
Financial Desintermediation and the Measurement of Efficiency in Banking: the case of Portuguese Banks

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Abstract:

In this paper we assess the impact of financial desintermediation on both efficiency and efficiency measures in banking. For that purpose we use the *Bank of Portugal's* proprietary database that combines both accounting and statistical data for each single bank operating in Portugal. For both costs and profits we simultaneously estimate frontiers and inefficiency determinants equations. We conclude that the usual practice found in the literature of not including off-balance sheet outputs in the frontier specification leads to a significant overestimation of bank inefficiency scores. While for cost efficiency, on and off-balance sheet loans (and similarly for deposits) don't seem to have a differentiated impact on efficiency, for profits we find that on and off balance sheet loans have different efficiency impacts. Thus, we conclude that these assets and liabilities play an important role on the frontier specification. For the particular case of this dataset a discussion on efficiency determinants is also presented.

Keywords: bank efficiency, desintermediation, off-balance sheet, securitisation

EFM classification codes: 510

Biographical notes:

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1. Introduction

The progressive elimination of barriers to capital movements and the intensification of the globalisation in the financial markets fostered a continuous innovation process with banks offering new and more sophisticated products while finding highly innovative opportunities to reengineer their activity. In particular, banks were able to move from pure financial intermediaries to highly sophisticated financial firms who are able to desintermediate their loans and funds gathered from customers, while keeping the associated benefits. In this context of increasing desintermediation of the banking activity, banks bear costs and obtain profits from loans and financial resources not registered in their balance sheets. Thus, nowadays, an important portion of banks profits and costs are associated with commission-related products as well as from desintermediated (off-balance sheet) assets and liabilities, thus making balance-sheet measures of output inappropriate to measure the true dimension of banking activity.

So far, the vast majority of studies on banking efficiency have concentrated mainly on cost and profit measures using (on)balance sheet output variables. It is therefore reasonable to argue that, given the increasing magnitude of financial desintermediation, efficiency measures that do not take them into account will most likely underestimate the efficiency levels of the most disintermediated banks.

Some authors have somewhat addressed this issue. Clark and Siems (2002) provide a valuable contribution to the rationale of considering off-balance sheet outputs, deriving US bank specific measures of cost and profit efficiency, with and without the inclusion of aggregate measures of off-balance sheet activities. They found that cost measures increase with the inclusion of such activities, while profit estimates are unaffected. The authors conclude also that the structure of off-balance sheet outputs is also relevant in explaining inter-bank differences. Moreover, in a study on the impact of technical change on the costs of European banks Altunbas *et al.* (1999) had also included as an output the pool of off-balance sheet business although without isolating the impact of their inclusion in the cost function.

Although these papers represent an important contribution to the impact of off-balance-sheet items, these authors' off-balance sheet data was somewhat limited to credit commitments and guarantees. However, among the banks' off balance sheet activities securitised loans deserve a special attention and, to the best of our knowledge, have not yet been treated in bank efficiency studies.

In the last decade there has been a burst in securitisation activity in Europe. According to the European Securitisation Forum, European securitisation issuance¹ soared from €47 billion in 1997 to €459 billion in 2006. Outstanding volume for the European securitisation market stood at €1.32 trillion, as of 30 September 2007. These off-balance sheet loans have been originated by a bank's retail network and remain serviced by it, despite being registered at an outside vehicle. Thus, despite being off-balance sheet, they contribute for the bank's costs and risk and, as the recent 2007 crisis has demonstrated, they may be reabsorbed by the bank's balance sheet in the event of a major liquidity crisis. Similarly, when gathering financial resources from customers, the bank may end up registering them as deposits or, at the customers' discretion, pass them to mutual funds which may be managed by the bank although registered off the balance sheet. In this case the bank administers the funds, issues statements and manages the whole customer relationship, thus incurring all the corresponding profits and costs.

In this paper we assess the impact of desintermediation on both efficiency and efficiency measures. For that purpose we use a *Bank of Portugal's* proprietary database that combines both accounting and statistical data for each single bank operating in Portugal. The combination of three different data sources, using individual data, makes this a unique database providing a complete and accurate characterization of the individual banks and their activities, both in terms of traditional and off-balance sheet business. In particular, this database allows the identification, with great level of detail, of loans and customer resources that have been desintermediated at individual bank level.

The deep transformations the Portuguese banking system underwent since the mid-1970s make this an interesting case study. In particular, we are able to compare a situation, in the first years of the sample, where only on-balance sheet loans existed with a completely different panorama, towards the end of the sampling period, where the weight of securitised loans with respect to total loans is one of the highest in the Euro Area². This way, we are able to capture not only the impact of these activities on banks' cost and profit efficiency but also on the cost and profit efficiency measures.

We conclude that the omission of off-balance sheet outputs leads to a significant overestimation of bank inefficiency scores. While for cost efficiency on and off-balance sheet loans (and similarly for deposits) don't seem to have a differentiated impact on efficiency, for profits we find that on and off balance sheet loans have different efficiency impacts, demanding that bank production should be modelled by explicitly incorporating these variables as independent outputs.

The remainder of this article is organized as follows. In Section 2 we describe the main structural changes occurred in the Portuguese banking system. Section 3 contains a review of the literature. Section 4 provides a brief analysis of the impact of financial disintermediation on the measurement of bank efficiency. In Section 5 we introduce the concepts of cost and profit efficiency, distinguishing between standard and alternative profit efficiency, and we refer to the technique used for estimating efficiency scores, before describing the models' specification. The data is described in Section 6 and the results are analysed in Section 7. Finally, we present some concluding remarks in Section 8.

2. Characterisation of the Portuguese banking system

The deep transformations the Portuguese banking system underwent since the mid-1970s make this an interesting case study. Following the 1974 revolution, banks were nationalized. For more than a decade, the banking sector comprised a set of State-owned banks and a few small foreign banks. There were restrictions to banks' activity, credit ceilings, administrative regulation of interest rates and restrictions to the creation of new banks or the expansion of the branching network. In 1984 the sector was open to private sector. The privatisation process started in 1989 gradually transferring most business to private administration. The majority of the restrictions imposed on bank's activity were lifted by late 1980's as a preparation for the Single European Market in Financial Services. In the mid-1990s the system moved towards a more concentrated market witnessing several mergers and acquisitions. In this period the C5 ratio increased by 21 percentage points, from 46% to 67%³,

The gradual lifting of interest rate limits led to an increase in the strategic importance of price competition. In parallel, banks competed in non-price issues, such as bank opening hours, service quality, etc, which had an impact on banking

costs. Additionally, free competition led to an increase in the array of products and services offered to customers. In most cases, banks adopted segmentation strategies leading to the development of (costly) differentiated offers by customer segment. Thus, in some cases, banks had to incur in higher costs (which could wrongly be taken as cost inefficiency) in order to achieve superior profit efficiency.

The Stage Three of Economic and Monetary Union in 1999 acted as a catalyst for a range of structural changes in the financial intermediation services provided in the European context and also in Portugal. The adoption of the single currency and the convergence to historically low interest rates increased the demand for loans and reduced the savings rate. At the end of 2006 loans represented 66.1 per cent of total assets while deposits were 46.4 per cent. At the end of 1997 these ratios were 35.2 and 50.1 per cent, respectively⁴. Thus, the low loan/deposit ratio moved from 0.93, denoting a small excess liquidity situation, to a value of 1.88 denoting a strong dependency from outside sources of funding.

