularity conditions, duality ensures that (1.1) and (1.2) describe the same technological process. Therefore, direct estimation of a specific formulation for (1.2) allows the verification of certain properties of the transformation function, namely the existence (or not) of constant returns to scale and cost complementarities among outputs.

At this stage, what the researcher needs to do is to identify the inputs and outputs of the banking firm. If the so-called *production approach* is followed, then the amount of services provided by the bank will be classified as the output, while capital and labour will take the role of inputs. Unfortunately, in most countries the information on the amount of services provided is not available, and the so-called *intermediation approach,* where that classification is based on accounting data, is followed instead.

The main controversy surrounding this issue lies in the classification of deposits as inputs or outputs. Followers of Sealey and Lindley (1977) claim that banks are productive units which use deposits and other funds to generate earning assets. As a matter of fact, in his survey of the banking costs literature, Clark (1988, pg 22) addresses this issue by saying "*Deposits are treated as inputs along capital and labour (...) authors who adopt this approach generally define the institutions various dollar volumes of earning assets as measures of output*" (sic).

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[4] Shepherd (1953, 1970), Diewert (1971).

Regardless of the sound statement above, authors have been addressing this matter in different ways. Early studies adopted a single-output approach to the banking firm and different variables were used to proxy it. While some authors preferred to use total assets, others adopted deposits, loans, the sum of deposits and loans, etc[5]. An alternative view tries to create a "composite" measure of output using divisia indexes or other aggregation methodologies[6].

Recently there has been some unanimity on the classification of banks as multi-output firms. Unfortunately, as Forestieri (1993, pg 68) put it "*The most controversial issues are the definition and measurement of output*". It is in the classification of deposits that there is more disagreement in the literature, since purchased funds are classified as inputs in the majority of studies. Justification for the classification of deposits as inputs ranges from a mere reference to Sealey and Lindley (1977) to an argumentation based on the negative sign associated with them in the profit function. Some authors argue that deposits are responsible for a significant part of banks' value added and, therefore, classify them as outputs[7]. Others give different treatments to time (input) and demand (output) deposits based in the difference of services provided to them. Others prefer to classify demand deposits as "fixed inputs"[8].

In some of the recent literature doubts have been raised about the arguments above. A good example is Hancock (1991, pg 32) who departed from the profit function and defined a user cost for deposits as the difference between marginal revenue and costs associated with them and says "*If the deposit has a positive user cost (...)* [it] *is an*

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[5]A very extensive review of this literature is provided by Forestieri (1993). Other surveys are provided by Clark (1988) and Gilbert (1984).
[6]Benston, Hanweck and Humphrey (1982) is the best example of this approach. Kim (1986) reviews these studies and rejects the aggregation hypothesis based on Israeli data.
[7]Humphrey (1992) and Pulley and Humphrey (1993) are examples of this approach.
[8]Surveys on this subject are provided by Colwell and Davis (1992) and Forestieri (1993).

input (...) if it has a negative user cost [it] *is an output*". There is also Humphrey's (1992) solomonic view which classifies deposits as *intermediate inputs*, i.e., goods that are produced by the bank in order to produce loans, the *final output*, thus describing deposits as having both characteristics. In a famous book in this field, Kolari and Zardkoohi (1987, pp 98-101) defined banks' production process as having three-stages, each with a different output mix: in the first phase deposits are produced, in the second it produces loans and securities and in the third there is a vertically integrated process of production of deposits and loans.

More recently, some authors seem to have changed their mind and have adopted the output classification for deposits. As an example, Pulley and Humphrey (1993) justify their new approach on the grounds that "*deposit services are such a large component of bank value added - they use up half of all physical capital and labour input expenditures*"[9]. Following this line of approach, Berg and Kim (1991, 1994) classify deposits as outputs and present an even more heterodox view by neglecting borrowed and purchased funds (money market) on the grounds that they do not generate value added[10].

Since deposits are the largest balance sheet item for the Portuguese banking sector their classification becomes a critical issue for empirical investigation. A simple theoretical model of the banking firm is developed in the next sub-section in order to determine the best classification for deposits in the context of a theory of production of the banking firm.

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[9]Pulley and Humphrey (1993, pg 446).

[10] In an earlier work, Berg (1991) argues that purchased funds do not use any real resources and therefore have no role to play in a bank's cost function. Later, in Berg and Kim (1993), this approach was kept, although deposits were handled as quasi fixed inputs since the authors' attention was concentrated on two loan market segments. In Berg and Kim (1994) and Berg, Claussen and Forsund (1993) deposits are handled as an output.

1.2.2. A Long-Run Model of the Banking Firm

In this sub-section we shall separate the origination and funding of loans. As a matter of fact, any institution may originate loans in any amount which are in no way related to the bank's choice concerning their funding[11]. After originating the loans, the *originator* has to decide how to fund them. This may be done through the issue of long-term debt, equity stock, deposits or purchased funds or, alternatively, the bank may decide to securitise the whole issue and, therefore, sell all the loans to others without losing the value-added associated with them. In other words, we shall assume that there is a separation between the activities of origination and funding of loans. Thus, we shall follow the "two phases" approach to banking production proposed by Humphrey (1992). In the first phase, Berg and Kim (1994) is followed and it will be assumed that outputs are individually originated by the use of physical capital (K) and labour (N). In the second phase, the balance sheet equation is introduced to describe the financial equilibrium of the firm.

Returning to the first phase, we may describe origination of loans (L) and deposits in the following way:

$$L = L(K,N) \tag{1.3}$$

$$D = D(K,N) \tag{1.4}$$

Unlike the authors who adopt this perspective, we are also interested in the evaluation of potential economies of scope. In order to allow for cost sub-aditivity, i.e., for the

[11]The best example of this situation is GMAC, General Motors Acceptances Corporation, which does not collect deposits and is one of the most important originators of consumers' loans in the US.

existence of joint production of both deposits and loans in such a way that some resources are shared by both activities allowing for economies of joint production, expressions (1.3) and (1.4) are dropped in favour of a more general transformation function:

$$F(L,D,K,N) = 0 \qquad (1.5)$$

Equation (1.5) describes the first phase of the bank's production and basically corresponds to the approach followed by Pulley and Humphrey (1993). However, there is a significant difference in the role played by joint production in the two articles. These authors try to estimate the potential costs associated with a separation between the "production" of deposits and loans resulting from securitisation of the latter. Their argument is: if economies of scope do exist, than the reduction of the loan portfolio due to dis-intermediation will result in cost dis-economies. In this chapter it is hypothesised that real resources costs of loans are associated with their origination and posterior monitoring. Therefore, in this context, securitisation of such loans does not imply any reduction of "produced loans", but rather the mere transfer of the securitised ones to an "off balance sheet" account[12]. In fact, in most cases the originator, regardless of having securitised the loan or not, remains responsible for its monitoring and, consequently, for the associated costs[13].

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[12]Origination and monitoring seem to be the most real resource consuming activities associated with loans, and they are unaffected by securitisation. If dis-intermediation occurs, in most cases the originator remains responsible for collection of principal and interest, and for loan quality monitoring as well. Therefore, I think that Pulley and Humphrey (1993) addressed this question in a wrong way, since there is probably no loss of eventual economies of scope associated with securitisation: The reduction in loans they foresee is for "on balance sheet" ones and if we account for all of them, i.e., including "off balance sheet loans" and all others under the bank's monitoring, then securitisation does not affect the "total loans" concept relevant for banking costs.

[13]A theoretical discussion of this issue is provided by Pennacchi (1988). Basically, this author concludes that banks have a lower incentive to monitor securitised loans, unless obliged to provide some credit enhancement themselves. Therefore, only loans requiring low monitoring effort constitute good securitisation candidates.

After originating loans and deposits the bank's management needs to raise money to cover any potential shortage of funds or to invest any surplus. This "second phase" of the bank's production is mathematically described by the balance-sheet constraint, which includes shareholders' equity (E). The bank's (static) long-run objective will be the maximisation of economic profits, defined as:

$$\underset{\{L,S,K,N,D\}}{\text{Max}}\ \Pi = R_L\, L + R_S\, S - r_K\, K - w_N\, N - R_D\, D - R_E\, E \qquad (1.6)$$

$$\text{s.t:} \quad F(L,D,K,N) = 0$$

$$\rho D + S + L + K = D + E \qquad (1.7)$$

Where R_L, R_S, R_D and R_E are the required rates of return on loans, securities, deposits and equity, respectively, ρ is the non-earning cash reserves coefficient, r_K is the operating cost of capital and w_N is the wage rate. The balance sheet constraint has, to the best of my knowledge, been completely ignored in the banking costs literature. This is absolutely remarkable for one main reason: most variables that are classified either as inputs or outputs are tied together by this equality constraint which reduces one degree of freedom in this problem and demands that one of those variables be dropped from the model.

The discussion above leads to the choice of the variable to be dropped. Following Berg (1991) and Berg and Kim (1991, 1994) the difference between money market investments and purchased funds, denoted by S in this model, is the excluded variable. Solving (1.7) for S and replacing in (1.6) the problem becomes:

$$\underset{\{L,S,K,N,D\}}{\text{Max}}\ \Pi = (R_L - Rs)L + (Rs(1-\rho) - R_D)D - (r_K + Rs)K - w_N N - (R_E - Rs)E \quad (1.8)$$

$$\text{s.t:} \quad F(L,D,K,N) = 0$$

The model above has some interesting features. First, it departs from an optimisation problem where both profit function and balance sheet constraint are explicitly considered, as in the short-run model of Klein (1971). As long as the money market rate (net of required reserves) is higher than deposits′ rates, they have a positive contribution to the bank's profits. If this does not occur (in marginal terms) the bank will choose to fund itself via money market purchased funds. In other words, the margins over security / money market rates on both deposits and loans are the "prices" that the bank charges on its outputs. Second, the cost of physical capital is the sum of two components, one is the traditional functioning cost and another, also important, is the opportunity cost of its funding, which is consistent with Jorgensen′s definition of user's cost of capital (if we ignore capital gains) but is surprisingly ignored in most banking costs literature. Another important aspect is the negative user′s cost of equity capital, assumed to be exogenous in this model.

As in most of the literature in this subject, equity will, hereafter, be ignored. Its price is very difficult to evaluate, as pointed out by Forrestieri (1993, pg 69) and it is somewhat difficult to assess its contribution to the bank′s production.

It is assumed that each bank makes its decisions in two stages. In the first, management chooses the desired capacity defined as the amounts of loans and deposits they wish to serve, denoted by L^* and D^*. This choice is generally assumed to result from maximisation of long-run profits. In the second stage, the bank will choose the cheapest way to produce the desired output mix, using the inputs capital and labour:

$$\underset{\{K,N\}}{\text{Min}}\ C = (r_K + Rs)K + w_N N \qquad (1.9)$$

$$\text{s.t.}\quad F(L^*, D^*, K, N) = 0$$

Using Shepherd's lemma and duality between production and costs, the problem (1.8) and (1.5) may be represented by the following cost function:

$$C = C(L^*, D^*, r_K + r_S, w_N) \qquad (1.10)$$

Therefore, technology above may be represented by some flexible-form cost function having loans and deposits as outputs and physical capital and labour as inputs.

1.2.3. Cost Function Specification

In order to proceed with an econometric estimation of (1.10) it is necessary to impose some parametric form upon it. Most studies in economies of scale and scope of financial institutions use the second order approach to the technology provided by the *translog* cost function, which consists in a second order Taylor approximation to a "true" cost function[14]. It is attractive in several ways. It allows a U-shaped average cost curve, does not impose *a priori* restrictions on the elasticity of substitution and

[14]See Clark (1988) and Forestieri (1993).

allows the computation of measures of the above for institutions of different sizes. Another advantage is the one widely explored by Benston, Hanweck and Humphrey (1982), consisting of the possibility of allowing the direct comparison between branch and wholesale banking. Another, introduced by Hunter and Timme (1986), is the interaction between time and other explanatory variables to test for technical change. Although it has been recently criticised for showing inappropriate properties for measuring economies of scope, there is thus far no widely accepted alternative[15].

Among the alternatives to the standard translog, the most popular is the introduction of the Box-Cox (1964) transformation. Some studies use this transformation on the outputs only and leave the log metric in the inputs, estimating what is now commonly known as *hybrid translog* (ex: Santos, 1991). The underlying idea associated with the choice of this formulation lies on the poor performance of the standard translog for low levels of output, making it imprecise in measuring economies of scope. Unfortunately, the use of the Box-Cox transformation has lead to results showing properties similar to that of the translog (see Berger, Hunter and Timme, 1993, pg 225). In his application to Portugal, Santos (1991) experienced several problems with his Box-Cox specification and was forced to adopt the translog in two of his three panels.

Given the problems inherent in the Box-Cox transformation and considering the econometric difficulties associated with the adopted estimation procedure, it was considered preferable to use a simple formulation in order to reduce convergence difficulties. Therefore, as in most banking costs literature, the specification to be estimated in this study is a multi-output translog where branching is allowed to

[15]See, for instance, Noulas, Miller and Ray (1993).

interact with the other variables, as proposed by Berger, Hanweck and Humphrey (1987). This explicit introduction of branches has been justified in the literature as a way to allow the pooling of both single and multiple branch banks[16]. The function is:

$$\ln(C)=\alpha_0+\sum_{i\in Y}\beta_i\ln(y_i)+\sum_{i\in W}\alpha_i\ln(w_i)+\frac{1}{2}\sum_{i\in Y}\sum_{j\in Y}\delta_{ij}\ln(y_i)\ln(y_j)+$$

$$\frac{1}{2}\sum_{i\in W}\sum_{j\in W}\gamma_{ij}\ln(w_i)\ln(w_j)+\sum_{i\in Y}\sum_{j\in W}\rho_{ij}\ln(y_i)\ln(w_j)+ \qquad (1.11)$$

$$\psi_b\ln(B)+\psi_{bb}\ln^2(B)+\sum_{i\in Y}\psi_i\ln(B)\ln(y_i)+\sum_{i\in W}\psi_i\ln(B)\ln(w_i)$$

where:

$W=\{w_K, w_N\}$, $Y=\{K, N\}$ and $w_k = r_k + r_S$

B stands for the number of the bank's branches

The specification above must satisfy certain theoretical conditions in order to be considered as a cost function. These are:

i) Symmetry:

outputs: $\delta_{L,D} = \delta_{D,L}$ (1.12)

input prices: $\gamma_{N,K} = \gamma_{K,N}$ (1.13)

ii) Input Price Homogeneity:

$$\alpha_N + \alpha_K = 1 \qquad (1.14)$$

$$\gamma_{N,N} + \gamma_{N,K} = \gamma_{K,N} + \gamma_{K,K} = 0 \qquad (1.15)$$

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[16]This issue is discussed in Benston, Hanweck and Humphrey (1982).

$$\rho_{L,N} + \rho_{L,K} = 0 \tag{1.16}$$

$$\rho_{D,N} + \rho_{D,K} = 0 \tag{1.17}$$

$$\psi_N + \psi_K = 0 \tag{1.18}$$

According to Shepherd's (1970) lemma, the demand for each production input may be obtained by partial differentiation of the cost function with respect to the input's price. Using it, the following system of factor shares equations may be obtained:

$$S_i = \alpha_i + \gamma_{i,N}\ln(w_N) + \gamma_{i,K}\ln(w_K) + \rho_{L,i}\ln(L) + \rho_{D,i}\ln(D) + \psi_i\ln(B) \tag{1.19}$$

$$i \in \{N,K\}$$

The inclusion of the number of the bank's branches is based on the assumption that banks may reach different costs for the same level of both outputs, even if they efficiently use their inputs whenever they choose different branching strategies. In other words, the generalisation on this variable of the approximation to the cost function is conducted in order to account for technological differences between branching and wholesale banks. Implicit in this approach is the belief that physical capital does not constitute a good indicator of the investment in branches, since the same investment may be required to buy one large building in which to concentrate operations or several smaller premises. Therefore, this variable is included to account for the potential costs or benefits of the spatial implementation of the bank[17].

[17]A discussion of this issue is found in Santos (1991).

1.2.4. Economies of Scale and Scope

Different measures of economies of scale and scope based on the estimation of a model such as the one described by equations (1.11) to (1.18) were proposed by Berger, Hanweck and Humphrey (1987), who adapted the usual single-product measures for the multi-product firm. Economies of scale may be measured using the *overall economies of scale*, as proposed by Panzar and Willig (1977):

$$OES = \sum_{i \in Y} \frac{\partial \ln(C)}{\partial \ln(y_i)} \quad (1.20)$$

The above measure may be interpreted in the following way. If all outputs are to be increased by a common multiplicative factor, say λ, then (1.20) is equivalent to δC/δλ. Therefore, OES > 1 implies that cost will have to increase more than proportionately the increase of the output (diseconomies of scale) and for OES < 1 we shall have the opposite situation (economies of scale). Benston, Hanweck and Humphrey (1982) argued that this measure is not appropriate for branching banks because they "*expand primarily by adding additional offices (which attract new accounts) rather than by adding accounts or balances to existing offices*"[18]. In order to adjust for this situation, they computed the total differential of the cost function in order to the outputs and the number of branches and proposed the following measure of *augmented economies of scale* AES, which is here generalised for the multi-output firm:

$$AES = \sum_{i \in Y} \frac{\partial \ln(C)}{\partial \ln(y_i)} + \sum_{i \in Y} \frac{\partial \ln(C)}{\partial \ln(B)} \frac{\partial \ln(B)}{\partial \ln(y_i)} \quad (1.21)$$

[18]Benston, Hanweck and Humphrey (1982, pg 445).

The first measure (1.20) is sometimes referred to as *plant economies of scale* while the second (1.21) is called *firm economies of scale*. The difference is based on the fact that the first one implicitly assumes the number of branches as constant, and therefore measures the sensitivity of costs to changes in the outputs for the "existing plant", while the second takes into consideration the need to increase the number of branches in order to expand outputs, as well as the way this interacts with the other variables.

The measures above fall into what is sometimes called measures of *ray economies of scale*, because they implicitly assume that all outputs always increase or decrease along a straight line (for two outputs), i.e., a ray starting from the origin. Berger, Hanweck and Humphrey (1987) criticise this approach on the grounds that firm expansion may imply changes in the output mix, and therefore make these measures inappropriate. To correct for these situations, they propose an alternative measure which they called *expansion path scale economies*. This, instead of assuming that output expansion follows a pre-determined ray (or straight line), is computed for "typical" banks of different dimensions whose output mix may differ. The measure, for a bank A moving to B´s output level, with $Y^B \rangle Y^A$, is:

$$EPSCE = \sum_{y \in Y} \left(\frac{(y^B - y^A)/y^B}{(C(y^B) - C(y^A))/C(y^B)} \right) \times \frac{\partial \ln(C(y^B))}{\partial \ln(y^B)} \qquad (1.22)$$

The measure of cost subadditivity has also been the subject of controversy, with the measure proposed by Panzar and Willig (1981) being criticized by Berger, Hanweck and Humphrey (1987), with the argument that the translog cost function does not behave properly for very low levels of output. New arguments against their measure were raised by Heathfield and Raja (1993), who showed that it may yield improper indications and show both types of economies for theoretical functions which do not possess them. This measure is:

$$SCOPE = \frac{C(0,D) + C(L,0) - C(L,D)}{C(L,D)} \qquad (1.23)$$

The alternative measure proposed by Berger, Hanweck and Humphrey (1987), designated by expansion path subadditivity, is gaining supporters and has two important advantages over the traditional measure: it does not require the evaluation of the translog at a zero level for one of the outputs; and duly incorporates the change in firm output mix along scale expansion. Basically, this measure evaluates the efficiency of a large firm B, comparing the cost of producing its output bundle with the sum of the costs for two smaller firms, one for which data is observed, designated by A, and another one (D), complementary to the latter, such that $y^B = y^A + y^D$ and their measure is simply:

$$EPSUB = \frac{C(Y^A) + C(Y^D) - C(Y^B)}{C(Y^B)} \qquad (1.24)$$

1.2.5. Productive Efficiency

Productivity of financial institutions is becoming one of the most popular research topics among banking economists, as may be observed in a recent issue of a prestigious journal, which was dedicated entirely to the topic[19]. Nevertheless, only recently has attention been devoted to efficiency measuring, and most particularly to the topic of X-efficiency. Moreover, as Berger, Hunter and Timme (1993, pg 222)

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[19]Allen Berger, William Hunter and Stephen Timme (eds), "The Efficiency of Financial Institutions", *Journal of Banking and Finance*, vol 17 (2-3), (April 1993).

note "*nearly all such papers had measured X-efficiency for US commercial banks, with less than a handful of papers measuring the efficiency of (...) banks outside the US*".

Many justifications have been put forward for the detected levels of inefficiency in financial institutions. For Portugal, high regulation and lack of competitiveness may have reduced incentives for "cost competition", i.e., for individual banks trying to increase their competitiveness through cost-reduction technological changes (see Eckard, 1992). Older banks were also forced to hire excessive numbers of staff returning from former Portuguese colonies in Africa, which may still be a factor today in both technical (surplus staff) and allocative inefficiency. Agency problems may be at the bottom of expense-preference behaviour of politically designated managers of nationalised banks[20].

The measurement of technical efficiency requires the existence of an estimated frontier, parametric or non-parametric, which gives the most efficient way (cost) of producing a given bundle of outputs. Having that information, we may compare the actual cost incurred by the firm with the "efficient" value for that bundle and compute a Farrel (1957) type measure of efficiency, which consists of the ratio between the "efficient" and observed costs. This issue was introduced by Färe and Lovell (1978) and later refined by Forsund, Lovell and Schmidt (1980) who connected this approach to the different alternatives of frontier estimation.

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[20] A classical reference to expense-preference behaviour in banking is Hannan and Mavinga (1980). Cebenoyan et al (1993) use the econometric frontier approach to conduct such a test for American Savings & Loans. Mester (1993) conducts this type of analysis estimating separate frontiers for manager-controlled and owner-controlled S&L's.

There is however, another major reason for the adoption of a frontier formulation instead of a "traditional" econometric approach: the measures of economies of scale and scope have been confounded with X-efficiency differences when the latter was used (see Berger, Hunter and Timme, 1993, pg 227). Thus, a frontier formulation must be adopted to allow the separation between the two effects.

Among the several alternative frontier methods, the parametric stochastic cost frontier was chosen. The use of a parametric function has the advantage of allowing the simultaneous computation of measures of economies of scale and scope and productive efficiency, which allows a check upon the possible dominance of inefficiency over economies of scale and scope as detected by Berger and Humphrey (1991) using a "thick" (parametric) frontier approach. A stochastic frontier has significant advantages over the deterministic alternatives, because it allows the estimated error to be decomposed between the inefficiency component and the statistical noise associated with measurement error and unanticipated random events that affect production and costs. For a survey of frontier methods see Lovell (1993). In Greene (1993) the econometric alternatives for frontier estimation are analysed and surveyed. Berger, Hunter and Timme (1993) review frontier applications to the financial services industry.

Unfortunately, the two-component error structure has an important disadvantage: As Forsund *et al* (1980, pg 14) put it "[it] *is not possible to decompose individual residuals into their two components, and so it is not possible to estimate technical inefficiency by observation. The best that one can do is to obtain an estimate of mean inefficiency over the sample*". This problem was somewhat softened by Jondrow *et al* (1982) who proposed a decomposition for this two component error term. But, as Bauer (1990, pg 43) commented: "*Unfortunately, these estimates* *cannot be shown to be consistent estimates of u* [the technical inefficiency component]".

Keeping in mind the above criticisms, an approach similar to that employed by Cebenoyan *et al* (1993) is followed in the present chapter[21]. Individual inefficiency measures will be computed using their expected value as suggested by Jondrow *et al* (1982), since this measure seems to be preferable to their "mode" estimate. In short, the procedure is as follows:

The function to be estimated is of the form:

$$C_{i,t} = C(\mathbf{Y}_{i,t}, \mathbf{w}_{i,t}, B_{i,t}) + u_{i,t} + v_{i,t} \qquad (1.25)$$

Where **Y** and **w** are the vectors of outputs and input prices, respectively, i stands for the bank's number and t for time. The residuals v have the usual properties, i.e., are assumed to follow a normal distribution with zero expected value and a constant variance σ_v^2. The other residual u follows a half-normal distribution, with $u \geq 0$ and variance σ_u^2 . Residuals u and v are assumed to be independent. While the first of these terms corresponds to the usual random disturbance used in econometrics, the second is assumed to correspond to deviations from the cost function attributable to inefficiency. In other words, non-negativity of u has to be imposed in order to ensure that most actual observations correspond to values above the cost function, because theory defines it as the minimum admissible cost to efficiently produce that bundle of outputs given the input prices.

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[21]There is, however, a major difference from the case presented in that article: Cebenoyan et al (1993) used a truncated normal distribution for u while in the present article the half-normal distribution is adopted.

In order to estimate individual inefficiency errors, their expected values are computed as (Jondrow *et al*, 1982):

$$E(u_{i,t}|\varepsilon_{i,t}) = \frac{\sigma_u \sigma_v}{\sigma}\left(\frac{\phi(\lambda \varepsilon_{i,t}/\sigma)}{\Phi(\lambda \varepsilon_{i,t}/\sigma)} + \frac{\lambda \varepsilon_{i,t}}{\sigma}\right) \quad (1.26)$$

where :

$$\lambda = \sigma_v / \sigma_u \qquad \sigma = \sqrt{\sigma_u^2 + \sigma_v^2} \qquad \text{and} \qquad \varepsilon_{i,t} = u_{i,t} + v_{i,t}$$

$\phi(x)$ represents the standard normal density function

$\Phi(x)$ represents the standard normal distribution function

These estimators are unbiased but, unfortunately, not consistent. Nevertheless, they are, until the present, the only ones available for estimating efficiency at the firm level. For a discussion of this issue, see Greene (1993, pp 80-82).

Once computed, the above inefficiency indicator may be used to derive productive efficiency indexes. For that purpose, a Farrel (1957) type measure is used. Productive efficiency is simply the ratio between "efficient" (i.e. computed over the frontier) and "total" costs. The relevant difference between them will simply be given by u, because the v residual represents random effects unrelated to either technology or inefficiency. Therefore, the measure is estimated as:

$$\hat{PE} = \frac{\hat{C}}{\hat{C} + \hat{U}} = \exp(-\hat{u}) \quad (1.27)$$

Where U is the cost component estimated to result from X-inefficiency.

The above measure, which yields 1 for "efficient" banks, has the disadvantage of not allowing a direct separation between technical and allocative inefficiency. Kopp and Diewert (1982) developed a method for decomposing the two sources of inefficiency based on "efficient" input demand functions. These authors use the input demand functions derived from the cost function to estimate the efficient level of each of the inputs, and therefore determine how much inefficiency results from the use of the wrong input mix (allocative) and from the excessive use of inputs (technical).

An alternative method consists of the simultaneous estimation of a cost and share function, in which deviations from the latter are considered to result from allocative inefficiency, and deviations from the first will result from a composed error structure summing allocative, technical and random effects[22].

In this chapter special attention will be given to banks′ staff. There is some anecdotal and journalistic evidence for the existence of excessive personnel in some banks, especially the older ones. Having estimated a frontier, the first step will be the computation of an input demand function for labour:

$$N^* = \frac{\partial C}{\partial w_N} = \frac{\partial \ln(C)}{\partial \ln(w_N)} \frac{C}{w_N} = N(L, D, w_K, w_N) \qquad (1.28)$$

Having computed the "efficient" value for N, observation by observation, we may compare these values with the actual number of employees and determine which institutions show under and overstaffing. Obviously, the latter may result from technical and / or allocative inefficiency.

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[22]See Bauer (1990) and Greene (1993).

