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2012

WP n.º 2012/15

DOCUMENTO DE TRABALHO

WORKING PAPER

DINAMIA'CET
CENTRO DE ESTUDOS SOBRE A MUDANÇA SOCIOECONÓMICA E O TERRITÓRIO
ISCTE-IUL

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Fundação para a Ciência e a Tecnologia

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ABSTRACT

The efficiency of the banking sector is one of the main concerns of regulators, especially in less developed countries. In this paper we study banking efficiency in the small and insular economy (SIE) of Cape Verde (CV). Based on the experience of this country, it is tested the extent to which the banking sector in SIEs is faced with specific restrictions to its efficiency. Another interesting aspect of the CV's case is that it allows assessing the impact of bank liberalization on efficiency. We conclude that the main constraints to profit efficiency are the weak competition, and that trade openness has a negative impact on cost efficiency, but a positive effect on profit efficiency. The small internal market also limits the acquisition of scale economies. Banking market liberalization increased cost and profit efficiency mainly through the entrance of foreign banks in the domestic market.

JEL Classification System: G21 e G29

Key words: Cost function, profit function, productive efficiency, cost stochastic frontier (SFA), banking sector in Cape Verde

1. INTRODUCTION

Commercial banks have an important role in money supply and financing of the economy. However, only efficient banks can play properly the function of financing the economy with low interest rates and in sufficient amounts, while ensuring the resilience of the banking system. Financial institutions exhibiting low efficiency for extended periods become insolvent, creating problems to the financial system.

The banking sector is particularly vulnerable to mismanagement because it operates in an environment with asymmetric information. Moreover, banking crisis cause panic, systemic risk (Beger et al., 1999) and strong negative effects in the real economy. The financial crisis of 2008 is an example of such mechanisms at work. Thus, performance's monitoring of the banking sector is a constant concern of economic agents, in particular of the regulators and governments. It is rather important to detect problematic institutions timely to take appropriate corrective measures.

In the actual context of global economic instability, with fragilities in the banking sector, the motivation for studies on performance measurement of banks has been growing. Such studies are even more important in Developing Countries, where the low availability of information and the low development of the economy creates conditions for banks to waste resources.

It is in this context that we are interested in studying the evolution of banking efficiency in Cape Verde (CV). This study's contribution to the literature is twofold. Firstly, CV has sought to improve its regional position with a strong betting on financial sector development, through the modernization and liberalization of that sector and the implementation of a sound legal and operational control system. It is then important to assess how the liberalization of the banking sector has affected its efficiency. Secondly, this work also contributes to the literature by focusing on the study of a small insular economy, which is usually characterized by small domestic markets and by high dependence of foreign trade and the State.

In this perspective, we use the stochastic frontier approach to analyse the cost and profit efficiency of the banking sector in Cape Verde, based on annual accounting data from 1995 to 2010.

The work has the following structure. In Section 2 we review the relevant literature on banking efficiency, with a special focus on studies about African economies. Section 3 provides a brief characterization of the banking sector in Cape Verde, highlighting the reforms undertaken during the period, especially the process of deregulation, opening up to private enterprise, emergence of new institutions and modernization of the banking sector. In Section 4, we present the methodology used to measure banking efficiency. Section 5 presents how banks'

inputs and outputs were measured and the chosen determinants of efficiency. In Section 6, empirical results are presented and discussed. Finally, Section 7 concludes.

2. LITERATURE ON BANK EFFICIENCY WITH A SPECIAL EMPHASIS ON DEVELOPING COUNTRIES

In this section we review the main studies on banking efficiency in Africa, other developing countries and other banking markets related to CV, focusing on the effect of banking market liberalization and of state-owned and foreign banks. In the literature, even though there are some papers mentioning CV, there is no work doing a deep analysis of banking efficiency in this country.

Kiyota (2009) studied profit and cost efficiency of commercial banks in 29 sub-Saharan African countries (including Cape Verde) in the period 2000 to 2007. The process involved two phases: the first consisted in the estimation of the cost and profit stochastic frontiers, and the second involved a separate regression in order to assess the impact of several factors in the efficiency of banks: credit and deposit interest rates, strategic funds, the net interest margin, domestic private credit to GDP, and M2 to GDP. Overall, results showed better profit efficiency for foreign banks compared to national banks. Moreover, Foreign banks from sub-Saharan Africa (SSA) and holders of more than 50% of market share were more efficient than foreign non-SSA. As regards cost efficiency, it was higher for large and medium sized banks. In the case of CV, results revealed that foreign banks were more profit efficient while domestic banks were more cost efficient.

Mwenda and Mutoti (2011) investigated the effects of financial reforms on the efficiency of commercial banks in Zambia, based on quarterly data of 11 commercial banks in the period 1999-2008. They used the SFA approach to measure efficiency. The determinants of banks' cost efficiency considered were liquidity, earnings, portfolio quality, size, ownership (private or public) dummies (to capture financial policy), GDP per-capita, and inflation. Overall, results were mixed and not very much in accordance with theoretical predictions. However, it was concluded that financial reforms contributed to the improving of cost efficiency. Moreover, some national and private banks have proved to be more efficient than foreign banks. Also, public banks were more efficient than private domestic and foreign banks.

Mlambo and Neube (2011) evaluated the competition and efficiency in the banking sector in South Africa. They used quarterly data on 26 banks between 1999 and 2008. Efficiency was measured by Data Envelopment Analysis (DEA). For the choice of inputs and outputs it was chosen an intermediation methodology, were deposits are seen as a cost supported to finance credit. The authors emphasized the fact that during that period, the banking structure of South Africa had monopolistic characteristics. On average, the South African banks

showed an improvement in technical efficiency from 0.73 in 1999 to 0.75 in 2008. They also sustain that the financial reforms undertaken in the 1990s resulted in an improvement of profit efficiency.

Also using DEA, Ceretta and Niederauer (2001) compared the efficiency of 144 Brazilian banks during the second half of 1999. They combine seven inputs (current assets, long-term assets, total assets, liability, equity, total revenue and profit) and three outputs (profitability, liquidity and leverage). Results indicate a greater degree of efficiency for large banks when compared with medium and small banks.

