Abstract / Resumo

This paper analyzes technical efficiency in Angolan banks from 2005 to 2010 with an innovative Data Envelopment Analysis (DEA) model, the B-Convexity model. The intermediate approach is adopted and the results reveal that efficiency varies among the banks analyzed. Policy implications are derived.

Keywords Angola, banks, B-convexity, efficiency.

Jel Classification Numbers G21, D24
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The main fields of investigation are the development economics, international economy, sociology of development, African history and the social issues related to the development. From a geographical point of view the sub-Saharan Africa; Latin America; East, South and Southeast Asia as well as the systemic transition process of the Eastern European countries constitute our objects of study.

Several members of the CeSA are Professors of the Masters in Development and International Cooperation lectured at ISEG/”Economics”. Most of them also have work experience in different fields, in Africa and in Latin America.

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1. INTRODUCTION

The issue of bank efficiency is a traditional theme in banking research adopting successive innovations in frontier models (Berger and Humphrey, 1992; Maudos and Guevara, 2004; Drake et al., 2009). This paper contributes to this tradition, analyzing for the first time banking in Angola and adopting the B-convexity model (Briec and Liang, 2011). Compared to traditional Data Envelopment Analysis (DEA) models, the main interest of the B-convexity is to relax the convexity assumption. In this way, this method is a part of the literature using non-convex models, such as the Free Disposal Hull (FDH) model (Tulkens, 1993). The B-convexity model has some innovative aspects. First, it is not necessary to suppose a priori the nature of returns to scale for the production technology. Second, it allows us to take into account in the production technology variations of marginal productivity that can be either increasing or decreasing. Third, the number of efficient firms characterizing the frontier is smaller than the number found by the non-convex model.

There are several motivations for the present research: Firstly, the focus on African banks has been relatively scarce (Figueira et al., 2009; KirKPatric et al., 2007; Kiyota, 2009; Assaf et al., 2010) and Angolan banks have not previously been analyzed. Therefore, the paper aims to answer two questions: first, do Angolan banks behave differently to banks of more developed countries? Second, if they behave differently, what are the causes? Next, the B-Convexity model is a DEA model not previously used in banking research. In adopting this innovative approach, this paper aims to take into account the non-convex production technology (Kerstens et al., 2011). Finally, Angola, with its vast wealthy natural resources, attracts the curiosity of the financial market which is confronted with a secrecy policy on data availability, inherited from the former colonial power, justifying the present research. From this research it emerges that Angola's current banking system has too many idiosyncratic banks in terms of efficiency.

The remainder of this paper is organized as follows. Section 2 presents the literature survey. Section 3 describes the contextual setting. Section 4 presents the research hypotheses. Section 5 details the methodology. Section 6 presents the data and the results. Section 7 discusses and concludes.

2. LITERATURE REVIEW

Although there are numerous literature references to banking (Berger and Humphrey, 1992; Park and Weber, 2006; Berger and Humphrey, 1997; Maudos and Guevara, 2007; Drake et al., 2009; Koutsomanoli-Filippaki et al., 2009; Fukuyama and Weber 2009,
2010; Holod and Lewis, 2011), the focus on African banks is restricted (Figueira et al., 2006; Kirkpatrick et al., 2007; Kiyota, 2009; Assaf et al., 2010), signifying that it is a relatively under researched topic. This situation contrasts with the vast amount of research on USA banks (Berger, et al., 1987; Bauer, et al. 1993; Berger and Humphrey, 1993), on European banks (Dietsch and Ana Lozano-Vivas, 2000; Bikker and Haaf, 2002; Casu et al., 2004; Bikker et al., 2007; Molyneux and Wilson, 2007; Barros et al., 2007; Bos and Schmiedel, 2007; Barros et al., 2009; Williams et al., 2010; Kontolaimou and Tsekouras, 2010), on Asian banks (Berger et al., 2009; Chen et al., 2005; Kumbhakar and Wang, 2005; Assaf et al., 2010; Barros et al., 2010; Chang et al., 2010; Barros et al., 2012), and even in South American banking (Nakane and Weintraub, 2005; Staub et al., 2010). In this context, this paper innovates, analyzing Angolan banks for the first time. Furthermore, innovative DEA appears currently in banking and finance (Holod and Lewis, 2011; Edirisinghe and Zhang, 2007; Brandouy et al., 2010; Kerstens et al., 2011), and this paper goes a step further, innovating again in DEA models applied to banking.