1.3. Estimation and Data

1.3.1. Estimation

The parametric cost function (1.11) using panel data and imposing the error structure of (1.25) is estimated using TSP's maximum likelihood algorithm. The number of parameters to be estimated was reduced by the imposition all theoretical restrictions required by the theory (1.12 to 1.18). The log-likelihood function for the model (1.25) above is the cost frontier variation of the one proposed by Aigner, Lovell and Schmidt (1977, pg 26) for production frontiers:

$$\ln(\mathcal{L}) = \frac{n}{2}\ln\left(\frac{2}{\pi}\right) - n\ln(\sigma) - \frac{1}{2\sigma^2}\sum_{i=1}^{n}\varepsilon_i^2 + \sum_{i=1}^{n}\ln\left(\Phi\left(\frac{\varepsilon\lambda}{\sigma}\right)\right) \qquad (1.29)$$

where n stands for the number of observations, $\mathcal{L}$ for likelihood, and $\Phi(x)$ for the cumulative normal distribution.

In order to avoid convergence difficulties, the iterative process (Gauss-Newton) was initialised using the starting values for σ and λ proposed by Waldman (1978) and reported in Greene (1982). All stationary points found during iterations were checked for possible situations of local optimum, the "third moment" method proposed by Waldman (1982) being used to decide whether or not resume the process following other direction.

A problem occurred when the process, sometimes, converged to points where one (or both) parameters σ or λ were negative. Whenever this situation arose, the process was reinitiated from that point using the absolute values of those previously estimated parameters. Generally, the model converged after a few iterations.

The Variance-Covariance matrix estimates were obtained using the Berndt-Hall-Hall-Hausman (1974) method (hereinafter, BHHH) and the White (1982) "robust" method. The latter has significantly important advantages, namely by being "robust" to misspecification and heteroscedasticity, and therefore was the one adopted to figure in the results. It should be noted that since all banks, from different sizes, were pooled in the sample, the presence of heteroscedasticity may not be discarded, and therefore this variance-covariance matrix estimator should be used.

Several formulations for (11) - (25) were tested. In what will, hereinafter be called Model A, all variables in (11) were included. This equation was also estimated without imposition of the theoretical restrictions, as it was concluded, through a Wald test, that the resulting estimates violated those restrictions and, therefore, the estimated equation did not correspond to a cost function. In another version of (1.11), hereinafter designated Model B, the "number of branches" variable was omitted. Once again, in this version, theoretical restrictions had to be imposed *a priori* since the otherwise resulting estimates violated them.

There are two reasons for making the *a priori* introduction of the theoretical restrictions. As in most of the literature, we impose them to assure that the resulting estimates do have the economic properties of a cost function, which are absolutely essential to allow the interpretation of the results in terms of economies of scale and scope. The other reason is associated with the econometric procedure used: by imposing those restrictions, the number of parameters to be estimated is significantly reduced and estimators′ efficiency, as well as convergence, is greatly increased.

In order to detect any possible technical change, a time trend was also included under different alternatives, from the inclusion of a single parameter to a fully second-order generalisation on this variable. The latter is basically the approach suggested by Hunter and Timme (1986).

Early estimates indicated a negative correlation in banks' efficiency indexes and the number of new branches opened in the year. This could be an indication that some costs associated with the opening of new branches may have been taken as costs rather than investments. On the other hand, it is reasonable to admit that in its first year the new branches do not have the same productivity as the others. In order to try to correct this situation, a rather more complex inefficiency error was also tested:

$$\varepsilon_{i,t} = z_1 \ln(\Delta B_{i,t} + 1) + z_2 \ln^2(\Delta B_{i,t} + 1) + u_{i,t} + v_{i,t} \tag{1.30}$$

With this specification, banks that do not open new branches are unaffected (ln becomes zero) and inefficiency resulting from u becomes isolated from the "new branches" effect. The 1 inside the logarithms is necessary to avoid computation of ln(0).

1.3.2. Data

This study was based on data published by the *Associação Portuguesa de Bancos* in its annual bulletin, for the years 1986/1992. In order to avoid using end of year data, balance sheet items (stock variables) were computed as the average of their end and beginning of year values. In some cases, when significant asset or liability composition changes were detected, half year accounts were used to improve the accuracy of computed averages. A similar procedure was followed to compute the number of bank's branches and employees for each year. For income statement data (flow variables) figures accumulated until 31 December were used. Therefore, one year of observations was lost, yielding an unbalanced panel for 1987/1991. New banks were added to the panel on the second year of their operations.

All banks except the *Caixa Geral de Depósitos* (CGD) were included in the sample. The CGD was excluded due to the fact that its dimension twice exceeds that of the second largest bank and results seemed to be severely sensitive to its inclusion or exclusion from the sample, making it an "outlier" in this context. Given its dimension and the monopoly situation from which it has benefited in several markets during part of the sample period, it was opted to drop this institution, choosing to work only with the remainder of the sample.

From the procedure above, 140 observations were obtained which were organised in an unbalanced panel with 2 to 6 observations per bank.

The price of labour was computed as the ratio of total labour expenses per worker. This approach, widely used in the literature, has some unpleasant disadvantages but, unfortunately, is difficult to replace. In fact, this is more of an average than a marginal cost for labour and therefore not very suitable for the computation of marginal costs for the bank's products. For the data set used, there is also the problem associated with different accounting practices regarding the treatment of the banks' future pension obligations, which go from fully accounted contributions to pension funds to situations (especially in the case of several nationalised banks) in which this cost is totally ignored and absent from the income statement.

It is also interesting to note that this variable is declining in the banks′ dimension (see Table 1.1., computed using 1986 prices). There are two reasons for this. Small wholesale corporate banks hire highly qualified personnel for the most part, while larger banks always have high percentages of less skilled workers such as tellers and attendants in branches. If we assume that banks expand their operations keeping their skilled/unskilled workers ratio constant, average costs above will constitute a reasonable measure of marginal costs of labour and, therefore, despite the criticisms above, it is here used to evaluate the price of labour.

TABLE 1.1.

Average Salaries and Bank Size

ASSET SIZE	SALARY
< 20M	3,205
20M - 100M	2,544
100M - 250M	2,161
250M - 500M	1,847
>500M	1,830
millions of 1986 contos	1986 contos

The computation of the user's cost of capital is a more controversial issue. Following Santos (1991), all costs other than labour incurred by the bank were allocated to capital, depreciation included. This last item, although not being an *expense*, but rather just a cost for tax purposes, has to be included since that is the only available way to proxy the economic depreciation of assets and for the costs on advertising and royalties paid to open new branches (both depreciated over three years for accounting purposes). Consistent with (1.10), an average money market rate was added to the average of above expenses to total capital in order to account for the opportunity costs of the bank's investments in fixed assets.

One problem with the above procedure lies in the inclusion or not in this variable of the operating expenses not directly associated with labour. This problem is due to accounting practices which take into the same account all kinds of services acquired from third parties. If we decide to include them, a bizarre situation occurs: banks which primarily lease their branches will have an exceptionally high cost of capital, since this option results in a very high balance for this "miscellaneous costs" account and results in a very small physical capital account, yielding a very high ratio between them. On the other hand, if those costs are excluded, then an important part of real resources costs will not be accounted for, making resulting estimates somewhat unreliable. Therefore two alternative solutions will be tested: the first one will take all costs other than wages as capital costs; the second will assume that depreciation and the opportunity cost of capital are the only relevant items for capital, but keep "miscellaneous" as an independent part of total costs.

This last approach is somewhat more atypical and may be justified in the following grounds: "miscellaneous costs" are generally variable costs used to produce output directly together with capital and labour. Therefore, they should be included as an input into the transformation function together with the two "primary" factors. The only problem with this approach is the impossibility of differentiating price and quantity in their total amount, leading to the need to model the problem assuming a unit input price for these "miscellaneous" costs, hereinafter denoted by M. The firm's problem, considering this cost allocation alternative, will be:

$$\underset{\{K,N,M\}}{\text{Min}}\ C = M + (\delta + Rs)K + w_N N \qquad (1.31)$$

$$\text{s.t.}\ \ F\left(L^*, D^*, M, K, N\right) = 0 \qquad (1.32)$$

This problem has a generic solution similar to (10), which makes this approach compatible with the estimation of its second order approximation (1.11). Here, δ stands for the depreciation rate. With this approach we obtain a "user cost" for capital which is similar to Jorgenson's when capital gains are ignored. From the above it may be seen that first derivatives of (1.31), in order to input prices, yield the input demand functions for both capital and labour, although such a procedure may not be followed for M.

Measures of economies of scale based on estimates of (1.11), using the above definition of user's cost of capital, should now be interpreted in the context of duality relative to the transformation function (1.32).

Estimations based on formulation (1.9) will be called models A(1) and B(1), while the ones based on (1.31) will be designated A(2) and B(2), respectively.

Summary descriptive statistics for the most relevant variables are shown in the following tables. Cost of capital is defined according to the two alternatives presented above.

Table 1.2.

Summary Descriptive Statistics

Variable	Mean	Std Dev	Minimum	Maximum
C	7,952.2	8,226.0	229.4	39,032.4
L	105,602.8	96,721.1	2,518.4	398,749.9
D	170,788.2	182,080.4	210.4	658,834.9
WN	2,774.9	2,162.7	1,298.0	25,450.3
WK(1)	64.7%	43.3%	20.9%	333.4%
WK(2)	28.0%	7.6%	16.7%	54.9%
B	64.1	68.1	1.0	254.0

Table 1.3.

Correlation Matrix

var	C	L	D	WN	WK(1)	WK(2)	B
C	1.000						
L	0.927	1.000					
D	0.917	0.885	1.000				
WN	-0.103	-0.026	-0.159	1.000			
WK(1)	-0.154	-0.139	-0.215	0.347	1.000		
WK(2)	-0.184	-0.172	-0.189	0.280	0.745	1.000	
B	0.950	0.855	0.912	-0.285	-0.236	-0.224	1.000

A few comments on the data above are called for: Costs, deposits and loans are expressed in millions of *contos* (one thousand escudos) deflated to 1986 prices. Price of labour is expressed in contos for the same base year. The reader should note the difference between the two alternatives for the computation of the price of capital. Most notably, the fact that some values for wk(1) are incredibly high.

1.4. Results

1.4.1. General Results

With the variables defined as above, the four alternatives considered for the cost frontier were estimated as specified in Section 3 with the specific imposition of theoretical restrictions. All tested dummy variables were rejected as having very low associated t ratios. The same applies to the different alternatives of including the time trend, which seems to indicate that no technical change has occurred during this period. Therefore, results presented here correspond to the base versions A and B of the model as explained above. Similar reasons lead the error structure (1.30) to be dropped, as well, in favour of the simple two-residual (u and v) structure.

As a note, prior estimation of the models without imposition of theoretical restrictions yielded results that, in some cases, did not converge to frontier solutions and, in all cases, Wald tests performed on those restrictions revealed that these estimates violated them.

The first thing to be checked is which model alternative, A or B, should be used. As will be seen later, all estimates seem to provide similar conclusions concerning economies of scope, but divergences are found for economies of scale. To be more precise, the two versions of model B show economies of scale for the first two classes of banks and dis-economies for the remainder. Although this represents a "typical" result in the literature, it may result from mispecification if branches do, in fact, effectively interact with the other variables.

To check for this, a Wald test was computed for both specifications A(1) and A(2). The null hypothesis was that all parameters associated with the branching variable were simultaneously zero. The resulting values were 259.6 for A(1) and 169.2 for A(2) which for a chi-square distribution with 5 degrees of freedom allows the rejection of the null hypothesis for both models (critical value for 99.5%: 16.75).

Considering the results of this test, we shall henceforth, as in most banking costs literature, concentrate our attention on the more general formulation A. This simply means that banks owning a small number of branches do not have the same technology as the others. The extent to which the introduction of the branching variable is enough to incorporate that technological difference is always difficult to evaluate.

Estimated coefficients for these models follow in the next pages. As the reader may see, in all cases except B(2) the t statistic associated with λ allows the rejection of the null hypothesis, since this parameter is zero, and therefore the estimated functions possess frontier properties, a conclusion that is reinforced by the high values of the third central moment of the estimated composed residuals[23].

All estimated cost frontiers are increasing in the output quantities (despite the negative sign associated with the first order terms in the outputs and in the number of branches). The same occurs for input prices. Nevertheless, whenever the first version of the cost of capital is used, the significance of most parameters associated with output quantities are not statistically significant. As an example, in A(1) the only significant parameter associated with deposits is Ψ_D (the parameter which gives the interaction between deposits and branches).

Model B(1) performs very poorly, since only four out of ten cost function parameters are statistically significant, and is therefore discarded.

It should also be noted that the estimation procedure for White's (1982) variance-covariance matrix for both versions of model B never converged. Therefore, estimates based on BHHH are produced.

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[23]Not shown. All exceeded the value of 100.

Given the considerations above, attention will be concentrated on model A(2). For a better understanding of the situation, measures of economies of scale and scope will be computed for both versions of model A. Decomposition of observed costs between the three components follows in appendix A.1.

Table 1.4.
Estimates for Model A

	MODEL A(1)				MODEL A(2)			
Para	**Value**	**Std Error**	**t statistic**	**signif**	**Value**	**Std Error**	**t statistic**	**signif**
α_0	14.871	9.083	1.637	*	21.665	7.910	2.739	**
β_L	-3.049	1.588	-1.921	*	-2.920	1.701	-1.716	*
β_D	-0.348	1.185	-0.294		-2.368	1.544	-1.533	
α_N	4.286	2.227	1.924	*	6.201	1.981	3.130	***
δ_{LL}	0.483	0.121	4.001	***	0.422	0.139	3.031	**
δ_{LD}	-0.106	0.078	-1.373		-0.124	0.063	-1.960	**
δ_{DD}	0.026	0.071	0.363		0.134	0.076	1.764	*
γ_{NN}	-0.139	0.299	-0.465		-0.775	0.250	-3.102	***
ρ_{LN}	-0.325	0.124	-2.622	**	-0.169	0.139	-1.216	
ρ_{DN}	0.198	0.099	2.001	*	0.257	0.103	2.496	**
B	3.246	1.075	3.019	**	3.883	0.857	4.530	***
BB	-0.008	0.123	-0.064		0.073	0.072	1.022	
D	0.140	0.069	2.037	*	0.066	0.096	0.687	
L	-0.277	0.111	-2.503	*	-0.236	0.091	-2.608	**
K	0.020	0.117	0.171		0.061	0.083	0.738	
$1/\sigma$	2.527	0.379	6.669	***	3.483	0.444	7.849	***
λ	2.823	1.034	2.730	**	1.819	0.863	2.107	*

Signifficance: * = 10%, ** = 5% and *** = 1% for two-tail test

Table 1.5.
Estimates for Model B

	MODEL B(1)				MODEL B(2)			
Para	**Value**	**Std Error**	**t statistic**	**signif**	**Value**	**Std Error**	**t statistic**	**signif**
α_0	28.386	19.843	1.431		-23.713	13.654	-1.737	*
β_L	-4.244	2.717	-1.562		-1.450	2.304	-0.630	
β_D	-0.033	1.781	-0.018		0.876	1.634	0.536	
α_N	3.574	3.012	1.187		7.752	1.900	4.081	***
δ_{LL}	0.240	0.182	1.321		0.507	0.217	2.339	**
δ_{LD}	-0.194	0.111	-1.740	*	-0.360	0.138	-2.613	**
δ_{DD}	0.275	0.087	3.154	***	0.327	0.104	3.140	***
γ_{NN}	-1.003	0.370	-2.709	**	-0.717	0.297	-2.416	**
ρ_{LN}	0.385	0.227	1.700	*	-0.127	0.276	-0.460	
ρ_{DN}	-0.062	0.160	-0.389		0.069	0.184	0.376	
$1/\sigma$	1.770	0.105	16.916	***	2.010	0.383	5.254	***
λ	3.714	1.272	2.921	**	1.091	0.747	1.460	

Statistics based on BHHH Variance-Covariance estimates

In order to better understand the estimates above, it is interesting to evaluate the resulting marginal costs for both deposits and loans. Such computation, as happens for economies of scale, may be conducted at both plant and firm levels. For the latter, an evaluation of how branching is related to the outputs must be performed. That is the purpose of the next sub-section.

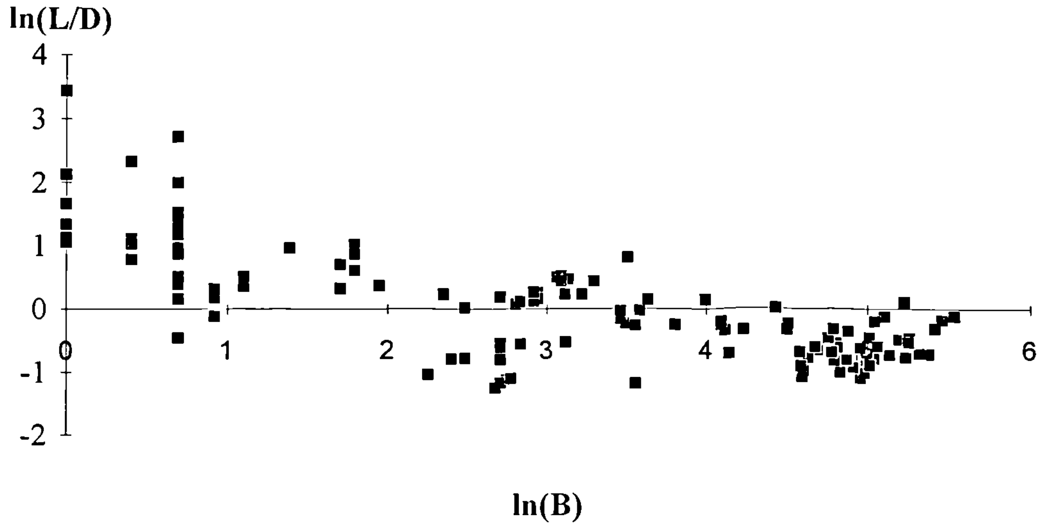
1.4.2. Output Mix and Branching

In this sample, banks of different sizes are pooled. This situation leads to possible problems associated with changes in output mix among classes of different dimension. Figure 1.1. below shows that smaller banks are almost specialised in lending, while the bigger ones spread from a few cases in which deposits and loans match, to a more general situation in which deposits greatly exceed loans[24]. Some dispersion is found for banks with a number of branches ranging from 10 to 25.

This situation implies that both economies of scale and scope must be evaluated through "expansion path" measures, (1.22) and (1.24) respectively, and raises the question of how much these two "extremist" types of banks may be losing with the possibility that scope economies actually do exist.

Figure 1.1.

Output Mix and Branching



In order to compute "firm" level measures of economies of scale and scope, as well as marginal costs, a relationship between the log of branches and the logs of outputs

[24]The graph is constructed in logs in order to provide a better understanding of differences among banks of different sizes.

must be estimated (see expression 21). Following Benston, Hanweck and Humphrey (1982), the following relationship is estimated:

$$\ln(B_{i,t}) = \theta_0 + \theta_L \ln(L_{i,t}) + \theta_D \ln(D_{i,t}) + \theta_{LD} \ln(L_{i,t})\ln(D_{i,t}) + \theta_{LL} \ln^2(L_{i,t}) + \theta_{DD} \ln^2(D_{i,t}) + \mu_{i,t} \quad (1.33)$$

in which μ is the usual white noise type econometric residual.

Unfortunately, in results from ordinary least squares (OLS) most of the parameters above were not statistically significant and all resulting $\partial \ln(B)/\partial \ln(D)$ estimates showed negative values for the larger institutions. Given the suspicion regarding heteroscedasticity, a Goldfeld-Quandt (1965) test was performed and the null hypothesis of homoscedasticity was rejected[25]. As a consequence, Aitken generalised least squares (GLS) were applied, assuming that the variance of the residuals is inversely proportional to bank's total assets. Although some general improvement was found, negativity of the above elasticity persisted for the largest three institutions.

Given this situation, a different alternative was tested:

$$B_{i,t} = \theta_0 + \theta_L L_{i,t} + \theta_D D_{i,t} + \theta_{LD} L_{i,t} D_{i,t} + \theta_{LL} L_{i,t}^2 + \theta_{DD} D_{i,t}^2 + \mu_{i,t} \quad (1.34)$$

Estimates obtained by OLS also showed significant heteroscedasticity and a similar GLS procedure was used. After successive estimates in which the less significant parameters were dropped, until only significant ones remained, the following estimate was retained:

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[25]Residual variance for the smaller institutions was much higher than that computed for the larger ones.

Table 1.6.
Branching Regression Estimates

Param	Estimate	t statistic
θ_{D}	4.4137E-07	9.723
θ_{LD}	6.05703E-16	2.532
θ_{DD}	-4.97947E-16	-2.947

This regression has a r squared of .901 and a F statistic of 19.2. To obtain the above-mentioned elasticity for any of the outputs the following computation is made:

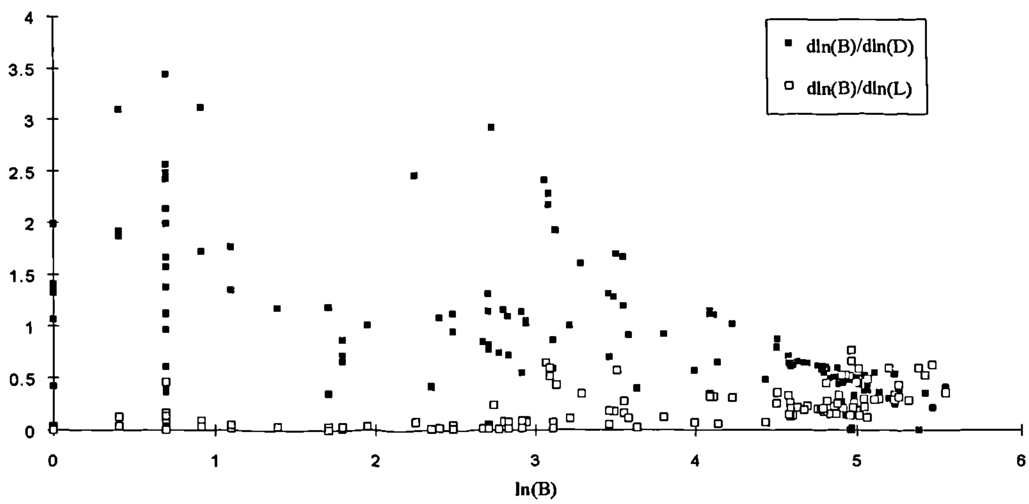
$$\frac{d\ln(B)}{d\ln(Y)} = \frac{dB}{dY}\frac{Y}{B} \quad \text{for } Y \in \{L, D\} \tag{1.35}$$

The resulting estimate shows positive values for that elasticity for all banks in the sample. The required number of branches is increasing in both outputs, but it is surprising to discover that loans and branches are only indirectly related, i.e., the only significant coefficient associated with loans is the one in which they interact with deposits. This seems to confirm some anecdotal evidence that, in general, branching expansion boosts deposits much more than credit. Probably, the above result may reflect a situation in which credit generated by new branches may result from the new attracted depositor customers, which would be reflected by the discovered indirect effect.

In order to obtain a better understanding of these regression results, the above elasticities are displayed in Figure 1.2. below:

Figure 1.2.

Output Expansion and Branching



Individual estimates depend on each bank´s output mix but it becomes obvious that the number of branches required to increase deposits in a certain percentage is a decreasing function of existing offices, while the opposite seems to happen for loans, especially for the largest branch networks. Actually, with the exception of the latter case, loans and total branches seem to behave very independently.

Also interesting to note is that the above elasticity is generally much higher for deposits that for loans, with the exception of the larger branch networks.

The above conclusions seem to imply an important competitive advantage for the larger networks, especially if the usual hypothesis that market power is positively correlated with dimension is actually verified. In that case, large institutions may inexpensively prevent their rivals from growing in the market for deposits: not only will the marginal effect of their branches be higher, but they may also be able to attract deposits generating higher margins.

These conclusions may also explain why many banks choose to concentrate on the market for loans and mantain only one or two offices. In order to attract a significant amount of deposits it is necessary to make huge investments in new branches, which may be too expensive and not profitable in the short run. To understand the rationality of this option, it is necessary to evaluate the potential cost benefits from diversification (scope) and from growth at the firm level (scale), together with an analysis of how market power is related to size. The latter will be the subject of a separate chapter, while the first is analysed in the next two sub-sections.

1.4.3. Marginal Costs and Input Price Sensitivity

As in most empirical studies of banking costs some negative marginal costs were found at the plant level[26]. Although this may result from inaccuracies in the measuring of the "real" prices of capital and labour, it is always impossible to exactly understand where those unrealistic results come from. A closer look at individual estimates from models A(1) and A(2) indicated that this result is more frequent for banks which pay average salaries below sample mean for the year and for institutions which show high ratios of total assets to total branches (which could be a productivity indicator) and for banks who do also have an important investment banking activity, not covered in

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[26]Santos (1991) was particularly affected by this phenomenon. In one of his estimations all classes but one showed negative marginal costs for some of his outputs.

the present study. It was also found that individual negative marginal costs are more frequent in models A(1) and B than in specification A(2), which may reflect their poor econometric performance.

When marginal costs are estimated at mean values of observations for the different classes of size, this problem only affects loans of one class. This may, in fact, corroborate the fact that observations which show "outlier" values for some of the variables may be hurt by measurement errors that result in this phenomenon. Estimated values for model A, follow in the next tables:

Table 1.7.
Marginal Costs Estimates for Model A(2)

Marginal Costs	Plant Measures		Firm Measures	
Asset Size	Loans	Deposits	Loans	Deposits
< 20M	0.68%	1.17%	0.69%	4.90%
20M - 100M	0.50%	1.45%	0.59%	4.74%
100M - 300M	0.66%	1.44%	0.97%	3.39%
300M - 500M	-0.15%	2.06%	0.55%	3.30%
> 500M	0.30%	1.95%	1.61%	2.41%
AVERAGE:	0.26%	1.89%	1.12%	2.89%

size: millions of contos deflated for 1986 prices

Table 1.8.
Marginal Costs Estimates for Model A(1)

Marginal Costs	Plant Measures		Firm Measures	
Asset Size	Loans	Deposits	Loans	Deposits
< 20M	0.26%	1.48%	0.28%	6.29%
20M - 100M	0.01%	1.30%	0.11%	5.15%
100M - 300M	0.58%	1.15%	0.91%	3.26%
300M - 500M	-0.25%	1.64%	0.50%	2.96%
> 500M	0.63%	1.48%	1.99%	1.95%
AVERAGE:	0.33%	1.47%	1.24%	2.54%

size: millions of contos deflated for 1986 prices

From the tables above, we always find marginal costs for loans to be lower than those for deposits. More surprisingly, most firm-level values for loans are even lower than plant figures for deposits. This may result in part from excessive capacity for loans associated with the long credit ceilings period, in which existing banks were subject to a progressive (in real terms) reduction of their loan portfolio. Another explanation is that operating costs associated with loan accounts are diluted by higher balances than the ones associated with deposit accounts.

The negative marginal cost for loans obtained for the [300,500] class may result from the "low" input prices found. It is in this class that the major number of "troubled" nationalised banks is concentrated. These are old institutions, where depreciation averages are small due to low investments in more modern equipment and which, in most cases, do not include future pension obligations under labour costs. The latter, combined with a high ratio of unskilled/skilled labour is reflected in a low average salary for this class. These facts, combined, may imply a null "true" marginal cost for loans in this class. In this case, we would have a U-shaped marginal cost curve for loans with a minimum in that class.

Marginal costs for deposits are monotonically increasing at the plant level in A(2) but show a U-shaped behaviour for A(1). The explanation for this contradiction can only be found in the different approaches followed in the computation of the cost of capital. As a matter of fact, smaller institutions in most cases do not even own the facilities in which they operate, leading to a very low amount of accounting physical capital. Consequently, whenever all costs other than salaries are allocated to capital the resulting "cost of capital" measure becomes severely high (up to 333%) which inflates the computed marginal costs for model A(1) relative to A(2).