Poshakwalen and Qian (2009) addressed the impact of financial reforms in the efficiency of the Egyptian banking sector, using annual data of 47 banks (private, public and foreign) in the period 2001 to 2007. The methodologies used to measure productive efficiency were DEA and SFA, and the methodology of intermediation was used to select inputs and outputs. The results of both DEA and SFA approaches showed an initial upward trend for all efficiency measures (except for cost efficiency) thus suggesting that in general the reforms in its first phase contributed positively to efficiency. However, the trend inverted when reforms have become more intense. Comparing public and private banks, findings were that the former have improved their profit efficiency in comparison with the latter, and notwithstanding, public banks had better profit efficiency than private banks. Finally, domestic banks proved to be more efficient than foreign banks, which can be justified by the high installation costs incurred by the latter.

Another paper with a not very positive view on the effect of deregulation in banking is Kumbhakar and Sarkar (2003), which finds that deregulation of the banking market in India did not have a significant effect on cost efficiency.

Limam (2001) studied technical efficiency in 8 banks (excluding the two largest) in Kuwait during the period 1994-1999, using SFA. He considered one output (return on assets) and three inputs (labor, financial capital and fixed assets). Results pointed to greater efficiency in larger banks, and that privatization can be a way of improving corporate governance and thus technical efficiency, leading to a reduction in intermediation margins and spreads and to an increase in the number of services provided.

Hassan et al (2012) for Middle East and North Africa (MENA) conclude that financial liberalization had a positive impact on operational efficiency. However, they find that it reduces profit margins in countries with less developed capital markets. Focusing in the same group of countries, Naceur and Omran (2011)'s empirical results indicate that the reduction in corruption improves cost efficiency. Hauner and Peiris (2008) for Uganda find that banking sector reforms increased competition and efficiency. Foreign-owned banks proved to be more efficient than the others, while smaller banks have been negatively affected by the increase in competition. Finally, one paper less optimist on the role of foreign-owned banks is Adjnei and Chakravarty

(2012), which in Ghana highlights that in the context of the liberalization of the banking sector foreign ownership per se was not the determining factor of efficiency.

CV is considered a country of intermediate development, half-way between developing and developed countries. A developed country economically and culturally near of CV is Portugal. Using SFA and a methodology of intermediation, Pinho (1995) in his study of the Portuguese banking sector (1988-1992), sought to demonstrate which components had a greater influence on operating costs, efficiency of scale or productive efficiency. His results pointed to a level of productive efficiency of around 82%. The state-owned and foreign private banks are those who exhibited lower efficiency. It was demonstrated that after privatization, banks improved their efficient. The conclusion was that the reduction of operational costs of the Portuguese banking sector was associated with a more rational use of resources (productive efficiency).

Pinho (1999) and Pinho (2001), in the periods between 88/97 and 86/92, respectively, measured the cost and profit efficiencies of the Portuguese banking sector, using the SFA approach. The findings pointed to an improvement of cost efficiency of the Portuguese banking sector in general and especially for the privatized banks. As regards profit efficiency, results showed some stability over time. In general, private banks revealed to be more efficient in terms of profit.

Ribeiro (2006) investigated the existence of economies of scale or scope, production efficiency, and the effects of concentration on bank efficiency for 22 credit institutions in Portugal. The data considered were annual and in panel for the period between 1995 and 2001. The methodology used to measure efficiency was the SFA. The findings revealed an average inefficiency in the sector varying between 4% and 12%, depending on the specification of the frontier cost function used (Cobb-Douglas, Translog or Fourier). The author also stressed that the process of concentration seems to have had a negative effect on costs.

In conclusion, the literature highlights that banking sector liberalization and the type of ownership (foreign or public) are important determinants of bank efficiency. Even though a number of studies indicates that banking liberalization and the entrance of foreign banks has a positive effect on efficiency in developing countries, this conclusion is not unanimous and it depends on the specific national context. This makes the study of these questions for the case of CV particularly interesting.

3. CHARACTERIZATION AND REFORMS IN CAPE VERDE'S BANKING SYSTEM

In this section we proceed to a brief characterization of the banking system in CV and the presentation of the major reforms undertaken in the sector. By the early 1990's, the banking system in CV was underdeveloped, with the Bank of Cape Verde (BCV) accumulating

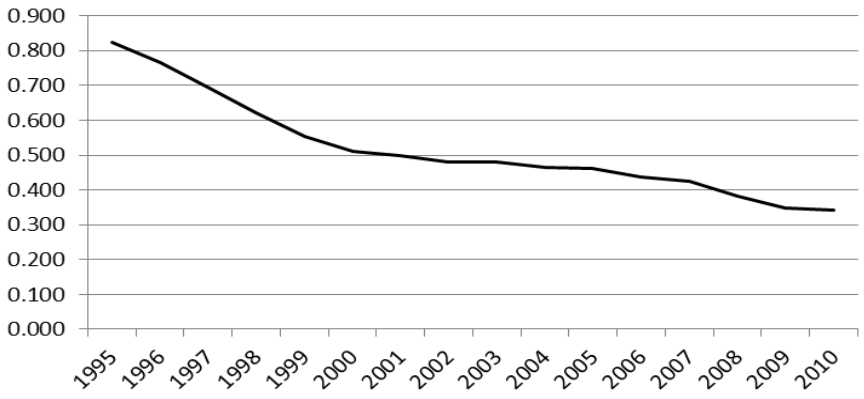
functions of central and commercial bank. In addition, there was also the *Caixa Economica* of CV (CECV), state owned and with authorization to perform only some of the operations reserved to commercial banks.

Since the 1990's, the financial sector in CV has undertaken deep reforms and modernization. With regard to the banking sector, in particular, the reforms concentrated on two basics pillars: the opening of the activity to the private sector and the liberalization of operations and diversification of banking products and services. The reforms were enshrined in several legal documents; in particular the Law nº 3/V/96, which regulates the entrance and functioning of Financial Institutions, establishing the openning of the CV's banking system. These reforms led to the entrance of new banks in the market, implying a reduction of concentration of the banking system measured by the Herfindahl index (Figure 1).[1] Moreover, the liberalization of the sector resulted in a gradual elimination of credit limits and the administrative limits to interest rates, enhancing competition among credit institutions.

