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**ABSTRACT**

The Portuguese banking sector has been recently subjected to important structural changes. The diversification of the supply of financial services, the specialization phenomena and the growing importance of new technologies are changing the sector dramatically. A profit perspective is used to investigate the efficiency performance of the commercial banking sector in Portugal in the period 2000-2004 and infer some implications for the banks´ management strategic orientation. The Nerlovian and an alternative profit efficiency measures are used, illustrating the potentialities of the directional distance functions to the profit efficiency analysis. A decomposition of the alternative profit efficiency measure is also proposed.

**Keywords:** *banking, Nerlovian profit efficiency, alternative profit efficiency, directional distance functions.*

**JEL Classification:** C61, G21, L11.

## 1. INTRODUCTION

In the late 1980´s, the Portuguese banking sector was subjected to significant changes. Following the entry of Portugal into the European Community, the sector was de-regulated. Price and credit controls were practically abolished, the majority of public banks were privatized and the entry barriers were significantly weakened. In this period, new (Portuguese and foreign) banks were created and competition in the banking sector increased substantially.

In the context of global financial markets and increasing competition (facilitated and accelerated by the new information technologies), banks are extending their activities to new types of services, getting away from their typical role of mere financial intermediaries. The Portuguese financial institutions are accompanying this global sophistication process by diversifying their activities and creating new and specialized lines of business. Portuguese banks have restructured their activities and they are currently providing not only generalist services (like credit and deposits) but also specialized services (e.g., securitization, project finance, swap operations, warrants emissions, private banking).

In this environment of significant structural changes, the Portuguese banks are faced with important issues (e.g., the optimal input-output mix) and challenges. In the Portuguese banking industry, the efficiency concerns are certainly important. Yet, those concerns have remained limited to a cost perspective. The Portuguese banks have adopted several policies to stabilize the ratio of the number of employees to the number of branches, the ratio of operating costs to income and also the ratio of costs to financial assets (*Boletim Informativo* No. 35, *Associação Portuguesa de Bancos*)[1]. A profit efficiency analysis can provide very useful insights for managers´ decisions on corporate strategy.

In this paper, we identify the sources of inefficiency from a profit efficiency perspective using Data Envelopment Analysis (DEA). We believe that our paper provides a triple contribution to the literature on banking efficiency. First, this study enriches the so far reduced empirical literature on

[1]*Boletim Informativo* is a periodical publication of the Portuguese Association of Banks (*Associação Portuguesa de Bancos*).

profit efficiency analysis and, to our knowledge it is the first paper where (standard and alternative) profit efficiency measures are computed for the Portuguese commercial banking sector, which makes this paper intrinsically interesting from an empirical perspective. Second, it provides an additional illustration of the potential benefits for profit efficiency analysis created by recent developments on the directional distance functions. Third, this paper provides a theoretical contribution by developing an alternative profit efficiency measure using a directional distance function approach and decomposing this measure into technical efficiency, input allocative efficiency and output price efficiency.

This paper is organized as follows. In section 2, a brief overview of the literature on banking efficiency is presented, with particular emphasis on banking profit efficiency and a few empirical studies on the Portuguese banking sector. The methodology is described in section 3 and the data is presented in section 4. The empirical results are discussed in section 5 and section 6 presents the main conclusions and some guidelines for future research.

## 2. Literature review

The literature on banking efficiency analysis is very extensive. Berger and Humphrey (1997) offer a comprehensive and useful survey on this literature. Both parametric and non-parametric techniques have been employed to compute efficiency scores, providing valuable insights not only for the academic research but also for regulation and management decisions (Berger and Humphrey, 1997). Nevertheless, the majority of these studies limit their efficiency analysis to the cost side. Indeed, among the 130 studies surveyed by Berger and Humphrey (1997), only fourteen of those studies employ a profit efficiency perspective.

The dominance of the cost efficiency analysis in the banking sector also applies to the Portuguese case. Although some studies (e.g., Guevara and Maudos, 2002) provide banking profit efficiency scores for several European countries, including Portugal, to our knowledge, there is no study focusing exclusively on the profit efficiency of the Portuguese banking sector.

In this section, we briefly review two studies on efficiency of the Portuguese banking sector and then we discuss some empirical studies that present interesting insights on the measurement of profit efficiency for the banking sector in general.

*2.1 The Portuguese case*

In Portugal, contrarily to other countries, the study of banking efficiency is a relatively recent topic and empirical studies do not abound. Mendes and Rebelo (1999) and Canhoto and Dermine (2003) are two of a few studies, employing, respectively, parametric and non-parametric techniques to study the efficiency of the Portuguese banking sector.

Mendes and Rebelo (1999) study the variable cost efficiency of the Portuguese banking sector from 1990 until 1995, the time period of strong transformations that followed the entry of Portugal into the European Community. The empirical results indicate a substantial variability in the efficiency levels of Portuguese banks, with some institutions having significantly higher levels of variable cost efficiency than others. The average cost inefficiency level is around 5.7% for the whole period. Their results also indicate that inefficiency scores tend to be stable (or even increase slightly) across the period 1990-1995. Therefore, Mendes and Rebelo (1999) argue that the increasing competition on the financial markets that followed the entry of Portugal into the European Community has not led to the expected increasing of efficiency levels.

Canhoto and Dermine (2003) compute technical efficiency levels for the Portuguese banks between 1990 and 1995 employing DEA. In addition, the efficiency performance of old established banks is compared with the performance of the new ones. The empirical results indicate that the technical efficiency scores of Portuguese banks have risen steadily from 0.73 (1990) to 0.93 (1995) and, in general, *de novo* banks tend to be technically more efficient (0.86) than the old established ones (0.73).[2]

---

[2] These results are average values obtained under the assumption of variable returns to scale. A similar time pattern is also found for the case of constant returns to scale, though efficiency scores are necessarily lower under this assumption.

*2.2 Profit efficiency analysis*

Despite the wide agreement on the relevance of profit efficiency analysis, the technical difficulties with the measurement and decomposition of profit inefficiency were the main reasons for the small number of empirical studies on banking profit efficiency. Although several measures of profit efficiency were previously proposed (e.g., see Färe *et al.*, 2004), a consensus on the most adequate one was difficult to be achieved, contrarily to the case of cost efficiency analysis.

Unlike the cost function, the profit function has an additive structure implying that the Shephard type distance functions, which are radial, are not the appropriate dual model of technology (Färe and Gosskopf, 2000b). We expect that the recent theoretical developments on the directional distance functions contribute extensively to the emergence of a consensus around the profit efficiency measurement as well as its decomposition (e.g., Chambers *et al.*, 1996a, 1996b, 1998; Färe and Grosskopf, 1997, 2000a, 2000b; Chambers and Färe, 2004; Färe *et al.*, 2004).