This notorious liquidity shortage was the combined result of two different factors: the increasing demand for loans, boosted by declining interest rates and market liberalisation (leading to increased product range) and a declining savings rate combined with increasing demand for off-balance sheet savings products (mutual funds). Consequently, banks were forced to find innovative solutions to raise funds in order to finance new loans. Among them, the securitisation of bank loans rapidly became one of the fastest growing solutions. In 1998 securitised loans represented less than 1% of total loans. By 2004, this value reached a peak of 9.6%⁵. Thus, liability desintermediation was one of the main drivers of asset desintermediation.

3. Literature review

Most of the pioneering works on bank efficiency focused on the USA market. The past decade witnessed a growing interest of the study of bank efficiency in Europe. Portugal is seldom included in European wide studies and, if so, only a small number of institutions are included. As a positive example, in a study of European banks between 1989 and 1997, Altunbas *et al.* (2001) found evidence that Portuguese banks operate nearly at constant returns to scale, with X-inefficiency ranging from 33% to 29% and that technical progress reduces total costs by around 4% per annum.

In banking it is important to study efficiency in both costs and profits. Due to differences in bank strategies, what could be regarded as cost inefficiency may be, in fact, the result of a strategy to capture value-added customers that would result in much higher profit efficiency. Berger *et al.* (1997) compared 130 studies that apply frontier techniques to the analysis of the efficiency of financial institutions in 21 countries. They conclude that the majority of studies have

centred on the analysis of cost efficiency alone with the revenue and profit sides being much less studied. There are, however, some important exceptions: In Berger and Mester (1997), Rogers (1998) and Maudos *et al.* (1998) the two types of efficiency are compared using the same samples of banks, in all cases being concluded that profit efficiency exceeds costs'.

The results from different empirical studies are comparable only to a limited extent as they depend, among other factors, on the different methods (parametric, non-parametric), on the specification of the production function and on the structure of the sample. Berger and Mester (1997) investigated and compared the results of the parametric methods under different assumptions on inefficiency components, functional form and model specification. Their results suggest that the prior assumptions are of not much relevance in determining the efficiency scores in the case of same sample and period. However, in the case of different samples, even when the same approach is employed, the level of efficiency becomes not comparable.

Recently, Weill (2004) provides a review of the main research on banking efficiency in five European countries⁶ making the following observations: i) mean efficiency scores are relatively dispersed, with an average efficiency score between 80 and 90% in many cases; ii) there is not any general rule for the hierarchy of scores obtained with parametric or nonparametric approaches; and, iii) there is ambiguous evidence across the literature concerning the relationship between efficiency and size. Maudos *et al.* (2002) analyse, by means of alternative techniques, both cost and profit efficiency in a sample of ten countries of the European Union for the period 1993–1996, obtaining profit efficiency levels lower than cost's. The authors conclude that there is a notably wide range of variation in efficiency levels in the banking systems of the European Union, with profit efficiency being more volatile than cost efficiency. Casu and Molyneux (2003) investigated whether there had been an improvement in and convergence of productive efficiency across European banking markets since the creation of the Single Internal Market. Using a bootstrapping technique, their results suggest that since the EU's Single Market Programme there has been a small improvement in bank efficiency levels, although there is little evidence to suggest that these have converged.

More recently, Holló and Nagy (2006) estimate bank efficiency differences across member states of the European Union (EU), from 1999 to 2003. They show that the level and spread of bank efficiency in the EU are significantly determined by characteristics of operational environment and the "conscious" behaviour of management. Their findings suggest that there is a cost efficiency gap and a convergence between the old and new member states, irrespective of the model specifications. With respect to profit efficiency, however, differences in efficiency between the two regions are only established after controlling for some major characteristics of the varying operational environments. Furthermore, their results lead to the conclusion that controls for selected distorting factors (inflation, depth of financial intermediation, market concentration, regulatory

regime) originating from the operational environment or the absence of such controls may modify the results. The authors provide also an excellent overview of bank efficiency studies.

To the best of our knowledge, only Mendes (1991), Pinho (2001) and Canhoto and Dermine (2003) have specifically studied the Portuguese banks' efficiency. The first author estimated for the period 1965-1988 a classical econometric cost function, following the translog/intermediation approach, finding economies of scale only for the smaller banks. No economies of scope were found between the various "earning assets" taken as outputs. Pinho (2001) considered a production process of the banking firm that explicitly incorporates the balance sheet constraint, in a multi-output translog where branching is allowed to interact with the other variables. In this study economies of scale were found for the smaller banks only while economies of scope between loans and deposits were found for all but the largest banks. Cost efficiency between 1986 and 1992 averaged 83%. Factors such as size, type of ownership and age were identified as determinants of inefficiency scores. Canhoto and Dermine (2003) examined the effect of deregulation and analysed the relative efficiency of new domestic banks as compared to that of older existing banks, following the data envelop analysis technique. The paper shows that the rapid deregulation in Portugal was accompanied by a major increase in the efficiency of banks over 1990-1995. It was also found that new domestic banks are more efficient than older banks. Average cost efficiency over the period was 69%.

Our study adds value to these prior works in the sense that i) it broadens the output bundles offered by the Portuguese banks, providing a more complete and accurate production function capturing the impacts of off-balance sheet assets and liabilities, which has marked the activity of the Portuguese banks in recent years; ii) it simultaneously incorporates explanatory variables for the banks' inefficiencies; and, iii) it analyses, for the same dataset, the efficiency at both costs and profits.

4. Financial Desintermediation

In this paper we analyse the impact of two forms of financial desintermediation on bank's efficiency and efficiency measurement: the transfer of deposits into mutual funds managed by the bank and the securitisation of bank loans. There are two main forms of securitisation. The first involves the issuance of securities by the bank itself, which still holds the loans and the associated credit risk on its balance sheet; this is often referred to as a synthetic securitisation and no loans are removed from the bank's balance sheet. In the second one, a true-sale securitisation, the bank sells the assets to separate entities called special purpose vehicles (SPV), a separate entity that will raise funds via the issuance of several "tranches" of securities with different seniority and rating, hence involving a partial transfer of the credit risks away from the bank's balance sheet⁷. In this

case, the loans sold are no longer registered in the bank's books, thus making them off-balance sheet. Credit securitisation is particularly attractive since it allows credit institutions to obtain liquidity and, in most countries, reduce capital requirements⁸.

According to Altunbas *et al.* (2007), the reasons for the spectacular growth in securitisation activity in the euro area since 1999 are linked to three main factors. First, the demand for asset-backed securities has grown rapidly from institutional investors, who are more willing and able to invest in credit risk. Second, technological progress has changed the cost structure of issuing asset-backed securities and increased the spectrum of financial products. Third, in addition to these global trends, the introduction of the euro has given a strong impulse to the corporate bond and securitisation markets (ECB, 2007). Regarding the so-called true securitisation, the UK is the leading country in Europe in terms of securitisation transactions (10% of GDP, in 2006). In the euro area, the market for structured products is particularly active in Ireland (6% of GDP), the Netherlands (5.7% of GDP), Spain (4.3% of GDP) and Portugal (3.9% of GDP).

The other form of disintermediation that we study consists on mutual funds managed by the bank. These funds are not registered on the bank's books although the bank remains responsible for their service and, from a customer servicing perspective, they are indistinguishable from traditional on-balance sheet savings products. However, banks have a strong preference to sell these products since, unlike in traditional deposits, most associated risks are effectively transferred to the customers.

5. Methodology

According to Farrel (1957) we can distinguish between technical efficiency, the ability to maximize the output given a certain set of inputs, and allocative efficiency, the skill to use the inputs in optimal proportions, given their prices and the available production technology. The combination of these two gives us a measure of total economic efficiency. The X-inefficiency comprises the deviations from the best practice banks that shape the frontier.