From September 1993 onward, the BCV ceased its commercial operations, and started to develop only the functions of central bank and supervisor of the financial system (money, capital and insurance markets). It was created the *Banco Comercial do Atlantico* (BCA), exclusively state owned, to perform the former commercial functions of the BCV.

As monetary authority, the BCV main goal was price stability. As supervisor of the financial system, its role was to monitor institutions' activities, issue standards to regulate the activity of the sector, and monitors their compliance. BCV began to pay more attention to its role of protector of market rules, ensuring an appropriate regulatory framework for better development and stability of banking institutions, and for full transparency and effective competition in the market.

Figure 1 – Evolution of the Herfindahl index of bank deposits in CV



Source: Own calculations.

[1] Herfindahl index: $\sum_{i=1}^{n}(\text{market share of deposits of bank i})^2$, where n is the number of banks in the sector.

The opening of the activity to the private sector through the privatization of CECV and BCA carried out by the end of 1998 marked a turning point in the banking sector. The State stopped having the majority of the capital in BCA. Two new foreign private banks entered the market, summing four commercial banks: BCA, the CECV, Bank *Cabo-verdiano of Negócios* (1996) – a branch of Bank *Totta e Açores* - and the Bank *Interatlantico* (BI). The opening to private initiative and the improvement of the legal framework, especially in 2008-10, lead to the entry of several new commercial banks in the market: *Banco Africano de Investimentos* (2007), *Banco Espírito Santo Cabo Verde* (2010), Ecobank Cabo Verde (2010) and *Novo Banco* (2010). A summary of the capital structure of banks in 2010 can be found in Table 1.

The entry of new banks increased competition and consequently improved banking services. Banks started to have presence in all the archipelago's islands, contributing to an improvement in people's quality of life and potentiating an increase in banks' profits. In the context of modernization of the banking system, CV had in 2010 a modern and reliable national and international system of payments, with a diversified offer of financial products and services, some of which are technologically innovative, such as ATM (Automated Teller Machines), automatic payment terminals / POS (Point of Sale), and credit cards, resulting in improved quality of services to banking clients.

TABLE 1 – Summary of the capital structure of banks in 2010

Commercial Banks	Participation in the social capital		
	State	National Private	Foreign
BCA	10%	25%	53%
CECV	47%	25%	27%
BCN	-	48%	52%
BI	-	30%	70%
BAI CV	-	10%	90%
BES CV	-	-	100%
ECOBANK CV	-	-	100%
NOVO BANCO	85%	10%	5%

Source: Websites of commercial banks in 2010. Position of reports to date of privatization.

The exchange rate cooperation agreement (ERCA) with the Portuguese escudo (later the euro) and the privatizations in 1998, made it possible to improve the credibility and financial strength of banks, which boosted greatly foreign direct investment (FDI), with a positive impact on Cape Verde's economic growth.

The opening of the stock exchange of CV in 2005, led to an increase of the dynamism of the capital market. Companies started having access to one more alternative way of funding. However, the volume traded on the stock exchange was small and did not constitute a real alternative to the banking system.

4. METHODOLOGY

In this section we describe the methodology used to measure efficiency. We start by describing the cost and profit functions of banks and after describe the estimation of the efficiency frontiers.

4.1 Cost and profit functions

When measuring the efficiency of a bank, we have to define its input and output. In this regard, some problems emerge. Firstly, it is difficult to measure bank output in terms of physical quantities like in an industrial firm, and secondly banks are multiproduct firms. The literature diverges both at a theoretical and operational level in the way of measuring the production of the banking firm. In this paper, we choose to follow the production approach, which understands a bank as a producer of services: it raises funds in the form of deposits, which are basically made available to customers in the form of credit (Benston, 1965; Beston, 1972; and Bell e Murphy, 1968; Humphrey, 1982; Berg e Kim, 1994). Output appears as the volume of services, defined as services provided to depositors and borrowers. The factors of production of those services, the inputs, are only capital and labor. Usually it is considered, the monetary value of deposits and credits, given the ease of access to this information. Total cost is given by the sum of labor and capital costs (production costs) excluding financial costs. In a simply way, the production approach can be summarize by a cost function of the following type: *CT = f(Y,w,r)*, where, *CT* – Total cost; *Y* – output; *w* – average salary; *r* – cost of physical capital.

A bank's goal is to maximize profit. It uses factors of production, physical capital (*K*) and labor (*L*), and takes deposits (*D*) and equity (*E*) in order to grant credits (*C*), make investments in securities (*S*) and investment in physical capital. A proportion (ρ) of deposits is channeled into cash reserves. The general function that translates the output of bank *i* is given by:

$$F(C_i, D_i, K_i, L_i) = 0 \quad (1)$$

A bank maximizes the economic profit[2] (π) - Pinho (1999):

$$\pi_i = r_i^C C_i + r^S S_i - r_i^D D_i - r_i^E E_i - w_i^K K_i - w_i^L L_i \quad (2)$$

, where, r_i^C – interest rate of credit; r^S – interest rate on the interbank money market (IMM); r_i^D – interest rate of deposits; r_i^E – cost of equity; w_i^K – physical capital's cost; and w_i^L – price of labor.[3] The amount of credit and deposits of bank *i* depend on the demand curves faced by the bank, $C_i(r_i^C)$ and $D_i(r_i^D)$. The equality of the balance is defined as:

$$\rho D_i + C_i + S_i + K_i = D_i + E_i \quad (3)$$

Choosing C_i, D_i, K_i, S_i, E_i, and L_i, the bank's objective is to maximize expression (2) subject to (3) and (1).

[2] Economic profit measures the profit earned by shareholders by investing in the business and not in other applications.

[3] Notice that in this formulation the financing obtained in the interbank market appears with a minus sign in S_i.

Understanding r_i^C as loans' interest rate net of the expected rate of default (Pinho, 1999) and solving equation (3) in order to the adjustment variable S_i, and replacing in (2), we obtain the following expression for profit:

$$\pi_i = \left(r_i^C - r^S\right)C_i + \left(r^S(1-\rho) - r_i^D\right)D_i - \left(r_i^E - r^S\right)E_i - \left(r_i^K + r^S\right)K_i - w_i^L L_i \quad (4)$$

The first part of expression (4) is net revenues (*R*) and the second part is operating costs (*CO*):

$$CO = \left(r_i^E - r^S\right)E_i + \left(r_i^K + r^S\right)K_i + w_i^L L_i \, . \quad (5)$$

As defined in Pinho (1999) and in most studies, given the difficulty in measuring the the cost of equity, we consider $r_i^E = r_i^S$ thus eliminating equity. By replacing the last equality in (4), using the demand functions of deposits and credit, and the first-order conditions, we have the following profit function:

$$\pi_i = \pi_i(C_i, D_i, r_i^K + r_i^S, w_i^L) \quad (6)$$

The profit is function of outputs (credit and deposits) and inputs prices (capital and labor), and takes into account the effects of banks decisions on both revenues and costs.