3 CONTEXTUAL SETTING

Angola attained its independence in 1975 after a long war of liberation against the former colonial ruler, Portugal. However, ideological and ethnic fractionalization ensured that peace did not accompany independence, igniting a brutal, costly civil war that only came to an end in 2002 (Ferreira and Barros, 1998). Given its exceptional potential wealth thanks to raw materials, particularly oil and diamonds, present-day Angola, with a democratically-elected government, is well placed to embark upon a process of growth. The country is currently the world's fourth-largest producer of diamonds and the second-largest producer of oil in Sub-Saharan Africa, after Nigeria. Output in 2005 rose to 1.3 million barrels per day, providing 91.94% of Angola's total export revenues. This situation signifies that the present rise of oil prices has boosted the economy's growth to its current 15% annual increase rate. However, without this rise in the price of oil, growth would decline to small values, which highlights Angola's strong economic dependency on oil. With the end of the civil war, Angola was in a condition of macro-economic turmoil, with rising ination and a devalued national currency (the kwanza). The intervention of the IMF was reinforced in 2000 with the adoption of a macro-economic stabilization program that has started to achieve its aims. The banking sector is a potential growth industry, financing the present growth rate. Table 1 presents some characteristics of the Angolan banks.
### Table 1. Characteristics of Angolan banks in 2010

<table>
<thead>
<tr>
<th>Nobs</th>
<th>Banks</th>
<th>Start Year</th>
<th>Number of Employees</th>
<th>Loans (Angola Kwanza)</th>
<th>Securities (Angola Kwanza)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BAI-Banco Africano de Investimentos</td>
<td>1997</td>
<td>1299</td>
<td>229418491416.10</td>
<td>206379406378.48</td>
</tr>
<tr>
<td>2</td>
<td>BFA-Banco de Fomento de Angola</td>
<td>1993</td>
<td>1890</td>
<td>145244558968.18</td>
<td>259486977022.25</td>
</tr>
<tr>
<td>3</td>
<td>BPC-Banco de Poupança e Crédito</td>
<td>1976</td>
<td>2900</td>
<td>293346490414.70</td>
<td>81641150405.94</td>
</tr>
<tr>
<td>4</td>
<td>BIC-Banco BIC</td>
<td>2005</td>
<td>1250</td>
<td>181049593798.75</td>
<td>128098677993.48</td>
</tr>
<tr>
<td>5</td>
<td>BES-Banco Espirito Santo</td>
<td>2002</td>
<td>509</td>
<td>349614949259.14</td>
<td>245175216550.06</td>
</tr>
<tr>
<td>6</td>
<td>BSOL-Banco Sol</td>
<td>2001</td>
<td>680</td>
<td>29398206610.11</td>
<td>34724123291.31</td>
</tr>
<tr>
<td>7</td>
<td>BMA-Banco Millenium Angola</td>
<td>2006</td>
<td>519</td>
<td>53790892217.61</td>
<td>29266269017.84</td>
</tr>
<tr>
<td>8</td>
<td>BCA-Banco Comercial Angolano</td>
<td>1999</td>
<td>2030</td>
<td>26264734195.53</td>
<td>14765165799.61</td>
</tr>
<tr>
<td>9</td>
<td>BCGTA-Banco Caixa Geral Totta de Angola</td>
<td>1993</td>
<td>260</td>
<td>19558517892.63</td>
<td>30546574399.95</td>
</tr>
<tr>
<td>10</td>
<td>KEVE-Banco Keve</td>
<td>2003</td>
<td>235</td>
<td>18934764440.15</td>
<td>2825136251.54</td>
</tr>
</tbody>
</table>

(1) The exchange rate between the national currency (Kwanza) and the US dollar in July 2010 was 1 US Dollar = 92.34 Angola Kwanza.