While cost efficiency is defined as the quotient between the minimum cost at which it is possible to obtain a given vector of output as determined by the frontier C^* and the cost actually incurred C ,

$$\text{Cost EFF}_{it} = E(C_{it}^{\text{MIN}*} | u_{it} = 0) / E(C_{it} | u_{it}) \quad (1)$$

profit efficiency relates the profits generated with a specific production vector Π to the maximum possible profit associated with that vector as determined by the frontier Π^* :

$$\text{Profit EFF}_{it} = E(\Pi_{it}^* | u_{it}) / E(\Pi_{it}^{\text{MAX}*} | u_{it} = 0) \quad (2)$$

Following Berger and Mester (1997) one can distinguish two profit frontier specifications: the standard profit frontier and the alternative profit frontier. The standard profit frontier assumes the existence of perfect competition in the input and output markets, so that firms take prices as given. These authors show that there are reasons to believe that banks are able to exercise market power on their output markets, thus making preferable to use the “alternative” profit function, where output prices are replaced by quantities. In particular, they identified some assumptions behind the “standard” approach that, if violated, make the “alternative” approach a better approximation of the reality: the assumption of perfect competition in output markets, differences in output quality among individuals of the sample and when there are difficulties in the calculations of output prices. In this study we follow the alternative profit specification.

Regarding the X-inefficiency estimation methods, there are generally four types commonly used depending on the different assumptions made: stochastic frontier approach (SFA), thick frontier approach (TFA), distribution-free approach (DFA) and data envelopment analysis (DEA). They differ on the basis of the arbitrary assumptions to disentangle efficiency differences from random error using a single observation for each firm. They are further separated into parametric (SFA, TFA, DFA) and non-parametric (DEA) approaches. All approaches have their advantages and disadvantages. Furthermore, for the parametrical approaches, on the choice of the functional form for the cost function there is also some debate on whether the most common translog specification is adequate or an alternative option, like the Fourier-flexible functional form, should be considered. In the vast literature on banking efficiency, only a few studies have applied two or more techniques for the estimation of efficiency scores on the same data set. Berger and Mester (1997) have found that the efficiency estimates are fairly robust to differences in methodology. Bauer *et al.* (1998) provide vast research on the consistency of frontier approaches. Their main conclusion is that all parametric approaches provide efficiency measures that are consistent with one another, while DEA does not provide results consistent with parametric approaches.

Battese and Coelli (1992) propose a stochastic frontier production function for (unbalanced) panel data, which has firm effects assumed to be distributed as truncated normal random variables, permitted also to vary systematically with time. A cost function identical to the one proposed in Schmidt and Lovell (1979) can be obtained from a production specification with few simple sign changes⁹.

The profit version of the model may be expressed as:

$$Y_{it} = x_{it}\beta + (v_{it} - u_{it}), i=1,\dots,N, t=1,\dots,T, \quad (3)$$

where Y_{it} is (the logarithm of) the cost of the i -th firm in the t -th time period;

x_{it} is a $k \times 1$ vector of (transformations of the) output quantities of the i -th firm in the t -th time period;

β is a vector of unknown parameters;

the v_{it} are random variables which are assumed to be iid $N(0, \sigma_v^2)$, and independent of the

$$u_{it} = (u_i \exp(-\eta(t-T))), \text{ where} \quad (4)$$

u_i are non-negative random variables which are assumed to account for technical inefficiency in profits and are assumed to be iid as truncations at zero of the $N(\mu, \sigma_U^2)$ distribution;

η is a parameter to be estimated;

and the panel of data need not be complete (i.e. unbalanced panel data).

The error term has therefore two components, one to account for random effects and another to account for technical inefficiency. The parameterisation of Battese and Corra (1977) is used, replacing σ_v^2 and σ_U^2 with $\sigma^2 = \sigma_v^2 + \sigma_U^2$ and $\gamma = \sigma_U^2 / (\sigma_v^2 + \sigma_U^2)$. This is done in view of the calculation of the maximum likelihood estimates. The parameter γ must lie between 0 and 1; the closer to 1 the estimate is, the better the frontier properties of the function.

Once the predicted firm-level efficiencies using these estimated functions are obtained, it is then possible to regress the predicted efficiencies upon firm-specific variables not used in the previous regression in an attempt to identify some of the reasons for differences in predicted efficiencies between firms in an industry. This is known in the literature as the two-stage estimation procedure. However, this procedure has also been long recognised as inconsistent in its assumptions regarding the independence of the inefficiency effects in the two estimation stages. The two-stage estimation procedure is unlikely to provide estimates as efficient as those that could be obtained using a single-stage estimation procedure. The Battese and Coelli (1995) model specification addresses this issue assuming the u_{it} independently distributed as truncations at zero of the $N(m_{it}, \sigma_U^2)$ distribution, with

$$m_{it} = z_{it} \delta, \quad (5)$$

where z_{it} is a $p \times 1$ vector of variables which may influence the inefficiency of a firm; and

δ is an $1 \times p$ vector of parameters to be estimated.

It should be noted that these two model specifications are non-nested and hence no set of restrictions can be defined to permit a test of one specification versus the other.

In our study, the banks' production function was defined according to the "two phases" approach¹⁰ to banking production, that is to say, first banks originate loans and deposits and in the second phase, the bank's treasury is used to cover for any mismatch between sources and uses of funds. Following Pinho (2001), the objective function was modelled as the maximization of long-run profits, subject to the balance sheet constraint.

The bank's (static) long-run objective is to maximize economic profits defined as:

$$\text{Max } \Pi = R_L L + R_M M - r_K K - w_N N - R_D D - R_E E \quad (6)$$

$$\{L, M, SL, D, F, K, N\}$$

$$\text{s.t.: } f(L, SL, D, F, K, N) = 0 \quad (7)$$

$$\rho D + M + L + K = D + E \quad (8)$$

where L stands for loans, M stands securities, D stands for deposits, E stands for financial equity, SL and F represent the off balance-sheet outputs, securitised loans and managed funds, respectively. R_L , R_M , R_D , and R_E are the respective required rates of return. The equation (8) represents the real resources transformation function of the bank.

We consider both on-balance sheet outputs and off-balance sheet outputs. Regarding on-balance sheet outputs we take the most representative outputs for banks operating in Portugal: loans and deposits. Consequently, we also considered the off-balance sheet items associated with these outputs: securitised loans and mutual funds under the bank's management¹¹. Both types loans and customer funds contribute to the bank's costs and revenues and thus should be included in the model specification as outputs.

Input factors are labour (N) and capital (K). ρ is the nonearning cash-reserves coefficient, r_K is the operating cost of capital and w_N is the wage rate.

With the introduction of the balance-sheet constraint and solving (8) with respect to M, the problem becomes:

$$\text{Max } \Pi = (R_L - R_M)L + (R_M(1 - \rho) - R_D)D - (r_K + R_M)K - w_N N - (R_E - R_M)E \quad (9)$$

$$\{L, SL, D, F, K, N\}$$

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

Concentrating on the operating cost side of the profit function, the problem becomes:

$$\text{Min } C = (r_K + R_M)K + w_N N \quad (10)$$

$$\{K, N\}$$

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

where C denotes the sum of real resources costs ($r_K K + w_N N$) with the opportunity cost of financial physical capital ($R_M K$); $(r_K + R_M)K$ corresponds to the "user's cost of capital".

Regarding the function specification, we used the multi-output translog where branches interact with the other variables, as proposed by Berger *et al.* (1987). The alternative profit function is defined as:

$$\ln(\Pi_{it}) = \ln(\Pi(Y_{it}, w_{it}, B_{it})) + v_{it} - u_{it} \quad (11)$$

where Π are the operational profits (revenues minus costs); Y and w , the vectors of outputs and input prices, respectively, and B , the number of branches; i stands for the bank's number and t for time.

