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## Finance

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Impact of Microfinance Loans

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Discovering Thoughts, Inventing Future

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# Faculty of Economics and Management of Sfax

By Ines Ben Salah

*Abstract-* The aim of this paper is to investigate the determinants and the joint relationship between capital, risk and liquidity of conventional and Islamic banks. Particularly, we focus on the impact of financial and political instabilities on the risk-taking behavior of conventional and Islamic banks. Using the simultaneous equation model with partial adjustment, we find a positive bidirectional relationship between capital and risk of Islamic banks. Moreover, results highlight the risky aspect of this category of banks mainly caused by the type of contracts put in practice, obeying Sharia principles, such as Moudharaba and Moucharaka contracts. Also, changes in liquidity affect positively risk within Islamic and conventional banks, suggesting that both types of banks, by accumulating liquid assets; tend to have relatively riskier portfolios. Moreover, we find a significant impact of the Global financial crisison the capital, risk and liquidity of conventional and Islamic banks.

*Keywords:* *islamic bank, capital, risk, liquidity, arabspring.*

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## I. Introduction

Islamic banking is growing widely over the last thirty years. We are seeing more and more an increasing number of banks, branches and amount of capital that is invested (Khan, 2010). This is well supported by the fact that many international conventional financial institutions are now offering Islamic finance services through their Islamic windows (Citigroup, Bank of America, Standard Chartered, HSBC, …). Subsequently, Islamic financial institutions, more particular Islamic banks, have become an important element in the global financial industry.

Like all financial institutes, Islamic banks must control their level of capital, risk and liquidity to rival their conventional competitors. A sufficient level of capital makes it possible to absorb losses and strengthen solvency. It also offers easy access to financial markets and protects against liquidity problems caused by the outflow of funds. In addition, the capital of the bank reduces the risk taking. So, the second pillar of Basel II highlights the close link between risk and capital position when it confirms that a bank's capital position is consistent with its overall risk profile. In this context, Islamic banks, identical to conventional ones, face many types of risks. This is intensified after the recent subprime crisis which has introduced a critical financial atmosphere and significant challenges. Liquidity position and liquidity risk are the most important challenges for Islamic banking (IFSB Stability Report, 2013). Salman (2013) show that Islamic banks are called upon to make greater efforts to manage their liquidity and thereby to control liquidity risk. This shift in the Islamic bank liquidity is of importance since the assets of Islamic banks are not as liquid as conventional ones. Moreover, Islamic banks have usually difficulties to raise funds quickly from the markets because of the slow development of financial instruments (Ahmed 2011).

Vogel and Hayes (1998) proposes that to increase liquidity requires to establish an Islamic secondary market. This will generate liquidity by allowing banks to start moving away from Murabahah operations. Islamic banks cannot utilize lender of last resort facilities and moreover, most of them do not have a ready formal liquidity management systems. All these factors exacerbate the liquidity risk in Islamic banks that also requires banks to hold more capital.

Then, banks' capital, risk and liquidity positions prompt us to explore in depth their relationship between conventional and Islamic banks.

This paper investigates capital, risk and liquidity decisions of conventional and Islamic banks in the MENA region over the period 2005 to 2013. Our estimations show that there is a positive bidirectional relationship between capital and risk for Islamic banks suggesting excessive risk taking at these financial institutions. This result highlights the risky aspect of this category of banks that originated in the type of contracts put in practice, obeying Sharia principles, such as the Moudharaba and Moucharaka contracts. As for changes in liquidity, they positively affect risk within Islamic and conventional banks, suggesting that both types of banks, by accumulating liquid assets, tend to have relatively riskier portfolios.

This paper contributes to the debate on the banking literature in several ways. First, it is the first to jointly examine capital, risk and liquidity decisions in Islamic banks. Moreover, it is the first that makes a comparative study between Islamic and conventional banks. Second, in this study we focus on the impact of financial instability such as the 2008 global financial crisis and political instability caused by the 2011 Arab revolutions on the risk-taking behavior of conventional and Islamic banks

This paper is organized in the following manner: the introduction is followed by a brief literature review; subsequently, methodology and model specification are described; thereafter the data used are detailed; the empirical results is conducted in order to understand the behavior of each banking type towards the relationship

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capital risk and liquidity and finally, the conclusion is offered.

## II. Literature Review

Rapid growth of Islamic banking and the important place occupied in many countries, has encouraged many researchers to examine the relative competency of Islamic banks compared to conventional banks from several different dimensions including performance, stability, efficiency, etc.

The interrelation between capital, risk and liquidity is of great importance for banking sector. Brown and al. (2007) show that Islamic banks have higher levels of equity capital than conventional ones. In contrary, Hassan (2006) and Beck and al. (2013) show that Islamic banks have a higher intermediation ratio as well as are better capitalized. However, as capital is costly, banks with higher capital may increase their level of risk to maximize revenues. This case is analyze din a first attempt by Shrieves and Dahl (1992) who study adjustments between banks' capital and risk levels and emphasize that exposure to risk and the level of capital are simultaneously linked. They argue that the majority of banks tend to mitigate the effects of rising capital levels by increasing their exposure to asset risks.

In the Islamic context, studies examining risks are rather limited. Cihak and Hesse (2008) show that small Islamic banks are more stable than conventional banks of similar size. Abedifar and al. (2013), Beck and al. (2013) suggest little difference in terms of stability between Islamic and conventional banks, showing that the quality of loans given by Islamic banks is less sensitive to domestic interest rates than to conventional banks. Ghosh (2014) shows that conventional banks generally increase capital to address the growing risks, and not the reverse. They also conclude that there is an unequal impact of regulatory pressure and market discipline on the attitude of banks to risk and capital. As for Islamic banks, they increase their capital more compared to conventional banks. Rahmen and al. (2015) examine the effect of capitalization on credit risk and overall risk in Islamic and conventional banks. They found a negative relationship between credit risk and the level of capitalization.

While researches on banking capital and risk in the banking system has become abundant, liquidity, on the contrary, as a more complex concept, appeared only recently in the banking literature. Djankov and al. (2007) and Acharya and al. (2011) conclude in their studies that better access to information reduces surveillance expenditures, allowing banks to retain more of their capital reserves. According to these authors, this available capital could allow banks to take more risks and provide more loans, which can ultimately help to create more liquidity.

Distinguin and al. (2013) examine the link between bank capital and liquidity, using a model of simultaneous equations. They show that banks reduce their capital ratios due to decreases in liquidity.

The above contradictions imply that there might not be any direct causal relation between bank risk, capital and liquidity. Consequently, the relationship between capital, risk and liquidity is not linear. The joint relationship between capital, risk and liquidity has not been well explored by researchers. Empirically, Repullo (2005) is the first to examine the joint relationship between capital, risk and bank liquidity. He studies the strategic interaction between a bank and a lender of last resort to calculate optimal levels of liquidity, capital and banking risk with and without capital adjustment and with and without a penalty rate. He concludes that a higher capital requirement reduces the level of risk in the bank's loan portfolio and reduces its liquidity. Aspachs and al. (2005) are the first to test the empirical implications of Repullo (2005). They begin their study on a sample of UK banks to analyze the determinants of bank liquidity. They find that obtaining potential support from the central bank adversely affects the level of "liquidity-buffer" in banks. Their work focuses only on "liquidity-buffer", its determinants and the effect of macroeconomic conditions on liquidity assets. Jokipii and Milne (2011) argue that the more liquid banks tend to have a lower level of "buffer" and are more likely to increase their credit risk. However, their liquidity estimates are not statistically significant.

In a recent study, Salman (2013) points out that the liquidity position of Islamic banks and their liquidity risk change over the years. Indeed, most banksevolve from a situation of "liquidity surplus" in the year 2000 to a situation of "lack of liquidity" in the year 2009. This requires a great deal of effort as regards their management of liquidity risk.

Kochubey and Kowalczyk (2014) also examine the decisions of US commercial banks in terms of capital, liquidity and risk during the period 2001 to 2009. They extend the model of simultaneous equations with partial adjustment introduced by Shrieves and Dahl (1992) to study the relationship between bank liquidity adjustments, capital and risk in the presence of securitization. Their results indicate that banks simultaneously coordinate short-term adjustments between capital, risk and liquidity.

This joint relationship is not the subject of studies on Islamic banks. To our knowledge, this is the first work that deals with this issue in a comparative framework between conventional and Islamic banks.

## III. Data and Methodology

*a) Model specification*

The main objective of this paper is to examine the relationship between liquidity, capital and banking

risk. Our idea is inspired from the article of Repullo (2005), the first that analyzed jointly the relationship between capital, risk and liquidity of conventional banks.

To ensure this joint coordination, it is necessary to use a simultaneous equation model with partial adjustment, to consider the interrelationship between these three components. This approach suggested by the financial theory and emphasized in the empirical works of Shrieves and Dahl (1992), Jacquers and Nigro (1997), Jokipii and Milne (2011) and Kochubey and Kowalczyk (2014). According to this approach, observed changes in bank capital, risk and liquidity are the result of bank discretionary behavior and exogenous random shock. Formally, the model can be expressed as follows:

$$\Delta CAP_{it} = \Delta CAP_{it}^{bank} + u_{it} \quad (1)$$

$$\Delta RISK_{it} = \Delta RISK_{it}^{bank} + v_{it} \quad (2)$$

$$\Delta LIQ_{it} = \Delta LIQ_{it}^{bank} + \varepsilon_{it} \quad (3)$$

Where $\Delta CAP_{it}$, $\Delta RISK_{it}$ et $\Delta LIQ_{it}$ are the observed changes in bank capital, risk and liquidity, respectively. $\Delta CAP_{it}^{bank}$ ,$\Delta RISK_{it}^{bank}$ , $\Delta LIQ_{it}^{bank}$ are the changes in capital, risk and liquidity managed by banks, while $u_{it}$,$v_{it}$ and $\varepsilon_{it}$, are exogenous random shocks in capital, risk and liquidity levels for bank i at time t.

Therefore, changes in capital, risk and liquidity are modeled as the sum of a discretionary component and a random shock.

Financial theory advocates that banks are always threatened by financial turmoil and must prepare for adjustment costs to make instant adjustments in their capital, risk and liquidity. Accordingly, we first modeled a discretionary portion of changes in capital, risk and liquidity by using a partial adjustment framework. This approach assumes that banks choose optimal levels of capital, risk and liquidity. Then they make adjustments over time. Thus, adjustments in bank capital, risk and liquidity are defined as:

$$\Delta CAP_{it}^{bank} = \alpha\,(CAP_{it}^{*} - CAP_{it-1}) \quad (4)$$

$$\Delta RISK_{it}^{bank} = \beta\,(RISK_{it}^{*} - RISK_{it-1}) \quad (5)$$

$$\Delta LIQ_{it}^{bank} = \gamma\,(LIQ_{it}^{*} - LIQ_{it-1}) \quad (6)$$

Where$\alpha$, $\beta$ and $\gamma$ are the respective adjustment speeds on capital, risk and liquidity of banks. $CAP_{it}^{*}$, $RISK_{it}^{*}$ and$LIQ_{it}^{*}$ are the optimal levels of capital, risk and liquidity, respectively. $CAP_{it-1}$, $RISK_{it-1}$ and$LIQ_{it-1}$ are the respective levels of capital, risk and liquidity for the previous period.