Source: KPMG report on Angola banking.

The main Angolan Banks are BAI, BESA, BFA, BPC and BIC. All banks are quoted companies with the exception of BPC, which is a savings bank. Some banks belong to Portuguese banks, namely BESA (51.9% of the capital is held by the Portuguese bank, BES), Millenium (68.5% of the capital is held by the Portuguese bank, Millenium) and BFA-Banco de Fomento Angola (50% of the capital is detained by the Portuguese bank, BPI), while the Banco Caixa Geral Totta de Angola jointly belongs to the oil company Sonangol (49%) and to the public Portuguese bank Caixa Geral de Depósitos (51%), signifying that the former colony maintains a strong presence in the banking activity of its former colony. Furthermore, other foreign-owned banks include the BCP, which belongs to the South African bank and Barclays (50%), but leading figures from the Angolan governing party are numbered among the shareholders. The remaining banks are under Angolan sole ownership. The BIC belongs to the daughter of the President of the Republic (25%), in partnership with a Portuguese entrepreneur (Américo Amorim), who also owns 25%. The other 50% is spread among various Angolan businessmen. BIC is the sole Angolan bank also established in Portugal, and recently bought the Portuguese bank, BPN. The Keve is a small Angolan bank with many owners. The maximum share is 6.95% of the capital. Banco Sol is owned by GEFI - Sociedade de Gesto e Participações Financeiras/Business Management and Finance Company, which is owned by MPLA members registered in Panama, holding 55% of the shares through its subsidiary Sansul, while other politically influential MPLA members retain...
the remainder. GEFI owns other assets in the hotel industry, fisheries, media, construction and real estate. BPC-Banco de Poupança e Crédito is a public bank and BAI-Banco Africano de Investimentos belongs to Sonangol. The Sonangol Oil Company accounts for 52% of the country's GDP. Therefore, this contextual setting describes a situation in which foreign capital blends with national capital in all foreign-owned banks, while some banks are wholly Angolan-owned.

4 RESEARCH HYPOTHESES

Based on the literature survey and contextual setting, some hypotheses are defined. We aim here to test the relationship between bank technical efficiency and the following covariates: group ownership, bank size, time and local ownership. The justification for the selection of each of these covariates is provided in the following subsections.

4.1 Group Ownership

In line with the impact of size, group membership might also impact efficiency by contributing to the transfer of knowledge and economies of scale between firms in the group. Chu (2004), for example, tested this hypothesis on a sample of Taiwanese firms and reached the conclusion that group affiliation can be beneficial, though success might be dependent on the size of the group. Other studies have also linked the success of a group affiliation to the type of market, where firms with group affiliation tend to outperform non-group affiliated firms in competing markets, since it becomes harder to obtain resources and gain new market shares (Khanna and Palepu, 2000; Ghemawat and Khanna, 2000). As banks in Angola face a highly competitive and saturated industry, it might thus be more profitable for them to join a group, since they can benefit from the sharing of resources and reputation to make up for the external market failures (Kharna and Palepu, 2000). We thus assume H1: Group ownership has a positive influence on the efficiency of Angolan banks.

4.2 Firm Size

It is often argued that large firms are possibly more efficient because they can use more specialized inputs, coordinate their resources better, and reap the advantages of economies of scale (Alvarez and Crespi, 2003). In our present context, firm size might also take on an additional importance, since banking in present-day Angola is characterized by distinct market values. These banks might thus be more profitable if
they increase their size, in order to achieve economies of scale and make up for the external market failures (Khanna and Palepu, 2000; Ghemawat and Khanna, 2000). Since related studies on banking also indicate that firm size contributes to higher efficiency (Altunbas et al., 1997; Berger and Humphrey, 1991; Alvarez and Arias, 2003), we thus assume H2: Firm size has a positive impact on the efficiency of Angolan banks.