Firm-size measures of marginal costs for deposits are considerably higher than those for plant, reflecting a high estimated cost of expansion through branching. This effect, however, is decreasing on bank size, showing a significant advantage for large banks which results from the effect already discussed at the end of the previous sub-section.

As a last note, it is detected that computed marginal costs in model A(1) are more dispersed than A(2). This may constitute a good indication that the cost of capital measures for the first model may be very imprecise and introduce additional noise into the estimated results. This conclusion is reinforced by their high volatility (Table 1.2.) and the generally higher standard errors in estimates for A(1).

Table 1.9.
Input Price Sensitivity

Asset Size	Model A(1)		Model A(2)	
	dlnC/dlnWn	dlnC/dlnWk	dlnC/dlnWn	dlnC/dlnWk
< 20M	0.814	0.186	0.195	0.805
20M - 100M	0.859	0.141	0.534	0.466
100M - 300M	0.745	0.255	0.663	0.337
300M - 500M	0.736	0.264	0.660	0.340
> 500M	0.718	0.282	0.741	0.259

The impact on total costs of changes in the input prices may also be obtained from direct derivatives. The reader should recall that by Shepherd's lemma the derivatives above correspond to the factor shares. All such results are positive for all classes of size considered, although a few negative results for individual observations were found. The above estimates show the input price elasticities of total costs. Due to *a priori* imposition of theoretical restrictions on input price homogeneity, the sum of the computed results for each model is equal to one, which is in accord with the definition of factor shares. The results above show the importance of choosing appropriate measures of input prices since resulting estimates will be strongly dependent on the choice made.

For the classes considered, only the last one (corresponding to the largest banks) shows similar estimates for the two alternative cost of capital specifications. They show a higher sensitivity to salaries than to the price of capital, indicating that labour accounts for the highest share of total operating costs. To be more precise, they show that for every 1% of salary increase total, operating costs rise slightly more than 0.7%. For model A(2) the lower the bank's size the, less will be the impact of salary changes, which is in accord with a higher capital / labour ratio for the smaller banks, but is opposite to the results of model A(1).

The impact of new branches on total costs was also tested, and was found to be very dispersed at the individual observation level but much more regular when evaluated at mid-points of classes. Those costs are decreasing with asset size, ranging from 85 thousand contos (1986 prices) for the small banks and progressively declining to 40 thousand contos for the larger ones.

1.4.4. Economies of Scale and Scope

Results from the frontiers above are now used to check for the possible existence of economies of scale and scope. Deriving the cost frontier for each of the outputs, it is possible to obtain measures of marginal costs and ray economies of scale (expression 1.20). As may be seen in Tables 1.10. and 1.11. below, estimated values for both versions of model A are similar, showing that these measures are not too sensitive to the cost of capital measurement.

Both models predict economies of scale for the smaller banks in the sample. This, which results directly from declining marginal costs of deposits, is already an "almost" standard result in this literature (see Forestieri, 1993) and was also found in Portugal by Santos (1991). This conclusion is reinforced by the estimated values for expansion-path scale economies, which show economies of scale for banks which move from class 1 to class 2.

Table 1.10.

Estimated Measures of Ray Economies of Scale

		Ray Economies of Scale			
Class	Asset Size	A(1) plant	A(1) firm	A(2) plant	A(2) firm
1	< 20M	0.231	0.725	0.323	0.668
2	20M - 100M	0.270	1.091	0.377	1.005
3	100M - 300M	0.485	1.197	0.533	1.180
4	300M - 500M	0.429	0.927	0.515	0.954
5	> 500M	0.538	0.893	0.578	0.957

Since we found significant output mix differences along the "expansion path" (see Section 1.4.2., Figure 1.1.) estimates using formulation (1.22) would give a better approach to the effective gains from dimension change, and our attention shall concentrate on them. It is, however, convenient to note that the two approaches present compatible conclusions.

When expansion is made from class two to class three, dis-economies of scale are found at the firm level, which are associated with a peak of the marginal cost for loans. At this size, no significant advantages result from the branching network, and average labour costs are still high. This result seems to be associated with a change in the output mix trend. In Figure 1.1. we saw that the ratio L/D is decreasing in the bank's size, but for the classes 2 to 3 this trend appears to be temporarily positive but then starts to descend again. This fact is related to individual strategies of the banks which fall into classes 2 to 3 and should not be generalised as part of an expansion path which all growing banks must follow. Therefore, the above measure is probably exaggerated, and should be interpreted with extreme care.

Table 1.11.

Estimated Measures of Expansion Path Scale Economies

	Expansion Path Scale Economies			
Class	A(1) plant	A(1) firm	A(2) plant	A(2) firm
1 - 2	0.230	0.912	0.297	0.850
2 - 3	0.515	1.270	0.568	1.223
3 - 4	0.428	0.859	0.509	0.911
4 - 5	0.561	0.921	0.615	0.960

The biggest advantage is found for banks which move from classes 3 to 4, which may benefit from slight economies of scale in their expansion. Less obvious are those economies for banks moving to the largest size class. These results are associated with a declining plant marginal cost for deposits together with a favourable change in output mix in which the progressively less-costly product becomes the most important output.

This last result is surprising because it contradicts most empirical findings for other countries, as well as the ones obtained for Portugal by Santos (1991). An explanation for the apparent contradiction between estimated (by most authors) dis-economies of scale and many banks' desire to grow lies in the translog's tendency for U-shaped curves leading to the "need" to show increasing marginal costs for the largest institutions as a counterpart to the decreasing values found for the smaller ones.

In this chapter these "supereconomies" of scale are only found in model A. Ray type estimates for specification B show the typical U-shaped marginal cost curve with economies of scale for small banks and dis-economies for the large ones. On the other hand, expansion path subadditivity measures for that specification show constant returns to scale for all classes.

The contradiction between the two models is, therefore, associated with the interaction between the number of branches and the other variables. The estimated declining marginal cost of branches, together with estimates of (1.34) which show a significant advantage of larger branching networks on "producing" deposits (the most important output for larger banks), are combined in a measure which shows a firm-size overall cost expansion advantage. Thus, some kind of network economies seem to be responsible for this conclusion.

The contradiction between these findings and Santos' (1991) are most likely a result of the different input and output classification. In this study it is found that deposits are the output which consume the most in terms of real resources, and this one is handled as an input in Santos (1991). Moreover, we find that interaction between deposits and branching is responsible for some kind of cost advantage for the larger institutions, and this effect is, obviously, absent from that author's estimations[27].

As the present study is based on a real resources cost function, the conclusion above may be contested along the line of Humphrey's (1990, pg 40) arguments that "*if only operating costs are used in a statistical analysis of bank scale economies (...) greater scale economies (...) will typically be measured*". This author bases his conclusion on the finding that for US banks, the ratio of total operating costs (in which he ignores the opportunity cost of physical capital) to total assets is declining on the bank's size

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[27]Also, in Santos (1991) no firm size measures are computed for the specifications on which several earning asset measures interact with branches.

while the ratio of total costs to assets remains much more stable. There are two reasons for not accepting such arguments in the present context: First, for the reasons presented before, we believe that deposits should be handled as an output, and therefore, is their margin and not just their interest cost that is relevant for the bank's profits. Second, that declining relationship is not verified by Portuguese banks, the two ratios relationship with size being very similar .

In the section on output mix and branching we found that some (small) banks specialise in loans while others (large) show a very high deposit / loan ratio. This may constitute an indication that gains from specialisation exist and that Portuguese banks do not benefit from economies of scope. To check for this, measure (1.23) was computed for both models, using 1 as a proxy for zero output. The conclusion is that substantial economies of scope do exist for all classes.

Unfortunately, the above conclusion seems to result from the limitations of the translog cost functions for the measuring of these economies. For many observations, arithmetic errors occurred due to the very high values of the resulting estimates. Changing the proxy for zero to 1000 significantly modified the magnitude of the results but not the conclusions.

To check for jointness in the cost function, a test on the relevant parameters is performed. A cost function is said to show jointness in production of two outputs if increases in production in one of them reduces the marginal cost of the other. This is equivalent to testing the sign of the cross derivatives. Therefore, a sufficient condition for its existence is (see Clark, 1988):

$$\beta_L \times \beta_D + \delta_{LD} < 0 \qquad (1.36)$$

For model A(1) the left-hand side of (1.36) yields 0.956 and the associated t statistic is 0.325, which does not allow the rejection of the null hypothesis of non-jointness. For A(2) the test yields 5.211 and a t statistic of 1.904, which not only allows rejection of non-jointness but also shows some dis-economies of joint production.

The contradiction between the previous alternative tests may be solved by the use of expansion path subadditivity measures because they simultaneously incorporate the previously mentioned effects and combine them with the detected change in output mix.

Results for that measure may be found in Table 1.12., below. Both versions of model A show similar results. All banks, with the exception of the larger ones benefit from cost subadditivity. For the latter, dis-economies of scope around 4% of total costs were found. This seems to indicate a reason why larger banks are not making efforts to increase their loan / deposit ratio. On the other hand, the table below shows that smaller banks benefit from significant expansion path cost subadditivity which means that, when they expand their size and the deposit / loan ratio together, cost economies are generated, effects which must be added to the previously found expansion path scale economies.

Table 1.12.
Estimated Measures of Expansion Path Subadditivity

	Exp Path Subadditivity	
Class	A(1)	A(2)
1 - 2	0.268	0.079
2 - 3	0.238	0.230
3 - 4	0.100	0.083
4 - 5	-0.046	-0.035

Results for classes 2 to 3 have to be interpreted with care, due to the reasons already presented in the discussion of expansion path scale economies.

The conclusions above are, in fact, consistent with some anecdotal evidence, since most tasks are shared in small banks while the larger ones separate most activities and may create a bureaucratic environment that generates costs disadvantages.

1.4.5. Input Substitution

The matter of input substitutability has been ignored in most of the empirical literature on banking costs, but the importance of this issue was restated by Noulas, Ray and Miller (1990). These authors used the classical intermediation approach and found that capital and labour were closer substitutes than financial liabilities and real resources inputs. In this essay only the first two are handled as inputs, for the reasons previously raised. Moreover, unlike those authors, we have some doubts on the way in which a bank may keep its earning assets constant while dropping all financial liabilities and increasing capital and labour to replace them. In other words, it does not seem reasonable to model banking technology in a way that money and real resources are substitutes in the production of monetary values of earning assets.

To check on input substitutability the Allen-Uzawa partial elasticity of substitution is computed. This is defined as:

$$\Gamma_{NK} = 1 + \frac{\delta_{NK}}{S_N S_K} \tag{1.37}$$

where S stands for input cost share.

Results for both versions of model A show similar conclusions. For A(1) the above elasticity yields 1.025 ($t = 63.3$) and for A(2) yields 1.097 ($t = 8.3$). Therefore, both elasticities are statistically significant and slightly above unity, showing that capital and labour are close substitutes in the production of banking products. In neither case may the hypothesis of unit elasticity of substitution be rejected.

1.4.6. Productive Efficiency

One of the most surprising findings in this study is the relative sensitivity of individual inefficiency scores to the model specification. As a matter of fact, the average value for u always decreased whenever new variables were added to the regression, and therefore the average asymmetric residual worked more as a goodness of fit measure rather than as an indication of an average of technical inefficiency. Nevertheless, this average is quite similar for both model A alternatives, being just slightly higher for model B. And it was especially in the latter that significant sensitivity to specification was found.

Appendix A.1. shows the decomposition of costs for model A(2). The columns show the observed costs, followed by costs at the efficient frontier, costs resulting from inefficiency, costs due to random effects and the productive efficiency indicator defined in (1.27). We find an average productive efficiency value of 0.826 ranging from 0.471 to 0.963. The interpretation for this is that, on average, Portuguese banks use 17% more real resources than actually needed for the production of their output bundles. As a matter of comparison, Cebenoyan *et al* (1993) found 15% waste for US savings and loans associations. Evanoff and Israilevich (1991, pg 25) survey this type of measurement for the US, and for 11 studies they mention only two showing average inefficiency levels above the one estimated here for Portuguese banks.

To explain inefficiency determinants, some authors regress productive efficiency estimates on several independent variables. Lovell (1993, pg 53) recommends that "*Variables under the control of the decision maker during the time period under consideration belong in the first stage* [frontier estimation]. *Variables over which the decision maker has no control during the time period under consideration belong in the second stage* [efficiency determinants estimates] ". Nevertheless, some authors have been less cautious with this, namely Cebenoyan *et al* (1993) and Mester (1993).

In this essay several variables were tested as efficiency determinants. Market share on deposits (MSD) was considered as a proxy for size and both MSD and its squared value were included to allow for non-linearity. Also included was a dummy variable called PUB (=1 for nationalised) to check for efficiency differences between nationalised and private banks. To account for possible cost advantages for the older banks, a variable called AGE (=1 for bank created before 1974) was also considered. A dummy variable designated by GROS (=1 for wholesale) was also included to check for differences between retail and wholesale banks. Since non-price competitive expenditures may be handled by the model as "inefficiency" in some cases, the ratio of advertising to deposits (ADV) was also included.

Another variable which might affect estimated efficiency is branching expansion, since new branches take a certain time to attain their associated "desired" level of outputs. To account for this, the branch growth rate (BRX) was added to the regression. The same was done for the loan to deposit ratio (LD) and branch to deposits ratio (BRD) to check for the possible correlation between efficiency and the output mix -

branching relationship. The last variable included was time (T) in order to detect for possible changes in efficiency over time.

The dependent variable is the productive efficiency indicator, as defined by expression (27). Estimates based on OLS showed significant heteroscedaticity and once again Aitken's GLS estimators were used, it being assumed that residuals variance is inversely related to total assets. After dropping variables with statistically non significant parameters, we obtained the estimated regression, the results of which follow in Table 1.13.

Table 1.13.
Efficiency Determinants Estimate

Variable	Coefficient	Std Error	t-statistic	Signiff
MSD	-2.53218	0.96240	-2.63111	***
MSD2	18.14660	6.99344	2.59481	**
AGE	0.12810	0.03281	3.90419	***
PUB	-0.07972	0.02384	-3.34413	***
GROS	-0.06724	0.04436	-1.51555	
ADV	-32.69920	10.66030	-3.06738	***
T	0.00912	0.00043	21.29960	***

This regression has an r-squared of .284 and an F statistic of 8.708. The small value for the r-squared may be an indication that observation-specific factors are more important than the considered variables. Nevertheless, this approach enables the identification of some general efficiency determinants, which in some cases does not occur when both time and firm-specific dummies are included.

The effect of market share on efficiency is convex, declining from zero to a minimum of 7% and then grows back to zero close to the 14% level and is positive from there on. Its impact, nevertheless, is very small, reaching a value close to -0.7% at the minimum.

Another interesting finding is that older banks show, on average, higher efficiency scores, which may be associated with the fact that most their assets are already fully depreciated and they may also benefit from cheaper rents on their premises.

More interesting is the finding that nationalised banks are less efficient than the private ones, which may reflect overstaff and excessive investment in large bank headquarters and mislocated branches, or may simply reflect an agency problem associated with the separation between ownership and management, or both.

Wholesale banks seem to be less efficient than retailers, although the corresponding coefficient is clearly on the frontier of rejection of the null hypothesis. This could reflect the non-existence of a common technology for the two types of banks, but estimates based on the retailers′ subsample indicated problems with the statistical significance of the parameters.

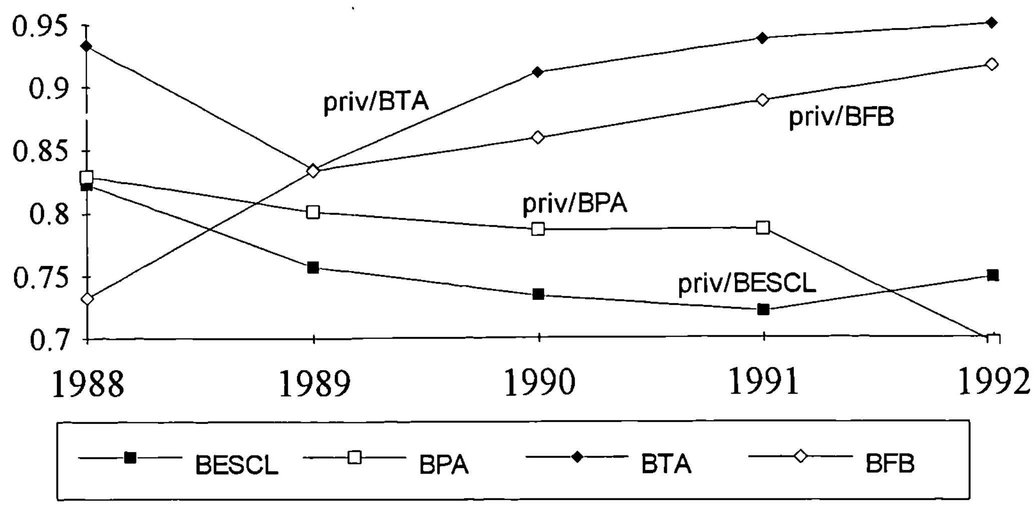
Clearly significant is the parameter associated with the advertising / deposits ratio, which constitutes an indication that this type of model often confuses servicing costs and non-price competition related costs. Therefore, some more research on the determinants of non-price competition in banking and the separation between these costs and the others directly associated with the generation of basic bank services needs to be performed in order to correctly understand the meaning of computed marginal costs and efficiency indexes.

Another important conclusion is that across sample average efficiency grew about one percent per year, which seems to indicate that the current restructuring process that the sector is experiencing has a positive impact on efficiency. This is corroborated by the fact that all privatised banks except one experienced an increase in efficiency in the year following privatisation.

Figure 1.3. shows the evolution for some recently privatised banks. From here it may be concluded that only BPA did not show an efficiency increase after privatisation, while BFB simply continued a trend started before it, which reflects the success of the turnaround process started in 1989. Curiously, BPA is, in fact, the only case on which privatisation did not imply significant changes on the management team. On the other hand, for both BTA and BESCL, privatisation was associated with a change in a declining efficiency trend.

Figure 1.3.

Productive Efficiency: Privatised Banks

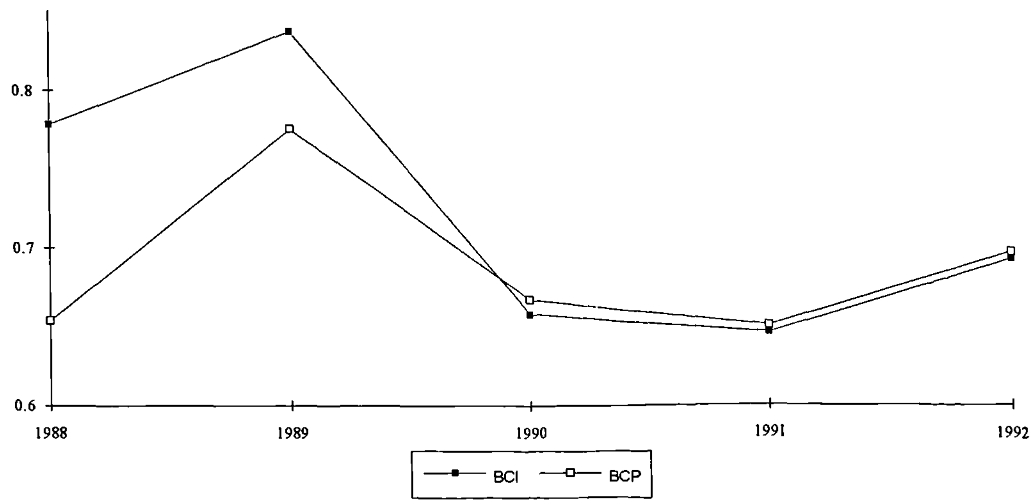


The effect of branching expansion strategies on banking efficiency was also checked. Figure 1.4. shows the evolution of efficiency indexes for the two most aggressive new private retail banks.

Both BCP and BCI show lower efficiency ratios than the older banks depicted in Figure 1.3. For BCP, 1989 represents the end of its first phase, i.e., the consolidation of what is generally designated as its "traditional network", and in that year the bank had its highest efficiency ranking. Starting in that year, this bank started a major expansion through a new branching network (*Novarede*), which had negative repercussions on efficiency. Nevertheless, as in 1989, as soon as the new branches become more productive, i.e., originate more deposits and loans, the efficiency indicator starts to grow again. Although more efficient than BCP until 1989, BCI's expansion (after a successful takeover by *Banco de Santander*) led to similar efficiency evolution, but ended with lower values for that indicator than BCP's. The lesson seems to be that expansion leads to a temporary decrease in efficiency which may be overcome if, and only if, that policy results in a sufficiently high number of new customers (and balances) that compensates the increase in real resources. Otherwise, expansion will merely imply a decrease in productivity and increased average costs not explained by technology but, rather, by pure waste.

Figure 1.4.

Productive Efficiency: New Private Banks



As explained before, the stochastic frontier does not allow for a direct separation between allocative and technical efficiency. Nevertheless, using factor demand functions, one may try to determine which resources are responsible (being excessively used), as proposed by Kopp and Diewert (1982) as a first step to separating inefficiency between technical and allocative components. Unfortunately, since we may not know the exact amount of capital used by the banks (due to the different accounting methods for leased and owned facilities) we are able to attempt such computation only for labour.

The procedure is the following: First, using individual bank´s data, demand for labour is computed for each bank. Then, demands for individual banks are added and compared with the actual number of bank´s employees. This procedure was employed for the whole sample and for each year separately.

The first important conclusion is that versions A(1) and A(2) yield entirely different results. Cost of capital definition 1 leads to very high values for this variable, which results in the conclusion that banks operate with 20% fewer workers than they "should". This is contrary to all evidence and any observer will immediately conclude that this result is absurd. On the other hand, version A(2) shows a situation on which most Portuguese banks suffer from excessive staff. Nevertheless, the actual values for excessive staff were dependent on the value of the money market interest rate used. To be more concrete, if the average value for 1992 is used, than we find about 500 surplus employees in the sector, but if, alternatively, we use end of year figures, then surplus staff grows to 1500 (sample total staff: 50,553).

This contradiction is related entirely to the alternative definitions for the cost of capital in banking, and have the merit of showing the inadequacy of measure 1, still very popular in the banking costs literature. It also shows that the decomposition of inefficiency into technical and allocative components is crucially dependent upon input price measurement and that conclusions obtained may be severely biased if an inappropriate measure is used. Therefore, probably more important than the discussion about how much inefficiency results from the misapplication of resources, is the discussion on the appropriate measurement of the cost of capital for the banking industry, a field in which more fundamental research has still to be performed.

Regardless of the described measuring problem, cost of capital sensitivity of measures based in model A(2) are entirely in accord with the computed elasticity of substitution. Consequently, we shall conclude that, since both factors are close substitutes, during high interest rate periods, labour intensive strategies should be adopted. This is due to the opportunity costs of financing physical capital which, myopically, are often ignored by bank managers, since those economic costs are not accounted for in the bank´s income statement. On the other hand, as should be expected, low interest rate periods should be associated with more capital intensive strategies.

As a final conclusion, the use of input demand functions in this context, as proposed by Kopp and Diewert (1982), should be undertaken with extreme caution. The high sensitivity of figures and conclusions to input price measurement does not allow us to gain much applicable information from them.

1.5. Conclusions

In this chapter, two versions of a translog cost frontier are estimated in order to study the existence of economies of scale and economies of scope between deposits and loans. A second objective consisted in the checking of possible regular patterns of banking inefficiency.

From a theoretical stand-point it is argued that banking production occurs in two phases. In the first one, banks use capital and labour to originate deposits, which is described by a transformation function. The second one is the fund matching of assets and liabilities, which is described by the balance-sheet equation. By using this framework we obtained profit functions in which deposits have a positive user price, and therefore, unlike the classification used in most literature, they must be classified as an output. Therefore, the empirical approach followed employs a "real resources" cost concept rather than a "total" costs concept.

Results are based on the estimation of parametric cost frontiers. In relation to the cost function formulation, it appears that consideration of the number of branches as a variable that interacts with deposits and loans shows a better adherence than the alternative, where this variable was excluded. Such estimation resulted in small marginal costs for loans at both plant and firm levels and marginal costs for deposits which are increasing at the plant level and decreasing at the firm level.

Also tested were two cost allocation alternatives, resulting in two different measures for the cost of capital. It was found that measures of economies of scale and scope are quite insensitive to this measuring problem while strong dependence on this variable definition was detected in the measurement of input price sensitivity and, most importantly, in the decomposition of X-inefficiency between technical and allocative components.

All computed measures of economies of scale seem to exclude the existence of dis-economies of scale, with the exception of mid-sized banks, and found economies of scale for the smaller banks. Possible small economies of scale for the larger institutions associated with an apparent high productivity of large branch networks may not be discarded. Therefore, we do not find evidence in favour of cost-reduction mergers.

In relation to economies of joint production of deposits and loans, they were found, in an expansion path context, for all banks except the largest ones, which may constitute an indication that in the latter, separation of borrowing and lending activities achieved such a high level that there are no longer any resources shared by them. Thus, the specialised lending banks may, in fact, be losing potential cost economies associated with the joint production of deposits and loans. On the other hand, large commercial banks, in which deposits, in some cases, double total loans may also be discarding a potential cost-saving strategy.

Contradiction with the findings of previous researchers - e.g. Santos (1991) - may be attributed to a different output bundle choice, to a different econometric approach and to the fact that this study uses more recent data. In particular, the treatment of deposits as an output may be responsible for these contradictory results.

In relation to efficiency, it was found that Portuguese banks are wasting a significant amount of resources (about 17%). Among the factors that were found to influence negative efficiency are the public (Government) ownership of the bank, market share on deposits of around 5%-9%, and the wholesale nature of the bank. The combination of the first of those factors describes the majority of nationalised banks, and it is concluded that privatisation is an important policy for the reduction of inefficiency in the sector.

As a first step to determine how much inefficiency is associated with technical and allocative components, input demand functions were used to check for possible excessive use of factors. The conclusion is that results were severely dependent upon the measure of cost of capital employed, a field in which some additional fundamental research seems to be necessary.

In relation to the search for a bank's optimal dimension, two important aspects must be considered. First, although we did not find sufficient evidence to support a "natural monopoly" conclusion for Portuguese banks, it is found that larger banks benefit from some small cost advantage which is related to a high productivity of large branching networks. Second, a full response to this question also implies the analysis of the revenue side of profits which in turn demands a study on how market power is related to the bank's dimension, an issue which will be addressed in a separate chapter.