By substituting equations (4), (5) and (6) respectively in equations (1), (2) and (3), we obtain the following expressions:

$$\Delta CAP_{it} = \alpha(CAP_{it}^{*} - CAP_{it-1}) + u_{it} \quad (7)$$

$$\Delta RISK_{it} = \beta(RISK_{it}^{*} - RISK_{it-1}) + v_{it} \quad (8)$$

$$\Delta LIQ_{it} = \gamma(LIQ_{it}^{*} - LIQ_{it-1}) + \varepsilon_{it} \quad (9)$$

Observed changes in capital, risk and liquidity depend on their optimal levels, delayed levels and random shocks. Target capital, risk and liquidity levels are not directly observable, but are assumed to depend on a set of variables describing the observable conditions of the bank, state of the country, and study period.

In a next step, the model is completed by adding changes to the level of capital, risk and liquidity in each equation, which explains the simultaneity of changes in capital, risk and liquidity.

$$\Delta CAP_{it} = \alpha(CAP_{it}^{*} - CAP_{it-1}) + \emptyset_1\,\Delta RISK_{it} + \emptyset_2\Delta LIQ_{it} + u_{it} \quad (10)$$

$$\Delta RISK_{it} = \beta(RISK_{it}^{*} - RISK_{it-1}) + \theta_1\,\Delta CAP_{it} + \theta_2\Delta LIQ_{it} + v_{it} \quad (11)$$

$$\Delta LIQ_{it} = \gamma(LIQ_{it}^{*} - LIQ_{it-1}) + \varphi_1\,\Delta CAP_{it} + \varphi_2\Delta RISK_{it} + \varepsilon_{it} \quad (12)$$

Given that changes in liquidity, capital and risk are influenced by different individual characteristics of the bank, we estimate the following equations:

$$\Delta CAP_{it} = \alpha_0 + \alpha_1 SIZE_{it} + \alpha_2 LLP_{it} + \alpha_3 ROA_{it} + \alpha_4 LOAN_{it} + \alpha_5\Delta RISK_{it} + \alpha_6\Delta LIQ_{it} - \alpha_7 CAP_{it-1} + \alpha_8\,INF + \alpha_9 GDP + \alpha_{10} CRISIS + \alpha_{11} SPRING + u_{it} \quad (13)$$

$$\Delta RISK_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 LLP_{it} + \beta_3 FUND_{it} + \beta_4 NII_{it} + \beta_5 LOAN_{it} + \beta_6\Delta CAP_{it} + \beta_7\Delta LIQ_{it} - \beta_8 RISK_{it-1} + \beta_8\,INF + \beta_9 GDP + \beta_{10} CRISIS + \beta_{11} SPRING + v_{it} \quad (14)$$

$$\Delta LIQ_{it} = \gamma_0 + \gamma_1 SIZE_{it} + \gamma_2 ROA_{it} + \gamma_3 NIM_{it} + \gamma_4 LOAN_{it} + \gamma_5\Delta CAP_{it} + \gamma_6\Delta RISK_{it} - \gamma_7 LIQ_{it-1} + \gamma_8\,INF + \gamma_9 GDP + \gamma_{10} CRISIS + \gamma_{11} SPRING + \varepsilon_{it} \quad (15)$$

Where $\Delta CAP_{it}$ are changes in capital for bank i in year t, $\Delta RISK_{it}$are changes in risk for bank i in year t, $\Delta LIQ_{it}$ are changes in liquidity for bank i in year t, $SIZE_{it}$ : size of the bank measured by the natural logarithm of its total assets.$ROA_{it}$ : Return on assets, measured by the ratio "Net income / Total assets". $NIM_{it}$ : Net interest margin, measured by the ratio "Net interest income / Average earning assets".$LOAN_{it}$ : Loan growth rate.$LLP_{it}$ : loan loss provision.$FUND_{it}$ : funding. $NII_{it}$ : net interest income.$CAP_{it-1}$ : Capital level of the previous period. $RISK_{it-1}$ : Risk level of previous period.$LIQ_{it-1}$ : Level of liquidity in the previous period.$INF$ : Macroeconomic variable indicating the level of inflation for the year t.$GDP$ : Macroeconomic variable for GDP in year t.$CRISIS$ : Binary variable for the

subprime crisis: 1 for years 2007, 2008; 0 if not.$SPRING$ :Binary variable to capture the impact of Arab revolutions: 1 for years 2011, 2012,2013; 0 if not.

Contrasting to Shrieves and Dahl, 1992; Jacques and Nigro, 1997, we use dynamic panel data technique to control for bank-specific heterogeneity $\mu i$. In particular, we use the two-step Arellano-Bond difference GMM estimator (Arellano and Bond, 1991). Our choice is motivated by the fact that the presence of fixed effects in the model make lagged dependent variable endogenous.

*b) Data description*

We need to check the relation between capital, risk and liquidity. In this regard, we apply three regression equations. The first model equation explains banking sector capital, the second model equation checks bank risk levels and the final model equation examines the determinants of bank liquidity. The first model uses the ratio of equity to total assets as a proxy for banking capital as dependent variable, whereas in the second model, Z score (risk) is the dependent variable and, finally, in the third model the ratio of liquid assets to total assets (liquidity) is the dependent variable.

Capital is calculated simply as the ratio of equity to total assets ($\Delta CAP_{it}$). Z score is used as a measure of banking risk ($\Delta RISK_{it}$). Higher levels of Z score indicate a greater banking risk. Liquidity is obtained by the ratio of liquid assets to total assets. The liquid assets include cash, reverse repurchase agreements, marketable securities and federal funds sold. The liquidity ratio is delayed by a period, as credit rating agencies continue to monitor liquidity levels before issuing credit ratings (Bordeleau and Graham, 2010).

A variety of bank-specific variables are also included which are also believed to explain the variation in bank capital, risk and liquidity. *SIZE* and *LOAN* are employed in the three equations. *SIZE* is measured by a logarithm of its total assets and *LOAN* includes all credit categories, namely customer loans and interbank loans. For Islamic banks, they do not offer loans in a similar way to conventional banks. Thus, the term *LOAN* is a generic term used to describe the equity financing products it uses.

Loan loss provisions (*LLP*) are also introduced as an explanatory variable in the capital and risk equation. For Islamic banks, this variable is measured by the bank's total loan loss provisions, including those shared with depositors (including the Moucharaka and Moudharaba participative contracts (Farook and al., 2012)).

Return on assets (*ROA*) is measured by the ratio of net income to total assets in order to control capital and liquidity equation. For Islamic banks, this ratio is presented as the ratio of Net income after tax and Zakat to Total assets.*ROA* provides information on the ability of the bank to manage profitability and the overall efficiency of the bank.

The Funding (*FUND*) is introduced following Huang and Ratnovski (2011), Adrian and Shin(2009) and Raddatz (2010), who show that banks relaying heavily on their funding are more affected by the liquidity crisis. Non-interest income (*NII*) is measured by the ratio of non-interest income to total operating revenue to control the bank's risk. Net interest margin (*NIM*) is measured by the ratio of net interest income to average earning assets. In Islamic banks, this ratio is called (*NPM*) "Net Profit and Loss Sharing / PLS margin" (Ascarya and Yumanita (2010)). In the rest of this paper, we will adopt the same nomination for both types of banks (*NIM*), to facilitate interpretations.

It should be noted that Islamic banks do not deal with interest rates, which implies, for this type of bank, fixed costs of profit or financing costs as interest expenses. changes in banks' liquidity, capital and risk might be influenced by individual's bank characteristics. We account for bank unobserved heterogeneity by incorporating bank fixed effects, which are designed to absorb all time invariant bank heterogeneity.

Logarithm of GDP per capita (*GDP*) and inflation (*INF*) are incorporated in three equations.

Given that the estimate covers the period of the Arab revolutions and in order to test the impact of changes in the political and economic environment on capital, risk and bank liquidity, a binary variable is added to the specification. Thus, we awarded 1 for the years 2011, 2012 and 2013 and 0 for the rest of the period.

We introduce a binary variable taking 1 for the years 2007, 2008 and 0 for the remainder of the period to account for the effect of the subprime crisis.

Relevant data mentioned above are collected from the Bank scope database for 88 conventional banks and 42 Islamic banks. Descriptive statistics of data are presented in Table 1.

## IV. Results and Discussion

Table 1 presents summary statistics for variables in the study. The mean of each variable is calculated using observations for all banks for all years of the study period (2005-2013), and the standard deviation of a variable measures the dispersion of its observations from its mean. Maximum and minimum columns present the highest and lowest observation fined for bank-related variables. Skew ness and kurtosis are also recorded in the descriptive statistics of banks variables.

*Table 1:* Descriptive Statistics of Islamic and Conventional Banks variables

| | N | Mean | SD | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| **Panel A : Conventional Banks** | | | | | | | |
| *CAP* | 873 | 0,13 | 0,06 | -0,01 | 0,49 | 1,84 | 8,68 |
| *RISK* | 873 | 2,88 | 0,96 | -1,87 | 5,34 | -0,7 | 4,08 |
| *LIQ* | 873 | 0,25 | 0,17 | 0 | 1,17 | 1,62 | 6,44 |
| *SIZE* | 873 | 6,77 | 0,66 | 4,74 | 8,09 | -0,26 | 2,58 |
| *LOAN* | 873 | 0,93 | 4,81 | 0,02 | 117,64 | 19,02 | 423,47 |
| *LLP* | 873 | 0,01 | 0,01 | -0,01 | 0,23 | 9,92 | 166,43 |
| *NIM* | 873 | 3,96 | 2,23 | -2,08 | 33,26 | 3,92 | 40,24 |
| *NII* | 873 | 3,96 | 0,17 | -0,45 | 1,65 | 1,35 | 11,05 |
| *FUND* | 873 | 0,68 | 0,14 | 0,14 | 2,01 | 1,07 | 18,96 |
| *ROA* | 873 | 1,26 | 5,93 | -19,29 | 63,17 | 5,28 | 35,26 |
| *GDP* | 873 | 4,67 | 4,21 | -15,09 | 0,66 | 8,61 | 0,89 |
| *INF* | 873 | 5,97 | 5,2 | -10,07 | 53,23 | 2,56 | 20,64 |
| *Δ CAP* | 776 | 0 | 0,02 | -0,11 | 0,17 | 0,69 | 10,58 |
| *Δ RISK* | 776 | -0,01 | 0,29 | -2,94 | 3,08 | 0,25 | 44,23 |
| *Δ LIQ* | 776 | -0,01 | 0,08 | -0,4 | 1,06 | 2,49 | 38,09 |
| **Panel B : Islamic Banks** | | | | | | | |
| *CAP* | 342 | 0,23 | 0,22 | -0,13 | 1,19 | 2,13 | 7,36 |
| *RISK* | 342 | 2,52 | 0,98 | -3,79 | 6,47 | -1,16 | 8,35 |
| *LIQ* | 342 | 6,21 | 0,75 | 2,72 | 7,92 | -0,22 | 3,64 |
| *SIZE* | 342 | 0,29 | 0,23 | 0 | 2,05 | 2,59 | 15,38 |
| *LOAN* | 342 | 0,71 | 1,6 | 0 | 14,65 | 6,46 | 47,19 |
| *LLP* | 342 | 0,01 | 0,03 | -0,11 | 0,47 | 11,45 | 174,13 |
| *NIM* | 342 | 4,45 | 5,08 | -4,05 | 48,2 | 4,25 | 29,57 |
| *NII* | 342 | 0,45 | 0,96 | -1,17 | 16,23 | 13,21 | 213,45 |
| *FUND* | 342 | 0,63 | 0,47 | 0 | 6,7 | 6,66 | 85,64 |
| *ROA* | 342 | 0.01 | 0.08 | -0.88 | 0.16 | -6.48 | 59.09 |
| *GDP* | 342 | 4,81 | 4,41 | -15,09 | 26,17 | 0,36 | 9,06 |
| *INF* | 342 | 5,87 | 5,7 | -10,07 | 53,23 | 2,55 | 18,46 |
| *Δ CAP* | 304 | -0,01 | 0,13 | -1,06 | 1,06 | -0,38 | 33,91 |
| *Δ RISK* | 304 | -0,09 | 0,52 | -4,57 | 2,72 | -3,12 | 36,11 |
| *Δ LIQ* | 304 | 0 | 0,19 | -1,05 | 1,64 | 1,65 | 27,59 |

We note a net superiority of variable *NII* (3.96) for conventional banks compared to Islamic banks (0.45).In addition, the average risk of conventional banks (2.88) is higher than that of Islamic banks (2.52). This result is due to the sets of variables associated with the stability of the banking environment. We note that the average capital ratio of the Islamic sample is 23%, whereas it is 13% for conventional one. High levels of capitalization show that Islamic banks have managed to maintain financial strength, despite strong competition from conventional banks.