4.3 Efficiency and Time

The need to improve cost efficiency through economies of scale and scope or to increase revenues through gaining additional market share are usually the main drivers for most companies acting in competitive markets. This activity usually results in a selection, with efficiency increasing along the time (Jovanovic, 1982), leading to more competitive organizations. We highlighted above that time is an important driver of efficiency through the selection of best practices and on this basis, we assume H3: Time has a positive influence on the efficiency of Angolan banks.

4.4 Local Ownership

Local ownership may be a source of competitive advantage in banking, since combining ownership and financial sta® in the area means superior access to local information. The importance of local conditions to bank lending has been analyzed in the literature (Leland and Pyle, 1977; Diamond, 1984). The Angolan government exercises its influence in order for foreign investors to merge with local investors. Based on this evidence, we assume H4: Local ownership has a positive impact on efficiency.

5 METHODOLOGY

We first define the mathematical \( \in \mathbb{R}_+^d \) notation used in this paper. Let \( \forall i \in [1, \ldots, d] \) be the non-negative Euclidean \( d \)-orthant; for \( z; w \) we denote \( z \leq w \) for \( z_i \leq w_i \). Now let \( m; n \in \mathbb{N} \) be two positive natural numbers so that \( d = m + n \). A production \( \subset \mathbb{R}_+^{m+n} \) technology transforms inputs \( x = (x_1; \ldots; x_m) \) into outputs \( y = (y_1; \ldots; y_n) \). The set \( T \) of all input-output vectors that are feasible is called the production set. Specifically, it is defined as follows:

\[
T = \{ z = (x, y) \in \mathbb{R}_+^{m+n} : x \text{ can produce } y \}. \tag{5.1}
\]

\( T \) can also be characterized by an input correspondence \( L : y \rightarrow L (y) \) and an output correspondence \( P : x \rightarrow P (x) \), where:
is the set of all input vectors that yield at least $y$ and

$$L(y) = \{ x \in \mathbb{R}_+^n : z = (x, y) \in T \}$$

is the set of all the output vectors obtainable from $x$. Let us denote $K = \mathbb{R}_+^n \times (-\mathbb{R}_+^n)$.

There are some assumptions that can be made on the production technology (see Shephard, 1970):

T1: $T$ is a closed set

T2: $T$ is a bounded set, i.e. for any $z \in T$, $(z - K) \cap T$ is bounded.

T3: $T$ is strongly disposable, i.e. $T = (T + K) \cap \mathbb{R}_+^d$.

T1-T3 defines a technology with freely disposable inputs and outputs.

5.1 B-convex concept

This section presents the B-convexity concept. Complete details are given in Briec and Horvath (2004) and Briec and Liang (2011). One can loosely say that B-convexity is obtained from the usual convexity, making the formal substitution $+$ $\rightarrow$ $\max$. A subset $L \subset \mathbb{R}_d$ is said to be:

- an upper-semilattice if $\forall z, t \in L \text{ then } z \lor t \in L$, where:

$$z \lor t = (\max\{z_1, t_1\}, \ldots, \max\{z_d, t_d\})$$

- a lower-semilattice if $\forall z, t \in L \text{ then } z \land t \in L$, where:

$$z \land t = (\min\{z_1, t_1\}, \ldots, \min\{z_d, t_d\})$$

Let us consider $z^1, z^2, \ldots, z^l \in \mathbb{R}_d$. In the remainder of the paper we denote:

$$\bigwedge_{k=1}^l x^k = (\max\{z^1_1, \ldots, z^l_1\}, \ldots, \max\{z^1_d, \ldots, z^l_d\})$$