Appendix to Chapter One

Decomposition of Observed Costs (model A2)

OBSERV.	Observed Costs	Efficient Costs	Costs due to Ineffic	Random Component	Productive Efficiency
ABN 91	334,573	362,529	29,186	-57,142	0.925
ABN 92	348,343	528,520	20,274	-200,451	0.963
BANIF 90	2,750,591	2,013,618	563,004	173,968	0.781
BANIF 91	3,692,451	3,177,639	523,115	-8,303	0.859
BANIF 92	4,552,686	4,260,322	532,332	-239,968	0.889
BARCL 88	543,435	402,658	108,426	32,351	0.788
BARCL 89	702,514	461,156	176,870	64,488	0.723
BARCL 90	2,024,572	1,064,850	679,320	280,401	0.611
BARCL 91	3,505,748	2,422,824	805,057	277,867	0.751
BARCL 92	4,082,009	3,932,327	448,069	-298,387	0.898
BBI 87	10,459,313	8,295,991	1,792,980	370,342	0.822
BBI 88	10,365,702	8,386,781	1,697,000	281,922	0.832
BBI 89	10,145,621	8,665,872	1,462,834	16,916	0.856
BBI 90	9,989,500	8,766,467	1,352,050	-129,017	0.866
BBI 91	9,965,548	9,349,012	1,158,794	-542,259	0.890
BBI 92	12,497,515	12,568,527	1,254,603	-1,325,615	0.909
BBV 88	2,060,482	1,296,204	555,375	208,903	0.700
BBV 89	2,055,581	1,539,390	400,825	115,367	0.793
BBV 90	2,694,774	1,581,587	800,141	313,046	0.664
BBV 91	2,455,325	1,690,254	568,002	197,069	0.748
BBV 92	4,154,873	4,098,116	433,957	-377,200	0.904
BCA 87	1,150,027	1,243,012	100,763	-193,748	0.925
BCA 88	1,217,774	1,216,269	123,967	-122,461	0.908
BCA 89	1,439,218	1,374,037	161,064	-95,882	0.895
BCA 90	1,550,845	1,141,826	313,634	95,385	0.785
BCA 91	1,979,740	1,274,980	514,374	190,385	0.713
BCA 92	2,255,715	1,775,213	393,692	86,810	0.818
BCI 88	1,334,983	1,091,567	213,244	30,172	0.837
BCI 89	2,161,925	1,908,984	288,444	-35,504	0.869
BCI 90	4,148,118	2,781,962	1,006,389	359,767	0.734
BCI 91	7,785,995	5,152,498	1,933,479	700,018	0.727
BCI 92	10,455,065	7,454,187	2,259,404	741,473	0.767
BCP 87	3,227,309	1,865,472	976,721	385,115	0.656
BCP 88	5,326,927	3,584,408	1,284,789	457,731	0.736
BCP 89	9,154,384	7,229,574	1,584,981	339,829	0.820
BCP 90	17,377,141	12,024,558	3,980,917	1,371,666	0.751
BCP 91	27,028,431	19,013,253	5,998,791	2,016,387	0.760
BCP 92	39,032,448	29,790,827	7,300,254	1,941,367	0.803

OBSERV.	Observed Costs	Efficient Costs	Costs due to Ineffic	Random Component	Productive Efficiency
BESCL 87	16,122,212	13,316,245	2,515,162	290,806	0.841
BESCL 88	18,032,326	15,104,457	2,721,965	205,904	0.847
BESCL 89	18,108,047	13,270,453	3,698,144	1,139,450	0.782
BESCL 90	21,226,330	15,149,669	4,577,499	1,499,163	0.768
BESCL 91	26,498,072	19,660,174	5,271,696	1,566,202	0.789
BESCL 92	31,966,328	25,205,577	5,554,504	1,206,247	0.819
BEX 91	685,972	622,729	85,872	-22,629	0.879
BEX 92	981,123	966,003	102,851	-87,731	0.904
BFB 87	9,917,837	6,861,836	2,272,748	783,253	0.751
BFB 88	9,712,849	7,358,847	1,846,401	507,602	0.799
BFB 89	9,587,393	8,487,559	1,271,524	-171,691	0.870
BFB 90	10,508,015	9,753,063	1,251,239	-496,287	0.886
BFB 91	12,515,742	12,164,768	1,348,003	-997,030	0.900
BFB 92	14,725,740	15,428,151	1,365,390	-2,067,801	0.919
BFE 87	3,492,444	3,872,861	292,828	-673,246	0.930
BFE 88	3,290,108	3,553,415	288,662	-551,970	0.925
BFE 89	3,683,566	3,808,225	350,268	-474,927	0.916
BFE 90	4,596,824	4,062,062	612,238	-77,476	0.869
BFE 91	5,019,511	4,548,933	630,817	-160,239	0.878
BFE 92	7,756,780	7,498,521	845,104	-586,846	0.899
BNP 88	327,534	361,032	27,742	-61,240	0.929
BNP 89	410,890	409,070	42,101	-40,281	0.907
BNP 90	514,942	429,214	78,634	7,094	0.845
BNP 91	632,805	610,319	69,286	-46,800	0.898
BNP 92	748,936	602,315	124,340	22,280	0.829
BNU 87	14,804,993	10,675,074	3,127,240	1,002,678	0.773
BNU 88	13,967,280	10,609,146	2,640,291	717,843	0.801
BNU 89	14,757,928	11,245,766	2,769,983	742,179	0.802
BNU 90	16,252,343	11,478,795	3,578,740	1,194,809	0.762
BNU 91	16,612,858	12,549,005	3,178,897	884,957	0.798
BNU 92	18,875,144	15,609,597	2,935,998	329,549	0.842
BPA 87	18,002,499	15,631,406	2,497,732	-126,639	0.862
BPA 88	19,175,599	16,634,880	2,666,158	-125,440	0.862
BPA 89	19,423,698	16,152,135	2,982,457	289,106	0.844
BPA 90	20,605,670	16,414,163	3,497,458	694,049	0.824
BPA 91	26,363,217	20,885,359	4,531,792	946,066	0.822
BPA 92	33,076,996	24,825,074	6,419,197	1,832,726	0.795

OBSERV.	Observed Costs	Efficient Costs	Costs due to Ineffic	Random Component	Productive Efficiency
BPI 88	833,178	433,385	282,551	117,242	0.605
BPI 89	1,129,101	654,488	340,533	134,080	0.658
BPI 90	1,798,681	861,760	654,600	282,322	0.568
BPI 91	2,655,707	1,036,792	1,098,192	520,723	0.486
BPI 92	16,302,813	13,491,779	2,531,689	279,346	0.842
BPSM 87	18,450,456	11,116,763	5,291,916	2,041,777	0.677
BPSM 88	18,716,710	11,550,568	5,190,520	1,975,623	0.690
BPSM 89	19,077,433	12,694,555	4,692,543	1,690,335	0.730
BPSM 90	19,505,730	13,845,515	4,252,862	1,407,353	0.765
BPSM 91	19,815,740	15,558,085	3,477,077	780,578	0.817
BPSM 92	22,533,752	18,598,335	3,521,411	414,006	0.841
BRASIL 88	246,411	184,386	48,132	13,893	0.793
BRASIL 89	269,023	204,350	50,850	13,823	0.801
BRASIL 90	281,546	236,820	42,084	2,642	0.849
BRASIL 91	341,692	297,025	47,282	-2,615	0.863
BRASIL 92	317,836	261,816	49,896	6,123	0.840
BTA 87	12,656,853	10,570,224	1,923,986	162,643	0.846
BTA 88	13,137,122	13,375,708	1,286,855	-1,525,441	0.912
BTA 89	13,431,838	12,052,479	1,726,797	-347,439	0.875
BTA 90	15,234,316	15,918,015	1,419,705	-2,103,404	0.918
BTA 91	18,490,716	21,191,042	1,470,221	-4,170,548	0.935
BTA 92	25,343,113	31,325,440	1,809,326	-7,791,653	0.945
CHASE 88	253,638	208,822	39,868	4,948	0.840
CHASE 89	229,422	222,800	24,754	-18,132	0.900
CHASE 90	298,059	215,091	62,853	20,116	0.774
CHASE 91	268,292	201,786	51,827	14,678	0.796
CHASE 92	252,977	218,787	35,426	-1,236	0.861
CITI 88	521,710	519,371	53,462	-51,123	0.907
CITI 89	680,179	560,506	106,686	12,987	0.840
CITI 90	847,199	707,531	128,782	10,886	0.846
CITI 91	774,503	661,800	111,568	1,135	0.856
CITI 92	766,204	640,105	116,378	9,721	0.846
CLP 88	2,155,587	1,754,439	348,051	53,097	0.834
CLP 89	2,425,996	1,925,482	415,247	85,267	0.823
CLP 90	3,532,936	2,364,118	860,515	308,303	0.733
CLP 91	2,999,113	2,567,044	430,311	1,759	0.856
CLP 92	3,116,084	2,624,531	464,332	27,221	0.850
CPP 87	7,178,268	5,150,656	1,531,421	496,191	0.771
CPP 88	7,431,548	5,294,755	1,608,280	528,512	0.767
CPP 89	8,754,646	6,258,215	1,881,980	614,452	0.769
CPP 90	9,128,396	7,346,351	1,513,113	268,932	0.829
CPP 91	10,287,054	8,639,549	1,543,225	104,280	0.848
CPP 92	11,565,653	10,240,265	1,533,404	-208,017	0.870

OBSERV.	Observed Costs	Efficient Costs	Costs due to Ineffic	Random Component	Productive Efficiency
DBI 91	691,519	602,118	95,321	-5,920	0.863
DBI 92	1,572,397	1,539,130	166,858	-133,592	0.902
GENERALE 91	264,747	249,032	30,604	-14,889	0.891
GENERALE 92	285,726	370,027	19,268	-103,569	0.951
MANUF 88	426,968	441,788	40,535	-55,355	0.916
MANUF 89	683,493	589,025	96,513	-2,045	0.859
MANUF 90	844,016	845,839	85,330	-87,154	0.908
MANUF 91	775,709	764,230	81,213	-69,734	0.904
MANUF 92	824,926	683,939	127,555	13,432	0.843
MELLO 91	934,983	350,735	393,990	190,258	0.471
MELLO 92	1,226,073	582,221	449,278	194,575	0.564
MG 88	3,620,522	3,410,586	417,181	-207,245	0.891
MG 89	4,348,920	3,809,925	590,973	-51,978	0.866
MG 90	4,838,713	4,575,801	552,840	-289,928	0.892
MG 91	4,882,574	4,800,211	513,421	-431,059	0.903
MG 92	5,761,609	5,669,208	604,791	-512,390	0.904
UBP 87	10,410,460	9,210,005	1,382,833	-182,378	0.869
UBP 88	9,872,183	9,284,134	1,141,752	-553,704	0.890
UBP 89	9,725,117	10,083,274	919,674	-1,277,832	0.916
UBP 90	10,149,246	10,472,514	968,663	-1,291,932	0.915
UBP 91	10,572,616	11,358,097	936,411	-1,721,892	0.924
UBP 92	14,738,642	12,319,554	2,235,847	183,241	0.846

all data in thousands of escudos, deflated for 1986 prices

Chapter Two

The Impact of Deregulation on Price and Non-Price Competition in the Portuguese Deposits Market

2.1. Introduction

Portugal has a long tradition of administrative restrictions on banking activity. Until 1986 all deposit and lending interest rates were set by authorities, entry in the market was simply banned, opening of new branches depended on the central bank's authorisation and all but three small institutions were owned by the Government. This institutional framework led to a situation of virtually no competition in the market.

In the early 80s, some banks decided to make a more affirmative use of non-price instruments in order to gain (or avoid losing) market share. Branch expansion was the main competitive instrument during that period, but unfortunately, opening of new branches depended upon permission by the central bank, and was often denied to the most solvent institutions as a way of "helping" the other ones. This contributed to the consolidation of this virtual cartel. Advertising expenditures, at that time, were very small.

After 1985, when a Constitutional amendment was passed, the regulatory framework was significantly changed. Banking was opened up to the private sector and new institutions initiated activities in the market. Although permission for new banks was subject to a rationing process, more than ten new foreign banks established themselves in Portugal from 1985 to 1990 and four new Portuguese private banks were chartered in the same period. This may be compared to a total of 16 banks in existence in 1982. Interest rate deregulation was progressively introduced, but the process only became completed in the early 90s. On the other hand, branching deregulation was much slower and some restrictions persisted until 1992, i.e. one year before this market's integration into the single European market for financial services.

In 1989 the first privatisation of a nationalised bank took place. The Government-held institutions' market share dropped from above 80% in 1989 to about 45% in 1993, as a result of privatisation of five such institutions and aggressive actions on the part of a few of the new private banks. This change in ownership structure is expected to have a significant impact on competition, since private sector banks are generally assumed to be much more aggressive than their public competitors.

This deregulation process had an important impact on market concentration. As a matter of fact, some new institutions rapidly achieved market shares above 4% at the expense of the old institutions, which in some cases experienced negative real growth rates. This concentration reduction is likely to have had an impact on the prices of banks products. Our aim is to evaluate the extent to which this deregulation process changed the pricing and non-price behaviour of Portuguese banking institutions. Thus, unlike most price concentration studies in banking, our purpose is not to make a comparison between banks operating in different local markets (with different concentrations), but rather to evaluate the competitive impact of concentration changes in one specific market.

A secondary purpose is to evaluate how banks' market power is related to dimension, which is particularly important for merger policy. In the previous chapter, our study on banking costs found no significant evidence for the existence of economies of scale, although a higher productivity for large bank networks was detected. However, if higher market power is detected for the larger institutions, they will possess a significant competitive advantage which is not detected when the analysis is conducted for costs alone. In that case, mergers will increase bank's profits via the margin generated by deposits and / or loans.

In countries where market power is related to size, bank mergers have to be evaluated with extreme care. In that context, whenever two large banks become one single unit, market concentration will increase and the new institution will achieve a significant advantage over its competitors. If a price-concentration relationship do also exist, such mergers will benefit the profitability of the whole industry via the concentration effect. These gains for the banking sector result from lower depositor's surplus and generate a net "deadweight loss". Thus, if these relationships are found, authorities should evaluate the potential welfare effects of a bank merger before authorising it.

Given the interest rate regulatory regime, it is advisable to include non-price competitive instruments in the analysis. Advertising and branching were the selected variables, because of their importance and because of data availability. The inspiration for this empirical test is the oligopolistic framework developed by Hannan (1991), augmented to include non-price instruments.

This chapter concentrates on the market for deposits for several reasons. First, loan market deregulation was much slower, where both price (interest rate) and quantity (credit ceiling) were exogenously imposed by the authorities for the major part of the sample period. Second, competition for loans occurred only for corporate customers, since consumer credit was virtually non-existent and mortgage lending was restricted to three banks until the late 80s, thus rendering the use of non-price competitive instruments relevant only for deposits. Third, the empirical approach will be based on the margins charged by the bank, which in the case of loans includes a risk premium that must not be taken as part of a price-cost margin associated with market power and the value of which is virtually impossible to estimate.

The chapter is organised as follows. Section 2 presents the theoretical background for the study. In section 3 the econometric procedures and data employed are presented. Section 4 presents and discusses the empirical methodology and results. In section 5 we present the main conclusions of this study.

2.2. Theoretical Framework

2.2.1. Previous Research

Several authors have tried to measure the impact of market structure on banking profits. The most popular approach is to regress a profitability index for banks or their interest rates on several market structure and other control variables. Generally, this approach has been employed in the US, where the main findings have been that highly concentrated local markets are more profitable for financial institutions than the more competitive ones. The most important references on this "*reduced form*" literature are Berger and Hannan (1979), Evanoff and Fortier (1988), Heggestad (1979), Heggestad and Mingo (1976) and Rhoades (1977, 1982). The early literature is analysed and surveyed in Gilbert (1984) and a more detailed survey is conducted in Weiss (1989). This approach is criticised by Clark (1986) who argues that this "single equation" approach may fail to capture the different variables which are affected by concentration, and proposes a multi-equation modelling strategy as a better alternative.

More recently, many authors have preferred to abandon this *reduced form* approach in favour of structural models firmly based on the recent theory of industrial organisation (IO). Although this is a general trend in the IO literature, special attention has been devoted to the specificities of the banking industry. Generally, these articles depart from a homogeneous product oligopoly model in which some assumptions are made in order to allow the estimation of some conduct parameters and/or their relationship with market structure. Examples of this approach are Berg and Kim (1993, 1994), Nathan and Neave (1989), Spiller and Favaro (1984) and Shaffer (1989, 1993). More recently, the differentiated product hypothesis was introduced in this literature, along the lines of Hannan (1991), and examples of this approach are provided by Hannan and Liang (1993) and Heffernan (1993). Barros and Leite (1994) conducted an empirical study compatible with both approaches.

For Portugal, the price-concentration relationship is very difficult to test, since the local market concept is somewhat difficult to apply in such a small country. Nevertheless, in a recent work by Barros and Leite (1994), a variable based on the concentration of branches by borough (*concelho*) was constructed in order to test the effect of individual "local market" position over the bank's margins (computed at national level). These authors worked with both sides of the balance sheet (deposits and loans) using data for 15 banks in the 1991/92 period. They concluded that the market for deposits is much more competitive than that for loans, but since risk was adjusted through the use of reported provision allowances, conclusions for this second market have to be handled with a certain amount of caution. Nevertheless, their main conclusions seem robust, and their paper's principal contribution is that spatial competition, i.e., branch location and local market concentration, are important elements in the explanation of individual bank's market power.

In this study both price and non-price competitive variables are included. Heggestad and Mingo (1976) is the classical reference on this approach, although many differences exist between the two studies. As a matter of fact, while we use advertising and branches as non-price instruments in the context of a bank's optimising model, Heggestad and Mingo (1976) use reduced form equations in which interest rate and a few "service" variables (office hours, and several dummies related to specific products) are used as dependent variables.

Generally, American literature on bank's optimising behaviour under deposit interest rate ceilings assumes monopoly behaviour by which the bank sets some kind of "implicit interest" rate consisting of goods or services provided to depositors in some percentage of their deposit balance. Main references in this literature are Merris (1985), Mitchell (1979), Spellman (1977), Startz (1983) and Whitesell (1992). A new approach, developed by Heffernan (1992), uses individual product data to estimate an "interest equivalence" to some non-price features of banking products. A problem with some implicit interest literature is whether both types of interest are complementary or substitute. For Whitesell (1992), interest rate deregulation has a reduction impact over non-price instruments, but both types of interest will persist (complementary) after it. On the other hand, for Startz (1983) such deregulation will imply the complete elimination of "implicit" payments (substitutes). Evidence for the UK from Heffernan (1992) seems to support the first view.

So far, there are few studies on the advertising behaviour of commercial banks. Even for other industries, empirical studies on advertising practices are scarce, which seems to result from the duopoly characteristic of most available structural theoretical models. Roberts and Samuelson (1988) made an important contribution to this literature and used a dynamic conjectural variation model to test for advertising competition in the US tobacco industry. Their model separates advertising effects over the total market size and individual player's market shares, making it very robust from a theoretical point of view but, on the other hand, very difficult to handle econometrically. Gasmi, Laffont and Vuong (1992) used a more standard duopoly framework and estimated individual first order conditions together with demand functions, making specific use of separately estimated cost function marginal costs, for the *Pepsi - Coca Cola* duopoly. In order to easily identify several behavioural situations, they had to assume linear demand functions and developed a model suitable only for duopoly markets.

The factor of determinants in branching location has received much greater attention from researchers than the overall use of branches as a competitive instrument. Examples of the first approach are Avery (1991) and Evanoff (1988) and for the second are Barros (1994) and Cabral and Majure (1993). Barros (1994) used a spatial competition model to discuss the use of branching as a competitive instrument in the context of local markets while Cabral and Majure (1993) tested where branching should be seen as a strategic complement or substitute, concluding in favour of the first. Both studies indicate that branching determinants in urban and rural areas are different.

2.2.2. The Model

In this chapter the differentiated product approach is followed. Basically, Hannan's (1991) approach is extended for the use of a vector of non-price instruments and attention is focused on the market for deposits. Thus, unlike the "implicit interest theory" developed in Mitchell (1979), Merris (1985) and Startz (1983), non-price competition is introduced via explicit instruments, rather than by computation of the subsidy implicit in the (low) charges on banking services. Our approach is, therefore, more compatible with the pioneering work of Heggestad and Mingo (1976).

An important hypothesis to be made concerning the non-price instrument is that it affects mainly deposits. This is not very unrealistic when we consider the sample period that will be used for empirical work, since during most of that time bank's total credit was subject to a binding ceiling and therefore banks' non-price effort was directed toward attracting new depositors.

The model's other assumptions are:

i) The bank holds four kinds of assets: Cash reserves (R) which are a fraction ρ of total deposits, Government Securities and Money Market investments (S), Loans (L) and Physical Capital (K); S may be negative, meaning funding from money market sources;

ii) The bank is funded with both Deposits (D) and Equity Capital (E);

iii) Banks face a continuously twice differentiable demand function for deposits $D_i(\mathbf{r}_D, r_S, \mathbf{V})$ where $\mathbf{r}_D$ is the vector of the interest rates paid on deposits by all banks in the market, r_S is the interest rate on Government securities and $\mathbf{V}$ is the non-price instrument vector, $\partial D_i/\partial r_{Di} > 0$, $\partial D_i/\partial r_{Dj} \leq 0$, $\partial D/\partial r_S \leq 0$, $\partial D_i/\partial V_i > 0$ and $\partial D_i/\partial V_j \leq 0$;

iv) Banks face a continuously twice differentiable demand function for loans $L_i(\mathbf{r}_L, r_S)$, where $\mathbf{r}_L$ is the vector of interest rates charged on loans and $\partial L_i/\partial r_{Li} > 0$ and $\partial L_i/\partial r_{Lj} \geq 0$;

v) Banks are price-takers in a perfectly competitive money market / market for Government securities;

vi) Bank equity capital is exogenous and constant;

vii) Real resources costs are given by a differentiable function C(D,L,V), with $\partial C_i/\partial D_i>0$, $\partial C_i/\partial L_i>0$, $\partial C_i/\partial V_i>0$;

Given the above and assuming the bank to be a profit maximising unit, each bank's problem is (ignoring the i subscript) characterised by:

$$\underset{\{r_L,\ r_D,\ V\}}{\text{Max}}\ \Pi = r_L L + r_S S - r_D D - C(D,L,V) \tag{2.1}$$

$$\text{st:} \quad \rho D + S + L + K = D + E \tag{2.2}$$

Solving (2.2) for S and replacing in (2.1), after dropping the exogenous variables the problem becomes:

$$\underset{\{r_L,\ r_D,\ V\}}{\text{Max}}\ \Pi = (r_L - r_S)L + (r_S(1-\rho) - r_D)D - C(D,L,V) \tag{2.3}$$

The first-order conditions for this problem will be:

$$\frac{\partial \Pi}{\partial r_L} = 0, \quad \frac{\partial \Pi}{\partial r_D} = 0\ , \quad \frac{\partial \Pi}{\partial V} = 0 \tag{2.4}$$

The first of those conditions characterises optimal behaviour in the market for loans and will be ignored if any (or both) price or quantity is exogenously set by the authorities. For deposits, interest rates may be either exogenously set by authorities or freely set by the bank. The first case may be described as:

$$r_D \leq \overline{r_D} \tag{2.5}$$

Where the right-hand side represents the deposit rate ceiling. So, for the regulated interest rate situation, in which the above expression is an equality whenever the deposit rate ceiling is binding, the bank's optimal behaviour is described by :

$$\frac{\partial \Pi^i}{\partial V^i} = \left(r_S(1-\rho) - r_D - \frac{\partial C}{\partial D^i} \right) \left(\frac{\partial D^i}{\partial V^i} + \sum_{j \neq i} \frac{\partial D^i}{\partial V^j} \frac{\partial V^j}{\partial V^i} \right) - \frac{\partial C}{\partial V^i} = 0 \tag{2.6}$$

The term $\partial V_j / \partial V_i$ is generally designated by conjectural variations of firm i relative to firm j. It may interpreted as firm i's beliefs in firm j's reactions to i's changes in the non-price instrument. A zero value will imply that firm i completely ignores firm j when making its non-price decisions and a unit value means that firm i believes that j exactly matches its non-price decisions.

Although the above interpretation is generally adopted in the theoretical literature, some authors have challenged its use in the context of econometric models and proposed a re-interpretation of this methodology, in which such "conjectures" merely represent deviations from perfectly competitive pricing. For a discussion of this issue see Riordan (1985) and Dockner (1992).

When dealing with a panel of several firms it is virtually impossible to estimate all the conjectural variation parameters involved and generally some simplifying hypothesis is made to allow identification. In this study a solution based on Cubbin (1983) and Waterson (1984) and also used in Hannan (1991) is followed. Although we do not have the possibility of estimating a conjectural variation parameter as a consequence of the differentiated product modelling, this approach allows a better understanding of the estimated results.

Defining a weighted average conjecture:

$$\alpha_V^i = \sum_{j \neq i} \frac{\partial V_j}{\partial V_i} \frac{\frac{\partial D_i}{\partial V_j}}{\sum_{k \neq i} \frac{\partial D_i}{\partial V_k}} \tag{2.7}$$

Expression (2.6) becomes:

$$\frac{\partial \Pi^i}{\partial V^i} = \left(r_S(1-\rho) - r_D - \frac{\partial C}{\partial D^i} \right)\left(\frac{\partial D^i}{\partial V^i} + \alpha_V^i \sum_{j \neq i} \frac{\partial D^i}{\partial V^j} \right) - \frac{\partial C}{\partial V^i} = 0 \tag{2.8}$$

From this expression it becomes obvious that the non-price elasticity of deposits plays an important role in the solution of this problem. Evaluating it:

$$\varepsilon_V^i = \left(\frac{\partial D_i}{\partial V_i} + \alpha_V^i \sum_{j \neq i} \frac{\partial D_i}{\partial V_j} \right) \frac{V_i}{D_i} \tag{2.9}$$

Two extreme situations are worth investigating. One occurs when the firm ignores all its competitor's reactions, i.e., assumes α=0, behaviour compatible with the Cournot hypothesis. The result is simply:

$$\eta_V^i = \frac{\partial D_i}{\partial V_i} \frac{V_i}{D_i} \tag{2.10}$$

The other one, often identified with cartel behaviour, occurs when the firm believes that all competitors will match its non-price variations exactly, i.e., α=1. The solution is:

$$\xi_V^i = \left(\frac{\partial D_i}{\partial V_i} + \sum_{j \neq i} \frac{\partial D_i}{\partial V_j} \right) \frac{V_i}{D_i} \tag{2.11}$$

It should be obvious that elasticity (2.10) has a higher value than (2.11) since $\partial D_i / \partial V_i > 0$ and the sum of cross derivatives is non-positive. Elasticity (2.9) may now be expressed as a linear convex combination of the two extreme cases:

$$\varepsilon_V^i = \alpha_V^i \xi_V^i + \left(1 - \alpha_V^i\right) \eta_V^i \tag{2.12}$$

This means that the "perceived" non-price elasticity of deposits ε_V^i will be dependent upon the bank's conjectures and will assume its lower value for "collusive" conjectures $\left(\alpha_V^i = 1\right)$ and a maximum for Cournot conjectures $\left(\alpha_V^i = 0\right)$. Therefore, this elasticity's value will depend upon demand-specific characteristics and upon the bank's conduct, here represented by parameter α.

We may now solve (2.8) for V, incorporating (2.9) and rearranging:

$$\frac{V^i}{D^i} = \frac{r_S(1-\rho) - r_D - \partial C^i / \partial D^i}{\partial C^i / \partial V^i} \varepsilon_V^i \tag{2.13}$$

Equation (2.13) above describes non-price competition behaviour under deposit interest rate regulation. The amount of the instrument (V) will be proportional to the amount of deposits. That proportion depends upon the margin generated by each unit of deposits and upon marginal costs. Differences between banks will depend upon cost efficiency (more efficient institutions will provide more of the instrument), upon demand characteristics (banks facing less elastic demand for deposits will be less aggressive) and upon conjectures (Cournot leads to higher non-price competition).