Next, we present a graphical analysis showing the evolution of capital, risk and liquidity during the period of the study in order to test the effect of the subprime crisis and the Arab revolutions on the main indicators of Islamic and conventional banks. Figure 1, 2 and 3 shows respectively the evolution of capital, risk and liquidity for Islamic and conventional banks for the period 2005 to 2013.

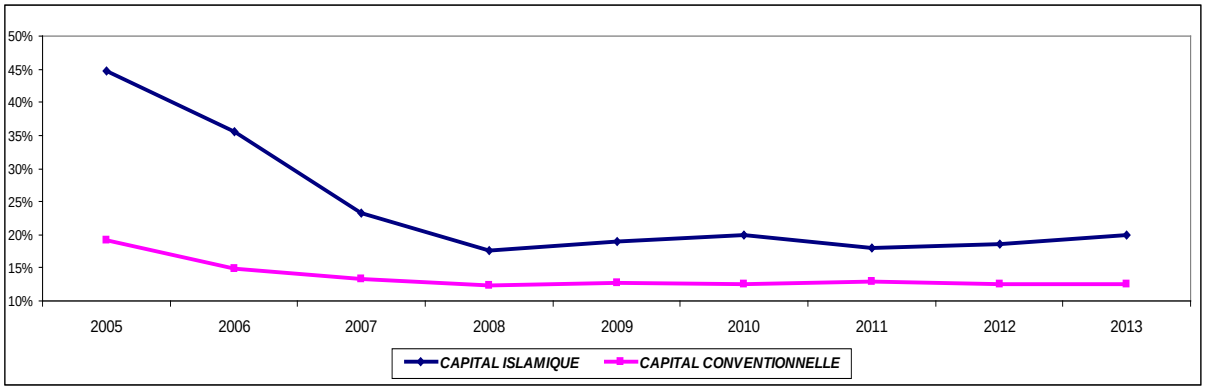


*Figure 1:* Capital evolution of Islamic and conventional banks

Figure 1 shows that the capital ratio is higher for Islamic banks compared to their conventional counterparts. Moreover, a remarkable drop is noted during the period 2005-2007. A slight increase in the capital of the Islamic banks is observed during the year 2010, then it decreased during the period 2011-2012 coinciding with the Arab revolutions.

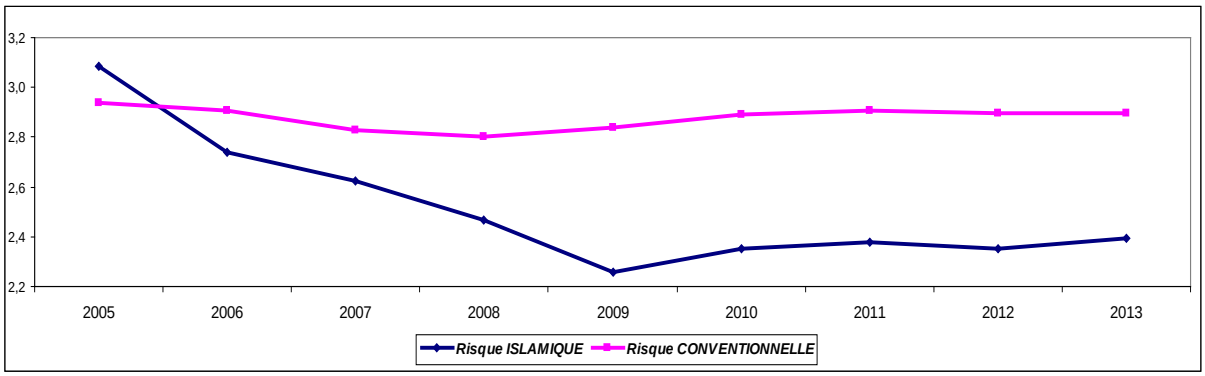


*Figure 2:* Risk evolution of Islamic and conventional banks

Figure 2 shows that the evolution of the risk of conventional banks is almost stable during the study period. In addition, we note a decline in the risk level of Islamic banks even in times of crisis, followed by a slight increase in subsequent years. So, the political risk generated by the revolution seems to have a greater effect on the risk of Islamic banks than that of the global financial crisis.

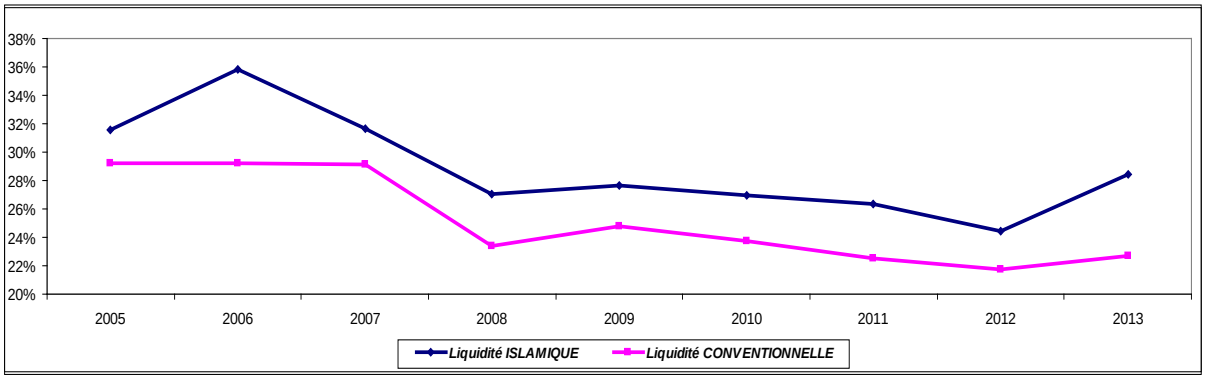


*Figure 3:* Liquidity evolution of Islamic and Conventional Banks

Figure 3 shows that behavior towards liquidity for Islamic banks is unstable during the study period. Liquidity decreased from 2006 to 2008 with intensity and start to rise in 2012.In general, the financial crisis has a more intense effect on the liquidity of both types of banks.

*a) Determinants of bank capital*

Table 2 presents the estimation results for the capital equation (13) for Islamic and conventional banks.

*Table 2:* Capital Determinants of Conventional and Islamic Banks

| | Islamicbanks | | Conventional Banks | |
|---|---|---|---|---|
| | Coef | P>\|z\| | Coef | P>\|z\| |
| $CAP_{t-1}$ | 0,112** | 0.023 | -0,010 | 0.466 |
| *SIZE* | 0,015 | 0.297 | 0,001** | 0.013 |
| *LLP* | -1,765* | 0.068 | 0,336 | 0.366 |
| *ROA* | 0,103** | 0.017 | 0,000** | 0.017 |
| *LOAN* | 0,001*** | 0.001 | 0,002*** | 0.004 |
| $\Delta RISK$ | 0,062** | 0.010 | 0,024 | 0.484 |
| $\Delta$ *LIQ* | -0,421 | 0.225 | 0,110 | 0.498 |
| *SPRING* | 0,023 | 0.211 | -0,003 | 0.159 |
| *CRISIS* | -0,015** | 0.015 | -0,001*** | 0.001 |
| *INF* | -0,002 | 0.322 | -0,000 | 0.158 |
| *GDP* | -0,001*** | 0.000 | -0,001** | 0.037 |
| *CONS* | -0,097 | 0.364 | 0,014 | 0.177 |

****, ** and * Denote statistical significance at 1, 5 and 10%, respectively.*

The results show that capital is positively influenced by the change in risk for Islamic banks. This implies that a high level of capital generates a higher risk. This can be attributed to the fact that when the bank accumulates a high level of capital, it can protect itself against excessive risk taking. Indeed, Shrieves and Dahl (1992) confirm that a positive correlation between capital and risk may result from regulatory costs, the unintended impact of minimal capital requirements, avoidance of bankruptcy costs, or risk aversion by the bank's managers. The result also shows that the change in capital is positively influenced by the level of risk for Islamic banks at the 5% level.

Changes in liquidity have insignificant effect and negatively influence the capital of Islamic banks. This is consistent with results of Kochubey and Kowalczyk (2014) who indicates that these banks increase their liquidity following a decline in the capital ratio. profitability measured by "*ROA*" variable is positively related to capital for both types of Islamic and conventional banks. The higher the *ROA*, the greater will be the retained earnings of the business, which will increase the bank's capital ratio.

Size and capital are positively related for both categories of banks. This is consistent with Miah and Sharmeen (2015) result, who suggest that large banks should operate with a higher level of capital. This result is only significant for conventional banks. We assume that this result may be related to the capital adequacy requirement associated with the size of bank assets during the sampling period of our study, especially as this period covers the years of crisis and after crisis. Generally, at such times, banks try to rebuild themselves in terms of solidity. Boyd and Runkle (1993) explain this finding by the fact that large banks having easier access to investment opportunities, capital markets and financing, can maintain higher levels of risk.

A significant part of the bank's assets appears in the form of loans, and therefore banks with a higher level of the loan portfolio tend to have a higher level of capital to maintain the optimal leverage ratio. This confirm the conclusion of Berger (1993) showing that the level of capital and profitability are positively related to Islamic and conventional banks.

As for the loan loss provision variable, it is not significant for the conventional sample but negative for Islamic banks. It shows that banks of this type are not cautious about changes in capital, as they have a lower level of loan loss provision. However, they dispose of a large proportion of these provisions in order to protect themselves against risks. Such contradiction in the behavior of Islamic banks may reflect the lack of experience of these banks.

The rate of growth of loans have a positive effect on the capital of two types of banks showing that financial risk management dominates the strategy of banks, because banks are asked to increase their capital ratio for a safer structure when their loan ratio is high.

The *GDP* coefficient is significant and negative at the 1% level. The negative relationship between economic growth and capital confirms that investment decisions are influenced by the economic cycle. During periods of economic expansion, Islamic banks are better able to raise their capital levels and finance the riskiest projects. Conversely, during periods of recession, the reduction in risk-taking and the increase in forecast losses lead banks to reduce their volume of assets in order to improve their position on capital. With regard to the effect of the Subprime crisis and the Arab Spring, we note that the crisis variable has a negative and significant impact on the capital of Islamic and conventional banks. This suggests that during this period banks decrease their capital ratios, which reflects the logic of the Subprime crisis. As regards *SPRING*, we find no significant effect on capital for both types of banks.