The majority of studies investigating banking profit efficiency adopt a parametric approach following the prominent works of Berger and Mester (1997), DeYoung and Nolle (1996) and DeYoung and Hasan (1998). There are two interesting studies employing DEA to compute profit efficiency levels: one is Färe *et al.* (2004) and the other one is Maudos and Pastor (2003). In what follows we briefly review each of these studies.

Färe *et al*. (2004) use the new developments on the directional distance functions to compute Nerlovian profit inefficiency measures for the USA banking sector in the years of 1992, 1993 and 1994. Additionally, profit inefficiency is decomposed into technical and allocative inefficiency.

This study points interesting insights on the American banking sector: the allocative inefficiency is the major determinant of profit inefficiency for the USA banks. In the model with no regulatory conditions (like ours) and considering two fixed assets, Färe *et al.* (2004) obtain technical inefficiency scores ranging from 0.078 in 1992 to 0.128 in 1994 whereas profit inefficiency levels range from 0.795 to 0.796, respectively in 1992 and 1994. These results show that the allocative inefficient choices are the prominent determinant for the bank's deviations from profit optimization. These conclusions are precisely the opposite of some previous studies (e.g., Berger *et al.*, 1993), where technical inefficiencies were found to be the major determinant for profit inefficiency in the banking sector.[3]

Maudos and Pastor (2003) also employ DEA to investigate profit efficiency in the Spanish banking sector from 1985 till 1996. However, their objectives and methodology are significantly different from Färe *et al.* (2004). Färe *et al.* (2004) provide a decomposition of profit inefficiency in order to identify the sources of inefficiency. Maudos and Pastor (2003) focus on a different problem, intending to study empirically the differences between cost efficiency scores and profit efficiency scores.

They found that the profit inefficiency levels are quite superior to the cost inefficiency levels. Indeed, for the period beginning in 1985 and ending in 1996, average profit efficiency of the Spanish banking sector is around 0.574[4], while the average cost efficiency for the same period is around 0.87 (Maudos and Pastor, 2003). Hence, the results in Maudos and Pastor (2003) suggest that the omission of the revenue side (under the cost perspective) may introduce important empirical distortions.

In addition, Maudos and Pastor (2003) also try to derive implications of price making behaviour from the profit efficiency scores of Spanish banks. In the literature, the computation of (standard) profit efficiency scores focuses on the deviations from the optimal input-output mix, assuming that firms act as price-takers. However, this price taking assumption is not always adequate since in several circumstances banks are able to set the prices they charge. In this context, some authors propose the concept of alternative profit efficiency, where firms are free to set their prices assuming that their production plans remain unchanged (DeYoung and Nolle, 1996; Berger and Mester, 1997; Rogers, 1998; DeYoung and Hasan, 1998). The alternative profit efficiency measures revealed to be appropriated not only in the presence of price-making behaviour, but also when there are significant differences on product quality and difficulties in obtaining data on output prices (Rogers, 1998).

[3] These studies employed parametric techniques.

[4] This estimate (0.574) is very close to the average standard profit efficiency score found by Berger and Mester (1997) for the American banking sector (0.549).

The few existing studies on alternative profit efficiency have employed parametric methodologies. To our knowledge, Maudos and Pastor (2003) is the only study where alternative profit efficiency scores are computed with a non-parametric approach. Maudos and Pastor (2003) find an average value of 0.425[5] for the alternative profit efficiency score for the Spanish banking sector between 1985 and 1996. The lower level of alternative profit efficiency captures an additional source of inefficiency that is explained by an erroneous price/quality decision. Maudos and Pastor (2003) interpret these results as evidence for the existence of some degree of market power in the Spanish banking sector.

We end this brief review of the literature on profit efficiency analysis for the banking sector emphasizing some important ideas. Firstly, the exclusive analysis of the cost side might create a bias in the efficiency measurement. Secondly, the recent contributions of the directional distance functions should be regarded as an innovative and simpler approach to generate the profit efficiency measure and its decomposition. Finally, when price making behaviour or quality differentiation are relevant, the standard profit efficiency measurement might lead to biased results and the alternative profit efficiency scores should be computed.

## 3. METHODOLOGY

In the efficiency literature, we find several concepts of profit efficiency (e.g., Färe *et al.*, 2004). Here, we will adopt two distinct concepts: the Nerlovian profit efficiency and the alternative profit efficiency.

### *3.1 Nerlovian Profit Efficiency*

The Nerlovian profit efficiency assumes price-taking behaviour and provides an indication of profit losses due to an inadequate choice of the input-output mix. This measure is computed as a normalized difference between the optimal profit and the profit obtained from the actual input-output

[5] This estimate (0.425) is very close to the average alternative profit efficiency score found by Berger and Mester (1997) for the American banking sector (0.463).

choices. The particularity of the Nerlovian profit inefficiency measure derives from its normalization that, in turn, depends on a specific direction vector.

The Nerlovian profit inefficiency measure is formally given by (Chambers *et al.*, 1998):

$$NE = \frac{\pi(p,w)-(py-wx)}{(pg_y + wg_x)}, \tag{1}$$

where the normalization of eventual profit losses is the value of the direction vector, $(g_x, g_y)$. This normalization is extremely useful since it eliminates some traditional difficulties on the profit efficiency measurement like the zero or negative profits. Furthermore, this normalization implies that *NE* is a unit-free measure of profit inefficiency (e.g., Färe *et al.*, 2004; Färe and Grosskopf, 2000b).

The normalization of the *NE* measure results from the duality between the directional technology distance function and the profit function (Chambers *et al.*, 1998). The directional technology distance function provides a measure of the simultaneous maximum input contraction and output expansion of a particular production plan to the production frontier, according to a pre-assigned direction vector.

The directional technology distance function is formally defined as (Chambers *et al.*, 1998):

$$\vec{D}_T(x, y; g_x, g_y) = \begin{cases} \max\{\beta \in \Re : (x - \beta g_x, y + \beta g_y) \in T\}, \; if \; (x - \beta g_x, y + \beta g_y) \in T, for \;\; some \;\; \beta \\ \inf\{\delta \in \Re : (y + \delta g_y) \in \Re_+^M\}, \;\; otherwise \end{cases} \tag{2}$$

where *T* denotes the physical production technology of a particular bank, $x \in \Re_+^N$ represents a vector of inputs, $y \in \Re_+^M$ denotes a vector of outputs, and $(g_x, g_y)$ is a non-zero vector in $\Re_+^N \times \Re_+^M$ determining the direction that is followed to measure the contraction in inputs ($g_x$) and the expansion in outputs ($g_y$). Under free disposability of inputs and outputs (which is generally the case of the banking activity) and other mild assumptions on *T*, Chambers *et al.* (1998) demonstrate that the directional technology distance function is a complete representation of the technology.