Under unregulated deposit interest rates or whenever (2.5) ceases to be binding, optimal behaviour of the banks will result from the solution of the system of equations (2.8) and (2.14) below:

$$\frac{\partial \Pi^i}{\partial r_D^i} = -D^i + \left(r_S(1-\rho) - r_D - \frac{\partial C}{\partial D^i} \right)\left(\frac{\partial D^i}{\partial r_D^i} + \sum_{j \neq i} \frac{\partial D^i}{\partial r_D^j}\frac{\partial r_D^j}{\partial r_D^i} \right) = 0 \qquad (2.14)$$

Defining a similar weighted average conjecture for deposit interest rates, the "perceived" price-elasticity of deposits may be expressed as:

$$\varepsilon_{rD}^i = \left(\frac{\partial D_i}{\partial r_D^i} + \alpha_{rD}^i \sum_{j \neq i} \frac{\partial D_i}{\partial r_D^j} \right) \frac{r_D^i}{D_i} \qquad (2.15)$$

With all parameters defined in a way similar to expressions (2.9) to (2.12), the reduced form solution for this system, after replacing (2.16) in (2.13), is given by:

$$r_D^i = \frac{\varepsilon_{rD}^i}{1+\varepsilon_{rD}^i}\left(r_S(1-\rho) - \partial C^i / \partial D^i \right) \qquad (2.16)$$

$$\frac{V^i}{D^i} = \frac{\varepsilon_V^i}{1+\varepsilon_{rD}^i} \frac{r_S(1-\rho) - \partial C^i / \partial D^i}{\partial C^i / \partial V^i} \qquad (2.17)$$

This reduced-form system has a particularly interesting feature. While, for the optimal deposit rates, the only relevant perceived elasticity is the one for the deposit rate, for the non-price instrument, both perceived elasticities will affect its optimal value. This fact is responsible for an ambiguous response of non-price competition to changes in market structure. This is discussed in the following sub-section.

2.2.3. The Impact of Deregulation and Market Structure

Under this framework, non-price competition persists after interest rate deregulation. Expression (2.17) shows the optimal value for this "implicit interest" (V/D) under free interest rate competition. When deregulation is progressive, i.e., the rate ceiling is smoothly increased until it is no longer binding, this "implicit rate" will gradually fall. At a certain stage, the ceiling will coincide with the optimal rate given by (2.16) and the values given by (2.13) and (2.17) coincide, and will be greater than zero. In other words, unlike in the Startz (1983) monopolistic competition model, here deregulation reduces implicit payments but they do not cease.

The above analysis is conducted under the usual *ceteris paribus* assumption, assuming that all the other parameters remain constant. This may be its most severe flaw because interest rate deregulation may affect both conduct and market structure in the market. Under regulation, the only relevant conduct parameter is the one associated with the non-price instrument. Deregulation may affect it and may also result in more aggressive behaviour using the interest rate instrument. The combined effect on (2.17) is, *a priori*, unknown, but the possibility may not be discarded that, after deregulation, banks make more aggressive use of non-price instruments.

Another possibility is that after deregulation depository institutions use non-price instruments as a way of increasing product differentiation and thus become less sensitive to the most likely price war that will follow. Therefore, if product substitutability is directly related to the use of non-price instruments, deregulation may imply an increase in their use as a way of generating market power.

To show how this may happen we need to evaluate the potential impact of concentration changes over price and non-price competition. Hannan (1991, pg 72) shows that if an increase in concentration has a positive impact over the average conjectural variations parameter ($d\alpha/dCR>0$), then such an increase will also result in a rise in loan interest rates. For deposits, it is also unambiguous that a concentration increase will result in a reduction of the interest rate paid to depositors. For non-price instruments on deposits, changes in market structure have an ambiguous result. Denoting market concentration by CR, and assuming that this variable affects conduct only through the parameter α, we may evaluate this effect (omitting i):

$$\frac{d(V/D)}{dCR} = \frac{(1+\varepsilon_{rD})\frac{d\varepsilon_V}{dCR} - \varepsilon_V \frac{d\varepsilon_{rD}}{dCR}}{(1+\varepsilon_{rD})^2} \times \frac{r_S(1-\rho) - \partial C/\partial D}{\partial C/\partial V} \qquad (2.18)$$

This expression has, *a priori*, an undetermined sign. Changes in concentration may imply similar moves on both price and non-price competition (negative sign for 2.18) or may result in opposite moves for them. In other words, if the market concentration falls, it may result either in an increase in both types of competition or a more aggressive pricing policy accompanied by a reduction of the "non-price" instrument (measured as a percentage of deposits). A necessary condition for the first case is:

$$(1+\varepsilon_{rD})\frac{d\varepsilon_V}{dCR} - \varepsilon_V \frac{d\varepsilon_{rD}}{dCR} < 0 \qquad (2.19)$$

Since both elasticities are assumed to be negatively dependent on concentration (via assumption that $d\alpha/dCR>0$), it is convenient to take their modulus and rewrite it as:

$$\frac{\varepsilon_V}{1+\varepsilon_{rD}} < \frac{\left|\frac{d\,\varepsilon_V}{dCR}\right|}{\left|\frac{d\,\varepsilon_{rD}}{dCR}\right|} \tag{2.20}$$

Or, as another interesting alternative, as:

$$\frac{\varepsilon_V}{1+\varepsilon_{rD}} < \frac{\eta_V - \xi_V}{\eta_{rD} - \xi_{rD}} \times \frac{\partial \alpha_V / \partial CR}{\partial \alpha_{rD} / \partial CR} \tag{2.21}$$

The above result has a simple interpretation: In order to have a negative relationship between non-price competition and concentration, the perceived non-price elasticity of deposits has to change in response to a concentration variation in an amount, at least, equal to the ratio $\varepsilon_V / (1+\varepsilon_{rD})$. Thus, this non-price concentration relationship is dependent upon demand characteristics (low demand sensitivity to rival's non-prices leads to an inverse relationship), and upon the conjectures formation mechanism (if the average conjecture for non-prices needs to be sensitive to changes in market concentration).

2.3. Empirical Implementation

2.3.1. Empirical Model

In this empirical test it will be assumed that, although some interest rates were still administratively set by authorities, banks may have had the power to influence customers to accept the low interest earning deposits. Thus, in this context, observed differences between average deposit rates would reflect the banks' power over its customers, the less powerful banks having to accept paying higher interest rates[28]. Thus, although some strange interest rate regulations were still prevailing in 1988 and part of 1989, we shall handle the model as in the deregulated scenario (2.16)-(2.17).

In order to estimate the determinants of (rate) margins in the market for deposits, we shall follow Hannan and Liang (1993) and use the ratio between the interest rate on deposits and its corresponding marginal return. Expression (2.16) may be rewritten as:

$$\frac{r_D^i}{r_S(1-\rho)-\partial C^i/\partial D^i}=\frac{\varepsilon_{rD}^i}{1+\varepsilon_{rD}^i} \qquad (2.22)$$

The right-hand side of (2.22) corresponds to an indicator of the bank's pricing policy and depends on demand characteristics as well as on the bank's conduct, so far expressed through the parameter α. An estimated value of zero signifies that the

[28]At the begining of the sample period the time deposits rate was set above its competitive value (to stimulate savings) and the demand deposits rate was clearly below its optimum value (to avoid profitability problems caused by the other regulation). In most cases banks offered their customers some combination of both types of deposit or, for some customers, simply refused to accept time deposits. This bizarre regulation led, in practice, to a situation in which banks had some (although not totally free) capability to influence their average deposit rate but not the rates charged for individual products.

bank's pricing policy is totally independent of market conditions or that the bank pays no interest to depositors. A value of one means that the bank passes to depositors all of its marginal return (net of marginal costs). A value greater than one means that the bank pays to depositors more than the marginal return on such funds. Therefore, this measure is a ratio which may be used to evaluate market power whenever only price is considered as a competitive weapon: the lower its value, the higher will be the bank's power exercised over its customers.

The reader may note that the measure above does not correspond to the "usual" market power measure generally used in the IO literature (the Lerner index), which for the deposits market, may be expressed as:

$$\frac{r_S(1-\rho)-r_D^i-\partial C^i/\partial D^i}{r_D^i}=\frac{1}{\varepsilon_{rD}^i} \qquad (2.23)$$

Expressions (2.22) and (2.23) are just two alternative ways of expressing the same optimality condition. And there is a univocal relationship between the right-hand sides of both expressions. In other words, from the value of one of the above market power indicators we may directly obtain the value of the other, making them perfectly equivalent. However, some practical reasons lead to the choice of (2.22) as the best alternative: it allows a direct test of "marginal revenue" pricing of deposits and it behaves better whenever interest rates are observed to be set above marginal revenue[29].

[29]In this context, "marginal return" means marginal revenue of funds applied in the money market net of the non-earning cash reserves coefficient and real resources marginal costs. Marginal return pricing of deposits occurs whenever the bank offers a rate which exactly matches that marginal return. As an analog to competitive industrial markets, some authors classify this practice as "marginal cost pricing", although in the market for deposits the bank sets the financial marginal cost rather than a price charged to consumers.

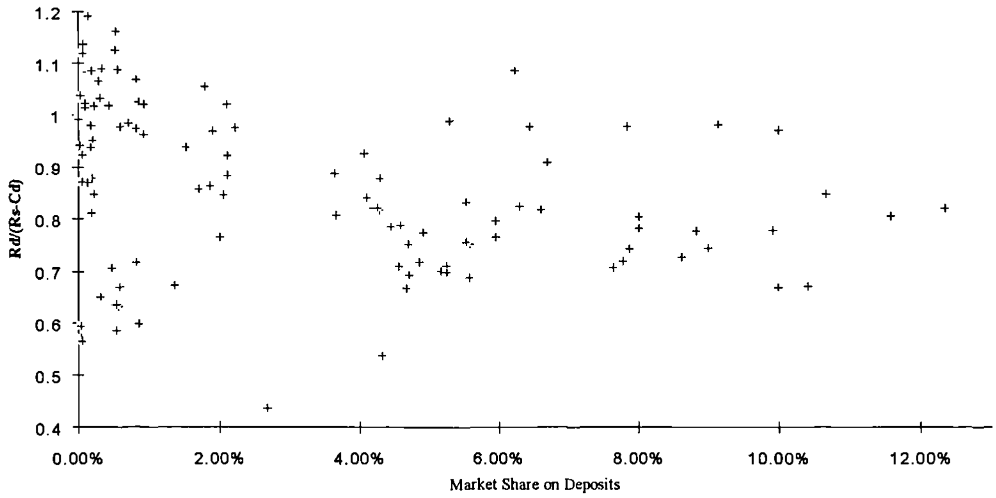
Given the considerations above, we will test which variables influence the firms′ pricing conduct in the market. As suggested in the previous sections, the most important explanatory variables for our test are the market concentration index (CR) and market share (MS). Some control variables were added in order to account for firm differences associated with ownership and strategy. Those dummy variables were defined as AGE (=1 for "banks operating before 1974"), PUB (=1 for "Government-owned"), FOR (=1 for "foreign-owned"), PRIVR (for "privately-owned retail banks") and WHO (=1 for "wholesale banks"). To simplify the econometrics of this test, a linear relationship was assumed, with the justification that it may be valid for deviations around some central point. Equation (2.22) is therefore estimated in the form:

$$\left(\frac{r_D}{r_S(1-\rho)-\partial C/\partial D}\right)_{i,t} = \mu_C CR_t + \mu_S(MS_{i,t}) + \mu'_X X + u_{i,t} \qquad (2.24)$$

Where X is the vector of control dummy variables and μ_X is the vector of associated parameters, u is the usual white-noise econometric residual, and $\mu_S(MS)$ is a non-linear function of the market share. Non-linearity between the price-marginal return ratio is suggested by the data, as may be seen in Figure 2.1.

Figure 2.1. (where observations relating to CGD were omitted) suggests that may be non-linear the relationship between the price-marginal return ratio and market share. Three alternative specifications for that relationship are tested: linear, squared and cubic polynomials.

Figure 2.1.
Price - Marginal Return Ratio



For non-price competition two different variables were considered: advertising and branching. For the first one, total advertising (ADV) expenditures for each bank is used as a measure of the bank's non-interest competition. The bank's cost function is additive on advertising expenditures and ∂C/∂ADV=1. Then, in an analogous way to the above, banks' advertising policy may be described as:

$$\frac{ADV^i / D^i}{r_S(1-\rho) - \partial C^i / \partial D^i} = \frac{\varepsilon^i_{ADV}}{1+\varepsilon^i_{rD}} \tag{2.25}$$

The right-hand side of expression (2.25) above characterises the bank's advertising effort, where it is assumed that this is related to market structure, banks' market share and other variables as above. Some banks have exceptionally high advertising expenditures in the year of their privatisation (IPO's offer) and that effect must therefore be discarded using a dummy variable (PR=1 if bank is being privatised that year). The equation to be estimated is:

$$ADV_{i,t} = p \times PR_{i,t} + \left(\gamma_C CR_t + \gamma_S (MS_{i,t}) + \gamma'_X X\right)\left(r_S(1-\rho) - \partial C/\partial D\right)_{i,t} D_{i,t} + v_{i,t} \tag{2.26}$$

The expression between the first parentheses in (2.26) represents the right-hand side of (2.25) above, where regressors are the same as in (2.24). The product of the second parentheses and the volume of deposits is the total margin generated on deposits and v is the usual white-noise econometric residual. The reason for the non-linear (on the regressors) specification of (2.26) as opposed to the simple linear relationship (2.24) lies in the need to separate privatisation-specific promotional expenditures from the advertising motivated by competitive reasons. Non-linearity in the market share is also assumed.

For branching, writing the analog of expression (2.25) is straightforward, the main difference between both expressions being the presence of the marginal cost of the non-price instrument below:

$$\frac{B^i / D^i \times (\partial C^i / \partial B^i)}{r_S(1-\rho) - \partial C^i / \partial D^i} = \frac{\varepsilon_B^i}{1+\varepsilon_{rD}^i} \tag{2.27}$$

The total number of branches is a stock variable, rather than a flow as advertising. In order to open a new branch, a bank has to consider the required investment against expected present value of future cash-flows. Thus, a non-permanent drop on a bank's margins will not necessarily imply the closure of some branches, since their future profits may compensate short-run losses. This, associated with the very slow deregulation process in this field and the adjustment difficulties found by Cabral and Majure (1993) make the use of a partial adjustment process advisable:

$$B_t - B_{t-1} = \lambda(B_t^* - B_{t-1}) \tag{2.28}$$

Where B stands for the actual number of the bank's branches and B^* their desired value, obtained through the optimality condition (2.17), for V=B. Replacing it in

(2.28) and considering the usual conduct determinants, including non-linearity in the market share, as usual, yields:

$$B_{i,t} = \frac{\lambda}{\left(\partial C / \partial B\right)_{i,t}} \left(\beta_C CR_t + \beta_S (MS_{i,t}) + \beta'_X X\right) m_{i,t} D_{i,t} + (1-\lambda) B_{i,t-1} + w_{i,t} \tag{2.29}$$

where:

$$m_{i,t} = \left(r_S(1-\rho) - \partial C / \partial D\right)_{i,t}$$

2.3.2. Data

In order to test the impact of deregulation on both price and non-price competition in the Portuguese market for deposits we will assume that the evolution of the market concentration index reflects the competitive impact of deregulation. Authorities have been introducing progressive liberalisation measures since 1985, by allowing new private institutions, deregulating deposit and lending rates, and by adopting a more open approach to new branch creation and location. The Herfindahl index for deposits shows a progressive reduction in the market concentration which is most likely a direct consequence of such liberalisation processes[30]:

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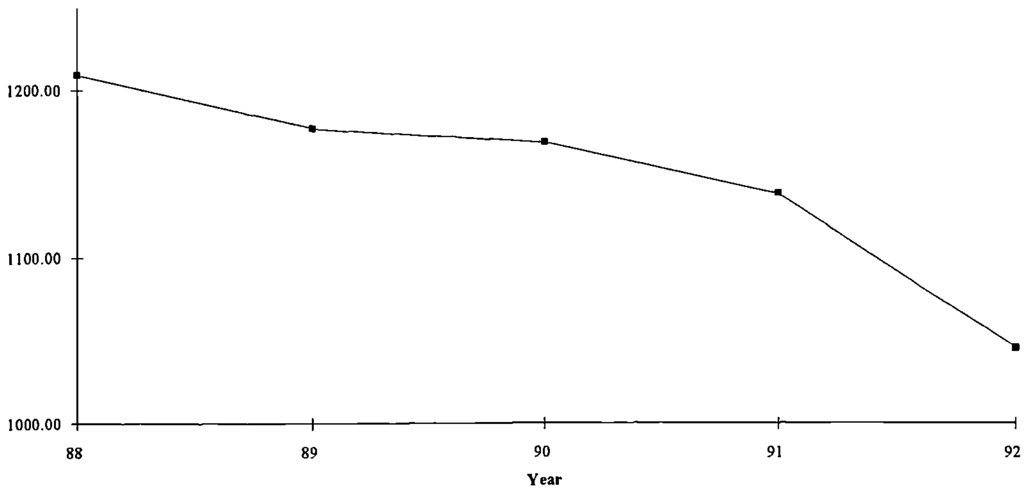
[30]The Herfindahl index of market concentration is defined as the sum of the squared market shares of all firms in a market.

Figure 2.2.

Herfindahl Index: Deposits



This change in market concentration was accompanied by important changes in the relative importance of institutions in the market for deposits. The year 1992, the first in which full liberalisation of branching installation was established, was the most turbulent one. This evolution may be easier to understand through the analysis of the variability index (VI), defined as:

$$VI_t = \frac{1}{2}\sum_{i=1}^{N}\left|MS_{i,t} - MS_{i,t-1}\right| \qquad (2.30)$$

Values for (2.30) follow in Table 2.1. In general, the evolution of the above indicators shows a growing mobility (and contestability ?) of the market during this liberalisation period. Therefore, the assumption that the concentration index evolution and liberalisation efforts may be tied together is, apparently, not too strong.

Table 2.1.

Variability Index

Year	Variab
1989	2.60%
1990	3.20%
1991	2.80%
1992	5.10%

In order to evaluate the impact of this reduction on market concentration, a pool of 23 banks, representing more than 95% of the market, for the years 1988 to 1992 was constructed. Balance sheet and income statement variables were obtained from the *Associação Portuguesa de Bancos* bulletins, figures on branches were obtained on those bulletins and from the *Banco de Portugal* for certain years. Estimates from *Sabatina* (a marketing research institute) were the source of advertising data. All money denominated variables were deflated for 1986 prices.

Data on interest rates on time and demand deposits at the individual bank level is not available, leading to the need to work with an average deposit rate. Although this is a common flaw of all empirical studies on the Portuguese market for deposits, it is impossible to overcome with the available data. Nevertheless, the previously presented arguments favouring the use of the "deregulated" model, even in the years in which the deposit rate regulation was still in force, recommended the use of the pool of deposits instead of its individual components.

Published interest expenses do not distinguish between deposits and money market funding, making it impossible to separate the cost of the two types of funds. Thus, the ratio between interest expenses and the yearly average of the sum of deposits and purchased funds is used as an interest rate indicator. This problem may not be too serious if we recall that banks without market power in deposits are precisely the ones who need to purchase (in relative terms) more money market funds and will show a higher average rate. Thus, the rate measurement error here involved may not lead to a bias in market power measurement.

Marginal return on deposits was computed as the yearly average of monthly money market rates published by the *Banco de Portugal* multiplied by a factor which adjusts for non-earning cash reserves and reserves invested at the central bank earning below market rate (where the difference is used as part of an additional adjustment). The real resources marginal cost for deposits was obtained through the author's estimate of a stochastic cost frontier for Portuguese banks (1987-92). Plant-size marginal costs were used since these represent the short-run costs which are relevant for pricing decisions.

Deposits were defined as the sum of time and demand deposits together with certificates of deposit and treasury bills sold under repurchase agreements. Market shares on deposits were constructed assuming the relevant universe to be the banks listed by the *Associação Portuguesa de Bancos*. Thus, the small rural savings institutions were excluded, but they represent less than 2% of the market. The Herfindahl index was calculated based on this universe and on the computed market shares. *Caixa Geral de Depósitos* was also excluded from the sample for the same reasons mentioned in the previous chapter[31].

The marginal cost of branches was computed for each observation from the stochastic cost frontier estimated in the previous chapter.

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[31]Barros and Modesto (1994) provide evidence on the non-profit maximisation nature of CGD, which makes this institution's behaviour incompatible with the structural model used in this study.

Tables 2.2. and 2.3. present descriptive statistics for the most important variables employed in the present study. Variables MRD, ADVM and BRM represent the left-hand sides of expressions (2.22), (2.25) and (2.27), respectively. Concentration is proxied by the Herfindahl index (HERF). Summary descriptive statistics for the variables used in this study follow in the next tables.

Table 2.2.
Summary Descriptive Statistics

	MEAN	STD DEV	MINIMUM	MAXIMUM
MRD	0.856	0.160	0.435	1.191
ADVM	0.005	0.011	0.000	0.075
BRM	0.241	0.334	0.069	3.383
HERF	0.115	0.006	0.105	0.121
MSD	0.033	0.033	0.000	0.123
AGE	0.682	0.468	0.000	1.000
PUB	0.427	0.497	0.000	1.000
FOR	0.364	0.483	0.000	1.000
PRIVN	0.182	0.387	0.000	1.000
WHO	0.173	0.380	0.000	1.000

Table 2.2. above shows that, on average, Portuguese banks pay deposit rates which represent only 85.6% of the marginal return they may obtain with them. However, if we assume that these market power indicators are normally distributed, the t-ratio (1-.856)/.160 yields 0.900, which doesn't allow the rejection of the hypothesis that the real value for that ratio is one. In other words, based only on the statistics above, we may not reject a perfectly competitive scenario for this market. Advertising expenditures represent an average of 0.5% of total margins generated by deposits, but are very dispersed, rising up to 7.5%. Branching behaviour is also very dispersed.

Table 2.3.
Correlation Matrix

	MRD	ADVM	BRM	HERF	MSD	AGE	PUB	FOR	WHO
MRD	1.000								
ADVM	0.124	1.000							
BRM	0.135	0.017	1.000						
HERF	-0.293	-0.056	-0.172	1.000					
MSD	-0.302	-0.227	-0.329	0.027	1.000				
AGE	-0.315	-0.376	-0.262	0.000	0.486	1.000			
PUB	-0.393	-0.294	-0.273	0.197	0.563	0.590	1.000		
FOR	0.542	0.158	0.370	0.000	-0.680	-0.498	-0.653	1.000	
PRIVN	-0.149	0.187	-0.091	-0.176	0.088	-0.184	-0.407	-0.356	1.000
WHO	0.184	-0.060	0.439	0.075	-0.439	-0.411	-0.395	0.604	0.215

Table 2.3. above shows that the three dependent variables are negatively correlated with market concentration, market share and the bank's age. Variables AGE and PUB are strongly correlated, which comes as no surprise, since most of the older banks were nationalised and the majority of them were not privatised during the sample period. It should also be noted that public ownership is positively correlated with market share, reflecting the fact that the nationalised banks still (at the end of 1992) occupy the most important positions in this market. The FOR and WHO dummies are also highly correlated because most wholesale banks are foreign-owned.

2.4. Estimation and Results

2.4.1. Estimation Procedure

The system of non-linear equations (2.24), (2.26) and (2.28) is estimated using the full information maximum likelihood technique (FIML). Using TSP's FIML estimates as a starting point, an additional iteration is performed to obtain White's (1980) robust estimates for the variance-covariance matrix of the parameters. This last feature is particularly important given that panel structure of the data may lead to heteroscedasticity problems.

The three equations are estimated simultaneously since they result from the same set of first order conditions and, therefore, there is a high likelihood that some contemporaneous covariance may exist between their residuals. In this context, OLS estimators are biased and inconsistent. We believe that the proposed procedure has an advantage over the single equation approach to market power on deposits (2.24), given the obvious interaction that must exist between explicit pricing (rate) of banking products and their correspondent promotion (advertising) and distribution (branching). To put it concisely, the whole "marketing mix" has to be considered as a whole, rather than its individual components separately. We also believe that it offers a better alternative to Clark's (1986) approach, since his different equations are specified in an *ad-hoc* manner, and do not explicitly result from profit maximising behaviour.

2.4.2. Results

Estimates for the system of equations (2.24)-(2.26)-(2.28) follow in the next page. Several formulations for the relationship between dependent variables and the market share were tested, namely linear, quadratic and cubic forms. Although a simple linear formulation failed to provide a good relationship between market share and the dependent variable, a good adjustment was found when cubic and quadratic polynomials were used. This means that the effect of market share and price (non-price) margins is highly non-linear. In Table 2.4 below, results are presented for the linear (model one) and cubic (model two) specifications.

In two equations the Herfindahl index has an associated significant negative coefficient, meaning that the fall in market concentration was accompanied by a more aggressive price and advertising behaviour among Portuguese banks, while branching policy seems to be less sensitive to that variable. To test the robustness of this conclusion, the concentration variable was replaced by a time trend, which was only significant for the first equation. Thus, the effect captured by the Herfindahl index goes beyond a mere trend, although some colinearity exists between the two variables which results from the evolution depicted in Figure 2.2. Therefore, these results indicate that both structure and conduct in the market have moved in the expected way.

Table 2.4.

System Estimates

	Model One				Model Two			
Variable	Estimate	Std Error	T Stat	Signif	Estimate	Std Error	T Stat	Signif
Interest Rate Equation:								
CONST	1.852	0.232	7.985	***	1.782	0.237	7.511	***
HERF	-9.478	2.118	-4.475	***	-9.636	2.077	-4.639	***
MS	0.722	0.465	1.552		9.196	3.213	2.862	**
MS^2	-	-	-		-158.896	64.424	-2.466	*
MS^3	-	-	-		818.875	348.600	2.349	*
AGE	-0.069	0.041	-1.679	*	-0.083	0.424	-1.945	*
PUB	0.059	0.042	1.401		0.053	0.039	1.357	
FOR	0.249	0.042	5.871	***	0.312	0.042	7.417	***
PRIVR	0.041	0.032	1.281		0.031	0.031	1.018	
WHO	-0.068	0.035	-1.919	*	-0.047	0.034	-1.361	
Pseudo R squared		*0.423*				*0.448*		
Advertising Equation:								
PR	105101	24546	4.282	***	120055	25481	4.712	***
CONST	0.019	0.004	4.634	***	0.020	0.004	4.863	***
HERF	-0.085	0.036	-2.371	*	-0.106	0.035	-3.031	**
MS	-0.020	0.008	-2.456	*	0.909	0.398	2.283	*
MS^2	-	-	-		-47.727	21.496	-2.220	*
MS^3	-	-	-		624.395	286.686	2.178	*
AGE	-0.007	0.001	-7.111	***	-0.007	0.001	-6.245	***
PUB	0.001	0.001	1.289		0.001	0.001	1.028	
FOR	0.003	0.002	1.043		0.000	0.003	0.764	
PRIVR	0.002	0.001	1.817	*	0.001	0.001	1.466	
WHO	-0.007	0.003	-2.139	*	-0.005	0.003	-1.372	
Pseudo R squared		*0.609*				*0.634*		
Branching Equation:								
CONST	0.625	0.230	2.717	**	1.083	0.510	2.123	**
HERF	-0.293	1.205	-0.243		-0.224	1.473	-0.152	
MS	-0.874	0.257	-3.406	***	-17.132	9.186	-1.865	*
MS^2	-	-	-		240.779	135.345	1.779	*
MS^3	-	-	-		-1096.000	618.710	-1.771	*
AGE	-0.277	0.101	-2.740	**	-0.380	0.177	-2.142	*
PUB	-0.089	0.028	-3.134	***	-0.105	0.042	-2.503	**
FOR	0.219	0.163	1.346		0.055	0.202	0.271	
PRIVR	-0.017	0.021	-0.824		-0.027	0.030	-0.921	
WHO	-0.448	0.261	-1.715	*	-0.727	0.420	-1.729	*
λ	0.144	0.039	3.708	***	0.113	0.042	2.695	**
Pseudo R squared		*0.944*				*0.995*		

The significance level of the estimated parameters in the table above is represented by * (95%), ** (98%) and *** (99%), for two-tailed tests.