*b) Determinants of bank risk*

Table 3presents the estimation results for the risk equation (14) for Islamic and conventional banks. The results show that the growth rate of loans has a positive effect on the risk of Islamic and conventional banks. Several evidences show that banks with high rates of loan growth are riskier. This may indicate that banks tend to reduce their collateral requirements to increase loan growth. According to Foos and al. (2010), banks with higher rates of loan growth can attract customers who do not have the opportunity to have credit in other institutions. Our results are coherent with those of Altunbas and al. (2007) and Foos and al. (2010), who find that banks with higher loan growth rates are riskier.

*Table 3:* Determinants of Risk for Islamic and Conventional Banks

| | Islamic Banks | | Conventional Banks | |
|---|---|---|---|---|
| | Coef | P>\|z\| | Coef | P>\|z\| |
| $RISK_{t-1}$ | 0,041*** | 0.005 | 0,012*** | 0.005 |
| SIZE | -0,057 | 0.551 | 0,013 | 0.448 |
| LLP | -2,188*** | 0.001 | -4,189 | 0.343 |
| FUND | 0,398* | 0.094 | 0,0409 | 0.867 |
| NII | 0,007** | 0.026 | -0,109 | 0.240 |
| LOANS | 0,007 | 0.548 | 0,021** | 0.048 |
| ΔCAP | 1,789** | 0.049 | 9,573** | 0.038 |
| Δ LIQ | 2,001** | 0.003 | 1, 484*** | 0.001 |
| SPRING | 0,065 | 0.331 | 0,019 | 0.561 |
| CRISIS | 0,041** | 0.021 | 0,052** | 0.011 |
| INF | -0,013** | 0.025 | -0,004*** | 0.002 |
| GDP | -0,005** | 0.020 | 0,004 | 0.631 |
| CONS | 0,036 | 0.944 | -0,177 | 0.501 |

****, ** and * Denote statistical significance at 1, 5 and 10%, respectively.*

Funding is not a relevant determinant of risk taking for conventional and Islamic banks. This result is consistent with recent studies by Adrian and Shin (2009), Raddatz (2010), and Ratnovski and Huang (2009). Non-interest income (*NII*) has a positive and significant impact on the risk of Islamic banks mainly attributed to the fact that a large share of non-interest income can destabilize banks. Indeed, *NII* are usually more volatile than interest income because regulators encourage banks to hold less capital against non-interest income-generating activities, leverage may be greater and therefore involve excessive volatility in profits (DeYoung and Roland, 2001). These explanations suggest that banks with a high share of non-interest income may also be less stable than banks that primarily provide loans. In this sense, we recall that Islamic banks do not provide loans at interest according to the principle of the prohibition of interest, and the PLS principle, which makes the Islamic banks products riskier.

Liquidity adjustments (*ΔLIQ*) have a positive impact on risk adjustments for Islamic and conventional banks. This positive relationship suggests that banks that accumulate liquid assets tend to have less secure portfolios. This result suggests a positive relationship between the level of liquidity and risk taking in Islamic and conventional banks. This confirms one of the implications of Distinguin and al. (2013), which

portfolios. This result suggests a positive relationship between the level of liquidity and risk taking in Islamic and conventional banks. This confirms one of the implications of Distinguin and al. (2013), which document a positive relationship between bank capital and liquidity for European and American commercial banks before the recent financial crisis. Nevertheless, this result contradicts the theoretical predictions of Repullo (2005).

The positive coordination of capital and risk for Islamic and conventional banks is in line with the findings of Shrieves and Dahl (1992) and Jokipii and Milne (2011), which indicate that banks are increasing their capital ratios in response to an increase in the risk of the bank's loan portfolio and vice versa. These suggest that banks increase the overall risk of their asset portfolio and reduce the risk of their loan portfolio when faced with a lower level of capital.

Inflation is negatively related to the risk of conventional and Islamic banks. This result is proved by Vong and Chan (2009) who suggest that inflation could affect the money value, purchasing power and the real interest rate billed and received by conventional banks as well as the profit margin of Islamic banks. The *GDP* affects negatively the risk of Islamic banks.

Global financial Crisis as well as Arab spring affect positively to risk changes in Islamic and conventional banks.

*c) Determinants of bank liquidity*

Table 4 presents the estimation results for the liquidity equation (15) for Islamic and conventional banks.

SIZE is statistically insignificant for conventional banks, which refers to a poor market valuation for liquidity needs and will further increase the risk (Akhtar and al., 2011).

*Table 4:* Determinants of Liquidity for Islamic and Conventional Banks

| | Islamic Banks | | Conventional Banks | |
|---|---|---|---|---|
| | Coef | P>\|z\| | Coef | P>\|z\| |
| $LIQ_{t-1}$ | -0,015*** | 0.002 | -0,003** | 0.033 |
| SIZE | -0,021*** | 0.010 | -0,001 | 0.871 |
| ROA | 0,531** | 0.039 | 0,002** | 0.044 |
| NIM | 0,002 | 0.673 | 0,002** | 0.017 |
| LOAN | -0,000 | 0.910 | 0,006 | 0.328 |
| ΔCAP | -0,320 | 0.666 | 3,129 | 0.238 |
| Δ RISK | 0,164 | 0.433 | 0,056 | 0.617 |
| SPRING | -0,022 | 0.303 | 0,011 | 0.488 |
| CRISIS | -0,061** | 0.048 | -0,006*** | 0.001 |
| INF | -0,001 | 0.775 | 0,001 | 0.674 |
| GDP | 0,001 | 0.668 | 0,003 | 0.252 |
| CONS | 0,148 | 0.558 | -0,022 | 0.732 |

***, ** and * Denote statistical significance at 1, 5 and 10%, respectively

ROA affects positively the liquidity of both types of banks. This finding is conforming to Was iuzzaman and Tarmizi, 2010 suggesting that more liquid is the bank, the lower are its return on assets. This stipulate that the bank can use its good revenue to cover its short-term obligation.

The positive impact of the net interest margin on the liquidity of conventional banks indicates that the most profitable banks maintain higher liquidity ratios. This variable is non-deterministic in the liquidity equation of Islamic banks.

We find a negative and significant effect of crisis on the liquidity of conventional and Islamic banks. These results are consistent with Vodova (2011). Indeed, the subprime crisis is a crisis of confidence which prompt the majority of depositors to withdraw their funds, which led to an inability to repay, and thus a reduction on liquidity in banks. Banks' reaction to the "Arab Spring" is insignificant for both types of banks.

## V. Conclusion

Capital, risk and liquidity are three key factors in the banking activities. Indeed, an effective synchronization between these three determinants can reduce financial turbulence; especially in instability periods. Toward, this paper examines the relationship between capital, risk and liquidity for both conventional and Islamic banks with considering the effect of financial and political instabilities. We use the simultaneous equation model with partial adjustment introduced by 88 conventional banks and 42 Islamic banks for the period 2005-2013.

By examining the variables introduced to control the relationship between capital, risk and liquidity, we conclude that all findings confirm a riskier character for the Islamic banks in our sample. Indeed, the principle of sharing losses and profits in Islamic banks is applied through the Profit Sharing Investment Accounts (PSIA), which account for a large share of the liabilities of Islamic banks. As a result, through these PSIA accounts, Islamic banks are able to invest in costly transactions such as Moudharaba and Musharaka, which are more risky than commercial operations (Archer and Karim, 2009). Moreover, in the context of incomplete information and lack of transparency, Investment Account Holders (IAH) are faced with the risk of mismanagement of Moudharaba funds because they are unable to effectively monitor the investment decisions made by the bank (Islamic Financial Services Board (IFSB, 2008)). Similarly, the PLS seems to constitute a constraint on liquidity for Islamic banks, since in some critical situations, it's so difficult for Islamic banks to liquid assets.

Unlike conventional banks, Islamic ones face many problems, such as the Shariah issue (asset sale and securitization), the structure of the assets (lack of diversification, concentration), the inefficiency of Islamic money markets (lack of liquidity management tools preventing banks from managing their cash flow and improving risk diversification).

With regard to the effect of the Subprime crisis, we note that it has a negative and significant impact on capital of Islamic and conventional banks. This suggests that during this period banks decrease their capital ratios, which reflects the logic of the Subprime crisis. The impact of the Global Financial Crisis is well emphasized on the risk equation since it affects positively risk changes in Islamic and conventional banks. Results found on changes in liquidity highlights more the effect of crisis on conventional and Islamic banks. As regards SPRING, we find no significant effect on capital, risk and liquidity for both types of banks.

From a practical perspective, Islamic bank regulators will be better prepared to supervise the Islamic banking system if they take into account that they should improve their Profit and Loss Sharing investment in order to reduce their liquidity risk. In addition, it is essential to strengthen instruments of liquidity risk management.

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# Comparison of Error Correction Models and First-Difference Models in CCAR Deposits Modeling

By Zi-Yi Guo

*Abstract-* A well-known issue associated with linear time-series models is the so-called spurious regression problem when the variables are non-stationary. To cure this issue, one usually differences the data first, tests the stationarity of the first differences, and then runs regressions on the revised data. Alternatively, error correction models (ECMs) can be used if the dependent and independent variables are co-integrated. In this paper, we investigate forecasting performance between first-difference models and ECMs through four different simulation designs: (i) non-correlated I(1) processes; (ii) correlated near-stationary I(0) processes; (iii) correlated but un-cointegrated I(1) processes; and (iv) cointegrated I(1) processes. Our results show that ECMs have more robust performance than first-difference models in terms of coefficients estimation and out-of-sample forecasting under the CCAR framework. A simple application for models constructed for banks' Comprehensive Capital Analysis and Review (CCAR) exercises is exhibited.

*Keywords:* *linear time-series models; stationarity; co-integration; forecasting.*

*GJMBR-C Classification:* *JEL Code: C32; G12; G13*


*Strictly as per the compliance and regulations of:*

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## I. Introduction

Linear time-series models, such as ARIMA, OLS and VAR models, have been quite frequently used in the banking industry for its CCAR deposits balance modeling exercises(e.g. An and and Schonert at McKinsey, 2015, Hughes and Poi at Moody's Analytics, 2016). A well-known issue associated with these models is the so-called spurious regression problem. Namely, a regression might provide statistical evidences of a linear relationship between independent variables when these variables are non stationary (Granger and New bold, 1974). Hamilton (1994) discussed three cures for the issue associated with spurious regressions and stated that many researchers recommend the approach that one should routinely difference the apparently non-stationary variables to make sure the stationarity assumption is satisfied before estimating regressions. Hamilton noted that there are two different situations in which this approach might be inappropriate. First, if the data are really stationary, then differencing the data will result in a mis-specified regression – the problem of over-differencing. Second, even if both dependent and independent variables are truly integrated processes, there is an interesting class of models for which the multi-variate dynamic relation between the dependent and independent variables, known as co-integrated processes, will be mis-specified if researchers simply difference these variables. In this paper, we revisit the issue that if time series data exhibit non-stationary or near non-stationary pattern, should the series be routinely differenced or a co-integration analysis should be conducted. Our interests particularly focus on its CCAR deposits balance modeling applications.

In the following two examples, we present two simple cases to show that omitting or incorrectly differencing time series data could generate misleading conclusions. The following equation is the data generation process (DGP) for Example One.

*Example One – DGP:*

$$\Delta y_t = \Delta x_t + e_t,\ \Delta x_t \sim i.i.d.N(0,1)\ and\ \ e_t \sim i.i.d.N(0,2),$$

Where $\Delta y_t = y_t - y_{t-1}$ and $\Delta x_t = x_t - x_{t-1}$. In the example, the first-order integrated (I(1)) dependent and independent variables are linearly correlated, but not co-integrated. The true coefficient of the differenced series is equal to one. Figure 1 illustrates dynamics of $x_t$ and $y_t$.