Additionally, the dual relation between the directional technology distance function and the profit function (see Chambers *et al.* (1998) for the formal proof) provides the basis for an additive decomposition of the Nerlovian profit inefficiency into technical inefficiency (given by the directional technology distance function) and allocative inefficiency (residually obtained). Formally, the decomposition is as follows:

$$NE = \vec{D}_T(x, y; g_x, g_y) + AE\,, \qquad (3)$$

where *AE* represents the allocative inefficiency measure.

Under the inefficiency decomposition in (3), profit inefficiency may be explained by technical reasons (when banks produce below their production frontier) and/or by allocative reasons (when banks suffer profit losses due to an erroneous choice of the input-output mix given the relative prices of inputs and outputs). Note that all these measures are necessarily non-negative, implying that if a bank is Nerlovian profit efficient, then it must be both technically and allocatively efficient (Chambers *et al.*, 1998).

*3.2 Alternative Profit Efficiency*

The alternative profit inefficiency measures provide an indication of potential profit losses in a price-making context. To our knowledge, alternative profit inefficiency measures have not been treated in the context of the directional distance functions. The normalization more frequently used to compute alternative profit inefficiency measures is the potential profit (e.g., Maudos and Pastor, 2003). However, in the context of the directional technology distance function, we are able to develop an alternative profit inefficiency measure with a normalization similar to the one considered in the Nerlovian profit inefficiency measure.

The alternative profit efficiency measure is defined as follows:

$$APE = \frac{\pi(y, w) - (py - wx)}{wg_x}\,, \qquad (4)$$

taking into account that the output vector is not a decision variable and consequently only the direction vector $(g_x, g_y) = (g_x, 0)$ should be considered. For given input price and output vectors, the *APE* measure is the difference between maximal profit, $\pi(y, w)$ and the actual profit obtained from current decisions on input quantities and output prices, normalized by the value of the input direction vector. Like the Nerlovian inefficiency measure, *APE* is a unit-free measure.

Notice also that, under the referred assumptions, technical efficiency is generated using the directional input distance function, $\vec{D}_T(y,x;g_x,0)=\vec{D}_i(y,x;g_x)$. Chambers *et al.* (1996) show the duality between the directional input distance function and the cost function. The following equation expresses formally that dual relation:

$$C(y,w)=\min_x\left\{wx-\vec{D}_i(y,x;g_x)wg_x\right\},$$
$$\vec{D}_i(y,x;g_x)=\min_w\left\{\frac{wx-C(y,w)}{wg_x}\right\}. \tag{5}$$

The duality expressed in (5) provides the basis for an additive decomposition of the alternative profit efficiency measure. In the present context, the profit maximization problem is given by:

$$\pi(y,w)=\max_{p,x}\{py-wx\}=\max_p\{py-C(y,w)\}. \tag{6}$$

Consequently, by the definition of profit function, the following inequality must hold:

$$\pi(y,w)\geq py-w(x-\vec{D}_i(y,x;g_x)g_x), \tag{7}$$

where, by the definition of $\vec{D}_i(.)$, $(x-\vec{D}_i(.)g_x,y)\in T$ and $\vec{D}_i(y,x;g_x)\geq 0$ (Chambers *et al.*, 1996). This inequality essentially states that maximal profit must be at least as great as the current profit plus potential profit gains derived at least from improvements on technical efficiency.

Expression (7) can be rewritten as follows

$$\frac{\pi(y,w)-(py-wx)}{wg_x}\geq\vec{D}_i(x,y;g_x), \tag{8}$$

where the left hand side of the inequality corresponds to the alternative profit efficiency measure explicated in (4).

The inequality in (8) may be closed by adding a residual inefficiency term, i.e.,

$$\frac{\pi(y,w)-(py-wx)}{wg_x}=\vec{D}_i(x,y;g_x)+RE, \tag{9}$$

where $RE \geq 0$. Note that all inefficiency measures in (9) are necessarily non-negative, implying that if $APE = 0$, then $\vec{D}_i(y, x; g_x) = 0$ and $RE = 0$.

Given the profit maximization problem in (6), maximal profit can be expressed as

$$\pi(y, w) = p^* y - wx^*, \tag{10}$$

where $p^* = p(y, w)$ and $x^* = x(y, w)$.

Using equation (10), the decomposition in (9) can be rewritten as

$$\frac{(p^* y - wx^*) - (py - wx)}{wg_x} = \vec{D}_i(x, y; g_x) + RE, \tag{11}$$

allowing for the identification of the following components of the alternative profit inefficiency measure:

$$OPE = \frac{p^* y - py}{wg_x}, \tag{12}$$

and

$$\frac{wx - wx^*}{wg_x} = \vec{D}_i(x, y; g_x) + AE_i, \tag{13}$$

where *OPE* is an output price inefficiency measure and $AE_i$ represents the input allocative inefficiency measure. *OPE* is the normalized difference between the profit-maximizing revenue and the actual revenue; $AE_i$ reflects the deviation between the actual input-mix and the profit-maximizing input-mix.[6] Note that the left-hand side of equation (13) is the normalized difference between the actual cost and the profit-maximizing cost. The value of $AE_i$ depends on the relation between $x$ and $x^*$. The actual choices of the input quantities are determined given $w$ and $y$ in the light of $p$, while the profit-maximizing input quantities are determined given $w$ and $y$ in the light of $p^*$. Hence, the input allocative inefficiency measure can be positive, null or negative.

The residual inefficiency term, *RE*, in (8) can be decomposed as

$$RE = OPE + AE_i. \tag{14}$$

[6] Färe *et al*. (1994) develop an overall output price efficiency measure in the context of revenue maximization.

Considering the broad potentialities subjacent to both concepts of profit efficiency previously described (Nerlovian and alternative profit efficiency), we are expecting them to allow for a strong and desirable strengthening on the literature of profit efficiency.

*3.3 Empirical models*

In this paper, we propose four models to compute the profit inefficiency scores for the Portuguese banking sector over the period 2000-2004.[7] In three of these models, price-taking behaviour is assumed and we compute the Nerlovian profit inefficiency scores and proceed into its decomposition into technical and allocative inefficiency as in (3). The three models are very similar, only differing on the direction vector used to project the observed production plan onto the frontier. In the first model, the direction $(g_x, g_y) = (x, y)$ is assumed, the second model assumes $(g_x, g_y) = (x, 0)$ and finally, the third model considers $(g_x, g_y) = (0, y)$.

In the fourth model, we consider a price-setting framework and we compute alternative profit inefficiency scores, which will be compared to the Nerlovian profit inefficiency levels to inquiry the existence of market power or important quality differences in the services provided by Portuguese banks. As mentioned before, the alternative profit inefficiency scores are necessarily computed using the direction vector $(g_x, g_y) = (x, 0)$. Furthermore, the alternative profit inefficiency scores are decomposed using equations (11)-(13).