A more simple approach consists in studying only the cost side of the profit function, minimising (5) – with $r_i^E = r_i^S$ - subject to the transformation function $F(C_i, D_i, K_i, L_i) = 0$, where we assume the optimal levels of production and the only choice variables are K_i and L_i. We get then:

$$CT_i = CT_i(C_i, D_i, r_i^k + r_i^S, w_i^L) \quad (7)$$

For the econometric estimation of profit function (6) and cost function (7) we need to assume a parametric form. The banking literature typically comprises two important specifications for the cost function: the Cobb-Douglas and Translog functions. Freixas and Rochet (1998) argue that Cobb-Douglas cost function, although easy to estimate, has empirical limitations, leading researchers to prefer the Translog function in studies of bank efficiency (Berger et al., 1987). In particular, contrary to the Cobb-Douglas specification, the Translog assume terms of degree two that enable a better adjustment, particularly for multiproduct enterprises. Therefore, this study also will choose a Translog function and the cost function can then be expressed as:

$$\ln \mathrm{CT} = \alpha_0 + \sum_{i=1}^{2} \alpha_i \ln \mathrm{Y_i} + \sum_{K=1}^{2} \beta_K \ln \mathrm{w_K} + \frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2} \delta_{ij} \ln \mathrm{Y_i} \ln \mathrm{Y_j} +$$

$$+ \frac{1}{2}\sum_{K=1}^{2}\sum_{L=1}^{2} \gamma_{KL} \ln \mathrm{w_K} \ln \mathrm{w_L} + \sum_{i=1}^{2}\sum_{K=1}^{2} \rho_{iK} \ln \mathrm{Y_i} \ln \mathrm{w_K} + \varepsilon \quad (8)$$

, where $Y_1 = C$; $Y_2 = D$; $w_1 = w^K = r^K + r^S$; $w_2 = w^L$

In the event of the parameters δ_{ij}, γ_{KL} and ρ_{iK} are null, the Translog form, boils down into a Cobb-Douglas. From the theoretical point of view, the Translog is considered a cost function, if simultaneously verify the properties of symmetry (δ_{12}=δ_{21} and γ_{12}= γ_{21}) and homogeneity of degree one regarding the prices of inputs.

The profit function (6) is also estimated using the Translog specification, and is subject to the same theoretical restrictions than the cost function.

The cost function allows studying the existence of scale economies. These are associated to a decrease in the average cost (AC) of production as production increases. According to Sassenou (1992), the measure of scale economies for multiproduct enterprises is given by the following expression:

$$EE = \frac{1}{\sum_{i=1}^{n} \varepsilon_i} \quad (9)$$

, where

$$\varepsilon_i = \partial lnC(Y,P)/\partial lnY_i \quad (10)$$

, with ε_i as the cost elasticity of output *i* (Y_i**)** for a given level of prices of inputs given by vector *P*, and with *Y* as the vector of outputs. There are economies of scale in the production when *EE* > 1, meaning that for a proportional increase in all outputs there is a less than proportional increase in total costs. When *EE* ≤ 1, there are decreasing returns to scale and when *EE* = 1 there are constant returns to scale.

4.2. Estimation of the efficiency frontier

The discussion of efficiency measurement has begun with Farrell (1957). The author proposed a measure of efficiency (productive or efficiency-X) for a multiproduct company, divided into two components: technical efficiency and allocative efficiency. Technical efficiency is the firm's ability to maximize production for a given level of inputs. In turn, allocative efficiency reflects the ability of a firm to use inputs for the optimization of production, given the respective prices and technology. As usual in the literature, in this paper we will use the concept of X-efficiency that combines technical and allocative efficiency.

It has been recognized that the best way to measure the efficiency of a banking institution is through the construction of an efficient frontier (Berger and Humphrey, 1997). The main parametric approach to estimate the efficiency frontier is the SFA. With this methodology, the efficiency of a company is measured with respect to a theoretical frontier. Deviations from the frontier are decomposed into two components: the random noise and inefficiency.

An alternative to the SFA would be the DEA methodology, which is a linear programming approach. We did not choose this methodology, since it is deterministic: all deviations from the frontier are explained by inefficiency (Farrell, 1957). This methodology would not be appropriate for developing countries, which are subject to many economic shocks and measurement errors in the variables. In addition, we also chose the SFA because it is more appropriate to the study of panel data.

Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977), presented a stochastic production frontier, where there is an inefficiency term and a random residual. The

reasons for production to deviate from the optimal level are inefficiency or random fluctuations (due to weather, economic problems, political problems, errors originating on the data, misspecification of the model, etc.). In our case, instead of production we will explain profits:

$$\pi_{i,t} = f\left(Y_{i,t}, W_{i,t}\right) + v_{i,t}^{\pi} - u_{i,t}^{\pi} \qquad i = 1,2,\dots,N \tag{11}$$

The random error (positive or negative) $v_{i,t}^{\pi}$ is independent and identically distributed (*iid*) and follows a normal distribution with zero mean and constant variance, σ_v^2. The component $v_{i,t}^{\pi}$ is independent of $u_{i,t}^{\pi}$. The latter element is strictly positive or zero, and is associated to productive inefficiency, leading to a decrease in profits. The component $u_{i,t}^{\pi}$ is also a iid random residual, with a normal distribution truncated at zero and with variance σ_u^2. Thus the component $u_{i,t}^{\pi}$ has an average that is modeled as follows:

$$\mu_{i,t}^{\pi} = \theta + \varepsilon_{i,t}^{\pi} \tag{12}$$

The constant θ is to be estimated and captures the average banking sector level of inefficiency. In a second phase, we explain why the profit efficiency varies over time and from bank to bank using OLS or Fixed Effect panel models.