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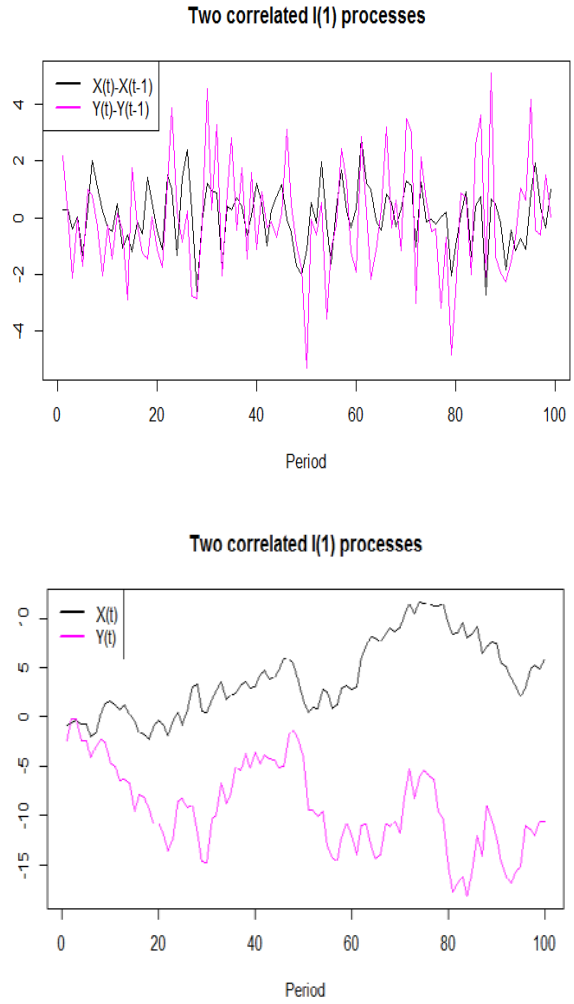


*Figure 1:* Two correlated but not co-integrated I (1) processes

The right panel in Figure 1 indicates $x_t$ is negatively correlated with$y_t$ even if the differenced series are positively correlated.Table 1shows a negative estimate of the regression coefficient $\beta$ will be produced if one directly runs the regression without differencing the data.

*Table 1:* Regression results of the raw and the differenced I (1) processes

| | Δy(t)=Δx(t)+e(t) | p-value | y(t)=x(t)+e(t) | p-value |
|---|---|---|---|---|
| Intercept | -0.15 | 0.40 | -8.08 | 0.00 |
| beta | 0.96 | 0.00 | -0.28 | 0.01 |

The following equation is the DGP for Example Two.

*Example Two – DGP:*

$$y_t = x_t + e_t \; and \; x_t = 0.9 * x_{t-1} + \varepsilon_t;$$

$$e_t \sim i.i.d.N(0,2) \; and \; \varepsilon_t \sim i.i.d.N(0,1).$$

In the example, the dependent and independent variables are near non stationary and linearly correlated. The true coefficient of the two series is equal to one. Figure 2 illustrates dynamics of $x_t$and $y_t$.

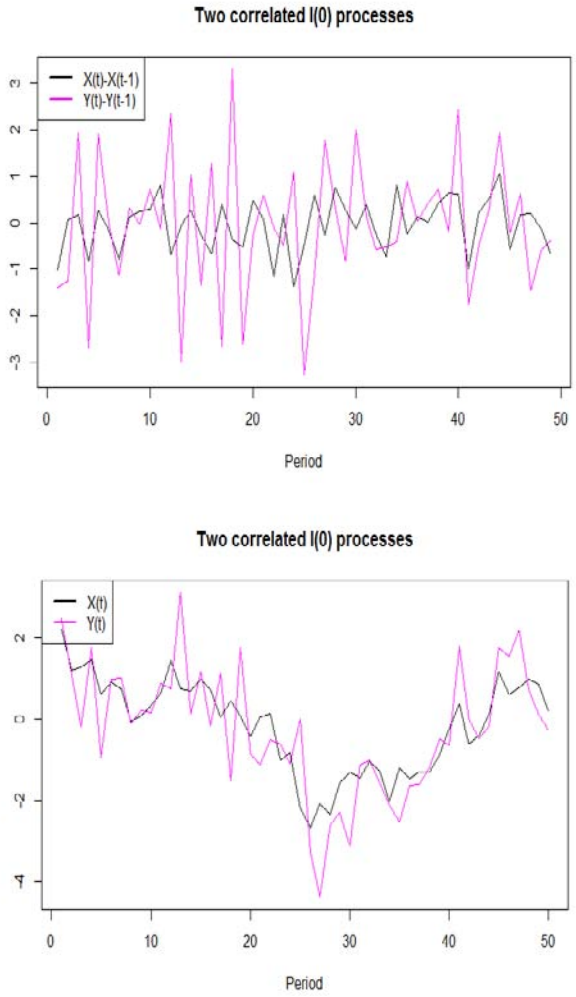


*Figure 2:* Two correlated stationary processes

The left panel in Figure 2 indicates $\Delta x_t$ is insignificantly correlated with $\Delta y_t$ even if the true series are significantly positively correlated. Table 1shows that the estimate of the coefficient $\beta$ becomes insignificantly if one over-differences the data and then run the regression

*Table 2:* Regression results of the raw and the differenced I(0) processes

| | Δy(t)=Δx(t)+e(t) | p-value | y(t)=x(t)+e(t) | p-value |
|---|---|---|---|---|
| Intercept | -0.04 | 0.86 | -0.09 | 0.51 |
| beta | 0.47 | 0.21 | 1.09 | 0.00 |

Example One and Two illustrate importance of correctly differencing the raw series in the final regression results. However, to determine if time series of interest should be differenced, one must rely on creditable statistical tests of non-stationarity. In practice, there are three types of unit root tests commonly used: the Augmented Dickey-Fuller (ADF) test, the Phillips and Perron (PP) test, and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test. However, there are two limitations forthese unit root tests. First, some tests are suffered with low power performance; second, tests results are sensitive to some of their arguments specification, such as lag selections or inclusion of a constant or time trend, which further deteriorates the tests' performance. In Example Three, we design a simple simulation and ignore possibility of a trend to explore how these tests perform in reality.

*Example Three – DGP:*

$$y_t = \frac{\gamma}{N}(y_{t-1} + \cdots y_{t-N}) + e_t,$$

$$e_t \sim i.i.d.N(0,1),$$

Where $\gamma$ measures consistency of the AR(*N*) process. Table 3 shows that all the three tests have fair size

performance ($\gamma = 1$) except the PP test when the number of lags *N*is large. However, none of the tests have good power performance ($\gamma < 1$). Overall, the ADF test seems to have the best performance among the three tests. We should note the DGP for this example is very simplified, and in reality it should be more complicated and consequently the results might be worse than the results in Table 3.

*Table 3:* Acceptance rate of the null hypothesis of non-stationarity

| | *T*=50 | | | | | *T*=100 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gamma | 1 | 0.95 | 0.9 | 0.8 | 0.7 | 1 | 0.95 | 0.9 | 0.8 | 0.7 |
| | ADF test | | | | | | | | | |
| *N*=1 | 93.7% | 82.8% | 71.2% | 48.4% | 29.9% | 95.8% | 70.1% | 37.1% | 6.2% | 2.0% |
| *N*=2 | 94.1% | 86.8% | 81.5% | 61.7% | 40.7% | 94.2% | 79.0% | 55.5% | 18.0% | 5.3% |
| *N*=3 | 93.4% | 87.6% | 81.6% | 66.2% | 49.3% | 93.3% | 84.7% | 64.5% | 29.7% | 13.2% |
| *N*=4 | 91.8% | 86.4% | 79.6% | 64.2% | 49.5% | 94.8% | 82.9% | 70.8% | 41.7% | 18.9% |
| | PP test | | | | | | | | | |
| *N*=1 | 94.0% | 93.5% | 85.0% | 63.4% | 31.0% | 95.5% | 85.2% | 64.1% | 11.0% | 0.3% |
| *N*=2 | 69.2% | 61.5% | 45.5% | 22.9% | 5.9% | 74.4% | 51.8% | 24.5% | 2.8% | 0.0% |
| *N*=3 | 44.9% | 30.8% | 22.2% | 7.1% | 2.1% | 42.9% | 24.0% | 8.2% | 0.3% | 0.0% |
| *N*=4 | 25.8% | 14.3% | 10.9% | 3.3% | 1.1% | 29.6% | 11.8% | 3.8% | 0.0% | 0.0% |
| | KPSS test | | | | | | | | | |
| *N*=1 | 87.2% | 79.7% | 69.8% | 49.6% | 37.6% | 92.4% | 78.6% | 66.7% | 40.8% | 27.5% |
| *N*=2 | 87.1% | 80.7% | 73.8% | 56.2% | 42.0% | 91.5% | 84.6% | 73.0% | 51.2% | 37.5% |
| *N*=3 | 83.9% | 77.5% | 71.4% | 59.2% | 48.3% | 90.6% | 84.1% | 78.0% | 56.5% | 42.0% |
| *N*=4 | 79.6% | 72.2% | 67.8% | 58.0% | 48.4% | 90.1% | 83.1% | 78.1% | 63.3% | 45.9% |

At 5% significance level, 10000 replications;
*T*=100 and 50, approximating one economic cycle data available to the banks for their CCAR exercises.

Example 3 shows that correctly determining non-stationarity of raw series is limited by statistical tests. Since co-integration analys as also require creditable non-stationarity tests, in this research we conduct a comprehensive simulation study and compare performance of three different approaches for the two situations in which Hamilton (1994) mentioned a routine difference is inappropriate. An and Schonert (2015) listed the three approaches as the major different methods commonly used for CCAR deposits modeling exercises[1]. The first approach is to ignore the non-stationarity and simply estimate the model in levels. This approach will not have the issue of over-differencing when the data is really stationary. However, when the true model is in differences or the variables are co-integrated, the model will be mis-specified and spurious correlations may be generated. The second approach is to routinely test unit roots and difference apparently non stationary variables before estimation. If the true correlations are in differences, then differencing should improve the small-sample performance of the estimates and eliminate the nonstandard asymptotic distributions associated with certain hypothesis tests. The limitation to this approach is that the true correlations may not be in differences. Some of the series may in fact are near-stationary, or perhaps some linear combinations of the series are stationary as in co-integration. In such circumstances models in differences will bemis-specified. The third approach is to investigate the nature of the non-stationarity, test each series individually for unit roots and test for possible co-integration among the series. Once the nature of the non-stationarity is understood, a stationary representation (Error Correction Model) as in Engle and Granger (1987) for the system can be estimated. The disadvantage of the third approach is that due to limitation of the tests the restrictions imposed may be invalid, and the investigator may have accepted a null hypothesis even though it is false, or rejected a null hypothesis that is actually true (e.g. in Table 3). Moreover, alternative tests of unit roots or co-integration might produce conflicting results, and the investigators may be unsure as to which should be followed.