In the literature of profit efficiency analysis of the banking sector, the parametric techniques are the most widely employed. In this paper we compute inefficiency levels using DEA. DEA is particularly suitable to embody the recent developments on the directional distance functions and provides a simple way to compute bank-specific profit inefficiency scores.

We start by defining a piecewise representation of each bank's physical activity. This representation is common to the four models. We adopt a short-run perspective, considering that banks are constrained with a fixed input (financial capital).[8] Additionally, we assume that each bank

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[7] Details on the data set used are presented in the next section.
[8] This issue is further developed in the next section.

activity exhibits variable returns to scale to allow for positive, zero and negative maximal profits. Under these assumptions, the piecewise representation for the banks´ production frontiers is constructed from the data set as follows:

$$
\begin{aligned}
T = \Big\{(x, y) : \sum_{k=1}^{K} z_k y_{km} \geq y_m,\ m = 1,...,M;\ \sum_{k=1}^{K} z_k x_{kn} \leq x_n,\ n = 1,...,N; \\
\sum_{k=1}^{K} z_k x_{kn+1} \leq x_{k',n+1};\ \sum_{k=1}^{K} z_k = 1;\ z_k \geq 0,\ k = 1,...,K\Big\},
\end{aligned}
\tag{15}
$$

where $k$ is a bank index, $K$ is the number of total banks, $n$ is an input index, $N$ is the total number of inputs potentially used by each bank, $n+1$ is a fixed input, $m$ is an output index, $M$ is the total number of outputs potentially produced by each bank and $z$ is the intensity vector.

Then, we focus on the standard profit efficiency models and we start with the computation of technical inefficiency measures. Under the three directions chosen to the measurement of technical inefficiency, we solve the following linear programming problems:

$$
\begin{aligned}
\vec{D}_T(x^{k'}, y^{k'}; g_x, g_y) = \max_{\beta, z} \Big\{\beta : \sum_{k=1}^{K} z_k y_{km} \geq y_{k'm} + \beta g_{ym}, m = 1,...,M; \\
\sum_{k=1}^{K} z_k x_{kn} \leq x_{k'n} - \beta g_{xn}, n = 1,...,N;\ \sum_{k=1}^{K} z_k x_{kn+1} \leq x_{k',n+1}; \\
\sum_{k=1}^{K} z_k = 1;\ z_k \geq 0,\ k = 1,...,K\Big\},
\end{aligned}
\tag{16}
$$

where $(g_x, g_y) = (x, y)$ for the first model, and $(g_x, g_y) = (x, 0)$ and $(g_x, g_y) = (0, y)$ for the second and third models, respectively.

The next step consists in solving the profit maximization problem, given input and output prices:

$$
\begin{aligned}
\pi(p^{k'}, w^{k'}) = \max_{y,x,z} \Big\{p^{k}{}'y - w^{k}{}'x : \sum_{k=1}^{K} z_k y_{km} \geq y_m,\ m = 1,...,M; \\
\sum_{k=1}^{K} z_k x_{kn} \leq x_n,\ n = 1,...,N;\ \sum_{k=1}^{K} z_k x_{kn+1} \leq x_{k',n+1}; \\
\sum_{k=1}^{K} z_k = 1;\ z_k \geq 0,\ k = 1,...K\Big\}.
\end{aligned}
\tag{17}
$$

The maximal profit associated with the optimal choices of each bank, obtained by solving (17), and the actual profit associated with the each bank's current choices generates the $NE$ in (2). The decomposition of the Nerlovian inefficiency scores in (3) for each bank is generated for our three models of standard profit efficiency.

Next, we focus on the computation of the alternative profit inefficiency scores. We begin with the resolution of the profit maximization problem in an output price-making context. The profit-maximizing output price and input quantity vectors are determined by solving the following linear programming problems:

$$\begin{aligned}\pi(y^{k'}, w^{k'}) = \max_{p,x,z}\Big\{ & p'y^{k'} - w^{k'}{}'x : \sum_{k=1}^{K} z_k p_{km} \geq p_m,\ m = 1,\dots,M; \\ & \sum_{k=1}^{K} z_k y_{km} \geq y_{k'm},\ m = 1,\dots,M; \sum_{k=1}^{K} z_k x_{kn} \leq x_n, n = 1,\dots,N; \\ & \sum_{k=1}^{K} z_k x_{kn+1} \leq x_{k',n+1}; \sum_{k=1}^{K} z_k = 1;\ z_k \geq 0,\ k = 1,\dots K\Big\}.\end{aligned} \quad (18)$$

The maximal profit obtained from (18) and the profit associated with their observed choices, given the direction vector, allows the computation of *APE* in (4) and *OPE* in (12). Technical efficiency scores for each bank are generated using (16), given $(g_x, g_y) = (x,0)$. Finally, expression (13) is used to obtain the input allocative inefficiency scores for each bank.

## 4. DATA

The first step towards the construction of an empirical model for the profit inefficiency "estimation" of the Portuguese commercial banks is the specification of their activity, which is crucial to achieve an adequate representation of their production frontiers. In the literature of banking efficiency, the specification of banking activities remains an unsolved debate. Favero and Papi (1995) provide important insights on this debate.

In the mainstream literature, there are two different perspectives on the definition of the banking activity: the production approach and the intermediation approach. The production approach regards banks from a physical perspective. It assumes that each bank combines physical inputs (like labour and capital) to produce financial services (frequently measured as the number of transactions). Instead, the intermediation approach focuses on the intermediation functions performed by banks.

This approach includes financial funds as an input factor, emphasizing their role as a crucial input for each bank's financial activities (credit, deposits and other financial services) (e.g., Favero and Papi, 1995).

Recently, a new variation of the intermediation approach is being used: the asset approach. This approach also focuses on the intermediation role of banks, yet deposits are exclusively regarded as inputs (Favero and Papi, 1995). In contrast, deposits may be simultaneously included as inputs and outputs within the broader intermediation approach.

The essential difference among these three perspectives lies in the role played by deposits.[9] Under a production (asset) approach, deposits are clearly an output (input). In the intermediation approach, deposits are surely an input and may also be included as an output.

The production approach is more frequently employed in the analysis of banking efficiency at the branch level. In this case, the required data is more easily available and the omission of the intermediation role of financial institutions is not so awkward, since each branch by itself has a minor influence on the institutions' strategy. For the opposite reasons, the intermediation or asset approach is the most frequently adopted at the bank level, particularly in the case of commercial banks.

Following Maudos and Pastor (2003) and Färe *et al.* (2004), we employ the asset approach, emphasizing the financial role played by the Portuguese banks included in the sample. According to our model, banks combine one fixed input – financial capital ($x_f$) – and three variable inputs – labour ($x_1$), physical capital ($x_2$)[10] and borrowed funds from clients (deposits) or other financial institutions ($x_3$) – to render three types of services: credit ($y_1$), financial services associated with their operational activity ($y_2$) and securities portfolios ($y_3$).