For the interest rate equation, the negative relationship between the dependent variable and market concentration indicates that deregulation has induced a more competitive conduct on the "price" instrument. If we keep the assumption that concentration reflects the impact of deregulation on market structure, the negative estimated coefficient is a clear indication that deregulation had a negative effect on the margins generated by deposits. This effect is very likely to result from a more aggressive behaviour on the part of the banks in this market, translated to their interest rates through a revision of their conjectures about their competitors' reactions. In other words, reduction in concentration may be associated with a less cooperative behaviour by the major players, leading to an increase in their "perceived" elasticities and, consequently, to lower margins on deposits.

This price-concentration relationship is particularly important for two reasons. One is merger policy, where it is concluded that mergers of large banks (increased concentration) may reduce competitiveness and increase bank margins. The other is associated with freedom of entry, a policy which is reducing concentration, and may in the medium term lead to a highly competitive situation and a "shake-out" of the market.

Also interesting in this context is an analysis of the evolution of the estimated values for the right-hand side of equations (2.22), (2.25) and (2.27) (which follows in Appendix) in which banks are ranked by market share. For all banks (as a result of the assumption of symmetry in reactions to concentration) these indicators rises over time, indicating an increased competitiveness in this market. The estimated value of (2.22) may be used to test against the hypothesis that its "true" value is one, i.e. that the bank sets the prices of deposits equal to their marginal revenue. For 1988 this hypothesis is not rejected only for one bank in the sample. With the decrease in concentration, in 1992 a situation is reached in which four firms were estimated to be practising marginal return pricing of deposits and, surprisingly, another five would be paying interest on deposits exceeding their marginal return (see Appendix). Most of the latter are foreign-owned and small.

Although this last finding seems somewhat difficult to understand, it may, in fact, result from three different causes. One is that the implementation of dynamic pricing strategies may result in such behaviour for small banks trying to grow quickly and explore economies of scale or other size-effects[32]. Another is that it may result from some myopia in the evaluation of real resources marginal costs involved in servicing deposits. And the final one is associated with our need to ignore commissions and other income which may be related to deposits[33].

The effect of market concentration on the two non-price variables is different. While in the case of advertising the strong increase in expenditures has to be explained, at least partially, by the increased competitiveness of the market, the growing number of bank branches during the sample period must be entirely justified by the increasing deposit margins (associated with time deposit interest rate deregulation) and privatisations. This last effect is detected via the significant negative coefficient of the variable PUB in the branching equation.

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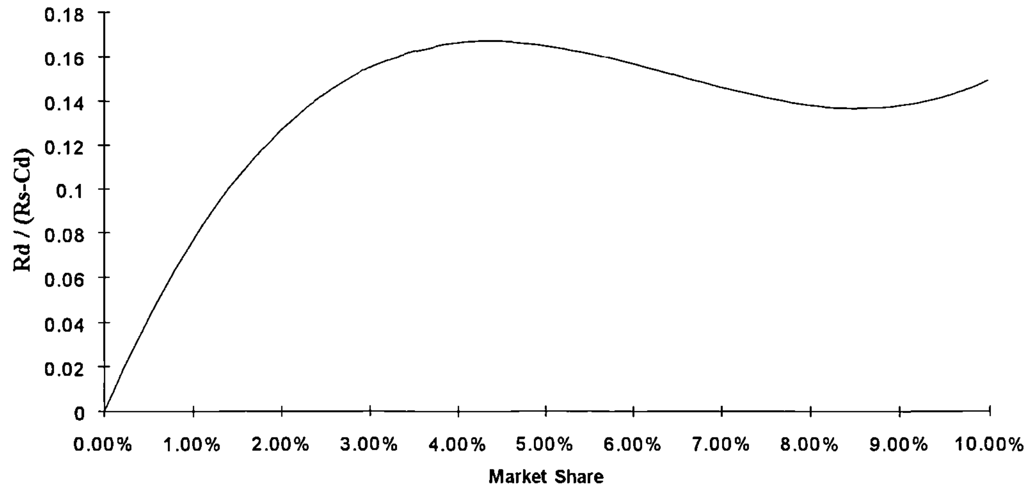
[32]Given the anedoctal evidence on switching costs in the deposit market, a possible theoretical explanation for this pricing policy is the one provided by Klemperer (1987).

[33]No data are available on the revenue generated by fees and commissions charged to depositors.

The relationship between the interest rate market power and market share is more difficult to interpret. Results for equation one show a positive non-significant coefficient between the two. This could be an indication that the two variables are not related. However, when the relationship between the two is specified in a more non-linear way, statistically significant coefficients are found. The best results were obtained with a third degree polynomial and suggest a curious inter-relation between the two variables (see Figure 2.3 below).

Figure 2.3.

Market Power and Market Share



The figure above suggests a negative relationship between market power and market share up to the level of 4%[34]. It is likely that banks which are trying to grow will become increasingly "price-aggressive", until they reach a dimension after which market power may be exploited. The reader may also recall from the previous chapter that plant-level marginal costs are positively related to bank size. It should also be

[34]The reader should recall that a rise on the left-hand-side of (2.22) is equivalent to a market power reduction.

noted that most banks with market shares above that level are "old" (which has a positive impact on market power), which in practice means that only the "new" retail banks are facing low market power above that level. In this context it is interesting to verify that market power estimates for privatised banks, which follow in the Appendix, allow the rejection of the hypothesis of marginal return pricing of deposits in the years following privatisation[35]. Thus, we may conclude that the "old" bank effect is clearly an important factor in the determination of market power.

Anther important aspect in the explanation of the shape of the figure above is the large positive coefficient associated with the FOR variable. This may be interpreted as an indication that foreign-banks have a strong disadvantage in this market, since that parameter's estimate indicate that they have to pay in interest costs 30% more of their marginal return than their local competitors. It should be noted that most small banks are foreign, and combining this fact with the shape of Figure 2.3. above, we have to conclude that the apparent advantage for the small banks is enjoyed only by the two small Portuguese-owned institutions. As a matter of fact, one of those, which is almost entirely focused on the islands of Azores, has the highest observed market power in the sample.

The other variables always failed to become statistically significant in this equation. Surprisingly, the new private retail banks' dummy is not significant, which seems to confirm that their current "aggressivity" is associated with some price dynamics of growth, which are somehow reflected in the effect depicted in Figure 2.3. above.

Coming back to the market power estimates, which follow in the Appendix, it is found for all large banks that the marginal return pricing hypothesis is rejected, with the exception of 1992 when such an assumption may not be rejected in the case of

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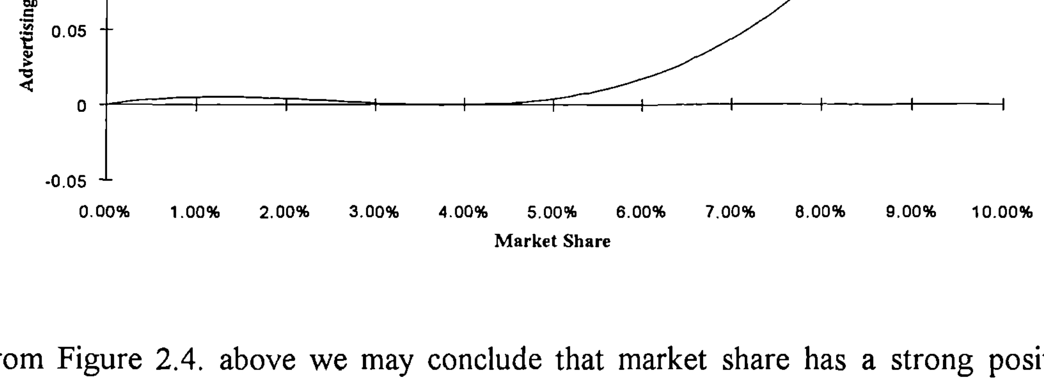
[35]Privatised banks are BTA (1989), BPA (1990), BES (1991), BFB (1991) and CPP (1992).

one private retail institution (BCP). Less pleasant is the situation of the majority of the other small foreign-owned banks which, in 1992, were either following marginal return or above marginal return pricing of deposits. Particularly disappointing is CLP's situation, which is the only notable exception to the "old bank - strong market power" rule.

For advertising, the estimated relationship with market share is also puzzling. When a linear specification is estimated, we detect a negative relationship between the two variables. However, higher degree polynomials provide different associations between the two variables, something which requires a more careful interpretation. The estimated relationship for model two is depicted in Figure 2.4. below.

Figure 2.4.

Advertising and Market Share



From Figure 2.4. above we may conclude that market share has a strong positive impact on advertising for the large banks. However, once again we must be cautious in the interpretation of these equations, since the dummy variables employed may provide partial explanations for some of the findings. Somewhat surprisingly, the only one of these which is statistically significant is AGE, which indicates that, as expected under a Nerlove-Arrow (1962) or other dynamic context, new banks have to advertise more than the older ones. The latter are all on the positive slope portion of the curve, together with only one "new" institution. This may be interpreted in a way which is similar to that regarding the previous equation, as demonstrating that newcomers have to make an increased effort to support growth.

If we look at the linear specification (model one), the small negative coefficient associated with market share should be related to other significant variables, as AGE, PRIVR and WHO. Thus, this last model seems to provide a more "qualified" view of the situation, by telling us hat wholesalers almost do not advertise. This explains why the equation in model two provides a zero value for small market shares, and a strong positive effect associated with the private retail banks, which are now competing above the 5% market share.

Analysis of the estimated values for the right-hand side of (2.25) allows the identification of a very curious pattern, which was partially detected by the parameters associated with market share. Values for the "advertising / margin on deposits" ratio are extremely low for the smallest banks in the sample (negative values were estimated for a few observations), being higher for some intermediate size institutions. The large commercial banks spend on advertising from 0.1% to 0.2% of the margin generated by deposits in 1992, while the pattern for banks in the [2%, 4%] market share range is irregular.

Some notable cases should be pointed out. First, among the largest commercial banks, BCP (the only "new" bank among the largest) is the most advertising-oriented institution (spending about 2% of its total margin generated in 1992). A smaller bank among the top 10 institutions, BFB, also shows a ratio above its peers. The first is the largest new private bank while the second is a privatised institution. Both share in announcing their intentions to strive for increased market share.

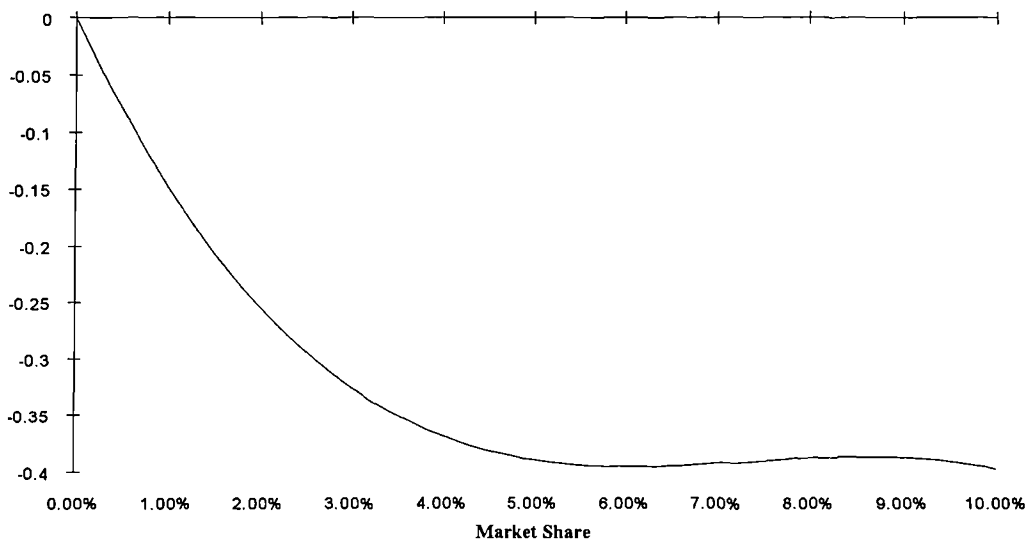
The impact of dummy variables AGE and FOR (although not statistically significant) becomes clear if we note that, among the smaller institutions, BCI, Manufacturers (today called Chemical Bank), BNP and Barclays are distinguished themselves by having very high values for this ratio. They are all new, foreign-owned and have publicly expressed their desire to grow in this market. The other small banks are wholesale institutions which show very low levels of advertising expenditures.

It is also interesting to note that the dummy variable PR is undoubtedly statistically significant, regardless of the specification tested, meaning that banks increase their advertising expenditures during the year of their privatisation in order to contribute to the sale of the shares (about 120 million escudos at 1986 prices - about twice that value at today's prices).

For the branching equation we find another curious pattern. Branching effort is decreasing in the market share variable up to the 5% level and stabilises above that. This means that growing banks have decreasing branching costs up to that value for the market share, spending a constant share of their margin for dimensions above that level. This behaviour is compatible with a dynamic non-price model and with the findings of the first chapter on the productivity of bank branches. That first explanation is also corroborated by the statistically significant negative parameter associated with dummy variable AGE, which shows that older banks are able to spend a significant lower portion of their margin on branching than do the new institutions. The estimated effect of market share (model two) is depicted in Figure 2.5 below:

Figure 2.5.

Branching and Market Share



Among the small institutions, the wholesale banks seem to benefit from a significant advantage because they are able to generate higher margins, despite having no more than two branches (effect of variable WHO). On the other hand, small entrants trying to grow, act primarily through the expansion of the number of offices, which take some time to attract deposits and generate margin, thus yielding the above mentioned relationship with market share.

Also interesting is the finding that Government-owned banks make a lower branching effort than the private ones (variable PUB). If we combine this finding with the significant coefficient associated with dummy variable AGE, we have to conclude that privatised banks increased their branching effort after privatisation[36].

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[36]The reader should note that the observations which are classified as "old" and not "public" are all relative to privatised or foreign-owned institutions.

The partial adjustment speed (λ) is still very slow in this estimation (0.11). This may be an indication that banks take some time to react to new environment conditions as a result to the entry and exit costs involved in the implementation of banking offices.

The estimated values for the branching ratio, which follow in the Appendix, are decreasing in the market share, where it is easy to identify some "outliers", i.e. banks with particularly high values for the estimated right-hand side of (2.27). These are BCP (the only "aggressive" bank found among the top 10 institutions), BCI, Manufacturers, BNP and Barclays. All these have already been mentioned as having the same kind of attitude concerning advertising as a competitive instrument, i.e. being likely that they were using both instruments as complements as a mean to support growth.

2.5. Conclusions

Among the major conclusions that are obtained from the present study is the fact that during the deregulation period the market concentration fell while competitiveness increased. This results from a strong correlation between both price and non-price competition intensity and market concentration. In other words, the fall in concentration was accompanied by an increased rivalry which resulted in lower market power for banks. Also important is the finding that the combined effects of deregulation and reduced concentration had a significant and positive impact on the use of advertising as a competitive instrument, while for branching, no such effect was detected.

Another finding is that small banks have a marked disadvantage relative to the larger ones: they have to pay higher interest rates, together with higher advertising expenditures and branches per each escudo of margin generated by deposits. The only exception to this rule occurs among the small wholesale banks, in which such a non-price disadvantage is less pronounced.

One of the major objectives of the present study is to analyse the market power effects of bank mergers. Results do not provide sufficient evidence on a positive effect of size on market power. Although for the very small banks a strong disadvantage is detected in this field. For institutions above levels of around 3% market share, we do not detect such an effect. However, since a strong price-concentration relationship was found, mergers of large banks should be evaluated with care, since they will decrease concentration and, consequently, increase the overall market power of the industry.

Also important to note is that a small group of new foreign-owned institutions with market shares ranging from 1% to 1.5% is experiencing an especially difficult situation, by paying interest rates that may exceed their marginal return, together with the need to carry the highest non-price costs. This behaviour, however, may be easily justifiable under a dynamic adjustment process for banks trying to achieve a high market share, and therefore has to be seen as a cost which is associated with a growth process. Barclays Bank is the most notable case within this group.

On the comfortable side are the "top 10" banks, made up of old institutions, which were (all but one) Government-owned in 1988 (some of them already being privatised). All seem to benefit from significant market power on deposits (with one exception in 1992) and to be able to keep their customer base with lower advertising and branching efforts than their smaller competitors. The exception is BCP, the only private institution within this group. Nevertheless, its situation looks far better than that of the smaller private banks. For the privatised institutions in this group, an increase in new branching creation was detected, while the other dependent variables in the study seem to have remained unaffected by the change of ownership.

These last paragraphs show how variable market power and the use of non-price instruments are from bank to bank. This raises the question of how the "representative firm" studies of market power can reflect the true nature of the market. In a quite simple test we found that the average market power indicator was not statistically different from unity, which could be an indication of perfect competitiveness. After estimating the model, we found that market power on price varied from large powerful banks to small institutions paying interest rates that exceed the marginal return on deposits. Thus, these "representative firm" studies may be biased by not accounting for individual firm situations

In short, we found that the Portuguese market for deposits is becoming increasingly competitive, which is most likely due to the current deregulation process. While for the larger institutions a non-perfectly competitive behaviour is found (i.e. they are able to exercise market power), an inverse situation is found for the smaller institutions. For the latter, high competitiveness is driving some institutions to a highly aggressive standing resulting in deposit interest rates set above their marginal return, as well as on very high ratios of advertising and branches relatively to the margin generated by deposits. For the banks in this situation, serious profitability problems should be expected in a near future.

Appendix to Chapter Two

Market Power Estimates

BANK / YEAR	MARKET POWER - INT. RATE Value	Test	t Stat	Concl	ADVERT eA/(1+eRD)	BRANCH eB/(1+eRD)
BPA 88	0.842	0.158	3.511	Rd<MR	0.0102	0.062
BESCL 88	0.755	0.245	10.813	Rd<MR	0.0102	0.155
BPSM 88	0.726	0.274	12.058	Rd<MR	0.0102	0.182
BNU 88	0.745	0.255	12.113	Rd<MR	0.0102	0.173
BTA 88	0.740	0.260	12.772	Rd<MR	0.0102	0.174
BBI 88	0.741	0.259	12.623	Rd<MR	0.0102	0.173
UBP 88	0.749	0.251	11.238	Rd<MR	0.0102	0.175
BFB 88	0.755	0.245	9.068	Rd<MR	0.0102	0.190
BFE 88	0.722	0.278	8.751	Rd<MR	0.0102	0.305
CPP 88	0.754	0.246	8.579	Rd<MR	0.0102	0.200
BCP 88	0.797	0.203	3.334	Rd<MR	0.0178	0.737
MG 88	0.696	0.304	6.703	Rd<MR	0.0107	0.394
CLP 88	0.943	0.057	1.378	Rd=MR	0.0052	0.585
BCI 88	0.676	0.324	7.291	Rd<MR	0.0168	1.009
BBV 88	0.924	0.076	1.848	Rd<MR	0.0060	0.624
MANUF 88	0.899	0.101	3.098	Rd<MR	0.0045	0.361
BCA 88	0.635	0.365	10.006	Rd<MR	0.0083	0.498
BNP 88	0.902	0.098	2.999	Rd<MR	0.0044	0.356
BARCL 88	0.946	0.054	2.356	Rd<MR	0.0129	1.101
CITI 88	0.894	0.106	3.296	Rd<MR	0.0047	0.371
CHASE 88	0.887	0.113	3.557	Rd<MR	0.0050	0.386
BRASIL 88	0.802	0.198	3.631	Rd<MR	-0.0021	-0.001
BPA 89	0.824	0.176	6.206	Rd<MR	0.0105	0.115
BESCL 89	0.766	0.234	9.929	Rd<MR	0.0105	0.174
BPSM 89	0.756	0.244	11.105	Rd<MR	0.0105	0.182
BTA 89	0.769	0.231	12.867	Rd<MR	0.0105	0.175
BNU 89	0.780	0.220	11.488	Rd<MR	0.0105	0.175
BBI 89	0.776	0.224	12.397	Rd<MR	0.0105	0.174
UBP 89	0.779	0.221	11.615	Rd<MR	0.0105	0.175
BCP 89	0.847	0.153	2.612	Rd<MR	0.0182	0.662
BFB 89	0.785	0.215	9.487	Rd<MR	0.0105	0.185
CPP 89	0.785	0.215	8.474	Rd<MR	0.0105	0.200
BFE 89	0.749	0.251	8.617	Rd<MR	0.0105	0.316
MG 89	0.727	0.273	6.701	Rd<MR	0.0110	0.395
CLP 89	0.980	0.020	0.510	Rd=MR	0.0053	0.572
BCI 89	0.722	0.278	6.553	Rd<MR	0.0165	0.978
BBV 89	0.952	0.048	1.245	Rd=MR	0.0064	0.631
MANUF 89	0.978	0.022	1.109	Rd=MR	0.0132	1.100
BARCL 89	0.976	0.024	1.226	Rd=MR	0.0133	1.104
BCA 89	0.664	0.336	9.338	Rd<MR	0.0087	0.502
BNP 89	0.940	0.060	1.994	Rd<MR	0.0044	0.342
CITI 89	0.922	0.078	2.690	Rd<MR	0.0051	0.377
CHASE 89	0.918	0.082	2.824	Rd<MR	0.0053	0.385
BRASIL 89	0.833	0.167	3.176	Rd<MR	-0.0018	-0.001

BANK / YEAR	MARKET POWER - INT RATE				ADVERT	BRANCH
	Value	Test	t Stat	Concl	eA/(1+eRD)	eB/(1+eRD)
BPA 90	0.787	0.213	9.163	Rd<MR	0.0106	0.163
BESCL 90	0.766	0.234	9.621	Rd<MR	0.0106	0.183
BPSM 90	0.767	0.233	10.777	Rd<MR	0.0106	0.182
BTA 90	0.713	0.287	7.084	Rd<MR	0.0098	0.289
BCP 90	0.855	0.145	2.563	Rd<MR	0.0183	0.650
BNU 90	0.792	0.208	10.636	Rd<MR	0.0106	0.178
BBI 90	0.789	0.211	11.460	Rd<MR	0.0106	0.175
UBP 90	0.792	0.208	10.445	Rd<MR	0.0106	0.178
BFB 90	0.794	0.206	9.376	Rd<MR	0.0106	0.185
CPP 90	0.795	0.205	8.465	Rd<MR	0.0106	0.197
BFE 90	0.751	0.249	8.677	Rd<MR	0.0106	0.335
MG 90	0.735	0.265	6.745	Rd<MR	0.0111	0.400
BCI 90	0.756	0.244	5.581	Rd<MR	0.0156	0.928
CLP 90	0.985	0.015	0.388	Rd=MR	0.0056	0.582
BBV 90	0.967	0.033	0.862	Rd=MR	0.0063	0.619
MANUF 90	0.989	0.011	0.562	Rd=MR	0.0132	1.097
BARCL 90	0.994	0.006	0.291	Rd=MR	0.0130	1.086
BCA 90	0.672	0.328	9.021	Rd<MR	0.0089	0.507
BNP 90	0.942	0.058	1.999	Rd<MR	0.0048	0.356
CITI 90	0.933	0.067	2.347	Rd<MR	0.0052	0.374
CHASE 90	0.928	0.072	2.537	Rd<MR	0.0054	0.384
BRASIL 90	0.844	0.156	3.002	Rd<MR	-0.0018	-0.003
BPA 91	0.808	0.192	7.320	Rd<MR	0.0109	0.173
BESCL 91	0.795	0.205	7.948	Rd<MR	0.0109	0.185
BTA 91	0.774	0.226	6.266	Rd<MR	0.0114	0.264
BCP 91	0.883	0.117	2.186	Rd<MR	0.0186	0.646
BPSM 91	0.799	0.201	9.015	Rd<MR	0.0109	0.181
BNU 91	0.824	0.176	8.639	Rd<MR	0.0109	0.183
BFB 91	0.825	0.175	8.287	Rd<MR	0.0109	0.186
BBI 91	0.822	0.178	9.418	Rd<MR	0.0109	0.178
UBP 91	0.825	0.175	8.101	Rd<MR	0.0109	0.189
CPP 91	0.825	0.175	7.679	Rd<MR	0.0109	0.195
BFE 91	0.779	0.221	7.814	Rd<MR	0.0109	0.340
BCI 91	0.817	0.183	3.992	Rd<MR	0.0186	0.862
MG 91	0.763	0.237	6.652	Rd<MR	0.0114	0.405
BBV 91	1.013	-0.013	-0.361	Rd=MR	0.0060	0.588
CLP 91	1.021	-0.021	-0.565	Rd=MR	0.0057	0.572
MANUF 91	1.016	-0.016	-0.828	Rd=MR	0.0137	1.105
BARCL 91	1.069	-0.069	-1.940	**Rd>MR**	0.0142	1.035
BCA 91	0.702	0.298	7.997	Rd<MR	0.0092	0.507
BNP 91	1.029	-0.029	-1.490	Rd=MR	0.0132	1.079
CITI 91	0.962	0.038	1.411	Rd=MR	0.0056	0.379
BRASIL 91	0.874	0.126	2.458	Rd<MR	-0.0014	-0.003
CHASE 91	0.955	0.045	1.657	Rd<MR	0.0058	0.393

	MARKET POWER - INT RATE				ADVERT	BRANCH
BANK / YEAR	**Value**	**Test**	**t Stat**	**Concl**	**eA/(1+eRD)**	**eB/(1+eRD)**
BPA 92	0.862	0.138	3.632	Rd<MR	0.0123	0.265
BTA 92	0.873	0.127	3.340	Rd<MR	0.0123	0.254
BESCL 92	0.863	0.137	3.961	Rd<MR	0.0123	0.264
BCP 92	0.962	0.038	0.761	Rd=MR	0.0195	0.645
BPSM 92	0.895	0.105	3.481	Rd<MR	0.0118	0.178
BFE 92	0.863	0.137	3.925	Rd<MR	0.0118	0.349
BNU 92	0.913	0.087	3.075	Rd<MR	0.0118	0.190
BFB 92	0.891	0.109	3.679	Rd<MR	0.0123	0.277
BBI 92	0.913	0.087	3.001	Rd<MR	0.0118	0.197
UBP 92	0.856	0.144	4.201	Rd<MR	0.0110	0.326
CPP 92	0.855	0.145	4.201	Rd<MR	0.0110	0.327
BCI 92	0.913	0.087	1.917	Rd<MR	0.0195	0.845
MG 92	0.838	0.162	5.186	Rd<MR	0.0123	0.437
CLP 92	1.093	-0.093	-2.374	**Rd>MR**	0.0072	0.605
BBV 92	1.101	-0.101	-2.589	**Rd>MR**	0.0069	0.590
BARCL 92	1.164	-0.164	-4.013	**Rd>MR**	0.0148	1.020
MANUF 92	1.100	-0.100	-3.386	**Rd>MR**	0.0147	1.114
BCA 92	0.785	0.215	4.654	Rd<MR	0.0103	0.518
BNP 92	1.104	-0.104	-3.570	**Rd>MR**	0.0146	1.106
CITI 92	1.047	-0.047	-1.446	Rd=MR	0.0065	0.386
BRASIL 92	0.960	0.040	0.752	Rd=MR	-0.0005	0.003
CHASE 92	1.041	-0.041	-1.251	Rd=MR	0.0068	0.397

Chapter Three

Banking Markets Imperfections and the Measurement of Interest Rate Risk

3.1. Introduction

The theoretical foundations of the interest rate risk exposure of financial intermediaries have received substantial attention by both academics and practitioners. At the beginning, the *immunisation of net interest margin* was the major concern for researchers, and the idea of matching *sensitive* assets and liabilities received a growing interest which resulted in a large number of articles devoted to what was called *gap management*. Later, the influence of interest rate movements on the *market value* of the intermediary received increased attention in the literature, and the articles by Simonson and Hempel (1982), Toevs (1983), Bierwag and Kaufman (1983, 1985) and Dermine (1985) are good examples. Kaufman (1984) and Dermine (1987a) provide simple and comprehensive approaches to the problem. More recently, Bierwag and Kaufman (1991) adapted the duration gap management to the use of off-balance sheet hedging instruments.