To answer the question if the time series should be differenced or not, we apply the three approaches to four different simulation designs: (i) non-correlated I(1) processes; (ii) correlated near-stationary I(0) processes; (iii) correlated but un-co integrated I(1) processes; and (iv) co integrated I(1) processes. The four different simulation designs cover the two situations mentioned

[1] An and Schonert (2015) also mentioned in rare cases second-difference models might be considered.

simulation designs cover the two situations mentioned by Hamilton (1994). In Simulation Two, one is required to estimate the models in levels to avoid over-differencing. In contrast, if we estimate the models in levels for Simulation One and Simulation Three, spurious relationships and incorrect coefficients estimates will be generated, and therefore under these two cases differencing is required before estimation. In Simulation Four, we have to rely on co-integration analyses and otherwise the models will be incorrectly estimated.

## II. Literature Reviews

The first to introduce and analyze the concept of spurious relationships was Udne Yue in 1926. Before the 1980s many economists used linear regressions on (de-trended) non stationary time series data. Granger and New bold (1974) showed that for integrated I(1) processes standard de-trending techniques may not eliminate the problem of spurious regressions, and that the superior alternative is to check for co-integration. Engle and Granger (1987) formalized the co-integration approach and coined the term. Engle and Granger argued that forecasts of levels of co-integrated variables will hang together in a way likely to be viewed as sensible by an economist, whereas forecasts produced in some other way, such as by univariate Box-Jenkins models, might not do so well. Since then, a variety of studies have been conducted to check forecasting performance of the error correction model (ECM), which belongs to a category of time series models most commonly used for the data where underlying variables have a long-run stochastic trend. A non-exhaustive list includes: Engle and Granger (1987), Engle and Yoo (1987), Phillips and Loretan (1991), Reinsel and Ahn (1992), Chambers (1993), Stock (1995), Lin and T say (1996), Harvey (1997),Chris t offer sen and Diebold (1998), Duy and Thoma (1998), Dolado, Gonzalo and Marmol (2000), Eitrheim, Husebo and Nymoen (2000), and Allen and Fildes (2005)[2]. However, there are conflicting evidences among these studies.

On the positive side, Engle and Granger (1987) showed that vector auto-regressions estimated with co-integrated data will be mis-specified if the data are differenced, and will omit important constraints if the data are used in levels. These constraints will be satisfied asymptotically but efficiency gains and improved multi-step forecasts may be achieved by imposing the co-integration constraints. Engle and Yoo (1987) proposed a multi-step forecast approach and argued that it would satisfy the co-integrating relationship exactly and that the particular linear combination of forecasts would have a finite limiting forecast error variance and outperform conventional estimation techniques. Chambers (1993) investigated four estimation strategies, namely a VAR in levels, a VAR in first differences, and the Engle-Granger 2-step and NLS estimators of the ECM models, and illustrated that the most accurate of these methods is NLS, followed by EG, and the VAR in first differences. Stock (1995) argued that if the variables are co-integrated, their values are linked over the long run and the two-stage estimation of Engle and Granger (1987) could produce substantial improvements in forecasts over long horizons. Duy and Thoma (1998) found imposing co-integrating restrictions often improves forecasting power, and that the improvements are most likely to occur in models which exhibit strong evidence of co-integration among variables. Dolado, Gonzalo and Marmol (2000) argued that imposing co-integration conditions models could be significantly improved by including long-run equilibrium conditions as suggested by economic theory, and the ECM representation will generate better forecasts than the corresponding representation in first-differences, particularly over medium and long-run horizons.

However, some studies exhibit ambiguous evidences in comparison between the ECM models and the First-difference (FD) models. Reinsel and Ahn (1992) showed that forecast gains from co-integrated systems depends on proper specification of the number of unit roots and under specifying the number of unit roots results in poor performance for ten to twenty-five steps ahead forecasts whereas over-specification results in inferior short-term forecasts. Lin and T say (1996)used simulation, real data sets, and multi-step-ahead post-sample forecasts to study the question. Based on square root of the trace of forecasting error-covariance matrix, Lin and T say found that for simulated data imposing the 'correct' unit-root constraints implied by co-integration does improve the accuracy of forecasts. For real data sets, the answer is mixed. Imposing unit-root constraints suggested by co-integration tests produces better forecasts for some cases, but fares poorly for others. Harvey (1997)emphasized tests of co-integration based on economic theory instead of pure statistical analysis, and argued that when there are two or more co-integrating relationships they can only be identified by drawing on economic knowledge. Chris to ffersen and Diebold (1998) argued that although the current value of the error-correction term clearly provides information about the likely near-horizon evolution of the system, it seems unlikely that it provides information about the long-horizon evolution of the system, because the long-horizon forecast of the error correction term is always zero. Eitrheim, Husebo and Nymoen (2000) compared ECM and d VAR forecasts in a model that is currently being used in the Norwegian economy. They found d VAR forecasts appear to

[2] In estimating non-stationary data, there are some other approaches, such as dynamic OLS and canonic co-integrating regression (see Eviews User Handbook, 2012). Since our focus is on ECM models and co-integration analysis, we skip discussions of them in this paper.

provide some immunity against parameter non-constancies that could seriously bias the ECM forecasts. On the other hand however, the mis-specification resulting from omitting levels information seems to generate substantial biases in the d VAR forecasts.

In this paper, we revisit the problem if incorporating the long-run restrictions in error correction models yields superior forecasts in comparison with first-difference models or models in levels. We conduct several simulation designs and compare the models' empirical performance in the Comprehensive Capital Analysis and Review (CCAR) framework. In CCAR deposits modeling, banks need to forecast deposits balances based on three given scenarios, Baseline, Adverse, and Severely Adverse, provided by the Federal Reserve Bank. Our simulation designs differ from the existing literature that the independent variables are given instead of forecasted simultaneously with the dependent variable, and thus our results serve for particular interests for the CCAR exercises. Our results show that incorporating the long-run restriction in ECMs generates the most robust estimations and forecasting results.

*a) The models*

We consider our simulation designs within an autoregressive distributed lag framework – ARDL(*p,q*):

$$y_t = \mu + \sum_{i=1}^{p} \gamma_i y_{t-i} + \sum_{j=0}^{q} \tau_j x_{t-j} + \varepsilon_t, \quad (1)$$

Where $\varepsilon_t$ is the error term and stationary, and only in one exceptional case, namely a spurious regression, when both $x_t$ and $y_t$ are non-stationary and all the model coefficients $\gamma_i$ and $\tau_i$ equal to zero, $\varepsilon_t$ is non-stationary. As proved in Phillips (1986), when both $x_t$ and $y_t$ are non-stationary and independent, the standard OLS estimator does not converge in probability to zero but instead converges in distribution to non-normal random variable, which is not necessarily centered at zero. The usual $R^2$ from the regression converges to unity as $T \to \infty$ so that the model will appear to fit well even though it is mis-specified.

To circumvent the potential problems of spurious regressions or over-differencing, the Engle and Granger representation theorem (Engle and Granger, 1987) enables simultaneous modeling of first differences and levels of the variables using an error correction model (ECM) mechanism, which provides a framework for estimation, forecasting and testing of co-integrated systems. Under this framework, the ARDL (*p,q*) process could be rewritten as:

$$\Delta y_t = \mu' + \sum_{i=1}^{p-1} f_{1i} \Delta y_{t-i} + \sum_{j=0}^{q-1} f_{2j} \Delta x_{t-j} + \delta(y_{t-1} - \alpha - \beta x_{t-1}) + \varepsilon_t, \quad (2)$$

Where

$$\Delta y_t = y_t - y_{t-1}, \Delta x_t = x_t - x_{t-1}, \delta = (\gamma_1 + \cdots + \gamma_p) - 1,$$

$$f_{1i} = \gamma_{i+1} + \cdots + \gamma_p, \text{and} f_{2t} = \tau_{i+1} + \cdots + \tau_q.$$

Equation (2) is known as the error-correction representation of the co-integrated system. Although Equation (1) and (2) could be derived from each other theoretically, they have different empirical performance as we are working on two different regressions. While it is argued that several other approaches, such as the Johansen (1996) and the ARDL techniques by Pesaran, Shin and Smith (2001), have better empirical performance, we choose the Engle and Granger two-step estimation approach as it its simplicity in practice.

- The first step is to pretest individual time series in order to confirm that they are non-stationary in the first place. If all the series are stationary (I(0)), standard regression analysis will be valid. If they are first-order integrated (I(1)), we then conduct a co-integration test, such as the Phillips-Ouliaries test (1990). If co-integration is rejected, then one differences the integrated variables and runs the regression.
- In the second step, if some variables are integrated and co-integration exists, we rewrite the estimation equation as in the Engle-Granger representation theorem. Firstly, we estimate the model $y_t = \alpha + \beta x_t + e_t$ using ordinary least squares. Then the predicted residuals $\hat{e}_t$ from the regression are saved and used in the regression of differenced variables plus a lagged error term (replacing $y_{t-1} - \alpha - \beta x_{t-1}$ by $\hat{e}_{t-1}$ in Equation (2))[3].

When $\delta = 0$, the Engle and Granger two-step estimation approach is equivalent to simply difference the series. Namely, estimations based on differenced data could be viewed as the ECM model with restrictions.

*b) Simulation studies*

To answer the question if the time series should be differenced and co-integration analysis should be conducted, we apply the three approaches in An and Schonert (2015)to four different simulation designs: (i) non-correlated I(1) processes; (ii) correlated near-stationary I(0) processes; (iii) correlated but un-cointegrated I(1) processes; and (iv) cointegrated I(1) processes. The three approaches are as follows: (i) estimating in levels (Level); (ii) testing unit roots firstly and estimating non stationary series in differences (FD); and (iii) the Engle and Granger two-step method (EG-ECM). To compare the three approaches, we focus on two key measures, the parameters estimates and out-of-sample forecasting. In out-of-sample forecasting, we only forecast the dependent variable and assume the

[3] Although iterative two-step or joint estimation is more theoretically sound, we apply this separate two-step approach for computational simplicity.

independent variables as given to reflect the models usage in CCAR deposits balance modeling practice.

*c) Non-correlated I (1) processes*

In Simulation One, the dependent and independent variables are non stationary and uncorrelated.

*Simulation One- DGP:*

$$y_t = y_{t-1} + \varepsilon_t \ \ and \ \ x_t = x_{t-1} + e_t,$$

$$\varepsilon_t \sim i.i.d\ (0,1) \ \ and \ \ e_t \sim i.i.d\ (0, \sigma_2),$$

Where $x_t = (x_{1t}, \cdots, x_{Nt})$, $\varepsilon_t$ *and* $e_t$ follow normal or T distribution with the degree of freedom being 4[4], and $\sigma_2 = \sqrt{N}/6$.

In Simulation One, we consider four situations: (i) $N$=2 and $\varepsilon_t$and $e_t$ follow normal distribution;(ii) $N$=4 and $\varepsilon_t$and $e_t$ follow standard normal distribution; (iii) $N$=2 and $\varepsilon_t$and $e_t$ follow T distribution; and (iv) $N$=4 and $\varepsilon_t$and $e_t$ follow T distribution. In Table 4, the most interesting results are in Panel B and C. From Panel B and C, we could see although mean estimates of the coefficients are close to the true values for the first approach – estimating in levels, the standard deviations of the estimates are quite large and around three quarters of the replications one will reject the null hypothesis that the coefficients being equal to zero. It is not surprising that the second approach – estimating in first-differences performs better than the third approach – the Engle and Granger two-step approach, as the second approach correctly specifies the model, but the difference is small.