[9] These three approaches are the most widely used when modelling banking activities. Yet, other approaches are also employed: the user cost approach and the value added approach. In the user cost approach, the sources of the bank's revenue are used to identify inputs and outputs. In the value added approach, inputs and outputs are identified according to their contribution to the added value of the financial institution.

[10] Canhoto and Dermine (2003, p.2091) emphasize that the measurement of the physical capital using the net book value of fixed assets "can arise a problem if historical data had been used to measure the physical capital". Nevertheless, "physical assets of banks reported in the book were re-evaluated at market prices", according to Decree Laws 49/91, 264/92 and 22/92.

The financial capital was included as a fixed asset to account for the recent contributions on the relevance of this input to the efficiency analysis. As Färe *et al.* (2004), among others, emphasize, the financial capital may affect efficiency scores either as source of financial funds or as a source of creditor's protection from the insolvency risk.

The recent literature on banking profit efficiency (e.g., Färe *et al.*, 2004) also states that the increasingly important non-traditional activities should be explicitly included when modelling each bank's activity (for instance through the inclusion of variables related to the off-balance sheet activity of financial institutions). However, we hadn't have access to data on this type of activity. Therefore, we attempted to incorporate these non-traditional activities through the variables $y_2$ and $y_3$. When the data about off-balance sheet becomes available, the efficiency scores should be re-estimated in order to eliminate eventual bias derived from the omission of this variable. Nevertheless, given the data currently available, we believe that our approach is the most adequate one.

Table 1 summarizes the relevant variables for our empirical models, identifying how each variable is computed. Also, this table presents the average value of each variable in the year 2004 for the Portuguese banks included in the sample.

The data used in this paper is taken from the *Boletim Informativo No. 35*, published on (at least) an annual basis by the *Associação Portuguesa de Bancos* (*APB*). In Portugal, this is the most reliable source of financial information at the bank-level. The balance sheet and the profits and losses accounts for the associates of the *APB* can be found in the *Boletim Informativo No. 35* for the period beginning in 2000 and ending in 2004. For comparability reasons, all the values were deflated by the consumer price index for the financial activities with base year 2004.[11]

The identification of a representative sample of the Portuguese commercial banking sector was relatively easy, considering the concentration degree that characterizes this sector as well as the dominance exercised by a small number of financial institutions. Firstly, we have identified the banks associated with the *APB*, where almost 100% of the banking activity is represented. The associates of

[11] Two series were collected from *Instituto Nacional de Estatística (INE): Consumer Price Index for financial services (base year 2002)* and *Consumer Price Index for financial services (base year 1997).* We transformed both indices to use 2004 as the base year.

the *APB* constitute a universe of 50 banks. Then, we eliminate from our sample the Portuguese banks whose core activity is not associated with commercial banking. In this step, we eliminate investment banks, private equity banks, on-line banks, recently created banks and banks with an insufficient number of branches to perform normally the typical activities of commercial banking. We ended with a sample of 19 banks for the year of 2004. Then, based on this sample, we construct the samples of banks for the previous years, eliminating those for which information was not available as well as those who played different functions in those years. In 2000, we obtained a sample of 13 banks; a sample of 14 banks is obtained for 2001; and in 2002 and 2003, the sample is composed of 16 and 17 banks, respectively.

Since each year has a different number of observations, we end up with a non-balanced panel of data. Yet, considering our institutional knowledge on the Portuguese banking sector, we believe that this sample is sufficiently representative of the Portuguese commercial banking system.

## 5. ESTIMATION RESULTS

Following the methodology previously described, we obtained profit inefficiency scores for each of the four models presented in section 3. Table 2 presents the Nerlovian profit inefficiency scores and its decomposition for the three standard profit efficiency models. According to the information on the table, the Nerlovian profit inefficiency levels of Portuguese banks range, on average, from 0.276 (2000) to 0.489 (2004) under model 1; from 0.591 (2000) to 1.009 (2004) under model 2, and from 0.519 (2000) to 5.89 (2004) under model 3.

These results suggest two comments. First, inefficiency scores are lower under model 1, which suggest that choosing the direction $(g_{x,} g_{y}) = (x, y)$, where both inputs and outputs can be adjusted, provides a better fit to the data than choosing the traditional directions (implicitly assumed on the radial measures of efficiency), where inputs and outputs cannot be altered simultaneously. This point is emphasized by Färe *et al.* (2004) and it is an additional argument in favour of directional distance functions.

Second, for all models, the empirical results indicate an increase of the profit inefficiency levels of the Portuguese commercial banks since 2000.[12] Note that this may not to be the case, since the results cannot be directly compared as we relied on a non–balanced panel data to obtain the inefficiency scores. In 2004, the higher number of observations may explain the increase in inefficiency scores. Thus, the time pattern of the inefficiency scores may be the result of the curse of dimensionality.

Nevertheless, even if the reduction on profit efficiency levels may be (at least partially) explained by differences on sample composition, taking into account the current situation of the Portuguese commercial banks, a reduction on the profit efficiency levels is indeed possible. Presently, the Portuguese banking system is facing important structural changes. The sector is now faced with a fierce competition on the financial intermediation activities and gradually banks are developing other types of services (the so-called non-traditional activities) where product quality is crucial and allows banks to gain higher margins.

Currently, we are faced with the appearance of a highly diversified portfolio of financial services that range from securitization, cross border leases, trust participations to car renting services. This situation creates a wide range of opportunities for the development of new lines of business in the banking sector. In turn, this also implies a substantial increase in the potential profits of financial institutions and it is possible that a large fraction of these potential profits remain to be exploited, explaining the high scores of profit inefficiency.

The structural changes mentioned previously are indeed very recent and as one would expect the Portuguese banks are reacting to them gradually. Progressively, the Portuguese banks have been investing in the diversification of their output portfolios and, in parallel with the intermediation services they are now offering an increasing bunch of financial services.

[12]Even if the behaviour of the profit inefficiency scores is not linear, it is also clear that there is a decreasing of profit efficiency when we consider the whole time period.

Obviously this strategic reorientation takes time, which may explain the recent decrease in profit efficiency levels[13]. Indeed, with banks reacting gradually to the changes observed on the environmental conditions (including new relative output prices), they do not benefit immediately from the increase in the potential profits and consequently, their profit efficiency scores become smaller.[14]

Focusing now on the Nerlovian profit inefficiency decomposition, the results in Table 2 indicate that profit inefficiencies are explained, to a large extent, by allocative inefficiencies. Actually, technical inefficiency scores are, on average, extremely low, suggesting the existence of little scope for improvements on the technical component of the bank's activity. For the period 2000-2004, the average value of technical inefficiency scores is around 0.06% in case of models 2 and 3 and 0.03% for model 1, suggesting that the Portuguese banks are operating very close to the production frontier. Actually, for all the years in the sample, only one or, at most, two banks are not technically efficient.