The main objective of this contribution is the application of a new type of semilattice technologies. A connectedness assumption is important because it allows the possibility of transforming a production technique continuously. Since a semilattice is generally not path-connected, B-convexity plays a crucial role in such a context, because B-convex sets are path-connected.
Definition 5.1 A subset $L \subset \mathbb{R}^d_+$ is said to be a B-convex set, if $\forall z^1, z^2 \in L$, $\rho_1, \rho_2 \geq 0$ and $\max \{ \rho_1, \rho_2 \} = 1 \rightarrow \rho_1 z^1 \lor \rho_2 z^2 \in L$.

A B-convex set satisfies the following properties (see Briec and Horvath, 2004):

i) If $L \subset \mathbb{R}^d_+$ is a B-convex set, then it is an upper-semilattice.

ii) $L$ is a path-connected set.

iii) If $\{ z^1, \ldots, z^l \} \subset L$, $\rho_k \geq 0$ for all $k = 1 \ldots l$ and $\max_{k=1\ldots l} \{ \rho_k \} = 1$ then $\bigvee_{k=1}^l \rho_k z^k \in L$.

iv) If $S \subset \mathbb{R}^d_+$ is a B-convex set, then $L \cap S$ is a B-convex set.

Along this line, a notion of the B-convex hull can be provided.

Definition 5.2 Let $A = \{ z^1, \ldots, z^l \} \subset \mathbb{R}^d_+$ then the set

$$B(A) = \left\{ \bigvee_{k=1}^l \rho_k z^k, \rho_k \geq 0, \max_{k=1\ldots l} \{ \rho_k \} = 1 \right\}$$

is called the B-convex hull of $A$.

5.2 Estimation of the B-convex technology

Definition 5.3 Let $A = \{ z^1, \ldots, z^l \} \subset \mathbb{R}^d_+$ a set of $l$ observed production vectors.

$$T_{\text{max}} = \left\{ z = (x, y) \in \mathbb{R}^d_+ : x \geq \bigvee_{k=1}^l \rho_k x^k, y \leq \bigvee_{k=1}^l \rho_k y^k, \max_{k=1\ldots l} \rho_k = 1, \rho \geq 0 \right\}$$

is called a B-convex estimation of the production technology.

The above estimation has a comprehensive economic meaning. In short, the semilattice conditions imply that if a producer uses a greater input quantity then he/she is able to produce a greater output quantity. If the maximum of two input bundles is feasible, then the maximum that they produce is also feasible. This condition is of course stronger than the free disposal assumption.
Observe that the lines joining the points are broken. The returns to scale are locally decreasing between points $z^3$ and $z^1$ and locally increasing between points $z^1$ and $z^2$. Comparing such an assumption to convexity, one can say that it has some advantages and some drawbacks. Regarding the input side, B-convexity encompasses as a special case the situation in which the technology assumes that the inputs are freely disposable. Looking at the output side, B-convexity implies, under a free disposal assumption, that the production set has an output cubic structure. This means that an assumption of output complementarity is implicitly made on the technology.

5.3 Measurement of technical efficiency and B-convex non-parametric technologies

We now recall a method for calculating the Farrell measure over a B-convex set of non-parametric technologies developed in Briec and Liang (2011).

**Proposition 5.4** Let $A = \{z^1, ..., z^l\} \subset \mathbb{R}^d++$. Let us consider $T_{\text{max}} = (B(A) + K) \cap \mathbb{R}^d+$. Moreover, denote:

$$\alpha_k^k = \min_{i=1,...,m} \left\{ \frac{x_i^k}{x_i} \right\}$$

The input distance function is:

$$D_{\text{max}}^{\alpha_k}(x^k, y^k) = \max \left\{ \max_{j=1,...,m} \min_{y_{j} \leq y_j} \left\{ \frac{y_j^k}{y_{j}^k} \alpha_k^k \right\} , \min_k \left\{ \frac{1}{\alpha_k^k} \right\} \right\}$$