The total variance of residuals is $\sigma^2 = \sigma_v^2 + \sigma_u^2$, and the ratio of the variance is given by $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$. If $\gamma = 0$ indicates that there are no technical inefficiency effects, and the deviations from the frontier are due to random occurrences that are not associated with the inefficient use of resources.

The estimation of function (11) and parameters λ and σ are made using the log likelihood function and assuming the normal truncated distribution for $u_{i,t}^{\pi}$ (Aigner et al., 1977, Waldman, 1978)

The level of X-profit efficiency (PE) is the ratio between the actual profit and the profit at the frontier:

$$\widehat{PE} = \frac{exp(x_i\beta + v_i - u_i)}{exp(x_i\beta + v_i)} = \exp(-u_i) \tag{13}$$

This indicator takes values between zero and one, with one being the maximum efficiency. The same logic can be applied to the cost function:

$$CT_{i,t} = f\left(Y_{i,t}, W_{i,t}\right) + v_{i,t} + u_{i,t} \tag{14}$$

The components v_{it} and $u_{i,t}$ have the same characteristics than in the profit function, and the indicator of cost *in*efficiency is

$$\widehat{CI} = \frac{exp(x_i\beta + v_i)}{exp(x_i\beta + v_i - u_i)} = \exp(u_i) \tag{15}$$

This indicator takes values between one and infinity. The cost efficiency can be defined as the inverse of inefficiency: $\widehat{CE} = \frac{1}{\widehat{IC}} = \exp(-u_i)$. The indicator of *CE* varies between a minimum of zero and a maximum of one (which indicates maximum efficiency).

5. VARIABLES AND DATA

In this section, we present the variables selected for the cost and profit functions, as well as the determinants of banking efficiency. As defined above, we consider that the banking enterprise uses the production factors physical capital and labor, to take deposits and grant credit.

Firstly, as in general, the cost of labor is the total of personnel costs divided by the total number of workers, as the number of hours worked is not available.

Following Pinho (2001), physical capital (x_K) is the stock of tangible and intangible assets. The cost of x_K is calculated following Jorgenson (1986): $w_K \equiv \left(r^s + r^k\right)x_K$, where r^s is the average of the IMM (defined as the opportunity cost of financing the physical capital) and r^k is the average rate of depreciation of physical capital, obtained as the ratio of annual amortizations to physical capital (x_K). We considered the average rate of Treasury bills as a proxy of the IMM rate due to inactivity [4] of the IMM until 2004, and very weak activity between 2005 and 2010.

The total cost includes operating costs (labor and others, excluding provisions and depreciations) plus the cost of physical capital (physical capital multiplied by the price of physical capital - $x_K * w_K$).

Our work also aims to measure profit efficiency of banks. As Pinho (1999, 2001), here our concern is with economic profit (π) measured as follows: Income before taxes (without subtracting depreciations) subtracted from the cost of physical capital. The existence of negative profits in the sample raises a problem due to the use of logarithms. Therefore, as in Kiyota (2009) and Vennet (2000) we calculated the economic profit adjusted as: π - (minimum profit of the sample) +1.

It should be noted that investments in securities are not considered because they were eliminated while obtaining the cost and profit functions above.

5.1. Determinants of efficiency

The determinants of banking efficiency vary according to each country's environment (Dietsch and Vivas, 2000). CV is a small and insular economy, with both large trade openness and presence of the Government in the economy. Therefore, we consider foreign trade (imports plus exports) in percentage of GDP and public spending as percentage of GDP as determinants of banks' efficiency. Also, as a country becomes more developed, this may contribute to the improvement of the banking system. For this reason, we consider GDP per capita (constant prices, 2000) as potentially important for explaining banks performance. A major objective of this study is to evaluate the impact of the liberalization of the CV banking system's on its

[4] The inactivity of this market is partly justified by a general situation of structural excess liquidity in the system and particularly of some institutions, especially until 2004. The institutions demanding funds went to the Central Bank, as there was no habit of commercial banks to finance each other.

efficiency. The liberalization led to the privatization of banks, entry of new banks, the entry of foreign banks, and the improving of the legal and regulatory framework. To evaluate the last point and the more intangible effects of liberalization, we will introduce a dummy variable that takes the value one after 1996. The other elements will be captured with the following variables: dummy for State-owned banks, dummy for foreign banks, and the Herfindahl Index.

In parallel with the liberalization of the banking system, it took place in CV a currency arrangement with Portugal to ensure the parity of the national currency with the Portuguese currency, and also the strengthening of central bank independence. These two measures have originated a reduction in inflation, which may have had a positive effect on banks' performance. Hence, inflation rate will also be considered a determinant of banking efficiency.

Finally, the size of a bank, measured by total deposits, may also affect banks' efficiency for two reasons. Scherer (1980) argues that larger banks can better exploit the gains of specialization. Kolari and Zardkoohi (1987), advocates that large banks have more favorable conditions for fund raising.

The estimation of the cost and profit frontiers is based on annual accounting data (from 1995 to 2010, and with reference to December), corresponding to a total of 62 observations (five commercial banks during 16 years). The information was obtained from BCV, supplemented with data from the reports of commercial banks, and with some data obtained directly from banks. The macroeconomic data was obtained from the World Bank.

We only considered five of the eight banks operating in 2010, since three of them started their activities in the mid or end of the year 2010. The database allows exploring both the temporal and cross-section characteristics of the data, which contributes to improve the estimation process.

6. EMPIRICAL RESULTS AND DISCUSSION

This section focuses on analyzing the evolution of cost and profit efficiency in the banking sector in CV between 1995 and 2010.

6.1. Analysis of cost efficiency

The results of the estimation of the cost efficiency frontier are shown in Table 2. Based on this estimation, we start by testing whether the Cobb-Douglas production function is an adequate representation of the data, against the alternative hypothesis that the Translog function is best suited for the data. The null hypothesis to test is: H_0: $\beta_{ij} = 0$, for all $i \geq 5$, with the LR test statistic:

$$LR = -2\{ln[L(H_0)] - ln[L(H_1)]\} = -2\ (-1{,}96 + 41{,}87) = 87{,}67 \qquad (16)$$

, where $L(H_0)$ e $L(H_1)$, are the log likelihood function under the null (H_0) and alternative (H_1) hypotheses, respectively. The LR has a Chi-square (χ^2) asymptotic distribution, with degrees of

freedom equal to the number of constraints involved. For a significance level of 5% (α = 0.05) the critical value is $\chi^2_{10}(2\alpha)$= $\chi^2_{10}(2 * 0.05)$= 18,307, lower than the observed value for the LR, 87.67. Therefore, the result suggests that we reject the null hypothesis that the Cobb-Douglas frontier is an adequate representation of the data.