Despite the methodological differences, our results are in line with the ones presented by Canhoto and Dermine (2003). Canhoto and Dermine (2003) report also low levels of technical inefficiency for the period 1990-1995 (although, not so low as ours) and predict a further increasing on technical efficiency levels, which seems to have occurred according to our results for the period 2000-2004.

The insignificant levels of technical inefficiency of Portuguese banks demonstrate that the allocative inefficiencies are the major determinants for the observed profit inefficiencies. This suggests that Portuguese banks may be choosing inadequately their input-output mix, given their relative input and output prices. This conclusion is consistent with our previous comment on the progressive adaptation of the strategic positioning of financial institutions to the recent structural changes in the banking sector with a diversification of the portfolio of financial services rendered by banks.

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[13]According to this interpretation, the decreasing of the efficiency scores is not due to the decrease in current profits (which would be at odds with reality) but to a substantial increase in the potential profits.

[14]In order to isolate the impact of these recent environmental changes on efficiency scores, new efficiency scores should be obtained with a balanced panel data.

To investigate more deeply the implications of our results concerning the strategic positioning of Portuguese banks and provide some additional insights to bank management, we compared the actual input and output choices made by Portuguese banks with their optimal choices. We compute the percentage deviation of the actual decision from the optimal decision. Table 3 presents these results. A positive value identifies an over-utilization of inputs and over-production of outputs, while a negative value has the opposite interpretation.

The information on Table 3 offers very interesting insights. First, the high values obtained for the standard deviation signal the heterogeneous nature of input and output choices made by the Portuguese banks. For all variables and all years, we find both positive and negative deviations. Given the heterogeneity of choices, the mean deviation analysis can lead to a biased interpretation. Consequently, for each year and each variable we compute the median deviation for the Portuguese banking sector as a whole.

On the input side, the comparison of the median deviation across variables reveals that, in general, median deviation is positive for $x_1$ and $x_2$ and negative for $x_3$. These results suggest that Portuguese banks are facing problems of over-utilization of labour and physical capital. This result is consistent with the facts presented in *Boletim Informativo* No. 35, namely in what concerns the stabilization or reduction of the number of employees and also the excessive number of branches of some financial institutions. Nevertheless, Portuguese banks seem to insist in increasing their number of branches (and, consequently their physical capital), precisely in the opposite direction of our results. This inconsistency may be explained by dynamic considerations which are not considered in our model and that can offer an interesting topic for future research.

The negative deviation observed for $x_3$, suggest that banks should invest more in getting financial funds than they are actually doing. Since available funds are an indispensable input to develop financial intermediation and non-traditional services, our models suggest that this input is a key factor for the growth of Portuguese banks. Consequently, banks should invest in capturing resources through a more aggressive commercial policy on deposits.

On the side of output choices, our results suggest the existence of a negative deviation for $y_1$ (credit) and $y_3$ (securities and other services). For $y_2$ (commissions), the median deviation sign is very close to zero (except for year 2004).

The under-production of securities, where some of the new non-traditional activities are included, is probably explained by the progressive reaction of banks to the new environmental conditions already mentioned. The under-production of credit suggests that, in parallel with the creation of new financial services, the Portuguese banks should continue to invest on their financial intermediation role. If additional data were available, we could compute the most profit efficient credit portfolio, which could provide very useful insights about the existence of any change on the equilibrium credit portfolio on the sequence of the new environmental changes. Concerning the provision of commissions, our results suggest that, with the exception of the year 2004, the Portuguese banks are producing almost the optimal level of commissions.

To conclude our empirical analysis of the profit efficiency of the Portuguese banking sector, we estimate a fourth model – the alternative profit efficiency model – where firms set their prices, assuming that their output levels must remain unchanged. Table 4 reproduces our alternative profit inefficiency scores and compares them with our "estimates" of standard profit inefficiency (under model 2, where the direction $(g_{x,} g_y) = (x,0)$ is also assumed).

These results suggest that, for each year, the average value of alternative profit inefficiency scores is lower than the mean value of the standard profit inefficiency scores. Even if additional tests should be conducted to demonstrate the statistical significance of the difference between alternative and standard profit inefficiency scores, our results suggest that, for the period 2001-2004, the alternative inefficiency scores are less than half of the Nerlovian profit inefficiency scores. The results presented in Table 4 may suggest that the high standard profit inefficiency scores of the Portuguese banks do not result exclusively from their inadequate choices, but, to a large extent, they result from the fact that this measure ignores the existence of market power and/or differences in product quality.

Given the alternative inefficiency scores reported in Table 4, we use equations (11) to (13) to determine the sources of inefficiency, when the existence of market power and differences in quality are taken into account. Our results are presented in Table 5.

Like in the previous cases, the Portuguese commercial banks are almost technically efficient and, consequently the technical inefficiency is a minor component of the profit inefficiency. Therefore, the profit inefficiency derives essentially from inadequate choices of output prices or input quantities, given the input price vector and the output quantities.

Indeed, our alternative profit inefficiency decomposition reveals that the major determinant of the alternative profit inefficiency is the *OPE*. For the whole time period, the average *OPE* is 0.195. This suggests that the Portuguese banks are not choosing their output prices optimally.

In contrast, the *AE* is, on average, negative in most of the years. In the period 2000-2004, the average value of the input allocative inefficiency is -0.00126. Given input prices and output quantities, the optimal input choices are determined in the light of optimal output prices while the observed input choices are determined in the light of actual output prices. The average value of the input allocative inefficiency may be explained by differences between observed and optimal prices, reflected in the *OPE* measure.

Nevertheless, the *AE* scores are very close to zero, suggesting that input choices of the Portuguese banks are indeed very close to the optimal levels and consequently, the *AE* cannot be considered a major source of profit inefficiency for the Portuguese commercial banks. To confirm these results, we compute the differences (in percentage) between the optimal and the current decisions of the Portuguese banks concerning the output prices and the input choices (Table 6).

Our results suggest that, in absolute values, the median deviations are smaller than the average deviations, illustrating again the phenomena of the heterogeneity of the Portuguese commercial banking sector. Indeed, we conclude that the median deviations are null both for the output price choices and for the input quantities decisions. Even if additional statistical tests should be made to verify if the median deviation from the optimal pricing policy is significantly different from zero, our results indicate that the high levels of the *OPE* in the Portuguese commercial banking system result from inadequate choices made by a reduced number of banks and, in general, the individual inefficiency scores (*APE*, *TE*, *AE* and *OPE*) are very close to zero.