Empirical studies have, so far, been based on Stone's (1974) two-factor model, and seem to show evidence of the sensitivity of bank's stock returns to interest rate changes. Recent articles of Kwan (1991), Kohers and Nagy (1991), Akella and Greenbaum (1992) and Neuberger (1992) provide good reviews on this literature.

The extensive literature on this subject, now mostly oriented towards the needs of practitioners[37] , seems to be completely stabilised and we may say, as Dermine (1985, pg 86), "*one may wonder what more can be written on the management of interest rate risk*". In this last paper, the perfect competition hypothesis, which is usually adopted in the literature, is replaced by imperfect competition and demand elasticities of deposits were incorporated in the solution. In this chapter, there are two major departures from the current interest rate risk literature: Operating costs are no longer ignored and a profit (or market value) maximisation behaviour by the financial intermediary is explicitly incorporated. Moreover, it is proved that under a profit (or market value) maximisation framework Dermine's (1985) result is not valid. In a latter section, competitive effects are explored, yielding conclusions based on oligopolistic interaction.

More recently, the debate on the measuring of interest rate risk has gained special importance as a result of the American *savings and loans* debacle and the proposals issued by the Basle Committee on Banking Supervision (BIS, 1993). The purpose of that document is to provide a measure to be used for supervision purposes and to compute a capital requirement for banks demonstrating an exposure exceeding some pre-determined level[38].

The specific purpose of this chapter is to assess the degree to which market imperfections may affect the usual duration measures of interest rate risk exposure. If they are relevant then by neglecting them the measure proposed by the Basle Committee on Banking Supervision may in fact create distortions in the requirements of bank capital. More specifically, if the measure is biased in one particular direction,

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[37]Antl (1988), Gilbert (1988), Smith et al (1990) and many others.
[38]A good review on this subject is provided by Dermine (1993).

then exposed banks would perhaps be incorrectly considered "hedged" while hedged banks may improperly be forced to raise capital to cover incorrectly measured exposures. As capital is the most expensive source of funds, this means that the BIS formula may result on the imposition of additional costs upon the wrong institutions.

This chapter is organised as follows: The next section presents the rationale for the modelling of interest rate risk under an imperfect competition (monopoly) and profit maximisation framework, and results are computed for this situation, showing the shortfalls of Dermine's (1985) approach. Section 3 deals with the measuring of interest rate risk by a monopolist bank and in Section 4 the same results are derived for a competitive (oligopolistic) framework. Section 5 provides the chapter's main conclusions.

3.2. The Basic Framework

3.2.1. Introduction

In this section a Klein (1971) type model of a monopolist bank is developed in order to evaluate the implications of the introduction of market imperfections under a profit maximisation framework, together with the inclusion of real resources operating costs, thus allowing us to perform a test on the validity of Dermine's (1985) conclusions under a more general situation. Additional considerations about the management of interest rate risk based on bank's optimal behaviour make this model fall into what Anthony Santomero (1984, pg 596) designated "*two side models of the* *banking firm*", in which balance sheet dimension, composition and articulation between assets and liabilities are endogenous.

The neglecting of banks' operating costs in Dermine's (1985) model must be considered odd[39] , since he assumes that changes in market determined interest rates affect both prices (interest) and quantities for each intermediary. So, those changes in dimension and composition of the balance sheet will certainly influence the bank's costs, and thus should be included in any model of imperfect competition. Nevertheless, Akella and Greenbaum (1992) is the only article on this subject where a real resources operating costs function is specifically included, although those authors do not explore the potential influence of this type of cost over interest rate risk exposure.

Moreover, imperfect competition helps banks to survive in the financial market and generate shareholder value[40] . In fact, if this market were perfect, there would be a very small place for financial intermediation. It is the information service provided by banks, as discussed notably in Diamond (1984) and Fama (1985) that is the main reason for their existence. Hence, Dermine's (1985) break with the traditional perfect market approach was a significant step in the right direction. That is why Santomero (1989) classified that model as an exception to the "*infancy stage*" of optimal behaviour modelling in banking.

Thus, the measuring of interest rate risk in banking demands much more than the simple computation of a duration gap, such as that in Kaufman (1984), rather requiring a more complex approach.

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[39]Baltensperger (1980) in the highly quoted survey severely criticizes banking literature for its common negligence of real resources costs. Nevertheless, Santomero (1984, pg 588) comments on it by saying, "Although (...) these criticisms are entirely correct, they do not appear to be particularly relevant or fundamental". In this paper it will be proved that operating costs influence interest rate risk exposure.
[40]See Dermine (1987b).

Optimisation behaviour is a crucial part of any imperfect competition model. In fact, it is difficult to justify the changes in the bank's "own" interest rates in response to fluctuations in Government securities' rates without explicitly modelling the bank's objectives and instruments. By ignoring this we may find a solution which is not consistent with the optimal behaviour of such institutions.

3.2.2. The Monopoly Model

The model's assumptions are:

i) The bank holds four kinds of assets: Cash reserves (R) which are a fraction ρ of total deposits, Government Securities and Money Market investments (S), Loans (L) and Physical Capital (K); S may be negative, meaning funding from money market sources;

ii) The bank is funded with both Deposits (D) and Equity Capital (E);

iii) As in Klein (1971) the bank is monopolist in its "own" products, thus not being affected by competitors' rates changes;

iv) Banks face a continuously twice differentiable demand function for deposits $D(r_D,r_S)$, where r_D is the interest rate on deposits, r_S the interest rate on Government securities, $\partial D/\partial r_D > 0$, and $\partial D/\partial r_S \leq 0$;

v) Banks face a continuously twice differentiable demand function for loans $L(r_L,r_S)$, where r_L is the rate charged on loans and $\partial L/\partial r_L < 0$;

vi) Banks are price-takers in a perfectly competitive money market / market for Government securities;

vii) Bank equity capital is exogenous and constant;

viii) The bank is in a stationary state and maximises its market value, using r_D and r_L as instruments;

ix) Operating costs are given by a Variable cost function $VC = VC(D,L)$, where $\partial VC/\partial D>0$, and $\partial VC/\partial L>0$, and real resources fixed costs (OFC);

x) Banks live perpetually and all profits are paid out as dividends where taxes are ignored on both profits and dividends;

xi) Credit Risk is ignored, so r_L may be seen as the *certainty equivalent* of the interest rate effectively charged on loans. Liquidity risk is ignored, as it is assumed that ρD is enough to face normal levels of withdrawals;

xii) The term structure of interest rates is flat and the bank's market power and "own" interest rates do not depend on assets and liabilities' maturities.

As the reader may, perhaps notice, these are basically the hypotheses of Dermine's (1985) article with the exceptions of (i) and (v) because we explicitly differentiate assets in securities (where bank is price-taker), loans (where bank is price-setter) and non-earning cash reserves; (viii) which states the optimisation objective; and (ix) a real resources cost function is included.

Given the hypothesis above, the bank's objective will be the maximisation of present value of future cash-flows (CF):

$$\underset{\{r_L, r_D\}}{\text{Max}} \ MV = \frac{1}{r_S} CF \tag{3.1}$$

s.t:

$$\rho D + S + L + K = D + E \tag{3.2}$$

where MV denotes the bank's market value and CF the bank's next period (steady state) short-run cash-flow. The latter may be expressed as:

$$CF = r_L.L + r_S.S - r_D.D - VC(D,L) - OFC \tag{3.3}$$

Maximisation of (3.1) is equivalent to the maximisation of (3.3) since r_S is a given exogenous parameter. Thus, the problem is equivalent to the maximisation of the bank's profits subject to the balance sheet constraint (3.2). So, solving (3.2) for S and replacing in (3.3) and keeping in mind that economic profit accounts for the cost of equity financing, the bank's problem becomes[41]:

$$\underset{\{r_L, r_D\}}{\text{Max}} \ \Pi = (r_L - r_S)L + (r_S(1-\rho) - r_D)D - (r_E - r_S)E - VC(D,L) - r_S K - OFC \tag{3.4}$$

Expression (3.4) above decomposes the bank's economic profit into five components. The first two items correspond to the margins generated by loans and deposits, respectively, which are the bank's revenues. Then, there are three cost items. The first

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[41] In this model economic profit is equal to cash flow minus the rate of return required by shareholders. The latter is excluded from cash-flow because it represents an opportunity cost of capital, rather than a cash payment.

is the costs associated with the use of equity, whose cost (r_E) is equal to the money market (risk free) rate in this model since all systematic (market) risk was excluded, thus making this term equal to zero. The other two are the variable and fixed costs. The latter may be decomposed into a real resources component (OFC) and the financial opportunity cost of the physical capital investments.

Ignoring corner solutions, the first order conditions for a maximum are (see Appendix 3.1):

$$\frac{\partial \Pi}{\partial r_L} = 0, \quad \frac{\partial \Pi}{\partial r_D} = 0 \qquad (3.5)$$

And so, from now on, it will be assumed that the bank follows the optimal behaviour described by the above conditions.

Let the market value (MV) of the banking firm be defined as the present value of future cash-flows:

$$MV = \frac{1}{r_S}\left[r_L.L + r_S.S - r_D.D - VC(D,L) - OFC\right] \qquad (3.6)$$

Which after a few analytical manipulations may be expressed as[42]:

$$MV = \rho D + V_L + V_S - V_D + \frac{1}{r_S}\left[(r_L - r_S)L + \left(r_S(1-\rho) - r_D\right)D - VC - OFC\right] \qquad (3.7)$$

42 The derivation here is analogous to Guttentag and Herring (1983) and Dermine (1985)

which is a Guttentag-Herring (1983) type expression for the market value of the banking firm. As in that article, the market value has two major components. First, there is the difference between the *market values* of assets and liabilities, represented by ρD, V_L, V_S and V_D as the values for cash holdings, loans, securities and deposits, respectively. Second, there is the value of the bank as a going concern, usually designated by *goodwill* (GW), thus:

$$GW = \frac{1}{r_S}\left[(r_L - r_S)L + \left(r_S(1-\rho) - r_D\right)D - VC(D,L) - OFC\right] \qquad (3.8)$$

and recalling expression (3.4):

$$GW = \frac{1}{r_S}[\Pi + r_S K] \qquad (3.9)$$

So, the bank's market value is now separated into two components which will be differently affected by changes in interest rates. Cash holdings have a constant market value in the present but the other assets and liabilities are subject to interest rate risk, since their market values fluctuate inversely to interest rate moves. Thus a duration-like measure, as is usually undertaken in the literature, is essential for the measuring of balance sheet exposure. Then, as Dermine (1985, pg 88) pointed out, there is also the exposure of goodwill. In fact, as that author said "*As the margin is likely to fluctuate over time, one must take into consideration the future interest rate differentials and volumes of deposits*[43] *to evaluate the market value of the intermediary*". In other words, interest rate fluctuations affect both margins and quantities and, consequently, goodwill.

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[43]And loans, in this article.

Despite the importance of this result, some authors, namely Bierwag and Kaufman (1983, 1985, 1991), still neglect the importance of the goodwill component of bank's market value and its corresponding interest rate sensitivity. That approach, in my view, although useful for the understanding of the impact of interest rate changes on the bank's assets and liabilities' market values, is incomplete and fails to capture the competitive nature of banking. Nevertheless, the two approaches may be seen as complementary and focusing on two different components of banks' interest rate risk. Thus, in this paper particular focus is made on the goodwill component.

In order to analyse this problem we have to calculate a measure of exposure and see which factors influence goodwill's sensitivity to interest rate changes. That is the purpose of the following section.

3.3. Measurement of Exposure in the Monopoly Case

3.3.1. Effective Duration Gap and Optimal Rate Setting

A change in the exogenous rate (r_s) will have two effects on the bank's value: the change in the *current* market value of assets and liabilities, associated with the change in their discount rate, plus the change in the bank's goodwill. This last effect results from the change in *future* profits associated with the new prices and quantities that will prevail in deposit and loan markets. Thus,

$$\frac{dMV}{dr_S} = \frac{\partial V_L}{\partial r_L}\frac{dr_L}{dr_S} + \frac{\partial V_S}{\partial r_S} - \frac{\partial V_D}{\partial r_D}\frac{dr_D}{dr_S} + \frac{dGW}{dr_S} \tag{3.10}$$

converting (3.10) to elasticities:

$$\eta_{MV,r_S} = \eta_{V_L,r_L}\eta_{r_L,r_S}\frac{V_L}{MV} + \eta_{V_S,r_S}\frac{V_S}{MV} - \eta_{V_D,r_D}\eta_{r_D,r_S}\frac{V_D}{MV} + \eta_{GW,r_S}\frac{GW}{MV} \tag{3.11}$$

where $\eta_{x,y}$ denotes the elasticity of variable x relative to y (Δ%X/Δ%Y).

The interest rate sensitivity of assets and liabilities is measured by the asset's (liability) *effective duration* (sometimes called *interest-elasticity*). For securities (and analogously for the others):

$$\eta_{V_S,r_S} = \frac{\partial V_S}{\partial r_S}\frac{r_S}{V_S} = \frac{\partial V_S}{\partial(1+r_S)}\frac{1+r_S}{V_S}\frac{r_S}{1+r_S} = -D_S\frac{r_S}{1+r_S} \tag{3.12}$$

where, D_S is a securities' Macauley's (1938) duration (and $r_S D_S/(1+r_S)$ is the correspondent *effective duration*).

Expression (3.11) is analogous to Dermine's (1985) when we ignore the market for loans, showing that interest rate sensitivity of a bank's market value is a weighted average of assets', liabilities' and goodwill's sensitivity. So, it is impossible to disagree when he says "*The formula is more complex than usual (...) as it takes in account the interest rate sensitivity of goodwill. (...) duration gap between assets and liabilities should be related to interest rate sensitivity of goodwill*"[44] .

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[44] Dermine (1985), pg 89.

Using the optimal values for interest rates in Appendix 3.1, and assuming constant elasticities of demand, it becomes clear that:

$$\eta_{r_L,r_S} = \frac{r_S}{r_S + \partial C/\partial L} \tag{3.13}$$

$$\eta_{r_D,r_S} = \frac{r_S}{r_S(1-\rho) - \partial C/\partial D} \tag{3.14}$$

From expressions (3.12) to (3.14) it becomes clear that the sensitivity of goodwill is not the only factor that makes the "traditional" duration gap analysis inappropriate, since the impact of durations associated with assets and liabilities for which the banks compete in imperfect markets are weighted by the sensitivity of "own" rates to those of the competitive market. For loans, its duration is multiplied by a factor (3.13) which is always less than one, whilst for deposits (3.14) is always greater than unity. This means that a traditional zero effective duration gap strategy is, in fact, a situation corresponding to a positive sensitivity of the market value of the firm to changes in securities rates.

It is important is to note the consequence of ignoring marginal costs. If they are assumed to be irrelevant, elasticity (3.13) will be equal to one, but (3.14) will be $1/(1-\rho)$ which is greater than one, and therefore the argument against the use of the "traditional" duration gap indicator as a measure of exposure would remain and does not depend upon just the need to consider the sensitivity of goodwill. As a matter of fact, only if both operating costs and required reserves are ignored, will the difference between (3.11) and traditional approaches depend exclusively on goodwill.

In short, if all market imperfections are ignored, then the traditional duration gap analysis is correct. Consideration of monopoly power implies the need to account for the sensitivity of goodwill. Additional consideration of financial intermediation costs, i.e., bank's real resources costs and required cash reserves, introduce a bias on the so-called "mutual fund type" duration gap measures. And the higher such costs are, the higher that bias will be.

It is also interesting to note that the sensitivity of "own" rates depends not on elasticities of demand (as in Dermine, 1985) but on the absolute values of securities rates and marginal costs, instead[45]. If, for the moment, we ignore goodwill, it becomes clear that the higher the marginal costs are (and required reserves which are just another type of cost), the higher the value of $\eta_{MV,Rs}$ will be. In other words, increases in banking marginal costs act, in relation to interest rate risk exposure, in the same way as an increase in duration of liabilities. On the other hand, the influence of this sensitivity of "own" rates to market rate moves is more important for low values of the securities rate, which makes the inappropriateness of the traditional duration gap analysis more relevant under low interest rates. Another effect of the securities' rate is associated with convexity, since the higher this rate is, the lower will be the effective duration for both assets and liabilities.

Although the above conclusions are based on the effective duration measure, most of them remain valid under alternative duration measures. Among them are the need to incorporate the sensitivity of goodwill and the existence of an impact of market imperfections on exposure. The only difference is that under modified duration and Macauley's duration a perfect hedge for assets and liabilities will require a higher duration for the latter. See appendix 3.3 for details.

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[45]This conclusion results from the constant elasticity assumption. Nevertheless, the use of a more general assumption is not likely to significantly change the magnitude of the above elasticities, and has the disadvantage of implying a much more complicated analytical framework.

3.3.2. The Sensitivity of Goodwill

In order to evaluate the sensitivity of goodwill to market rates, one has to differentiate it with respect to r_S (recall expression 3.8):

$$\frac{dGW}{dr_S} = \frac{1}{r_S}\left(\frac{d\Pi}{dr_S} + K - GW\right) \tag{3.15}$$

This means that changes in market interest rates have two effects upon the bank's goodwill: the effect over future profits and the other on the opportunity cost of capital used to discount future cash-flows. The first deserves closer attention:

$$\frac{d\Pi}{dr_S} = \frac{\partial\Pi}{\partial r_L}\frac{dr_L}{dr_S} + \frac{\partial\Pi}{\partial r_D}\frac{dr_D}{dr_S} + \frac{\partial\Pi}{\partial r_S} \tag{3.16}$$

Recall that optimising behaviour was explicitly introduced in the model, requiring conditions (3.5) to be always satisfied by the bank. In other words, this *derivative* is a simple application of the widely known *envelope theorem*:

$$\frac{d\Pi}{dr_S} = \frac{\partial\Pi}{\partial r_S} \tag{3.17}$$

Thus, Dermine's (1985) total differential approach is not valid in a profit (or market-value) maximisation context. In other words, in that article, an expression similar to (3.16) is used, since that author, by ignoring first order conditions, uses the total differential of the profit function with respect to the market rate, while it is possible to show that for a profit maximising bank only the partial effect $\partial\Pi/\partial r_S$ is relevant. Thus, the correct expression for goodwill's sensitivity is:

$$\frac{dGW}{dr_S} = \frac{1}{r_S}\left[D(1-\rho) - L + \frac{\partial D}{\partial r_S}\left(r_S(1-\rho) - r_D - C_D\right) + \frac{\partial L}{\partial r_S}\left(r_L - r_S - C_L\right) - GW\right] \tag{3.18}$$

where C_D represents $\partial C/\partial D$ and C_L represents $\partial C/\partial L$.

So, changes in market rates have three effects on goodwill. One, is the direct effect over bank's *current* margins, which we may call an *income effect*. Another is the impact on future margins resulting from the consequent change of the balance sheet composition, since depositors and lenders will adjust their demands to the new conditions of the securities market. This is a *substitution effect*. Effects resulting from changes in the bank's competition instruments are irrelevant by verification of first order conditions. The last effect is due to the change in bank stockholders' opportunity cost of capital. Converting the expression above into an elasticity form:

$$\eta_{GW,r_S} = \frac{D}{GW}\left[1-\rho+\frac{r_S(1-\rho)-r_D-C_D}{r_S}\eta_{D,r_S}\right] - \frac{L}{GW}\left[1-\frac{r_L-r_S-C_L}{r_S}\eta_{L,r_S}\right] - 1 \tag{3.19}$$

It is now interesting to compare (3.19) with Dermine's expression. In his model we have L=0, ρ=0 and C=0. Thus, (3.19) is reduced to:

$$\eta_{GW,r_S} = \frac{D}{GW}\left[1+\frac{r_S-r_D}{r_S}\eta_{D,r_S}\right] - 1 \tag{3.20}$$

and the bank's goodwill is now:

$$GW = \frac{r_S - r_D}{r_S}D \tag{3.21}$$

which allows (3.20) to be further simplified to:

$$\eta_{GW,r_S} = \eta_{D,r_S} + \eta_{D,r_D} \qquad (3.22)$$

One of the interesting aspects of the above expression is its simplicity. The interest rate sensitivity of goodwill is easily expressed as simply the sum of the two elasticities of demand. This simple result is modified by the introduction of operating costs in the model.

On the other hand, we have an alternative result proposed by Jean Dermine (1985, expression 3.9), which is:

$$\eta_{GW,r_S} = \eta_{D,r_D}\eta_{r_D,r_S} + \eta_{D,r_S} + \eta_{X,r_S} \qquad (3.23)$$

where:

$$X = \frac{r_S - r_D}{r_S}$$

Expressions (3.22) and (3.23) should be equal, but there are two main differences between them: the terms η_{r_D,r_S} and η_{X,r_S}. These differences result directly from Dermine's implicit assumption on the exogeneity of the bank's "own" interest rates.

In imperfect competition models firms, are not price-takers but, rather, price setters. So, η_{r_D,r_S} is not exogenous to the firm since it represents the bank's optimal reaction to changes in the market (exogenous) rates. Recalling the first order conditions and assuming that the bank is free to set its own deposit rate, then, making $C_D = 0$ in expression (3.14) yields $\eta_{r_D,r_S} = 1$. But by mere application of the envelope theorem (expression 3.17), this elasticity plays no role in the determination of interest rate exposure. In other words, in such a context, marginal responses of deposit and loans' rates to securities' yields are zero by first order conditions. Thus, (3.23) must be reduced to:

$$\eta_{GW,r_S} = \eta_{D,r_S} + \eta_{X,r_S} \tag{3.24}$$

and η_{X,r_S} has to be calculated using the partial derivative (that is assuming deposit rate to be fixed). Then:

$$\eta_{X,r_S} = \frac{D}{GW} - 1 = \frac{r_S}{r_S - r_D} - 1 = \frac{r_D}{r_S - r_D} = \eta_{D,r_D} \tag{3.25}$$

Thus, Dermine's expression (3.23), by using the optimal expression for r_D, is reduced to:

$$\eta_{GW,r_S} = 2.\eta_{D,r_D} + \eta_{D,r_S} \tag{3.26}$$

Expressions (3.22) and (3.26) have just one difference: the elasticity of deposits with respect to their interest rate is doubled in (3.26). In other words, the neglect of the first order condition (expression 3.5) on the evaluation of the total differential (expression 3.16), generates a measurement error which overestimates exposure. It is the wrongly added η_{r_D,r_S} term that is responsible for this result.

The appropriate measure of exposure is given by (3.22). That elasticity will almost certainly be positive, since it is usually assumed that deposits are more sensitive to their "own" rate than to their opportunity cost (r_S). This means that increases in the market interest rate will increase the *charter value* of the bank, because deposit interest costs will rise less than security interest revenues, thus generating higher net interest margins, which more than outweighs the effect of the increase in shareholders′ opportunity cost of capital.

If we drop some of Dermine's implicit assumptions allowing for the existence of required (or voluntary) cash reserves and introducing operating costs, expression (3.22) will be slightly modified. Continuing to ignore loans and assuming constant marginal costs, the expression for *goodwill* becomes:

$$GW = \frac{1}{r_S}\left[r_S(1-\rho) - r_D - C_D\right].D \tag{3.27}$$

and expression (3.19) is now reduced to:

$$\eta_{GW,r_S} = \frac{D}{GW}\left[1-\rho+\frac{r_S(1-\rho)-r_D-C_D}{r_S}\eta_{D,r_S}\right] \tag{3.28}$$

which, after substitution of (3.27) in (3.28) and introduction of the optimal expression for r_D^*, becomes:

$$\eta_{GW,r_S} = \eta_{D,r_S} + \left(1+\frac{C_D}{r_D^*}\right)\eta_{D,r_D} \tag{3.29}$$

Expression (3.29) is even more likely to be positive than its particular case (3.22), since the positive component is now affected by a factor greater than one. One obvious conclusion arises from this expression: operating costs increase the interest rate sensitivity of goodwill.

The impact of operating costs may be easier to understand if expressed as (see Appendix 3.1):

$$\frac{C_D}{r_D^*} = \frac{1+\eta_{D,r_D}}{\eta_{D,r_D}} \frac{C_D}{r_S(1-\rho)-C_D} \tag{3.30}$$

And replacing (3.30) in (3.29) makes this last expression easier to understand:

$$\eta_{GW,r_S} = \eta_{D,r_S} + \eta_{D,r_D} + \frac{C_D}{r_S(1-\rho)-C_D}\left(1+\eta_{D,r_D}\right) \tag{3.31}$$

As we can see, the left hand side of (3.31) exceeds the value of (3.24) because the first is equal to the sum of the last with a positive number related to deposits' operating costs. Thus, once again, we face an additional effect, usually neglected in the interest rate risk literature, which makes a positive contribution to the interest rate sensitivity of goodwill: The relation between operating costs and market interest rates. This effect is particularly important for lower levels of the security rate. As that rate rises, C_D/r_D^* declines, thus reducing this *operating leverage* (based on marginal costs) effect on the bank's interest sensitivity of goodwill. So, *ceteris paribus*, the less cost-efficient banks will face higher interest rate risk.

In expression (3.19) both deposit and loan markets were already considered in respect to their contribution to the interest rate sensitivity of goodwill. In order to take advantage of result (3.29), an additional hypothesis is introduced: the cost function is separable, has a fixed cost (OFC) element and marginal costs are constant[46], that is:

$$C(D,L) = OFC + C_D\,D + C_L\,L \tag{3.32}$$

[46]Although this assumption is made for analytical convenience, it requires no cost subadditivity and constant returns to scale which are not rejected by most empirical studies on banking costs functions. See Forestieri (1993).

In that case the bank's goodwill is also separable into two components, one attributable to deposit market imperfections (GW_D) and the other to loan market's (GW_L), that is $GW = GW_D + GW_L - OFC/r_S$, where GW_D is given by (3.24) and:

$$GW_L = \frac{1}{r_S}\left[r_L - r_S - C_L\right].L \tag{3.33}$$

Expression (19) can now be rewritten as:

$$\eta_{GW,rs} = \frac{GW_D}{GW}\eta_{GWd,rs} + \frac{GW_L}{GW}\eta_{GWl,rs} + \frac{OFC / r_S}{GW} \tag{3.34}$$

where:

$$\eta_{GW_D,r_S} = \eta_{D,r_S} + \left(1 + \frac{C_D}{r_D^*}\right)\eta_{D,r_D} \quad (>0) \tag{3.35}$$

$$\eta_{GW_L,r_S} = \eta_{L,r_S} + \left(1 - \frac{C_L}{r_L^*}\right)\eta_{L,r_L} \quad (<0) \tag{3.36}$$

From the above it is clear that increases in the security rate raises the goodwill associated with deposits. Despite facing a higher opportunity cost for discounting future profits, that movement allows increases in the bank's deposit rate which will imply higher margins and higher volumes of deposits, thus making (3.35) be always positive. Therefore, whenever interest rates rise, the bank's owners will profit from a reduction of the market value of liabilities and an increase in their associated discounted future profits.

In relation to loans, the situation is the opposite. Whenever interest rates increase the bank will lose due to a reduction of the market value of *current* loans and the discounted value of the profits associated with future periods. The latter results not only from a higher discount rate, but also from reduced future loan demand. Therefore deposits and loans have an opposite impact on the bank's exposure, both in terms of market values and in terms of their respective goodwill. In other words, a perfect immunisation strategy implies matching not only the durations of assets and liabilities (adjusted by expression 3.11) but also would have to take care with the sensitivity of goodwill, the sign of which is, *a priori*, undetermined, and has to be estimated case by case.