Then, we proceed to test the null hypothesis of non-existence of technical inefficiency effects H_0: $\gamma = \delta = 0$, which has a LR test statistic similar to (16). The critical value is $\chi^2_2(2 * 0.05)$= 4,60 < *LR* = 12,53. The result allows us to reject the hypothesis that there are no inefficiency effects.

As expected, the elasticities (evaluated at the average of the dependent variables) in relation to deposits, credit, prices of capital and labor are positive (Table 3). Using these elasticities, we can obtain a measure of scale economies:

$$EE = (\frac{\partial lCT}{\partial lnC} + \frac{\partial CT}{\partial lnD})^{-1} = (0.2843+0.5239)^{-1}=1.237$$

Since the indicator is larger than 1, we conclude for the existence of scale economies. This means that the small banking market of Cape Verde constitutes a restriction for banks to reduce production costs.

The evolution of cost efficiency (equation 16) does not shows a clear trend (Figure 2). Namely, the liberalization of the banking system seems not to have brought clear improvements in efficiency, and there is even a temporary reduction of cost efficiency after 1996. Also note that in 2007 and 2008, years of the Subprime crisis, there was a decline in the cost efficiency of the banking system. On average, CV banks had a cost efficiency of about 87.06%, *ie*, a waste of around 12.94%.

Let us now identify the determinants of efficiency using the efficiency indicator obtained in the first step regression as dependent variable and the set of variables chosen as explanatory variables. In addition, we also included six dummies to capture outliers (Table 4).

The negative sign of the dummy for state owned banks indicates that public banks are more efficient in terms of costs than private domestic banks. The explanation for this result may be related to the fact that public banks are the oldest, with investments in physical capital already fully amortized. Another possible justification may be that they have a large number of loyal customers, due to the characteristic of the country where the state is the major employer. . It should be noted that the higher efficiency of public sector banks had also been identified by Kiyota (2009), for Cape Verde, Poshakwalen and Qian (2009), for Egypt and Mwenda and Mutoti (2011) for Zambia.

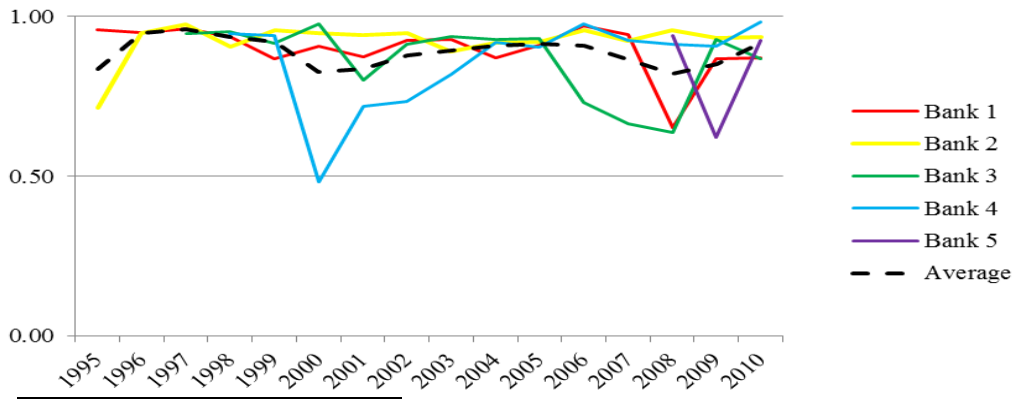
Table 2 - Estimated results of cost frontier stochastic for the Translog[5] specification

Variables		Coefficient	Standard-error	t-ratio
Constant1	beta 0	10.2506	14.5566	0.7042
Ln C	beta 1	-6.7744	1.0507	-6.4473
Ln D	beta 2	7.3941	1.1923	6.2015
Ln W_K	beta 3	-8.9409	3.6769	-2.4317
Ln W_L	beta 4	-5.8134	4.4133	-1.3172
Ln C^2	beta 5	-0.0561	0.0529	-1.0614
Ln D^2	beta 6	-0.0060	0.0308	-0.1958
Ln $W_K{}^2$	beta 7	0.7965	0.3595	2.2153
Ln $W_L{}^2$	beta 8	1.3831	0.4277	3.2336
LnC*LnD	beta 9	0.2495	0.0814	3.0668
LnW_K*LnW_L	beta 10	1.0654	0.6529	1.6317
LnC*LnW_K	beta 11	0.7184	0.2362	3.0411
LnC*LnW_L	beta 12	0.8494	0.2173	3.9098
LnD*LnW_K	beta 13	-0.4225	0.1803	-2.3431
LnD*LnW_L	beta 14	-1.5573	0.1823	-8.5419
Inefficiency model:				
Constant2	delta 0	-8.6971	11.8603	-0.7333
Number of observations				62
Gamma $\gamma = \frac{\sigma_u}{\sigma_v}$				0.9970
Log likelihood function				41.8714
LR test of Cobb-Douglas function				87.6700
(critical value χ^2_{10} (2*0,05))				(18.307)
LR test of no inefficiency effects				12.5317
(critical value χ^2_2 (2*0,05))				(4.60)

Table 3 – Elasticities of total cost

Elasticities (CT)	
dlnCT/dlnC	0.2842858
dlnCT/dlnD	0.5239964
dlnCT/dlnWK	0.0289940
dlnCT/dlnWL	0.4249657

Figure 2 - Evolution of cost efficiency estimated by Translog 1995-2010 [6]



[5] We use the Software Frontier 4.1

[6] Property of capital in 2010: Bank 1 (B1), B3, B4 and B5: foreign banks. B2: state owned bank.

Also foreign banks are more efficient than domestic private banks. This result was expected, since in general in developing countries foreign banks have higher efficiency than national banks (Kiyota,2009), as they bring more financial resources, advanced methods and expertise from the parent companies. Even when compared with foreign banks, public sector banks are more efficient, but with the difference between them not being statistically significant.