Furthermore, this proximity between the observed and the optimal decisions suggests that the alternative profit inefficiency measures are particularly suitable for the case of the Portuguese banking sector. In part, this is consistent with the recent institutional evolution of the Portuguese banking system where several mergers and other concentration phenomena have taken place. Additionally, we can also argue that the higher alternative profit efficiency may be due to quality differences that banks take into account when they make their choices, which are not considered in a standard profit efficiency analysis. Analogously, the lower levels of standard profit efficiency could also be explained by the existence of binding constraints on output production. These insights should be considered in a future research on this topic.

## 6. CONCLUSIONS

This paper provides a profit efficiency analysis of the Portuguese commercial banking industry for the period 2000-2004. Nerlovian profit inefficiency scores and alternative profit inefficiency scores are computed for the Portuguese commercial banks. The alternative profit inefficiency measure provides an indication of potential profit losses in a price-making context. An alternative profit inefficiency measure and its decomposition are developed using the directional input distance function.

Concerning the Nerlovian profit inefficiency, our results indicate that almost all the banks are technically efficient. Nevertheless, they are not profit efficient, facing losses of potential profits superior to 50% in 2004. These results suggest that the Portuguese banks are not doing the most appropriate choices of input-output mix and a repositioning strategy is required.

Using the available information, we try to concretize this repositioning strategy and point several conclusions. First, we argue that the commercial banks are facing over-capacity problems, i.e., using more than the optimal levels of labour and physical capital. Nevertheless, Portuguese banks have been increasing their physical capital, precisely in the opposite direction of our results. This inconsistency may be explained by dynamic considerations that are not considered in this study and can be an interesting topic for future research.

Second, the commercial banks should adopt a more aggressive policy in capturing financial resources. Third, the Portuguese banks should continue to invest in their credit activity, but they must continue simultaneously their diversification/specialization process, extending their activities to a wide range of financial services and benefiting from client loyalty and cross-selling activities.

In addition, we compute alternative profit inefficiency scores for this sector and verify that the alternative profit inefficiency scores are substantially inferior to the standard profit inefficiency ones. Therefore, our results suggest that the high "estimated" levels of Nerlovian profit inefficiency might derive from an inadequate assumption about the bank's pricing behaviour or product quality or both.

Our conclusions illustrate the pertinence of a profit efficiency analysis to the strategic repositioning of the Portuguese banks. In fact, when detailed information is available, profit efficiency analysis may provide crucial insights on the identification of a bank's optimal portfolio. Additionally, a more refined profit efficiency analysis should consider non-traditional banking activities and conciliate profit maximization objectives with risk minimization intentions that influence banks´ decisions. In this context, we expect an exponential growth of this literature in the next years.

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Table 1. Definition and Computation of the Variables for the Empirical Models

| | Description | Mean (2004) | Standard deviation (2004) |
|---|---|---|---|
| *Variable factors* | | | |
| $x_1$ | Number of employees | 3,923 | 5,998 |
| $x_2$ | Net book value of fixed assets | 215,290 | 324,177 |
| $x_3$ | Costumer accounts + Deposits from financial institutions + Debt securities in issue + Other liabilities | 15,497,689 | 21,622,588 |
| *Variable input prices* | | | |
| $w_1$ | Staff Costs/ Number of employees | 40 | 10 |
| $w_2$ | (Depreciations of the period + Other administrative expenses + Other operating expenses) / Gross value of physical capital | 1.35 | 2 |
| $w_3$ | (Interest payable and similar expenses + Paid commissions) / Funds | 2.64% | 0.88% |
| *Outputs* | | | |
| $y_1$ | Loans | 124,512 | 205,263 |
| $y_2$ | Received commissions | 12,257,322 | 16,787,037 |
| $y_3$ | Cash and balances at Central banks + Bonds and other fixed income securities + Shares and other variable income securities | 3,054,593 | 5,062,401 |
| *Output prices* | | | |
| $p_1$ | Interest receivable and similar income/ Loans | 5.36% | 0.28% |
| $p_2$ | Commissions /(Costumer accounts + Loans and advances to costumers) | 0.54% | 1.35% |
| $p_3$ | (Income from securities + Profit from financial transactions - Losses from financial transactions + Other operating income)/ $y_3$ | 6.95% | 12.13% |

Table 2. Nerlovian Profit Inefficiency and Its Decomposition (Models 1, 2 and 3)

| | 2000 (13 banks) | 2001 (14 banks) | 2002 (16 banks) | 2003 (17 banks) | 2004 (19 banks) | 2000-2004 |
|---|---|---|---|---|---|---|
| **Model 1** | | | | | | |
| *NE* | 3[a] | 4 | 4 | 3 | 3 | |
| Mean | 0.27606 | 0.43821 | 0.29861 | 0.33579 | 0.48871 | 0.36748 |
| Std. deviation | 0.38712 | 0.70724 | 0.40609 | 0.39888 | 0.84109 | |
| *TE* | 12[b] | 13 | 14 | 16 | 18 | |
| Mean | 0.00064 | 0.00026 | 0.00044 | 0.00016 | 0.00007 | 0.00031 |
| Std. deviation | 0.00231 | 0.00096 | 0.0017 | 0.00067 | 0.00030 | |
| *AE* | 3[c] | 4 | 4 | 3 | 3 | |
| Mean | 0.27542 | 0.43796 | 0.29817 | 0.33562 | 0.48864 | 0.36716 |
| Std. deviation | 0.38658 | 0.70739 | 0.40559 | 0.39877 | 0.84108 | |
| **Model 2** | | | | | | |
| *NE* | 3 | 4 | 4 | 3 | 3 | |
| Mean | 0.59126 | 0.96422 | 0.65249 | 0.73851 | 1.00874 | 0.79104 |
| Std. deviation | 0.83374 | 1.57397 | 0.88978 | 0.88277 | 1.85444 | |
| *TE* | 12 | 13 | 14 | 16 | 18 | |
| Mean | 0.00128 | 0.00052 | 0.00088 | 0.00033 | 0.00014 | 0.00063 |
| Std. deviation | 0.00460 | 0.00193 | 0.00341 | 0.00135 | 0.00061 | |
| *AE* | 3 | 4 | 4 | 3 | 3 | |
| Mean | 0.58999 | 0.96371 | 0.65161 | 0.73818 | 1.00860 | 0.790418 |
| Std. deviation | 0.83254 | 1.57427 | 0.88883 | 0.88253 | 1.85441 | |
| **Model 3** | | | | | | |
| *NE* | 3 | 4 | 4 | 3 | 3 | |
| Mean | 0.51925 | 0.80438 | 0.55114 | 0.61735 | 5.89324 | 1.67707 |
| Std. deviation | 0.72433 | 1.28592 | 0.74781 | 0.73010 | 22.02108 | |
| *TE* | 12 | 13 | 14 | 16 | 18 | |
| Mean | 0.00129 | 0.00051 | 0.00089 | 0.00033 | 0.00014 | 0.00063 |
| Std. deviation | 0.00465 | 0.00192 | 0.00346 | 0.00134 | 0.00060 | |
| *AE* | 3 | 4 | 4 | 3 | 3 | |
| Mean | 0.51796 | 0.80387 | 0.55026 | 0.61703 | 5.89310 | 1.67644 |
| Std. deviation | 0.72334 | 1.28622 | 0.74681 | 0.72993 | 22.02111 | |

Notes: [a] Number of banks that are profit efficient; [b] Number of banks that are technically efficient; [c] Number of banks that are allocative efficient.