It is also interesting to note the last part of the expression, i.e., the importance of the present value of fixed costs upon goodwill. Thus it is, the higher the amount of fixed costs the higher the interest rate exposure will be. This is just an operating *leverage effect*, based upon the fixed costs, and it is obvious that this effect is increasing on OFC and decreasing on r_S . The latter is due to the obvious fact that, the higher the security rate is, the lower will be the present value of future fixed costs. Thus, for banks, as for any other firm, the higher the fixed costs are, the higher the risk exposure to economic fluctuations will be.

Another meaningful alternative for (3.34) is:

$$\begin{aligned}\eta_{GW,r_S} &= \alpha_D\left(\eta_{D,r_S} + \eta_{D,r_D}\right) + \alpha_L\left(\eta_{L,r_S} + \eta_{L,r_L}\right) + \\ &+ \left(\alpha_D \eta_{D,r_D} \frac{C_D}{r_D^*} - \alpha_L \eta_{L,r_L} \frac{C_L}{r_L^*}\right) + \frac{OFC/r_S}{GW}\end{aligned} \tag{3.37}$$

where,

$$\alpha_D = \frac{GW_D}{GW} \quad \text{and} \quad \alpha_L = \frac{GW_L}{GW} \tag{3.38}$$

$$\eta_{D,r_D} \frac{C_D}{r_D^*} = \left(1 + \eta_{D,r_D}\right) \frac{C_D}{r_S(1-\rho) - C_D} \quad (>0) \tag{3.39}$$

$$\eta_{L,r_L} \frac{C_L}{r_L^*} = \left(1 + \eta_{L,r_L}\right) \frac{C_L}{r_S + C_L} \quad (<0) \tag{3.40}$$

From (3.37) to (3.40) we can now see clearly that there are four items contributing to the interest rate sensitivity of goodwill. The first two have opposite signs, but the last two are always positive. This combines the *monopoly power* and the operating costs *operating leverage* effects, the first associated with marginal costs and the last with fixed costs.

The higher the bank's monopoly power is the lower will be its goodwill exposure. This results directly from the fact that, in a competitive framework, powerful banks will have lower reactions to security rate moves than small fringe competitors. On the other hand, the cost-inefficient banks will suffer from a high operating leverage effect that increases their exposure. From (3.39), (3.40) and Appendix 3.1, we can also see that the higher the level of r_S is, the higher will be the *spread* between lending and deposit rates, and the lower will be the impact of operating costs (both fixed and variable) upon the bank's income statement. This is an important result because despite its intuitiveness, these two factors of exposure have so far been ignored in the literature, and are explored in the following sections.

3.3.3. Operating Costs and the Bank's Exposure

From the previous two sub-sections it is possible to conclude that operating costs affect exposure for both components of the market value of a bank (assets-liabilities and goodwill). Consideration of both types of costs (fixed and variable) increases the goodwill's sensitivity. From (3.11), (3.13), (3.14), (3.35) and (3.36), the impact of changes upon the marginal costs of servicing deposits and loans may be computed:

$$\frac{d}{dC_D}\left[\eta_{MV,r_S}\right]=\frac{r_S}{\left(r_S-C_D\right)^2}\left[\frac{GW_D}{MV}\left(1+\eta_{D,r_D}\right)-\frac{V_D}{MV}\eta_{V_D,r_D}\right] \qquad (3.41)$$

$$\frac{d}{dC_L}\left[\eta_{MV,r_S}\right]=\frac{r_S}{\left(r_S+C_L\right)^2}\left[\frac{GW_L}{MV}\left(\left|\eta_{L,r_L}\right|-1\right)-\frac{V_L}{MV}\eta_{V_L,r_L}\right] \qquad (3.42)$$

Both expressions are positive which, combined with considerations made about the fixed cost component, allow us to conclude that cost inefficiency increases have an effect which is similar to an increase in duration of liabilities. This reinforces the conclusion that traditional duration gap analysis is inappropriate for measuring interest rate exposure for financial intermediaries operating in an imperfectly competitive market. For the latter, *perfect immunisation* occurs for a situation in which effective duration of assets exceeds that of liabilities due to their multiplicative factors in (3.11). That "correct" difference depends upon the sign associated with goodwill's exposure and is positively associated with bank costs, and is especially significant at low levels of interest rates.

3.4. Goodwill Exposure for the Oligopolist Bank

In this section, the monopoly assumption is relaxed in order to evaluate how much bias may have been induced in the previous section by this assumption. Now, each bank offers a specific (differentiated from competitor's) type of deposits and loans and is going to face demand functions which will also depend upon the rival's interest rates. From expressions (3.11), (3.13) and (3.14) it became clear that the monopoly power of the bank and oligopolistic behaviour do not affect the sensitivity of the market value of assets and liabilities to changes in riskless securities interest rates. Thus, conclusions obtained in that section regarding the bias of the traditional duration gap concept remain valid under more general assumptions regarding the competitive nature of the markets. Nevertheless, those factors may affect exposure through the interest rate sensitivity of goodwill. Therefore, oligopolistic interaction may only affect our analysis through that component of the market value of the bank, and consequently will constitute the main focus of this section.

Now, and considering n banks, the demand functions for the i^{th} bank will be:

$$D^i = (\mathbf{r}_D, r_S) \quad \text{where} \quad \mathbf{r}_D' = \left[r_D^1, r_D^2, \ldots, r_D^i, \ldots, r_D^n\right] \tag{3.43}$$

$$L^i = (\mathbf{r}_L, r_S) \quad \text{where} \quad \mathbf{r}_L' = \left[r_L^1, r_L^2, \ldots, r_L^i, \ldots, r_L^n\right] \tag{3.44}$$

Concerning the competitive behaviour of firms, the recent article by Timothy Hannan (1991) will be followed, where each firm offers a specific product (on both sides of the balance sheet) and conjectural variations are incorporated in the elasticities of demand. With the exception of (iii), all assumptions made in section 2 are kept and an additional one has to be made in relation to the demand functions:

$\partial D^i / \partial r_D^j \leq 0, \text{ for } j \neq i \quad \text{and} \quad \partial L^i / \partial r_L^j \geq 0, \text{ for } j \neq i$

The first order conditions for a maximum are determined as before and the reader may be interested to see Hannan (1991) in order to analyse the assumptions made. Optimal values for interest rates are the ones given in Appendix 1, but now the elasticities account for market structure and rival's expected reactions. Since this article's focus is not on oligopoly market equilibrium, those problems are not followed here.

Expressions (3.1) to (3.16) are still valid. Application of the *envelope theorem* to determination of interest rate risk will account for the effects of the rival's reactions to security rate changes, but changes in the bank's "own" rates (by first order conditions) are still irrelevant. So, (3.16) becomes:

$$\frac{d\Pi^i}{dr_S} = \frac{\partial \Pi^i}{\partial r_S} + \sum_{j \neq i} \frac{\partial \Pi^i}{\partial r_D^j} \frac{dr_D^j}{dr_S} + \sum_{j \neq i} \frac{\partial \Pi^i}{\partial r_L^j} \frac{dr_L^j}{dr_S} \tag{3.45}$$

For analytical convenience I am going to keep the assumption of separability of the cost function. Thus, interest rate sensitivity of the goodwill generated by deposits and loans may be separated. For deposits:

$$\frac{dGW_D^i}{dr_S} = \frac{1}{r_S}\left[D^i(1-\rho) - GW_D^i - \frac{dr_D^i}{dr_S} D^i + \left(r_S(1-\rho) - r_D^i - C_D^i\right)\left(\frac{\partial D^i}{\partial r_S} + \sum_{j=1}^{n} \frac{\partial D^i}{\partial r_D^j} \frac{dr_D^j}{dr_S} \right) \right] \tag{3.46}$$

Converting into an elasticity, using (3.27) and (3.45), and replacing with zero the total differentials of profit in order to r_L and r_D (first order conditions), we have:

$$\eta^i_{GW_D, r_S} = \frac{D^i(1-\rho)}{GW_D^i} - 1 + \eta_{D_i, r_S} + \left[\sum_{j \neq 1} \eta_{D_i, r_{Dj}} \frac{r_{Di}}{r_{Dj}} \left(\frac{dr_{Dj}/dr_S}{dr_{Di}/dr_S} - \frac{dr_{Dj}}{dr_{Di}} \right) \right] \eta_{r_{Di}, r_S} \tag{3.47}$$

The optimal interest rates given in Appendix 3.1 are only valid for a monopolist bank. For an oligopolist, conjectures about other firms′ reactions to individual decisions have to be incorporated in the solution, because, for deposits, and analogously for loans:

$$\frac{dD^i}{dr_D^i} = \frac{\partial D^i}{\partial r_D^i} + \sum_{j \neq i} \frac{\partial D^i}{\partial r_D^j} \frac{dr_D^j}{dr_D^i} \tag{3.48}$$

The last term is the *conjectural variations* factor. In his article, Hannan (1991) follows Cubbin (1983) and Waterson (1984) and computes an *average conjectural variation* which simplifies the computation of the interest rate elasticity of deposits. Following that approach, optimal values for interest rates are similar to the expressions in Appendix 3.1, with that elasticity defined as:

$$\eta_{D_i, r_{Di}} = \left(1 - \beta_{r_D}\right) \varepsilon_{D_i, r_{Di}} + \beta_{r_D} \hat{\varepsilon}_{D_i, r_{Di}} \tag{3.49}$$

where:

$$\varepsilon_{D_i, r_{Di}} = \frac{\partial D^i}{\partial r_{Di}} \frac{r_D^i}{D_i} \tag{3.50}$$

$$\hat{\varepsilon}_{D_i, r_{Di}} = \left(\frac{\partial D^i}{\partial r_D^i} + \sum_{j \neq i} \frac{\partial D^i}{\partial r_D^j} \right) \frac{r_D^i}{D_i} \tag{3.51}$$

where β_{r_D} is the average reaction ($0 \leq \beta_{r_D} \leq 1$)

Elasticity (3.50) above corresponds to a Cournot conjecture, while the second one is associated with collusive behaviour. With the elasticity (3.49) defined this way, we may treat it as constant, as long as the conjectural variations parameter β remains unchanged, as well as the elasticity of demand. In other words, it no longer represents just the behaviour of demand since it means the elasticity "perceived" by the bank, which takes into account the expected reactions. On the other hand, the "own" elasticity of demand under monopoly conditions is higher than under more competitive conditions: $\varepsilon^M_{D,rD} < \varepsilon_{D,rD} < +\infty$.

In this context, using the optimal expressions for interest rates, expression (3.47) may be converted into:

$$\eta^i_{GW_D,r_S} = \eta_{D_i,r_S} + \left(1 + \frac{C^i_D}{r^i_D}\right)\eta_{D_i,r_{Di}} + \left(\sum_{j \neq i} \eta_{D_i,r_{Dj}} \frac{r_{Di}}{r_{Dj}}\left(\delta_{Dij} - \beta_{r_D}\right)\right)\eta_{r_{Di},r_S} \qquad (3.52)$$

where $\delta_{Dij} = \dfrac{dr_{Dj}/dr_S}{dr_{Di}/dr_S}$

The algebraic difference between (3.35) and (3.52) is just the last sum in this expression, which represents the impact of the competitor's reactions upon security interest rate changes. Nevertheless, the elasticity in the second term now includes conjectural variations and is higher than the value for monopolist banks. The last term is likely to be negative, since $\eta_{D_i,r_{Dj}} \leq 0$ for every $j \neq i$, and the value of the δ's in the expression will be around unity while the β's will always be equal to or less than that value.

It is therefore difficult, quantitatively, to assess the difference between (3.35) and (3.52). Nevertheless, if the "own" effect dominates, the increase on the second term associated with more competitive conditions may overcome cross effects, and therefore it is likely that (3.52) becomes larger than (3.35), thus making goodwill generated by competitive deposits riskier than that resulting from monopoly deposits.

Changes in the conjectural variations parameter β have opposite impacts upon the two parts of expression (3.52): an increase in this variable lowers the absolute value of both positive and negative parts of the above expression, making the final effect undetermined. In Appendix 2 the value of this elasticity is computed for both extreme cases, Cournot and collusive conjectures, and the final results are similar, although there are good reasons to believe that it will be larger for the second of those cases. This results directly from cartel behaviour which, by enhancing monopoly power of its participants, although making their deposit interest rates less sensitive to security rate moves, makes individual demand volume more sensitive to "own" rates and less sensitive to other's.

This conclusion seems to indicate that the use of the monopoly measure (3.37) under a more competitive framework will not imply a significant error, as long as "perceived" rather than "actual" elasticities are employed. Another interesting conclusion is that changes in the characteristics of demand and the degree of product differentiation have a much higher importance than any changes in the conduct parameters of the firm.

An analogous derivation for loans yields:

$$\eta^{i}_{GW_L,r_s} = \eta_{L_i,r_s} + \left(1 - \frac{C^{i}_{L}}{r^{i}_{L}}\right)\eta_{L_i,r_{Li}} + \left(\sum_{j\neq i} \eta_{L_i,r_{Lj}} \frac{r_{Li}}{r_{Lj}}\left(\delta_{Lij} - \beta_{r_L}\right)\right)\eta_{r_{Li},r_s} \qquad (3.53)$$

leading to analogous conclusions, since $\eta_{L_i,r_{Lj}} \geq 0$ for every $j \neq i$. Expression (3.53) above is similar to (3.37), the only differences being associated with a product substitutability and competitor's reactions and the fact that "own" price elasticities no longer represent demand parameters, but rather "perceived" elasticities (second term). Now "own rate" elasticity of loans is higher (in absolute value) than its monopoly value and if "own" effects dominate cross-effects, the sum of the second and third terms will be more negative, i.e. riskier, under competitive conditions.

As in the previous case, changes in the conjectural variations parameter have an ambiguous and probably small effect over the magnitude of exposure (see appendix).

It is also important to note that, once again, marginal costs have a role to play, since in both above expressions the cross elasticities factor is multiplied by the sensitivity of the bank's "own" rate to changes in r_s, which by expressions (3.13) and (3.14) has been shown to be related to the values of security rates and marginal costs. The higher the latter, the more important this factor becomes.

In short, for goodwill generated by both deposits and loans, the introduction of competition may increase interest rate risk, provided that changes in "perceived elasticities" dominate effects resulting from product substitutability and competitor's reactions. When effects for deposits and loans are added, the final result is undetermined, i.e., it is impossible to say what the final effect of increased competition over the bank's goodwill exposure will be.

3.5. Conclusions

As in Dermine (1985), it is shown that in imperfect bank markets, the interest rate sensitivity of goodwill has to be considered when evaluating the bank's market value exposure. However, by neglecting first order optimality conditions, his solution has nothing to do with the bank's maximising behaviour and overestimates exposure. Another important step made in this article is the result that market imperfections also affect the bank's exposure in relation to the difference between the market values of assets and liabilities whenever marginal costs of producing deposits and loans are duly considered. In other words, the imperfections effect is not reduced by the need to incorporate the duration of goodwill: it also (and mainly) affects the traditional duration gap measure.

The use of a separable short-run real resources cost function allows us to separate the bank's goodwill into two components, each one associated with each of the imperfect markets in which the bank competes. Goodwill generated by deposits is positively related to interest rates while the opposite occurs for the goodwill generated by loans.

Operating costs have two effects: Fixed costs constitute a factor of exposure via goodwill, and the higher their value, the greater the risk. On the other hand, marginal costs on deposits and loans contribute to the sensitivity of both goodwill and the difference between the market values of assets and liabilities. This last aspect is particularly important since the main conclusion to be obtained from the model is that a perfect immunisation of the market value of the bank will be ensured with a duration of assets higher than liabilities', for the effective duration measure, the relationship being exactly the inverse, whenever Macauley's or modified duration are used. The higher the bank's cost inefficiency, the higher this difference will have to be. It is also possible to show that an increase in the cost inefficiency of a bank has an effect similar to an increase in duration of its liabilities.

This last conclusion becomes particularly important in a period when bank regulators are trying to impose a standard measure of interest rate risk for evaluation of capital adequacy purposes (BIS, 1993). So far, all proposed measures are based on the traditional duration and maturity gap analysis. The first of them was already criticisable under Dermine's (1985) arguments, due to their negligence of competitive behaviour of banking, implying a bias associated with goodwill. Now, this chapter raises an additional problem about these "mutual fund" type measures of interest rate risk: financial intermediation costs and market power make those measures inappropriate and biased for the evaluation of the exposure component associated with the difference between the market values of assets and liabilities.

Consideration of competition leads to a better understanding of the problem of measuring interest rate risk exposure for banks operating in an imperfect competition context. Although this does not affect the sensitivity of the market values of balance sheet items, it may affect goodwill. Deviations from a monopoly / collusive solution through manipulation of conjectural variations may only slightly affect the measure of exposure, which means that the use of results based on the monopoly model for this purpose may only imply a small, and probably negligible, error.

In short, this article reaches the conclusion that traditional measures of interest rate risk exposure are only valid for banks operating in frictionless perfectly competitive markets. As we introduce market imperfections, via increased market power for individual institutions (associated with imperfect substitutability) and operating costs of financial intermediation, those traditional measures are shown to be incorrect and biased, since perfect immunisation is achieved with an effective duration of assets which exceeds that of liabilities. More important is the conclusion that all imperfections considered have the same effect (sign) in their contribution to the magnitude of that bias.

Appendix 3.1 Optimal Solutions for Interest Rates

As in Klein (1971), conditions given by (5) may be solved for the bank's interest rates. For deposits:

$$\frac{\partial \Pi}{\partial r_D} = 0 \Leftrightarrow -D + \left[r_S(1-\rho) - r_D\right]\frac{\partial D}{\partial r_D} - C_D\frac{\partial D}{\partial r_D} = 0 \qquad \text{(A3.1.1)}$$

Then,

$$r_D^* = \frac{\eta_{D,r_D}}{1+\eta_{D,r_D}}\left[r_S(1-\rho) - \partial C/\partial D\right] \qquad \text{(A3.1.2)}$$

For loans,

$$\frac{\partial \Pi}{\partial r_L} = 0 \Leftrightarrow L + (r_L - r_D)\frac{\partial L}{\partial r_L} - \frac{\partial L}{\partial r_L}C_L = 0 \qquad \text{(A3.1.3)}$$

Then,

$$r_L^* = \frac{\eta_{L,r_L}}{1+\eta_{L,r_L}}\left[r_S + \partial C/\partial L\right] \qquad \text{(A3.1.4)}$$

where,

$$\eta_{D,r_D} = \frac{\partial D}{\partial r_D}\frac{r_D}{D} \quad \text{and} \quad \eta_{L,r_L} = \frac{\partial L}{\partial r_L}\frac{r_L}{L} \quad \text{with} \quad \eta_{L,r_L} < -1 \qquad \text{(A3.1.5)}$$

Appendix 3.2 Conjectural Variations and the Exposure of Goodwill

Expression (3.52) may be evaluated for Cournot's conjectures, sa ituation in which we have $\beta_{r_D} = 0$:

$$\eta^i_{GW_D,r_S} = \eta_{D_i,r_S} + \varepsilon_{D_i,r_{Di}} + \left(1 + \varepsilon_{D_i,r_{Di}}\right) \frac{C^i_D}{r_S(1-\rho) - C^i_D} + \eta_{r_{Di},r_S} \sum_{j \neq i} \eta_{D_i,r_{Dj}} \frac{r_{Di}}{r_{Dj}} \delta_{Dij} \quad \text{(A3.2.1.)}$$

The first two elements correspond to a monopolist's situation, since the elasticities there are exactly the ones derived from the demand function, while the last one is associated with product substitutability. Therefore, for the same value of the elasticities of demand, a Cournot oligopolist will experience a lower exposure in the goodwill generated by deposits than will a monopolist. This difference is positively associated with the degree of substitutability between competitors and the bank's cost inefficiency (through 3.14).

For collusive conjectures we have to make $\beta_{r_D} = 1$. Following Hannan's (1991, pg 77) arguments, it will be assumed that in this situation the last part of (3.52) will be close to zero, and therefore ignored:

$$\eta^i_{GW_D,r_S} = \eta_{D_i,r_S} + \left(1 + \frac{C^i_D}{r^i_D}\right) \eta_{D_i,r_{Di}} \quad \text{(A3.2.2)}$$

Using (3.49) to (3.51) and (3.14), it may be converted into:

$$\eta^i_{GW_D,r_S} \approx \eta_{D_i,r_S} + \varepsilon_{D_i,r_{Di}} + \left(1 + \varepsilon_{D_i,r_{Di}}\right) \frac{C^i_D}{r_S(1-\rho) - C^i_D} + \eta_{r_{Di},r_S} \sum_{j \neq i} \eta_{D_i,r_{Dj}} \frac{r_{Di}}{r_{Dj}} \quad \text{(A3.2.3)}$$

It is interesting to note that the only difference between (A3.2.1) and (A3.2.3) is the δ which is not present in the last of them. Since the average of these parameters will not be too far from unity, the two expressions will yield similar results. Nevertheless, the interest rates ratio in (A3.2.3) will be lower than in the "Cournot" solution (due to a lower "own" rate), and therefore seems to yield a higher value for exposure.

It should be noted that expression (A3.2.3) falls into (3.31) whenever this last expression is computed using "perceived" elasticities, instead of elasticities of demand. And since a significant difference between (A3.2.1) and (A3.2.3) was not found, it may be said that, regardless of the oligopolist's type of conjectures, the use of the "monopoly" expression (3.31) is not significantly biased whenever "perceived" elasticities are used.

A similar analysis may be conducted for loans. Let us define:

$$\varepsilon_{L_i,r_{Li}} = \frac{\partial L^i}{\partial r_{Li}} \frac{r_L^i}{L_i} \quad \text{and} \quad \hat{\varepsilon}_{L_i,r_{Li}} = \left(\frac{\partial L^i}{\partial r_{Li}} + \sum_{j \neq i} \frac{\partial L^i}{\partial r_L^j} \right) \frac{r_L^i}{L_i}$$

Using the average conjectural variations concept, we may redefine:

$$\eta_{L_i,r_{Li}} = \left(1 - \beta_{r_L}\right) \varepsilon_{L_i,r_{Li}} + \beta_{r_L} \hat{\varepsilon}_{L_i,r_{Li}}$$

For Cournot conjectures, using an approach similar to the above, yields:

$$\eta^i_{GW_L,r_S} = \eta_{L_i,r_S} + \varepsilon_{L_i,r_{Li}} - \left(1 + \varepsilon_{L_i,r_{Li}}\right) \frac{C_L^i}{r_S - C_L^i} + \eta_{r_{Li},r_S} \sum_{j \neq i} \eta_{L_i,r_{Lj}} \frac{r_{Li}}{r_{Lj}} \delta_{Lij} \quad \text{(A3.2.4)}$$

And for collusive conjectures, using assumptions similar to the above mentioned for deposits, we obtain:

$$\eta^{i}_{GW_L,r_S} \approx \eta_{L_i,r_S} + \varepsilon_{L_i,r_{Li}} - \left(1+\varepsilon_{L_i,r_{Li}}\right)\frac{C^{i}_{L}}{r_S - C^{i}_{L}} + \eta_{r_{Li},r_S}\sum_{j\neq i}\eta_{L_i,r_{Lj}}\frac{r_{Li}}{r_{Lj}} \qquad \text{(A3.2.5)}$$

Appendix 3.3 - Exposure Measurement for Alternative Duration Measures

Some analysts and bank managers prefer to use the Modified Duration, instead of the interest elasticity (or effective duration) used in the main text of the present chapter. This measure is defined as:

$$MD_x = -\frac{\partial V_x}{\partial r_x} \times \frac{1}{V_x} \quad \text{with V and r defined as in (3.12)} \qquad \text{(A3.3.1)}$$

The analog of expression (3.11) is:

$$MD_{MV} = MD_L \frac{\partial r_L}{\partial r_S}\frac{V_L}{MV} + MD_S \frac{V_S}{MV} - MD_D \frac{\partial r_D}{\partial r_S}\frac{V_D}{MV} + \frac{\partial GW}{\partial r_S}\frac{1}{MV} \qquad \text{(A3.3.2)}$$

The expression above shows that if the impact of goodwill is ignored, the modified duration of liabilities must exceed assets′ if a perfect hedge is to be achieved. This results directly from the sensitivities of "own" interest rates to the market conditions, loan rates being more sensitive than deposits′, according to Appendix 3.1. In other words, the higher the bank′s market power, the greater that difference has to be if a perfect immunisation strategy is followed. The curious thing about this result is the fact that the relationship between durations of assets and liabilities is exactly the opposite of the result for the effective duration. However, if market imperfections do not exist, in both cases perfect immunisation will require equal durations for assets and liabilities.

A similar conclusion is achieved when Macauley's Duration is used. Unfortunately, this measure does not provide an analog for (3.11), which is as easy to analyse as the expression above. Defining that duration measure:

$$\mathcal{D}_X = -\frac{\partial V_X}{\partial(1+r_X)}\frac{1+r_X}{V_X} \tag{A3.3.3}$$

The analog for (3.11) is:

$$\mathcal{D}_{MV} = \mathcal{D}_L\frac{\partial r_L}{\partial r_S}\frac{1+r_S}{1+r_L}\frac{V_L}{MV} + \mathcal{D}_S\frac{V_S}{MV} - \mathcal{D}_D\frac{\partial r_D}{\partial r_S}\frac{1+r_S}{1+r_D}\frac{V_D}{MV} + \frac{\partial GW}{\partial r_S}\frac{1+r_S}{MV} \tag{A3.3.4}$$

The expression above differs from (A3.3.2) because of the ratios of the "one plus interest rate" effects. These, although not changing the conclusions above, reduce the bias associated with the direct comparison between durations of assets and liabilities, since they work as an opposite effect to the "own" interest rate impacts.

All of the conclusions obtained in the main text for the sensitivity of goodwill are unaffected by the duration measure used, since those results are now simply multiplied by exogenous constants.

Appendix

Sample Description

Abreviation	Bank's Name	Available Sample	Used in Chapter 2
ABN	ABN Amro Bank	1991-92	Not used
BANIF	Banco Internacional do Funchal	1991-92	Not used
BARCLAYS	Barclays Bank, plc	1988-92	1988-92
BBI	Banco Borges & Irmão	1987-92	1988-92
BBV/LLOYDS	Lloyds Bank, plc (untill 1990) Banco Bilbao Viscaya (after 1990)	1988-92	1988-92
BCA	Banco Comercial dos Açores	1987-92	1988-92
BCI	Banco de Comércio & Indústria	1988-92	1988-92
BCP	Banco Comercial Português	1987-92	1988-92
BES	Banco Espírito Santo	1987-92	1988-92
BEX	Banco Exterior de Espanha	1991-92	Not used
BFB	Banco Fonsecas & Burnay	1987-92	1988-92
BFE	Banco de Fomento e Exterior	1987-92	1988-92
BNP	Banque Nationale de Paris	1988-92	1988-92
BNU	Banco Nacional Ultramarino	1987-92	1988-92
BPA	Banco Português do Atlantico	1987-92	1988-92
BPSM	Banco Pinto & SottoMayor	1987-92	1988-92
B.BRASIL	Banco do Brasil	1988-92	1988-92
BTA	Banco Totta & Açores	1987-92	1988-92
CHASE	The Chase Manhattan Bank	1988-92	1988-92
CITIBANK	Citibank (Portugal)	1988-92	1988-92
CLP	Crédit Lyonnais Portugal	1988-92	1988-92
CHEMICAL	Banco Chemical	1988-92	1988-92
DBI	Deutsche Bank de Investimento	1991-92	Not used
GENERALE	Genérale de Banque	1991-92	Not used
MELLO	Banco Mello	1991-92	Not used
MG/CEL	Montepio Geral / Caixa Econ. de Lisboa	1988-92	1988-92
UBP	União de Bancos Portugueses	1987-92	1988-92
CGD	Caixa Geral de Depósitos	1987-92	1988-92
CPP	Crédito Predial Português	1987-92	1988-92

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