Due to the fact that some banks show negative profits, the variable is standardized according to the following transformation, well known in the literature:

$$\ln(\pi') = \ln(\pi + |\pi^{\min}| + 1) \quad (12)$$

so that the bank with the lowest profit will have $\ln(\pi') = 0$.

Similarly, in the the cost function branches are allowed to interact with other variables as a way to control for differences in bank size. It is defined as:

$$\ln(C_{it}) = \ln(C(Y_{it}, w_{it}, B_{it})) + v_{it} + u_{it} \quad (13)$$

where C are the operational costs. The standard restrictions of symmetry and input price homogeneity apply.

Additionally, in the “frontier” part of the equation, a time trend was included to capture any shifts of the frontier over time, in order to test for Hicksian-neutral technological progress. A positive (negative) coefficient associated to this variable indicates a positive effect of the technical progress on operating profits (costs), i.e., profits (costs) increase (fall) holding all else equal. Regarding the “inefficiency determinants” part of the equation we incorporated in the Z vector several firm-specific and macro-environmental variables.

6. Data

The data used in this study comprise a unique database that combines both accounting and statistical data for each single bank operating in Portugal¹². Three main sources were used: accounting data reported by the banks to the *Banco de Portugal* under the Charts of Accounts for the Banking System, data reported by the banks to the *Banco de Portugal* for statistical purposes¹³ and data published on the annual bulletin of the *Associação Portuguesa de Bancos*. For the purpose of this research we combined these different data sources, crossing individual data for each bank operating in Portugal, in order to have a complete and accurate characterization of the institutions and their activities, both in terms of traditional and off-balance sheet business.

The sample covers nearly all banks operating in Portugal during this period, the total market coverage being 97% on average. We have an unbalanced panel of 758 observations, with the number of institutions ranging from 30 in 1997Q3 to 22 in 2004Q4. Balance sheet items, number of workers and branches were computed from averages of end of quarterly data. Data for profit and loss

accounts has been annualised. Nominal data was deflated to 1996 prices using the GDP deflator. The price of labour was calculated as the ratio of total labour expenses per employee. Depreciation rate was obtained dividing depreciation costs by physical capital; in order to account for the opportunity cost of the banks' investments in fixed assets we used the yearly average money market rate (3 month EURIBOR).

7. Cost and profit efficiency estimates

7.1 Efficiency estimates

The estimations were computed using the FRONTIER Version 4.1¹⁴. We considered three different model specifications. In **Model I** we excluded off-balance sheet outputs considering thus only two outputs: loans and deposits. This is the specification most used in empirical studies. In **Model II** we consider four outputs: loans, deposits securitised loans and managed funds. Finally, in **Model III**, we consider two outputs: total loans (the sum of on and off balance sheet) and total customer resources (the sum of deposits with managed funds). The results follow in **Appendix**.

The evolution of average cost and profit efficiency estimates over time is shown in Charts 1 and 2 below.

Chart 1

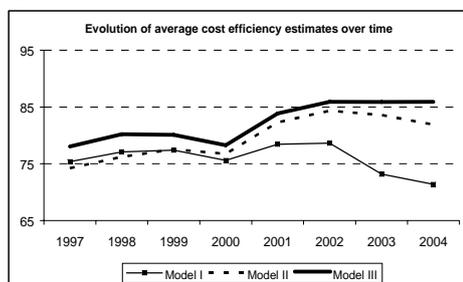
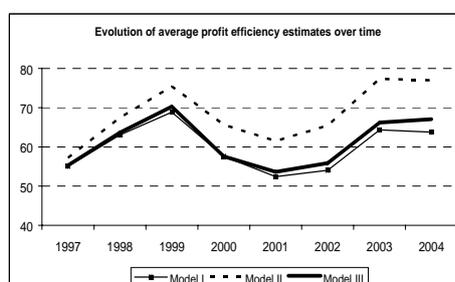


Chart 2



From Chart 1 it is clear the significant impact of off-balance sheet activities in terms of banks' cost efficiency scores. While in Model I we observe a decrease in average cost efficiency in 2003 and 2004, the other two models show a minor decrease or a stabilisation. In fact, these two years were precisely the ones where banks were more active in securitising loans. This shows that excluding such off-balance sheet outputs leads to an overestimation of inefficiency scores. Model III shows slightly higher efficiency levels¹⁵ than Model II. This may be an indication that, from a bank resource allocation perspective, on and off-balance sheet assets (and similarly for liabilities) are indistinguishable¹⁶.

For the period under analysis cost efficiency levels increased, on average 8 p.p., in Models II and III. However, when we exclude the off-balance sheet items (Model I) we find a 4 p.p. decline in cost efficiency. Thus, these items have an important role in the determination of the magnitude and evolution of efficiency scores.

The different specifications show similar results on the measurement of technical progress. In all cases we obtained a negative coefficient associated with the time trend, revealing a downward shift of the cost frontier over time. This means that, holding all else constant, operating costs would have decreased 3% to 4% per year, more than 20% between 1997 and 2004. Canhoto and Dermine (2003) also found a positive frontier shift for the period 1990 – 1995, using a non-parametric programming technique, DEA, and a Malmquist productivity index. The fact that similar results are found in all three models is an indication that technical progress is not intrinsically related to any specific outputs but to overall operating conditions such as IT developments, human resources training and management skills.

Regarding profit efficiency (Chart 2) we once again find that Model I produces the lowest average efficiency scores, thus showing that the neglect of the off-balance sheet variables has an important impact on efficiency measurement¹⁷. However, the impact of these variables is larger in Model II, where they are treated as separate outputs. Unlike in costs, it seems that on and off balance sheet outputs have different impacts on revenue. In fact, while income for loans and deposits is mostly related to net interest margins, in the case of securitised loans and managed funds income is mostly obtained via fees and commissions.

For the period under analysis the profit efficiency levels increased, on average, by 20 p.p. from 57% to 77% in Model II. In Model I and III, the average profit efficiency improved around 10 p.p. For all model specifications, efficiency scores are higher in costs than profits, which reflects the fact that, although most banks are pursuing cost reduction strategies, a large number of them still has a long way to go in terms of implementation of effective segmentation and customer relationship strategies that enable them to improve cross-selling and thus maximise profits for their established retail network.

In what concerns the impact of technological progress on profits in all models we obtained positive values for the time trend parameter, revealing a positive shift of the production frontier over time¹⁸. This means that, holding all else equal, operating profits would have increased between 1% (Model III) and 3% (Model I) per year between 1997 and 2004.

We turn now our analysis to the differences between classes of market shares¹⁹.

Table 1

Average cost efficiency estimates										
Model	Market share ¹	1997	1998	1999	2000	2001	2002	2003	2004	Mean
I	C1: < 1%	65	67	63	60	63	63	54	51	61
	C2: 1% - 2.5%	84	84	89	88	87	88	81	81	85
	C3: 2.5% - 5%	81	84	89	91	92	92	92	91	89
	C4: 5% - 10%	92	91	93	93	92	92	91	90	92
	C5: > 10%	93	91	94	95	94	94	94	94	94
Total average		75	77	77	76	78	79	73	71	76
II	C1: < 1%	66	67	65	62	69	71	70	68	67
	C2: 1% - 2.5%	80	81	88	89	89	92	87	86	87
	C3: 2.5% - 5%	76	80	86	90	93	93	95	93	88
	C4: 5% - 10%	92	92	94	94	94	94	94	93	93
	C5: > 10%	93	90	95	96	95	95	95	94	94
Total average		74	76	78	77	82	84	84	82	79
III	C1: < 1%	71	73	67	63	72	74	74	74	70
	C2: 1% - 2.5%	86	86	91	90	89	92	89	89	89
	C3: 2.5% - 5%	77	80	88	92	93	94	95	95	89
	C4: 5% - 10%	94	94	95	95	95	95	95	95	95
	C5: > 10%	94	94	96	96	96	95	95	95	95
Total average		78	80	80	78	84	86	86	86	82

¹ In terms of total assets.