Table 3. Deviations from Optimal Choices - Nerlovian Profit Inefficiency

| | *Credit* ($y_1$) | *Financial Services* ($y_2$) | *Securities Portfolio* ($y_3$) | *Labor* ($x_1$) | *Physical Capital* ($x_2$) | *Borrowed Funds* ($x_3$) |
|---|---|---|---|---|---|---|
| 2000 | | | | | | |
| Mean | -22% | 30% | 20% | 57% | 87% | -22% |
| Median | -8% | 0% | 0% | 34% | 12% | -3% |
| Std. deviation | 36% | 99% | 123% | 74% | 141% | 33% |
| 2001 | | | | | | |
| Mean | -33% | 19% | -19% | 146% | 39% | -33% |
| Median | -12% | 0% | -15% | 29% | 0% | -18% |
| Std. deviation | 38% | 76% | 54% | 242% | 101% | 37% |
| 2002 | | | | | | |
| Mean | -22% | 80% | 233% | 58% | 34% | -23% |
| Median | -9% | 0% | -17% | 11% | 19% | -3% |
| Std. deviation | 38% | 365% | 984% | 156% | 63% | 33% |
| 2003 | | | | | | |
| Mean | -23% | 35% | 32% | 93% | 124% | -22% |
| Median | -5% | 0% | -44% | 37% | 57% | -17% |
| Std. deviation | 36% | 131% | 151% | 172% | 199% | 38% |
| 2004 | | | | | | |
| Mean | 6% | 258% | 460% | 257% | 369% | 9% |
| Median | 0% | 1% | 0% | 20% | 33% | 0% |
| Std. deviation | 65% | 573% | 1047% | 631% | 902% | 81% |
| 2000-2004 | | | | | | |
| Mean | -19% | 84% | 145% | 122% | 131% | -18% |
| Median | -7% | 0% | -15% | 26% | 24% | -8% |

Table 4. Nerlovian and Alternative Profit Inefficiency – means (std. dev.)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2000-2004 |
|---|---|---|---|---|---|---|
| | 3[a] | 4 | 4 | 3 | 3 | |
| | 0.59126 | 0.96422 | 0.65249 | 0.73851 | 1.00874 | 0.79104 |
| *NE* | (0.83374) | (1.57397) | (0.88978) | (0.88277) | (1.85444) | |
| | 9[b] | 7 | 11 | 12 | 12 | |
| | 0.12975 | 0.16387 | 0.20064 | 0.20608 | 0.27080 | 0.19423 |
| *APE* | (0.22771) | (0.25437) | (0.32718) | (0.39230) | (0.50467) | |

Notes: [a] Number of banks that are Nerlovian profit efficient;
[b] Number of banks that are alternative profit efficient.

Table 5. Decomposition of Alternative Profit Inefficiency (Model 4)

| | 2000 (13 banks) | 2001 (14 banks) | 2002 (16 banks) | 2003 (17 banks) | 2004 (19 banks) | 2000-2004 |
|---|---|---|---|---|---|---|
| *APE* | 9[a] | 7 | 11 | 12 | 12 | |
| Mean | 0.12975 | 0.16387 | 0.20064 | 0.20608 | 0.27080 | 0.19423 |
| Std. deviation | 0.22771 | 0.25437 | 0.32718 | 0.39230 | 0.50467 | |
| *TE* | 12[b] | 13 | 14 | 16 | 18 | |
| Mean | 0.00128 | 0.00051 | 0.00088 | 0.00033 | 0.00014 | 0.00063 |
| Std. deviation | 0.00460 | 0.00193 | 0.00341 | 0.00135 | 0.00061 | |
| *OPE* | 9[c] | 8 | 11 | 12 | 12 | |
| Mean | 0.11219 | 0.17578 | 0.18869 | 0.22518 | 0.27248 | 0.19486 |
| Std. deviation | 0.22386 | 0.23540 | 0.31044 | 0.39628 | 0.44989 | |
| *AE* | 9[d] | 8 | 11 | 12 | 12 | |
| Mean | 0.01630 | -0.01241 | 0.01108 | -0.01943 | -0.00182 | -0.00126 |
| Std. deviation | 0.06947 | 0.11589 | 0.06485 | 0.11758 | 0.09969 | |

Notes: [a] Number of banks that are alternative profit efficient; [b] Number of banks that are technically efficient; [c] Number of banks that are output price efficient; [d] Number of banks that are input allocative efficient.

Table 6. Deviations from Optimal Choices - Alternative Profit Inefficiency

| | *Price of Credit* ($p_1$) | *Price of Financial Services* ($p_2$) | *Price of Securities Portfolio* ($p_3$) | *Labor* ($x_1$) | *Physical Capital* ($x_2$) | *Borrowed Funds* ($x_3$) |
|---|---|---|---|---|---|---|
| 2000 | | | | | | |
| Mean | -7% | -2% | -10% | 6% | 19% | -1% |
| Median | 0% | 0% | 0% | 0% | 0% | 0% |
| Std. deviation | 14% | 14% | 18% | 27% | 43% | 5% |
| 2001 | | | | | | |
| Mean | -10% | -18% | -6% | 6% | 18% | -3% |
| Median | -1% | 0% | 0% | 0% | 0% | -1% |
| Std. deviation | 14% | 31% | 45% | 33% | 54% | 5% |
| 2002 | | | | | | |
| Mean | -10% | -9% | 31% | 11% | 20% | -3% |
| Median | 0% | -1% | 0% | 0% | 0% | 0% |
| Std. deviation | 17% | 15% | 116% | 24% | 42% | 5% |
| 2003 | | | | | | |
| Mean | -11% | -14% | 22% | 0% | 13% | -3% |
| Median | 0% | 0% | 0% | 0% | 0% | 0% |
| Std. deviation | 19% | 25% | 127% | 29% | 54% | 6% |
| 2004 | | | | | | |
| Mean | -4 % | -1% | -22% | 25% | 7% | -9% |
| Median | 0% | 0% | 0% | 0% | 0% | 0% |
| Std. deviation | 24% | 31% | 36% | 57% | 75% | 23% |
| 2000-2004 | | | | | | |
| Mean | -8% | -9% | 3% | 10% | 15% | -4% |
| Median | 0% | 0% | 0% | 0% | 0% | 0% |