*Table 4:* Estimation results for Non-correlated I(1) processes, $T$=100, 1000 replications

| Panel A: Mean estimation of model coefficients | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 0.02 | 0.00 | 0.00 | -0.03 | 0.00 | 0.01 | 0.05 | 0.00 | 0.01 | -0.05 | 0.00 | -0.02 |
| beta_1 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| beta_2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| beta_3 | | | | 0.00 | 0.00 | 0.00 | | | | 0.01 | 0.00 | 0.00 |
| beta_4 | | | | 0.00 | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 |
| delta | | | -0.21 | | | -0.28 | | | -0.19 | | | -0.30 |
| Panel B: Standard deviation of coefficients estimates | | | | | | | | | | | | |
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 0.97 | 0.01 | 0.19 | 1.11 | 0.02 | 0.27 | 1.37 | 0.02 | 0.24 | 1.50 | 0.02 | 0.37 |
| beta_1 | 0.13 | 0.01 | 0.02 | 0.16 | 0.02 | 0.04 | 0.14 | 0.01 | 0.02 | 0.15 | 0.02 | 0.03 |
| beta_2 | 0.12 | 0.01 | 0.02 | 0.15 | 0.02 | 0.03 | 0.14 | 0.01 | 0.02 | 0.15 | 0.02 | 0.03 |
| beta_3 | | | | 0.15 | 0.02 | 0.04 | | | | 0.15 | 0.02 | 0.03 |
| beta_4 | | | | 0.15 | 0.02 | 0.03 | | | | 0.15 | 0.02 | 0.03 |
| delta | | | 0.09 | | | 0.08 | | | 0.09 | | | 0.10 |
| Panel C: Frequency of coefficients estimates different from zero at 5% significance level | | | | | | | | | | | | |
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 75.1% | 5.3% | 10.8% | 67.1% | 5.7% | 11.8% | 74.4% | 5.6% | 10.7% | 64.9% | 4.4% | 9.9% |
| beta_1 | 72.2% | 4.8% | 9.4% | 65.9% | 4.2% | 9.7% | 72.5% | 5.5% | 9.3% | 64.8% | 6.3% | 10.0% |
| beta_2 | 69.7% | 5.1% | 8.8% | 63.3% | 5.4% | 9.2% | 73.7% | 4.5% | 8.8% | 63.8% | 4.4% | 8.7% |
| beta_3 | | | | 63.2% | 5.0% | 9.8% | | | | 62.3% | 4.8% | 9.5% |
| beta_4 | | | | 64.7% | 4.2% | 9.2% | | | | 64.0% | 4.7% | 9.3% |
| delta | | | 1.9% | | | 2.6% | | | 2.3% | | | 2.1% |

[4] All the following simulation results still hold for other values of the degree of freedom or other types of heavy-tailed innovations, such as the normal reciprocal inverse Gaussian distribution in Guo (2017a).

Figure 3 presents percentage of 24-pearied (around two years) out-of-sample mean forecasting error. It further confirms the finding that although the FD approach outperforms the EG-ECM approach, the difference is very small. Table 5 presents the frequency of a co-integration relationship detected in each of the situations. The table shows only for a very small portion of replications the EG-ECM approach was wrongly applied.

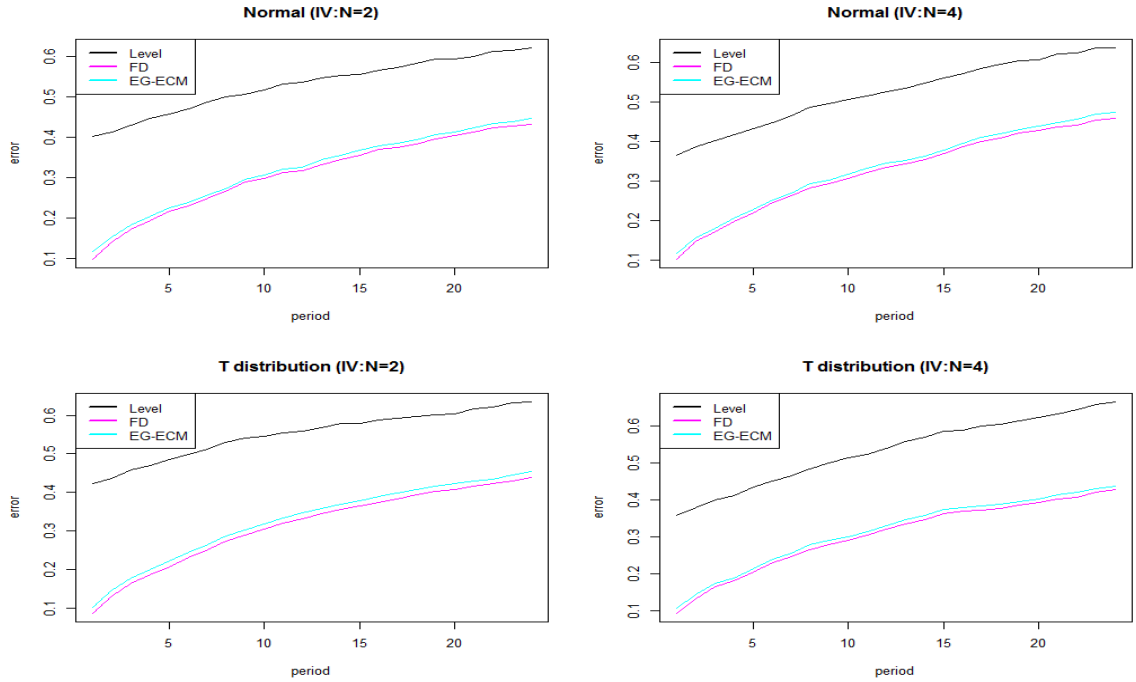


*Figure 3:* Percentage of 24-period mean forecasting error, 1000 replications

*Table 5:* Frequency of a co-integration relationship found, 1000 replications

| | Normal, $N$=2 | Normal, $N$=4 | T, $N$=2 | T, $N$=4 |
|---|---|---|---|---|
| Co-integration accept rate | 1.9% | 2.6% | 2.3% | 2.1% |

*d) Correlated near-stationaryI(0) processes*

In Simulation Two, the dependent and independent variables are stationary and correlated.

*Simulation Two - DGP:*

$$y_t = x_t\beta + \varepsilon_t \ \ and \ \ x_t = x_{t-1}\rho + e_t,$$

$$\varepsilon_t \sim i.i.d\left(0, \frac{1}{\sqrt{1-\rho^2}}\right) \ \ and \ \ e_t \sim i.i.d\,(0, \sigma_2),$$

Where $x_t = (x_{1t}, \cdots, x_{Nt})$, $\varepsilon_t$ $and$ $e_t$ follow normal or T distribution with degree of freedom being 4, $\sigma_2 = \sqrt{N}/6$, $\beta = (0.8, 0.9, \cdots, 1 - \frac{1}{5N})$ and $\rho = 0.9$.

In Simulation Two, we consider four situations: (i) $N$=2 and $\varepsilon_t$and $e_t$ follow normal distribution;(ii) $N$=4 and $\varepsilon_t$and $e_t$ follow standard normal distribution;(iii) $N$=2 and $\varepsilon_t$and $e_t$ follow T distribution; and (iv) $N$=4 and $\varepsilon_t$and $e_t$ follow T distribution. From Panel B and C in Table 6, we could see although mean estimates of the coefficients are close to the true values for the second approach – estimating in differences, the standard deviations of the estimates are almost twice compared to the other two approaches. It is not surprising that the first approach – estimating in levels performs better than the third approach – the Engle and Granger two-step approach, as it correctly specifies the model, but the difference is still not very big.

*Table 6:* Estimation Results For Correlated I(0) Processes, $T$=100, 1000 Replications

| Panel A: Mean estimation of model coefficients | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 0.00 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 0.00 |
| beta_1 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.81 | 0.80 |
| beta_2 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| beta_3 | | | | 0.93 | 0.93 | 0.93 | | | | 0.93 | 0.93 | 0.93 |
| beta_4 | | | | 0.95 | 0.95 | 0.95 | | | | 0.95 | 0.95 | 0.95 |
| delta | | | -1.03 | | | -1.06 | | | -1.01 | | | -1.06 |
| Panel B: Standard deviation of coefficients estimates | | | | | | | | | | | | |
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 0.01 | 0 | 0.01 | 0.02 | 0 | 0.02 | 0.02 | 0 | 0.02 | 0.04 | 0 | 0.04 |
| beta_1 | 0.03 | 0.08 | 0.03 | 0.04 | 0.11 | 0.05 | 0.03 | 0.08 | 0.03 | 0.05 | 0.12 | 0.05 |
| beta_2 | 0.03 | 0.08 | 0.03 | 0.04 | 0.11 | 0.05 | 0.03 | 0.08 | 0.03 | 0.05 | 0.13 | 0.05 |
| beta_3 | | | | 0.04 | 0.11 | 0.05 | | | | 0.05 | 0.11 | 0.05 |
| beta_4 | | | | 0.04 | 0.11 | 0.05 | | | | 0.05 | 0.12 | 0.06 |
| delta | | | 0.11 | | | 0.10 | | | 0.10 | | | 0.11 |
| Panel C: Frequency of coefficients estimates different from zero at 5% significance level | | | | | | | | | | | | |
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 4.7% | 0.0% | 4.4% | 4.2% | 0.0% | 3.8% | 5.1% | 0.0% | 4.9% | 5.1% | 0.0% | 4.5% |
| beta_1 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| beta_2 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| beta_3 | | | | 100% | 100% | 100% | | | | 100% | 100% | 100% |
| beta_4 | | | | 100% | 100% | 100% | | | | 100% | 100% | 100% |
| delta | | | 8.7% | | | 9.1% | | | 10.1% | | | 7.4% |

Figure 4 further confirms the finding that although the first approach outperforms the EG-ECM approach, the difference is small. Table 7 presents the frequency of a co-integration relationship found in each of the situations. The table shows only for a very small portion of replications the EG-ECM approach was wrongly applied.

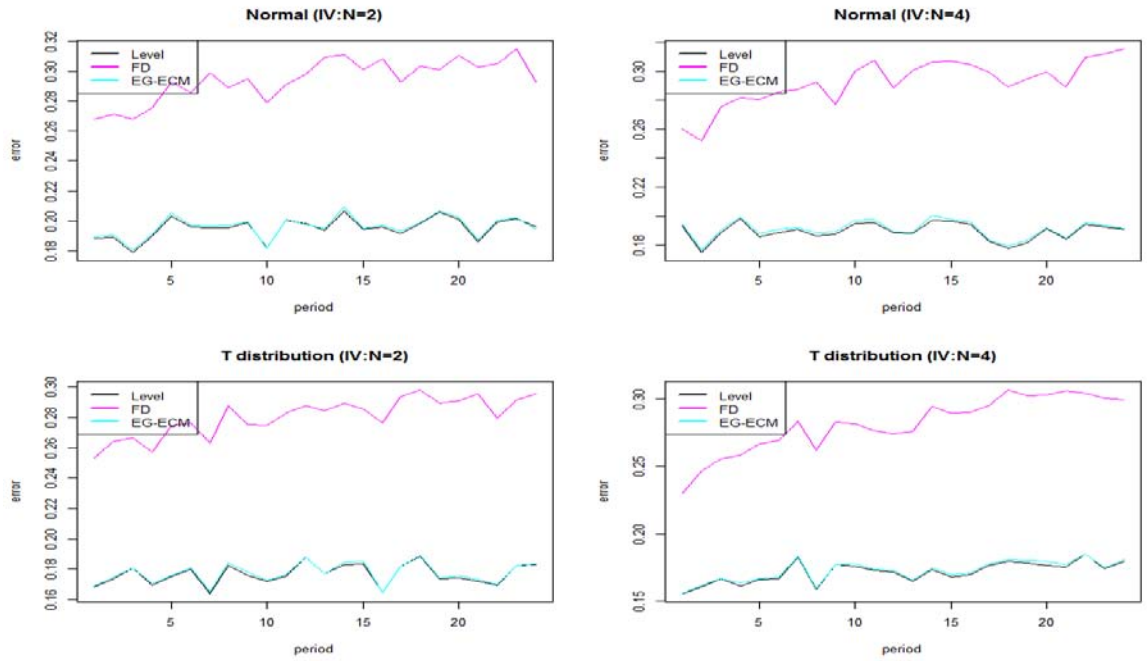


*Figure 4:* Percentage of 24-Period Mean Forecasting Error, 1000 Replicatio

*Table 7:* Frequency of a co-integration relationship found, 1000 replications

| | Normal, $N=2$ | Normal, $N=4$ | T, $N=2$ | T, $N=4$ |
|---|---|---|---|---|
| Co-integration accept rate | 8.7% | 9.1% | 10.1% | 7.4% |

As a well-known issue, most of standard unit root tests suffer with low power performance. To check how these three approaches perform, we change the value of the parameter $\rho$ in [0,1) and plot percentage of mean 24-period-end forecasting error in Figure 5. It is quite interesting that even if $\rho$ is close to one, the FD approach still performs the worst, and there is no significant difference between the first approach and the third approach. However, in Table 8, we do see the number of replications, in which the EG-ECM approach was wrongly applied, increases as $\rho$ is closer to one.