Table 2

Average profit efficiency estimates										
Model	Market share ¹	1997	1998	1999	2000	2001	2002	2003	2004	Mean
I	C1: < 1%	64	71	75	68	70	73	81	76	72
	C2: 1% - 2.5%	64	54	75	53	38	44	65	63	57
	C3: 2.5% - 5%	39	60	68	50	57	65	74	75	61
	C4: 5% - 10%	36	47	39	42	37	16	31	41	33
	C5: > 10%	47	58	77	54	42	33	37	36	45
Total average		55	63	69	58	52	54	64	64	60
II	C1: < 1%	65	74	81	75	76	81	87	82	78
	C2: 1% - 2.5%	66	60	83	64	52	57	75	75	67
	C3: 2.5% - 5%	42	64	71	52	62	75	83	80	67
	C4: 5% - 10%	39	52	49	54	49	27	55	67	47
	C5: > 10%	52	63	85	72	68	58	71	74	69
Total average		57	67	75	66	61	65	77	77	69
III	C1: < 1%	63	69	74	65	69	74	82	77	71
	C2: 1% - 2.5%	70	58	78	57	44	46	66	69	61
	C3: 2.5% - 5%	38	60	67	47	57	65	71	70	60
	C4: 5% - 10%	39	52	48	49	45	18	40	48	39
	C5: > 10%	53	63	83	57	44	39	44	46	51
Total average		55	64	70	58	54	56	66	67	62

¹ In terms of total assets.

From Table 1 above we conclude that in all model specifications the smallest banks are the least cost efficient ones. The inclusion of off-balance sheet outputs in the production function has a bigger impact in this class (<1% share), which is not surprising since these are the banks with higher levels of desintermediation, with off-balance sheet loans representing around 80% of total assets in 2004, while for the remaining classes this ratio varies from 30 to 65 per cent. The impact is larger in Model III, where off and on-balance sheet outputs are aggregated. From the cost perspective, there is evidence that larger banks (C3, C4 and C5) are the most efficient ones, with a minimum waste of resources. The dispersion of cost efficiency levels among classes is smaller in Models II and III, particularly in the last two observation periods where securitisation volumes significantly increased.

In terms of profit efficiency levels, from Table 2 there is evidence that, unlike in cost efficiency, the smallest banks register the highest efficiency scores. This may be related to the fact that banks included in this class are very specialised in certain market segments, namely consumer credit. In this market segment very high interest rates are charged because, in addition to the greater risk associated with these credits, banks benefit from a large degree of market power. In general, the small banks show a disproportionately high level of revenue, including a high

volume of fee income, when compared with the number of branches or traditional assets they held. Moreover, large banks show low efficiency scores in Model I and III, in contrast with we had just seen for costs. In all model specifications the differences between small and large banks are particularly large in 2002, a year of strong deceleration of economic activity. For all classes, Model II exhibits higher efficiency scores than model I, with the inclusion of off-balance sheet business as independent outputs resulting in significant improvements. This impact is particularly relevant for classes C4 and C5, especially in 2003 and 2004. In line with the results obtained on average terms, the analysis by class also shows that under model II the improvements over time are the most noteworthy. Thus, we once again conclude that by not including off-balance sheet items as individual outputs in the profit function we obtain lower than reality efficiency scores. These outputs have an impact in profit efficiency which is not only relevant but also different than these from their on-balance sheet counterparts.

7.2 Determinants of Inefficiency Scores

Following the formulation of the total effects model expressed by expressions (3) to (5), we simultaneously estimate of the cost or profit frontier together with the determinants (z) of the inefficiency scores (u_{it}). For that purpose we included a set of explanatory variables to account for firm characteristics such as size, business development and composition, loan quality, solvency and ownership and also a set of macroeconomic and bank market structure indicators. The results are shown in Tables 3 and 4 below.

Table 3

Determinants of profit inefficiency scores

	Model I		Model II		Model III	
	Value	t- signif	Value	t- signif	Value	t- signif
Size	-4.97	-4.58***	-9.92	-7.19***	-8.21	-5.23***
Assets_mkt_share	0.65	9.89***	1.00	10.32***	0.72	8.03***
Assets_mkt_share*2	-0.03	-9.98***	-0.04	-10.11***	-0.03	-8.14***
Business						
% Deposits_NFC	-0.02	-4.14***	-0.03	-5.08***	-0.02	-2.78***
Loans_growth	-0.01	-1.2	0.01	3.19***	-0.01	-2.33***
Loan's quality						
NPL_NFC	-0.17	-3.47***	-0.04	-1.09	-0.18	-3.64***
NPL_MTG	-0.41	-3.11***	-0.75	-5.73***	-0.32	-2.46**
NPL_OTH	0.08	3.95***	0.08	4.87***	0.11	5.17***
Solvency	0.04	1.63	0.08	3.63***	0.09	3.34***
dmy_MA	2.71	9.82***	3.58	11.25***	3.32	8.82***
dmy_PRT	-1.18	-5.63***	-2.22	-7.85***	-1.08	-4.33***
GDP_growth	-0.04	-0.37	-0.13	-1.44	-0.02	-0.19
HH_Deposits	0.00	2.1**	0.00	1.39	0.00	2.67**
Financial mkt						
MMI_rate	0.76	7.59***	1.46	9.98***	1.07	6.94***
coef_var_stock_index	-0.01	-0.37	0.03	1.12	-0.02	-0.62

***, **, * Significant at 1%, 5%, 10%, respectively.

Table 4

Determinants of cost inefficiency scores

	Model I		Model II		Model III	
	Value	t- signif	Value	t- signif	Value	t- signif
Size	-1.74	-5.14***	-0.97	-3.11***	-1.46	-4.04***
Assets_mkt_share	-0.12	-2.86***	-0.17	-7.36***	-0.24	-7.52***
Assets_mkt_share*2	0.01	2.88***	0.01	7.38***	0.01	6.49***
Business						
% Deposits_NFC	0.01	6.84***	0.01	6.79***	0.01	7.23***
Loans_growth	0.00	-1.39	0.00	-1.71*	0.00	-1.95*
Loan's quality						
NPL_NFC	0.10	8.78***	0.09	8.05***	0.13	9.31***
NPL_MTG	-0.37	-7.09***	-0.47	-4.77***	-0.25	-3.67***
NPL_OTH	0.00	-0.87	0.01	1.43	0.00	-0.14
Solvency	0.00	-0.17	0.00	0.38	-0.01	-1.51
dmy_MA	-1.00	-4.66***	-1.00	-7.67***	-0.45	-2.13**
dmy_PRT	-0.04	-0.56	0.15	1.67*	0.25	2.37**
GDP_growth	-0.01	-0.31	-0.02	-0.71	-0.01	-0.32
HH_Deposits	0.00	3.48***	0.00	2.03**	0.00	3.23***

***, **, * Significant at 1%, 5%, 10%, respectively.

The first variable is Assets mkt share, to capture any size effects²⁰. We also included a squared term to allow for nonlinearities. The effect of market share on cost inefficiency is convex irrespective of the model specification: it declines from zero to reach a minimum at 12% market share then grows back to zero close to the 22% share and is positive from then on in Models I and II, while it remains negative in Model III. Its impact reaches minimums of -0.6% , -1.0% and -1.6% in the three model specifications respectively. This shows that the high (low) cost efficiency ratios found for the larger (smaller) banks (see Table

1) are not directly a result of their size by itself, but rather on other factors discussed below.