The output distance function is:

\[
D^p_{T_{\text{max}}} (x^k, y^k) = \min_{j=1 \ldots n} \max_k \left\{ \frac{y^k_j \min \{ \alpha^k_j, 1 \}}{y^j_k} \right\}
\]

6 DATA AND RESULTS

To estimate the frontier, we use a balanced panel. The financial statements of Angolan banks are sourced from reports on Angolan banking published yearly by the consultative company KPMG, for the period 2005-2010, yielding 72 observations in relation to 12 banks. The intermediate approach in banking is adopted (Sealey and Lindley, 1977; Berger and Humphrey, 1992), which assumes that bank liabilities are transformed into earning assets.

Banks are assumed to produce three outputs that cover both in- and off-balance sheet activities: (i) loans, (ii) securities and (iii) interbank loans. Three inputs are used to produce bank output, which are assumed substitutable: (iv) deposits, (v) total assets and (vi) operational cost. The descriptive statistics are shown in Table 2.

Table 2. Characteristics of inputs and outputs, 2005-2010

<table>
<thead>
<tr>
<th>Variables</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inputs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total assets</td>
<td>621909749.74</td>
<td>838579003129.37</td>
<td>169033805183.55</td>
<td>218101807544.10</td>
</tr>
<tr>
<td>Operational costs</td>
<td>2295713.87</td>
<td>56297334285.73</td>
<td>5775400045.15</td>
<td>8933928972.18</td>
</tr>
<tr>
<td>Deposits</td>
<td>22041018.72</td>
<td>592424837455.04</td>
<td>114816328953.61</td>
<td>148893910590.45</td>
</tr>
<tr>
<td></td>
<td>Outputs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loans</td>
<td>338708719.76</td>
<td>349614949259.14</td>
<td>63148137421.47</td>
<td>85511635983.58</td>
</tr>
<tr>
<td>Securities</td>
<td>15064333.41</td>
<td>259486977022.25</td>
<td>46155473142.52</td>
<td>67268801960.00</td>
</tr>
<tr>
<td>Interbank loans</td>
<td>2708170.00</td>
<td>168538455006.66</td>
<td>17665175910.40</td>
<td>29738665269.93</td>
</tr>
</tbody>
</table>

Table 3 presents the output efficiency scores from the B-convex model for the Angolan banking sector from 2005 to 2010.

Table 3. Efficiency scores (2005-2010)

<table>
<thead>
<tr>
<th>Bank</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAI</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.11020239</td>
</tr>
<tr>
<td>BFA</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>BPC</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>BIC</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.0231039</td>
<td>1</td>
<td>1.15551283</td>
</tr>
<tr>
<td>BES</td>
<td>1</td>
<td>1.17052041</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

A score equal to one indicates that the corresponding Angolan bank is technically efficient at 100%, whereas a score greater than one indicates that the bank is inefficient. The following main observations can be stated regarding the results in Table 3. First, 3 banks (BFA, BPC and BAI-BMF) achieved a score equal to 1 and are technically efficient in each year during the period analyzed. These are the best practice banks which are always on the efficient production frontier and which have a relative top balance between the inputs used and the outputs produced. For the BFA, such a result is not surprising because it is the oldest bank of the sample, created in 1976, and also has the largest number of employees (see Table 1). The BFA is controlled by the Portuguese bank, BPI. BPC is a public savings bank. BAI-BMF is the Banco Africano de Investimentos for microcredit. Therefore, we find that the top ranking on performance includes distinct types of banks, namely a private bank controlled by a Portuguese bank, a public savings bank and a private microcredit bank, signifying that there is some heterogeneity in bank performance in the Angolan market. Second, in 2009, only one bank is inefficient (KEVE), whereas in 2010 only five banks (BFA, BPC, BES, KEVE and BAI-BMF) are efficient at 100%, reflecting the impact of the 2009 world financial crisis on Angola's banks. Angola's growth rate was the following: 2006: 18.6%, 2007: 23.3%, 2008: 15.6%, 2009: 2.4%, 2010: 1.6%. Clearly, the economic crisis hit Angola's banks, explaining the change in performance. Third, on average, the most inefficient bank is BCGTA; for example, in 2008, it would have needed to increase its output level by 32% without changing its input level in order to be technically efficient.