The positive coefficient (but not statistically significant) of Herfindahl index (HI) indicates that the concentration in the banking market reduces cost efficiency, probably because it reduces market discipline. This goes in the direction of Berger and Hannan (1989).

The ratio of trade to GDP reduces cost efficiency, as in Chan and Karim (2010) for the banks of the Asian region. This result has to be understood in light of the fact that greater openness of the economy implies a greater complexity of banking operations, particularly due to credit to exports and imports involving foreign currency. In addition, it may exist an increase in economic volatility leading to an increase of costs with risk management.

Table 4 - Determinants of cost *in*efficiency

Determinants	Coefficient	Standard deviation	t-ratio	p-value
Trade (% GDP)	0.0013*	0.0006	1.98	0.054
Inflation	0.0715	0.3855	0.19	0.854
Log Deposits	0.0052	0.0081	0.65	0.520
Expenditure of the State (% GDP)	-0.0050*	0.0028	-1.81	0.077
Herfindahl Index	0.0345	0.2273	0.15	0.880
Liberalization	-0.016	0.0831	-0.20	0.846
GDP per capita	0.0945	0.1537	0.62	0.541
Dummy for state owned bank	-0.1461***	0.0512	-2.85	0.006
Dummy for foreign bank	-0.1060***	0.0470	-2.25	0.029
Constant	0.6512	0.8535	0.76	0.449
Number of observations				62
Number of banques				5
R2				0.8808
F (15, 46)				22.65

Note: The base category is domestic private banks. Dummies variables are introduced to capture outliers. * (***) indicates significance at a 10% (1%) level.

The weight of public spending on GDP contributes for an improvement in cost efficiency. This may be explained because when the State increases its weight in the economy there are better business opportunities in terms of credit and deposits (especially for banks with State participation), which involve few operating costs, due to the large volume of these operations. We cannot also forget that in a small developing economy like CV, State investment has a pivotal role in promoting economic and social development, with positive spillovers on banks efficiency. Besides, the increase of public spending may lead to an increase of public debt with positive effects on financial development. Public debt offers to the financial system a safe asset

to invest in, an asset that can be used as collateral, and its yield curve facilitates the pricing of corporate bonds and equities (Hauner, 2009). Depositors also feel safer to put their savings in banks holding in their balance sheets public debt (functioning here as a collateral), which ultimately leads to a higher level of savings. The macro variables, GDP per capita and inflation, with low levels of significance, show a negative and positive impact on cost efficiency, respectively.

It is interesting to note that the dummy for financial liberalization, despite having a positive effect on cost efficiency, it is not statistically significant. Perhaps, one reason for this lack of significance lies in the fact that in CV liberalization has had as main consequence the entry of foreign banks, and this effect is already captured through the dummy variable associated with these banks. When we did the estimation with fixed effects for each bank, we concluded that the fixed effects are not relevant, and therefore the regression presented above produces consistent estimates[7].

6.2. Analysis of profit efficiency

Turning now to profit efficiency, the Translog function proves again to be superior to the Cobb-Douglas and the absence of technical efficiency effects is also rejected (Table 5). [8]

During the period under review, Cape Verde' banks had an average profit efficiency of 78.6%, *ie*, a waste of 21.4%. Therefore, the level of cost efficiency is larger than the one of profit efficiency. This can be understood in light of the fact that it is easier for the management to minimize costs than to maximize profits, which involve both revenues and costs.

Again, there is no clear trend in efficiency evolution, but we can see that in the early years of liberalization (1997 and 1998) on average there was an increase in efficiency (Figure 3). Also, it is possible to notice that during the peak of the subprime financial crisis (2008) and in the years after there was a steep reduction of profit efficiency.

[7] The test of the nullity of all banks' dummy variables has a F=0.38 (p-val=0.8201).

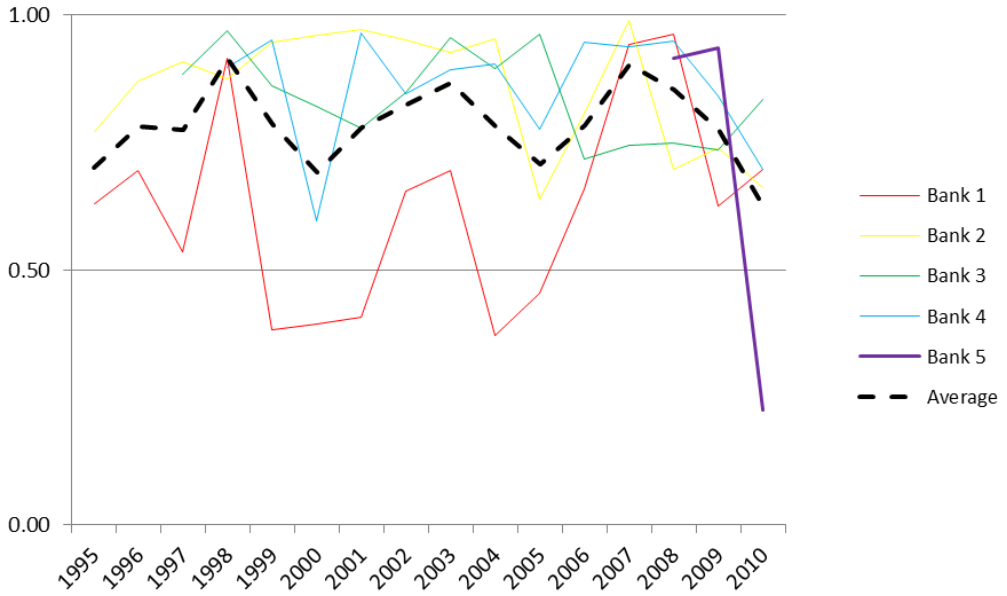
[8] The introduction of a dummy to capture an outlier was important to improve the fitting of the profit function.