On the other hand, we have the opposite situation in the case of profit inefficiency; it increases from zero to a maximum at 12% and then declines back to zero around the 24% level being negative from there on, in all models considered. The market share's impact reaches maximums of 4.0%, 5.7% and 4.3% in the three model specifications respectively. Once again, these results may indicate that small banks are active players in the specialised market segments where they operate, where the pricing conditions are derived from specific arrangements between the bank and the customer where the terms of the contract are negotiated on a bilateral basis rather than determined in a perfectly competitive market.

For a better insight in terms of the influence of the business structure we included the relative weight of deposits from non-financial corporations²¹. We find that banks more focused on corporate customers tend to be perceived as more cost inefficient and more profit efficient. This may be an indication that servicing corporate customers absorbs a large volume of resources something which is more than compensated by additional revenue they generate. Thus, we are inclined to believe that corporate and household deposits (and eventually loans) may have different impacts on costs and profits. Thus, a better measurement of efficiency could be obtained by treating corporate and household deposits and loans as distinct outputs. This is a topic that we would like to analyse in future research.

As a measure of bank marketing aggressiveness we also considered the loans' growth rate. It should be expected that banks pursuing such strategies should incur in higher customer attraction costs which should take some time to be converted into superior profits. However, there is also the possibility that aggressiveness may lead to less careful lending and thus to lower profits via higher loan losses. Contrary to the *a priori* expectations, the results show that higher growth banks show higher cost efficiency in the model specifications where off-balance sheet outputs are included. This may be an indication that more sophisticated (desintermediated) and efficient banks have higher propensity to engage and pursue high growth strategies that end up being partially financed by further loan securitisations. However, the results (with conflicting signs on Models II and III) do not allow for a definite conclusion of the impact of such strategies on banks' profits.

The quality of the banks' loan portfolio is also often referred in the literature to be associated with the levels of cost efficiency achieved by the banks. Given that banks operate in different credit segments with different risk levels we considered three different market segments. For each we computed, at individual bank and moment of time, the respective ratio of non-performing loans (NPL).

The chosen segments were loans to non-financial corporations (NFC), mortgage loans (MTG) and consumer credit (OTH).

For NFC's we find that banks with higher non-performing loans show lower cost efficiency and higher profit efficiency (except in Model II). Typically the highest ratios are found for banks with a higher proportion of loans to small and medium sized enterprises (SME's). Each loan involves the consumption of some fixed resources, which are independent of the amount lent. Thus, SME loans involve a proportionately (per euro lent) higher real resources cost than large corporation loans. Thus, we find that banks with higher volumes of NFC NPL's are shown to be less cost efficient but also that these banks have been able to pass such costs to consumers and still exercise some market power in this type of lending, ending up showing superior profit efficiency.

A more surprising result is found for banks with higher Mortgage-related NPL's, which are found to show lower levels of cost and profit inefficiency, regardless of the model specification. Finally, high NPL's on consumer loans seem to not affect operating cost efficiency while having a negative impact on profit's, thus showing that banks taking the highest risks in this product are unable to pass to consumers the corresponding cost²². From these results we conclude that the impacts of these product-related NPL variables vary according to the model and also whether we assess cost or profit performances. Thus had we employed an aggregate NPL ratio we would get biased the results, failing to reveal the idiosyncrasies of each credit segment.

In order to anticipate the effect of mergers on the efficiency levels we have also included a dummy variable (dmy_MA) with a value of 1 for any bank involved in such process at a certain moment in time. The results reveal that while merging banks are able to achieve some cost efficiency gains, there is some deterioration in terms of profit efficiency which may be an indication that the potential gains from merging may take some time to be fully exploited.

Dummy variable (dmy_PRT) was added to assess the impact of bank nationality. This assumes the value of 1 for Portuguese-owned banks. While from a cost perspective the results are not consistent across the model specifications, in terms of profits efficiency there is indication that Portuguese-owned banks show higher efficiency scores.

The Herfindahl-Hirschman index of the Portuguese deposit market concentration (HH_Deposits), computed for each sample quarter, was included to assess the impact of concentration. The results show that in periods of higher market concentration inefficiency scores are higher both in terms of costs and profits. This may be a consequence of the reduction of competition pressure diminishing the incentives of banks to move towards more efficient production techniques. Finally, in the case of the profit function, we have additionally tested the effects of the reference rate in the money market, which revealed to contribute to a deterioration of the efficiency levels, possibly linked to loan demand contractions

and higher defaults in high interest rate periods. The annual increase of the Stock Market Index was not shown to have an impact on profit efficiency.

8. Concluding remarks

In this paper we argue that in a context of increasing financial desintermediation the omission of off-balance sheet outputs in the measurement of bank efficiency may lead to an overestimation of cost inefficiency scores. This is due to the fact that, in practice, some of the most important off-balance sheet assets and liabilities are serviced by the bank in the same way as their on-balance sheet counterparts, thus consuming similar amounts of resources.

Using a proprietary data sample from *Banco de Portugal*, we estimated cost and profit frontiers for the Portuguese banking system. We considered two main on balance-sheet outputs, deposits and loans, and their respective off-balance sheet counterparts: securitised loans and mutual funds managed by the bank. Results show that both cost and profit efficiency scores are significantly higher when the off-balance sheets items are included in the frontier specification as outputs. This shows that the omission of these variables is a specification error that leads to an overestimation of the magnitude of inefficiency scores. Moreover, we also found that their evolution is also affected by the choice of output bundle: When off-balance sheet items are excluded, inefficiency scores rise in periods of high desintermediation activity, while the opposite result being found when a more complete bundle is employed. Interestingly, we find that on and off balance sheet outputs do not have a clearly differentiated impact in terms of costs (being loans and securitised loans indistinguishable from a cost perspective). However, they seem to have a clear differentiated impact from a profit perspective.

In terms of efficiency determinants, we find that some variables that are associated with cost inefficiency are, in turn, associated with profit efficiency. This is due to the fact that some banks are willing to take higher costs in order to obtain superior profits due to their ability to pass these costs to consumers and still capture some additional value-added. Therefore, we believe that the profit frontier approach is a superior form of analysing bank efficiency. Among such variables we find the weight of corporate banking activity, as well the ratio of corporate credit losses. This suggests that decomposing loans and deposits between several product and customer categories may constitute a better approach, something we propose to explore in future research. Other variables were found to have rather different impacts. In general we found that lending growth rate has a positive impact in cost but not profit efficiency. The quality of the loan portfolio has an impact which varies across loan products. Domestic banks seem to be more profit efficient. Periods of higher market concentration are associated with higher cost and profit inefficiency.

In general, we conclude that the cost and profit function specification affects estimated efficiency scores. A wider than usual choice of the output bundle allows a better separation between pure inefficiency and the differentiated cost and profit impact of different products. In this particular paper, we show that off-balance sheet assets and liabilities have an important contribution to both profits and costs and thus play an important role in the frontier's output bundle. The increasing financial innovation and desintermediation is an important factor for the reinforcement of this conclusion.