In relation to the research hypotheses, we are unable to accept Hypothesis 1, group ownership, because the sole foreign-owned efficient bank is BFA. We also do not accept Hypothesis 2 because of the main Angolan banks (BAI, BESA, BFA, BPC and BIC), only BPC and BFA display efficiency during the period. Hypothesis 3 is rejected since efficiency does not increase with the passage of time. Finally, we also reject Hypothesis 4 because local banks do not present efficiency above the mean, with the exception of BFA and BAI-BMF. Therefore, the general conclusion is that efficiency in Angolan banks is low and mixed, with savings, microcredit and foreign-owned banks displaying efficiency. However, no clear idea emerges from the results, leading to the rejection of all the hypotheses. This signifies that Angolan banks are affected by the local dynamics in a way that does not promote efficiency, even for foreign-owned banks.
7. DISCUSSION AND CONCLUSION

This article has proposed a simple framework for the comparative evaluation of Angolan banks and the rationalization of their operational activities. The analysis was conducted by means of the implementation of a DEA frontier model that does not allow us to suppose a priori the nature of returns to scale for the production technology and allows us to take into account variations of marginal productivity that can be either increasing or decreasing.

The main result of the present research is that Angolan banks' efficiency is mixed and varies along the period, with unclear changes. This result signifies that Angolan banks behave differently to those in other, more developed nations, with unclear dynamics along the time (Barros et al., 2011). Furthermore, group ownership has no clear effect, which contradicts prior research on banking (Barros et al., 2011). Similar results are obtained for the other hypotheses, all of which are rejected. Therefore, the focus on oil and the limited growth in other local industries, coupled with policies that promote joint-ventures between local and foreign investors, have not translated into efficiency. Moreover, this finding signifies that Angolan banks are relatively heterogenous, with their own idiosyncrasies that are uncommon in banking markets. These results may derive from the contextual setting in which the banks act, which is characterized by an intense relationship between the political system and the banking system, with allegations of corruption and appropriations of bank and other foreign investments by the ruling political elite. The contextual setting is recognized as an important explanatory variable in efficiency analysis (Murphy and Cleveland, 1991). Therefore, one policy implication is that some competition should be promoted in the market in order to increase the efficiency. Moreover, the separation between public affairs and business should be promoted in order to decrease the alleged corruption between political elites and banks, which does not enhance banking efficiency and affects negatively banking governance in Angola. Competitive shocks to banks are often bad news for managers since they enforce organizational changes that improve efficiency. Competition needs clear and fair rules for all participants, reduced barriers to entry, lower government intervention and deregulation. In addition, Angolan banks' performance should be analyzed on a regular basis, identifying the best and worst performers. The publication of the results would permit the regulator to identify the worst performers, as well as the best performers, which should be used as peers to improve the efficiency overall. These policies would introduce principles that would increase governance and competition, which would translate into efficiency.

As we mentioned in the introduction, the B-convexity model has significant advantages compared to other DEA models. The relaxation of the convexity assumption and the inclusion of a variety of marginal productivity allows a more intuitive and economic interpretation of the structure of the production technology. More precisely, the cubic...
form of the output set in the B-convexity model permits the characterization of complementarities between loans, securities and interbank loans, that is, the alternative means of investing the money. With regard to comparisons with other contributions using alternative DEA methods in banking studies, this paper adopts the innovative B-convexity model for efficiency measurement which has not previously been used in banking. Therefore, no clear comparison can be made. Finally, more research in Angolan banks is needed to confirm the present results.

REFERENCES