Table 5 - Estimated results of frontier profit stochastic for the Translog specification

Variables		Coefficient	Standard deviation	t-ratio
Constant1	beta 0	30.9881	17.5950	1.7612
Ln C	beta 1	3.6079	2.2345	1.6146
Ln D	beta 2	-6.4265	3.2968	-1.9493
Ln W_K	beta 3	7.5291	4.0694	1.8502
Ln W_L	beta 4	2.9574	4.6682	0.6335
Ln C^2	beta 5	-0.0873	0.1160	-0.7521
Ln D^2	beta 6	-0.0524	0.0660	-0.7938
Ln W_K^2	beta 7	-1.3901	0.7770	-1.7891
Ln W_L^2	beta 8	-0.8618	0.5856	-1.4716
LnC*LnD	beta 9	0.1613	0.1360	1.1861
LnW_K*LnW_L	beta 10	-1.7897	0.5661	-3.1613
LnC*LnW_K	beta 11	-1.4703	0.5751	-2.5567
LnC*LnW_L	beta 12	-0.8670	0.4087	-2.1217
LnD*LnW_K	beta 13	1.4237	0.5440	2.6171
LnD*LnW_L	beta 14	1.2020	0.4639	2.5913
Dummy	beta 15	-12.2614	0.3787	-32.3757
Efficiency model: Constant2	delta 0	-13.6839	4.6749	-2.9271

Number of observations		62
Gamma	$\gamma = \frac{\sigma_u}{\sigma_v}$	0.9998
Log likelihood function		11.3047
LR test of Cobb-Douglas function		36.6500
(critical value χ^2_{10} (2*0,05))		18.307
LR test of no inefficiency effects		7.6354
(critical value χ^2_2 (2*0,05))		4.60

Figure 3 - Evolution of the efficiency of profit estimated by the Translog, 1995-2010



We proceed next to analyse the determinants of profit efficiency, using the same determinants variables which were used for cost efficiency (Table 6). [9] In this case the fixed effects turn out to be relevant and we present the estimation with them included. The significance of the dummies for each bank indicates that there is a component of profit efficiency that is due to idiosyncratic characteristics of each bank, which may be related to the bank management culture.

Only three variables affect profit efficiency in a statistically significant way. The opening of the economy to foreign trade has a positive effect on profit efficiency, demonstrating that foreign trade, despite increasing costs, generates more profitable business opportunities. This last result was also obtained for banks of the Asian region by Chan and Karim (2010). The Herfindahl index has a negative effect on profit efficiency. This means that when the banking market is more concentrated, there are fewer incentives for banks to be efficient. Finally, smaller banks (the dimension being measured by the deposit variable) tend to be more efficient in terms of profits. A similar result was obtained for Kenya (Mwega, 2011), and it may translate the success of niche strategies and/or it may indicate that large banks loose efficiency due to the increase in organizational complexity.

Table 6 - Determinants of profit efficiency

Determinants	**Coefficient**	**Standard deviation**	**t-ratio**	**p-value**
Trade (%GDP)	0.0025*	0.0012	1.99	0.053
Inflation	1.0125	0.7024	1.44	0.156
Log Deposits	-0.1105**	0.0478	-2.31	0.025
Expenditure of the State (%GDP)	-0.0039	0.0052	-0.75	0.456
Herfindahl Index	-1.4082**	0.5329	-2.64	0.011
Liberalization	0.0612	0.1268	0.48	0.631
GDP per capita	-0.4540	0.2870	-1.58	0.120
Dummy for state owned bank	0.1755	0.1578	1.11	0.272
Dummy for foreign bank	-0.0223	0.0984	-0.23	0.821
Constant	5.1759***	1.8699	2.77	0.008
Number of observations				62
Number of banques				5
R2 (overall)				0.2895
F(9, 48)				2.10
Prob > F				0.0480
F (4, 48)				4.31
Prob > F				0.0046
Rho (fraction of variance due to the fixed effects)				0.671

Note: * /**/*** indicates significance at a 10%/5%/1% level.

[9] In this case, we explained $\exp(-u_i)$ from equation (13). Thus, unlike for the cost efficiency, an increase of the dependent variable means an increase in efficiency.

7. CONCLUSION

Throughout this study we analised the evolution and determinants of cost and profit efficiency of CV's banks, paying particular attention to the impact of the reforms undertaken in the banking sector. Based on a sample of annual data between 1995 and 2010, we used the SFA methodology to estimate banks' cost and profit functions. Regarding costs, we concluded that there are economies of scale on the banking business in Cape Verde. Concerning both cost and profit efficiency, there was not a clear tendency in the evolution of those indicators. However, there seems to have existed some transitory negative effect of liberalization on cost efficiency, and efficiency seems to have decreased during the Sub-prime crisis.

In a second step, we identified the determinants of efficiency using the variables that are more suited to the country specific characteristics. Results show that both public and foreign banks are more efficient in terms of costs than domestic private banks. The liberalization of the financial system contributed to the improvement of cost efficiency by allowing the entrance of foreign banks, and improved profit efficiency through the reduction of the level of concentration of the banking sector. The dummy variable that captures the improvement in the regulatory environment did not show statistical significance, despite improving cost and profit efficiencies.

The opening of the economy to foreign trade contributed to a reduction of cost efficiency, but increased profit efficiency. The weight of the state in the economy seems to positively affect cost efficiency, perhaps because it generates large amounts of deposits and credits with few operating costs for banks. However, the weight of the state does not affect profit efficiency. Even though larger banks can explore economies of scale, they are less efficient in terms of profit. One explanation for this may reside in the organizational complexity of large banks. It should be noted that the bank-specific unmeasured factors (fixed effect), which are also associated with the management culture of each bank, explain part of profit efficiency. In short, CV is a small insular economy with an average degree of development, high openness to external trade, weak competition in the banking sector, and with high weight of the State in the economy. These characteristics affect differently the efficiency of banks. The small size of domestic market inhibits banks to exploit scale economies, but it is not hampering cost efficiency. But the high degree of concentration in the banking sector leads to lower profit efficiency. The great importance of foreign trade and the considerable weight of the State in the economy turn out to have a positive effect on profit and cost efficiencies, respectively. Finally, the average level of development does not prevent banks for being efficient. Results show that the way of improving the efficiency of the banking system in CV is by deepening the liberalization process, with an increase in competition among banks. Our results support the continuation of the modernization and improvement of the regulatory framework of the financial system, in order to increase the transparency and credibility of the system, and thus serving as a stimulus for foreign direct investment with positive effects in banks efficiency.

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