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Appendix – Frontier and Efficiency Determinants Estimates

Model I - Cost estimates

Parameter	Value	Std error	t-statistic	signif
α	-44.37	1.19	-37.33	***
β_L	-1.82	0.75	-2.43	**
β_D	4.45	0.68	6.51	***
α_N	4.38	0.64	6.89	***
$\delta_{L,L}$	-0.02	0.04	-0.47	
$\delta_{D,D}$	-0.21	0.06	-3.28	***
$\delta_{L,D}$	0.12	0.05	2.36	**
$\gamma_{N,N}$	0.00	0.10	0.05	
$\rho_{L,N}$	0.01	0.07	0.07	
$\rho_{D,N}$	-0.20	0.06	-3.26	***
ψ_B	-0.53	0.33	-1.61	
$\psi_{B,B}$	0.08	0.02	4.51	***
$\psi_{L,B}$	-0.05	0.02	-2.32	**
$\psi_{D,B}$	0.03	0.02	1.47	
$\psi_{B,K}$	-0.10	0.03	-3.67	***
τ	-0.04	0.01	-6.39	***
δ_0	-1.74	0.34	-5.14	***
Assets_mkt_share	-0.12	0.04	-2.86	***
Assets_mkt_share^2	0.01	0.00	2.88	***
%_Deposits_NFC	0.01	0.00	6.84	***
Loans_growth	0.00	0.00	-1.39	
NPL_NFC	0.10	0.01	8.78	***
NPL_MTG	-0.37	0.05	-7.09	***
NPL_Other	0.00	0.00	-0.87	
Solvency	0.00	0.01	-0.17	
dmy_MA	-1.00	0.21	-4.66	***
dmy_PRT	-0.04	0.07	-0.56	
GDP_growth	-0.01	0.04	-0.31	
HH_Deposits	0.00	0.00	3.48	***
σ^2	0.11	0.01	10.94	***
γ	0.78	0.03	26.89	***

***, **, * - Significant at 1%, 5%, 10%, respectively.

Model II - Cost estimates

Parameter	Value	Std error	t-statistic	signif
α	-35.38	1.02	-34.7	***
β_L	-1.29	0.74	-1.73	*
β_D	3.51	0.63	5.54	***
β_{SL}	0.32	0.06	5.5	***
β_F	0.15	0.18	0.85	
α_N	3.24	0.51	6.31	***
$\delta_{L,L}$	0.13	0.04	3.16	***
$\delta_{D,D}$	0.03	0.05	0.59	
$\delta_{SL,SL}$	0.00	0.00	0.13	
$\delta_{F,F}$	0.00	0.00	0.32	
$\delta_{L,D}$	-0.07	0.04	-1.76	*
$\delta_{L,SL}$	-0.01	0.00	-3.39	***
$\delta_{L,F}$	-0.01	0.01	-2.2	**
$\delta_{D,SL}$	0.00	0.00	-0.08	
$\delta_{D,F}$	-0.01	0.01	-1.41	
$\delta_{SL,F}$	0.00	0.00	1.34	
$\gamma_{N,N}$	-0.06	0.08	-0.8	
$\rho_{L,N}$	0.08	0.07	1.15	
$\rho_{D,N}$	-0.19	0.06	-3.33	***
$\rho_{SL,N}$	-0.01	0.00	-3.51	***
$\rho_{F,N}$	0.02	0.01	3.11	***
Ψ_B	-0.19	0.28	-0.66	
$\Psi_{B,B}$	0.09	0.02	5.81	***
$\Psi_{L,B}$	-0.08	0.02	-4.24	***
$\Psi_{D,B}$	0.05	0.02	2.89	***
$\Psi_{SL,B}$	0.02	0.00	3.21	***
$\Psi_{F,B}$	0.03	0.01	4.88	***
$\Psi_{B,K}$	-0.04	0.02	-1.62	
τ	-0.03	0.01	-6.46	***
δ_0	-0.97	0.31	-3.11	***
Assets_mkt_share	-0.17	0.02	-7.36	***
Assets_mkt_share^2	0.01	0.00	7.38	***
%_Deposits_NFC	0.01	0.00	6.79	***
Loans_growth	0.00	0.00	-1.71	*
NPL_NFC	0.09	0.01	8.05	***
NPL_MTG	-0.47	0.10	-4.77	***
NPL_Other	0.01	0.00	1.43	
Solvency	0.00	0.01	0.38	
dmy_MA	-1.00	0.13	-7.67	***
dmy_PRT	0.15	0.08	1.87	*
GDP_growth	-0.02	0.03	-0.71	
HH_Deposits	0.00	0.00	2.03	**
σ^2	0.11	0.01	9.39	***
γ	0.87	0.02	48.72	***

***, **, * - Significant at 1%, 5%, 10%, respectively.

Model III - Cost estimates

Parameter	Value	Std error	t-statistic	signif
α	-37.91	3.13	-12.1	***
β L+SL	-0.61	0.48	-1.27	
β D+F	2.47	0.44	5.63	***
α N	4.29	0.67	6.4	***
δ L+SL, L+SL	0.13	0.03	4.82	***
δ D+F, D+F	-0.02	0.04	-0.5	
δ L+SL, D+F	-0.05	0.03	-1.73	*
γ N, N	-0.05	0.09	-0.55	
ρ L+SL, N	-0.04	0.05	-0.94	
ρ D+F, N	-0.10	0.04	-2.38	**
ψ B	0.50	0.31	1.63	
ψ B, B	0.13	0.01	9.14	***
ψ L+SL, B	-0.11	0.02	-6.34	***
ψ D+F, B	0.08	0.02	4.82	***
ψ B, K	-0.03	0.03	-1.06	
τ	-0.04	0.01	-7	***
δ_0	-1.46	0.36	-4.04	***
Assets_mkt_share	-0.24	0.03	-7.52	***
Assets_mkt_share^2	0.01	0.00	6.49	***
%_Deposits_NFC	0.01	0.00	7.23	***
Loans_growth	0.00	0.00	-1.95	*
NPL_NFC	0.13	0.01	9.31	***
NPL_MTG	-0.25	0.07	-3.67	***
NPL_Other	0.00	0.01	-0.14	
Solvency	-0.01	0.01	-1.51	
dmy_MA	-0.45	0.21	-2.13	**
dmy_PRT	0.25	0.10	2.37	**
GDP_growth	-0.01	0.04	-0.32	
HH_Deposits	0.00	0.00	3.23	***
σ_2	0.12	0.01	10.57	***
γ	0.78	0.03	30.75	***

***, **, * - Significant at 1%, 5%, 10%, respectively.

Model 1 - Profit estimates

Parameter	Value	Std error	t-statistic	signif
α	9.98	10.54		0.95
β_L	3.55	1.27		2.8***
β_D	-2.19	1.10		-2**
α_N	-0.65	1.79		-0.37
$\delta_{L,L}$	0.26	0.07		3.6***
$\delta_{D,D}$	0.40	0.09		4.21***
$\delta_{L,D}$	-0.26	0.08		-3.42***
$\gamma_{N,N}$	0.60	0.18		3.39***
$\rho_{L,N}$	-0.32	0.11		-2.83***
$\rho_{D,N}$	-0.02	0.10		-0.23
ψ_B	-3.95	0.48		-8.23***
$\psi_{B,B}$	0.06	0.03		2.12**
$\psi_{L,B}$	0.14	0.04		3.73***
$\psi_{D,B}$	-0.13	0.04		-3.38***
$\psi_{B,K}$	-0.30	0.04		-6.64***
τ	0.03	0.01		2.73***
δ_0	-4.97	1.09		-4.58***
Assets_mkt_share	0.65	0.07		9.89***
Assets_mkt_share^2	-0.03	0.00		-9.98***
%_Deposits_NFC	-0.02	0.01		-4.14***
Loans_growth	-0.01	0.01		-1.2
NPL_NFC	-0.17	0.05		-3.47***
NPL_MTG	-0.41	0.13		-3.11***
NPL_Other	0.08	0.02		3.95***
Solvency	0.04	0.03		1.63
dmy_MA	2.71	0.28		9.82***
dmy_PRT	-1.18	0.21		-5.63***
GDP_growth	-0.04	0.10		-0.37
HH_Deposits	0.00	0.00		2.1**
MMI rate	0.76	0.10		7.59***
coef_var_stock_index	-0.01	0.03		-0.37
σ^2	1.44	0.15		9.88***
γ	0.97	0.01		135.83***

***, **, * - Significant at 1%, 5%, 10%, respectively.

Model II - Profit estimates

Parameter	Value	Std error	t-statistic signif
α	20.36	7.40	2.75***
β_L	5.04	1.10	4.56***
β_D	-5.49	0.96	-5.75***
β_{SL}	-0.40	0.12	-3.32***
β_F	1.16	0.29	3.98***
α_N	-1.23	1.45	-0.84
$\delta_{L,L}$	0.27	0.06	4.4***
$\delta_{D,D}$	0.35	0.08	4.17***
$\delta_{SL,SL}$	0.00	0.00	0.81
$\delta_{F,F}$	0.00	0.00	-0.92
$\delta_{L,D}$	-0.22	0.07	-3.13***
$\delta_{L,SL}$	0.03	0.01	2.59***
$\delta_{L,F}$	0.01	0.01	0.68
$\delta_{D,SL}$	-0.03	0.01	-3.24***
$\delta_{D,F}$	-0.03	0.01	-2.29**
$\delta_{SL,F}$	0.00	0.00	-0.37
$\gamma_{N,N}$	0.55	0.17	3.28***
$\rho_{L,N}$	-0.53	0.11	-4.68***
$\rho_{D,N}$	0.30	0.10	3.08***
$\rho_{SL,N}$	0.04	0.01	3.99***
$\rho_{F,N}$	-0.06	0.02	-3.4***
ψ_B	-3.55	0.47	-7.62***
$\psi_{B,B}$	0.00	0.03	-0.02
$\psi_{L,B}$	0.07	0.04	1.83*
$\psi_{D,B}$	-0.02	0.04	-0.54
$\psi_{SL,B}$	-0.02	0.01	-1.43
$\psi_{F,B}$	0.00	0.01	0.39
$\psi_{B,K}$	-0.21	0.04	-4.75***
τ	0.02	0.01	2.12**
δ_0	-9.92	1.38	-7.19***
Assets_mkt_share	1.00	0.10	10.32***
Assets_mkt_share^2	-0.04	0.00	-10.11***
%_Deposits_NFC	-0.03	0.01	-5.08***
Loans_growth	0.01	0.00	3.19***
NPL_NFC	-0.04	0.04	-1.09
NPL_MTG	-0.75	0.13	-5.73***
NPL_Other	0.08	0.02	4.87***
Solvency	0.08	0.02	3.63***
dmy_MA	3.58	0.32	11.25***
dmy_PRT	-2.22	0.28	-7.85***
GDP_growth	-0.13	0.09	-1.44
HH_Deposits	0.00	0.00	1.39
MMI rate	1.46	0.15	9.98***
coef_var_stock_index	0.03	0.03	1.12
σ^2	1.73	0.16	10.57***
γ	0.97	0.01	176.24***

***, **, * - Significant at 1%, 5%, 10%, respectively.

Model III - Profit estimates

Parameter	Value	Std error	t-statistic	signif
α	18.75	9.77	1.92	*
β L+SL	-1.74	0.87	-1.99	**
β D+F	2.56	0.72	3.53	***
α N	-1.52	1.60	-0.95	
δ L+SL, L+SL	0.17	0.06	2.81	***
δ D+F, D+F	-0.06	0.06	-0.96	
δ L+SL, D+F	0.03	0.05	0.63	
γ N, N	0.68	0.17	3.93	***
ρ L+SL, N	-0.18	0.09	-2.08	**
ρ D+F, N	-0.16	0.07	-2.29	**
ψ B	-3.19	0.44	-7.25	***
ψ B, B	0.08	0.03	2.96	***
ψ L+SL, B	0.05	0.03	1.68	*
ψ D+F, B	-0.05	0.03	-1.75	*
ψ B, K	-0.25	0.05	-4.75	***
τ	0.01	0.01	0.97	
δ_0	-8.21	1.57	-5.23	***
Assets_mkt_share	0.72	0.09	8.03	***
Assets_mkt_share^2	-0.03	0.00	-8.14	***
%_Deposits_NFC	-0.02	0.01	-2.78	***
Loans_growth	-0.01	0.01	-2.33	**
NPL_NFC	-0.18	0.05	-3.64	***
NPL_MTG	-0.32	0.13	-2.46	**
NPL_Other	0.11	0.02	5.17	***
Solvency	0.09	0.03	3.34	***
dmy_MA	3.32	0.38	8.82	***
dmy_PRT	-1.08	0.25	-4.33	***
GDP_growth	-0.02	0.11	-0.19	
HH_Deposits	0.00	0.00	2.67	***
MMI rate	1.07	0.15	6.94	***
coef_var_stock_index	-0.02	0.03	-0.62	
σ^2	1.75	0.23	7.71	***
γ	0.97	0.01	154.32	***

***, **, * - Significant at 1%, 5%, 10%, respectively.

¹ It includes both issues retained by a bank and issues sold to external investors.

² ECB (2007).

³ ECB (2004, 2005).

⁴ *Banco de Portugal*, Annual Report (1997; 2006).

⁵ The adoption of the IAS implied changes in the accounting of credit that was securitised, simultaneously introducing more severe criteria for total derecognition of securitised assets from the balance sheet. Such derecognition will only occur in situations of total sale of rights and obligations related to the securitised assets. As a result, non-derecognised securitised credit continues to be included in the credit portfolio of banks. In addition, IAS envisage the consolidation of special-purpose vehicles within their financial group whenever the latter had effective control. This fact caused a reduction in the number (and volume) of new off-balance sheet securitisation operations. In June 2007 off-balance sheet securitised loans represented 6.3% of total loans.

⁶ France, Germany, Italy, Spain and Switzerland.

⁷ In most cases the bank retains the most junior tranche of the securities issued by the SPV, thus making it exposed to the “first losses” on the securitised loans.

⁸ In Portugal, the securitisation of bank loans is, according with Bank of Portugal rules, neutral in terms of capital requirements.

⁹ $Y_{it} = x_{it}\beta + (v_{it} + u_{it})$.

¹⁰ Humphrey (1992).

¹¹ Other off-balance sheet credit exposures could also have been considered: unused credit lines, irrevocable commitments and loan guarantees. However, their magnitude is negligible when compared with the amount of securitised loans.

¹² Individual and confidential data are not disclosed and are used for research purposes only.

¹³ Monetary and financial statistics regulated by Instruction N.º 43/1997 from *Banco de Portugal*, until 2002, and Instruction N.º 19/2002 from *Banco de Portugal*, from that year onwards.

¹⁴ Kindly made available to the public by Tim Coelli (<http://www.une.edu.au/econometrics/cepa.htm>).

¹⁵ The differences between the models are statistically significant in two-paired sample mean comparison tests.

¹⁶ Indeed, the servicing of on and off balance sheet loans is the same.

¹⁷ Also here, the differences are statistically significant in two-paired sample mean comparison tests.

¹⁸ Although the estimate is not statistically significant in Model III.

¹⁹ Measured in terms of total assets.

²⁰ Although desintermediation makes asset volume a poor indicator of bank size, market shares of deposits and credit should not be employed in equation (5) since these variables are also employed, although in (log) absolute values, in the frontier estimation (3).

²¹ As opposed to deposits received from households.

²² Our definition of operating costs does not include credit-risk related costs. These, however, are accounted for at the profit level.