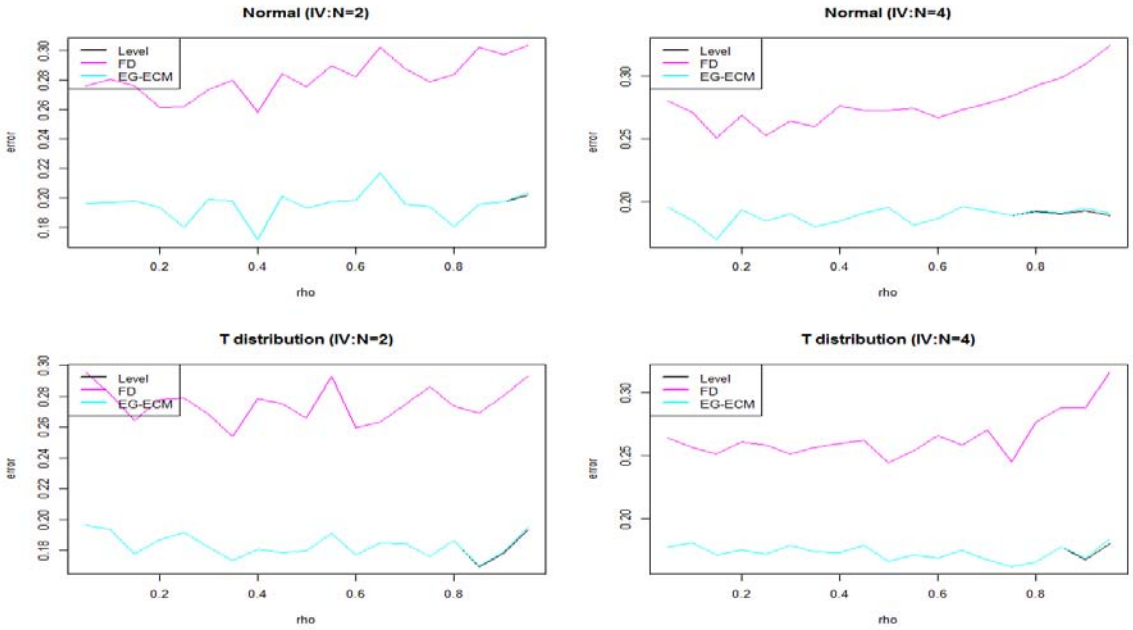


*Figure 4:* Percentage of 24-Period Mean Forecasting Error, 1000 Replicatio

*Table 8:* Frequency of a co-integration relationship found, 1000 replications

| rho | Normal, $N=2$ | Normal, $N=4$ | T, $N=2$ | T, $N=4$ |
|---|---|---|---|---|
| 0 | 0.0% | 0.2% | 0.0% | 0.0% |
| 0.5 | 0.0% | 0.2% | 0.0% | 0.2% |
| 0.9 | 8.0% | 9.2% | 9.2% | 7.8% |
| 0.95 | 41.6% | 41.4% | 39.4% | 40.0% |
| 0.99 | 77.6% | 81.6% | 81.8% | 79.8% |

However, in the extreme case when $\rho = 1$, the FD approach performs much worse than the other two approaches as shown in Figure 6. Overall, in Simulation Two, the EG-ECM approach has the most robust performance compared with the other two approaches.

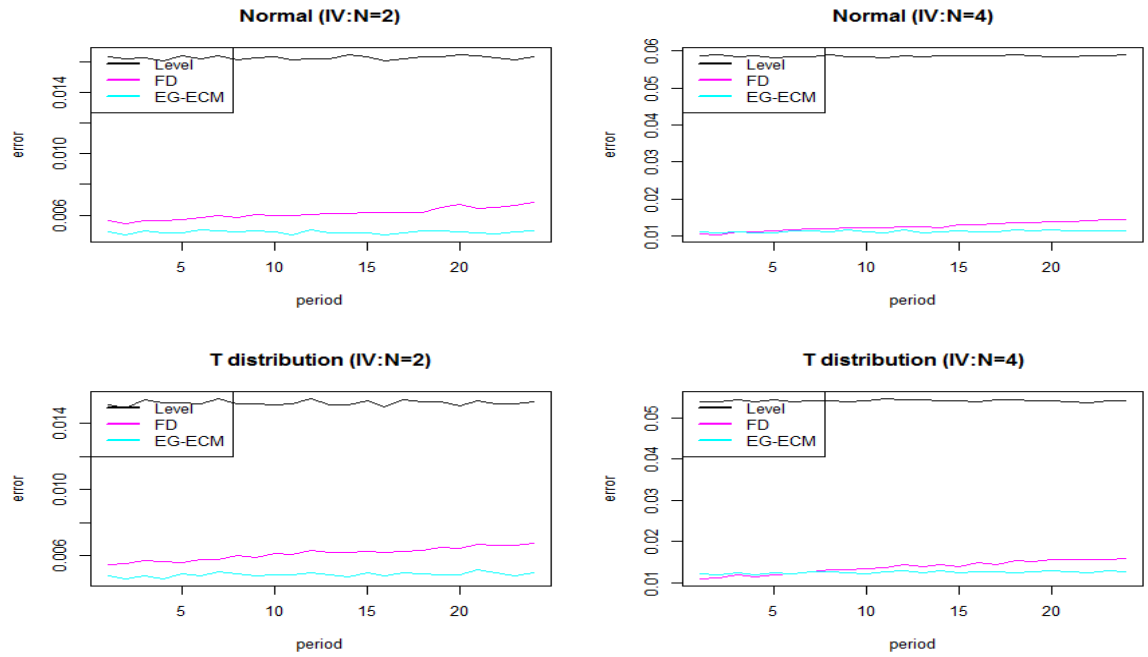


*Figure 6:* Percentage of 24-Period Mean Forecasting Error When $\boldsymbol{\rho}$=1, 1000 Replications

*e) Correlated but un-cointegratedI (1) processes*

In Simulation Three, the dependent and independent variables are non stationary, correlated, but un-cointegrated.

*Simulation Three - DGP:*

$$\Delta y_t = \Delta x_t \beta + \varepsilon_t \ \ and \ \ x_t = x_{t-1} + e_t,$$

$$\varepsilon_t \sim i.i.d\ (0,1) \ \ and \ \ e_t \sim i.i.d\ (0, \sigma_2),$$

Where $x_t = (x_{1t}, \cdots, x_{Nt})$, $\varepsilon_t$ *and* $e_t$ follow normal or T distribution with degree of freedom being 4, and $\sigma_2 = \sqrt{N}/6$.

In Simulation Three, we consider four situations: (i) $N$=2 and $\varepsilon_t$and $e_t$ follow normal distribution; (ii) $N$=4 and $\varepsilon_t$and $e_t$ follow standard normal distribution; (iii) $N$=2 and $\varepsilon_t$and $e_t$ follow T distribution; and (iv) $N$=4 and $\varepsilon_t$and $e_t$ follow T distribution. From Panel B and C in Table 9, we could see although mean estimates of the coefficients are close to the true values for the first approach – estimating in levels, the standard deviations of the estimates are much larger than the other two approaches. It is not surprising that the second approach – estimating in first differences performs better than the third approach – the Engle and Granger two-step approach, as it correctly specifies the model, but again the difference is quite small.

*Table 9:* Estimations for correlated but un-cointegrated I(1) processes, $T$=100, 1000 replications

| Panel A: Mean estimation of model coefficients | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | -0.02 | 0.00 | 0.00 | -0.02 | 0.00 | 0.00 | -0.04 | 0.00 | 0.01 | -0.10 | 0.00 | -0.03 |
| beta_1 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| beta_2 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.89 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| beta_3 | | | | 0.93 | 0.93 | 0.93 | | | | 0.93 | 0.93 | 0.93 |
| beta_4 | | | | 0.95 | 0.95 | 0.95 | | | | 0.95 | 0.95 | 0.95 |
| delta | | | -0.22 | | | -0.29 | | | -0.27 | | | -0.29 |

| Panel B: Standard deviation of coefficients estimates | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 1.00 | 0.01 | 0.32 | 1.16 | 0.02 | 0.30 | 1.32 | 0.02 | 0.34 | 1.60 | 0.02 | 0.54 |
| beta_1 | 0.13 | 0.02 | 0.05 | 0.16 | 0.03 | 0.06 | 0.13 | 0.02 | 0.05 | 0.15 | 0.03 | 0.06 |
| beta_2 | 0.13 | 0.02 | 0.05 | 0.15 | 0.03 | 0.06 | 0.14 | 0.03 | 0.05 | 0.15 | 0.04 | 0.05 |
| beta_3 | | | | 0.16 | 0.04 | 0.06 | | | | 0.16 | 0.04 | 0.07 |
| beta_4 | | | | 0.15 | 0.03 | 0.05 | | | | 0.16 | 0.03 | 0.06 |
| delta | | | 0.08 | | | 0.10 | | | 0.08 | | | 0.11 |
| Panel C: Frequency of coefficients estimates different from zero at 5% significance level | | | | | | | | | | | | |
| | Normal | | | | | | Student's T | | | | | |
| | $N$=2 | | | $N$=4 | | | $N$=2 | | | $N$=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 77.4% | 4.7% | 10.6% | 70.3% | 4.5% | 10.6% | 76.4% | 5.6% | 12.3% | 69.1% | 4.0% | 10.2% |
| beta_1 | 100% | 100% | 100% | 99.9% | 100% | 100% | 100% | 100% | 100% | 99.8% | 100% | 100% |
| beta_2 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| beta_3 | | | | 100% | 100% | 100% | | | | 99.7% | 100% | 99.9% |
| beta_4 | | | | 100% | 100% | 100% | | | | 100% | 100% | 100% |
| delta | | | 2.3% | | | 2.0% | | | 2.7% | | | 2.4% |

Figure 7 further confirms this finding that although the FD approach outperforms the EG-ECM approach, the difference is small. Table 10 presents the frequency of a co-integration relationship found in each of the situations. The table shows only for a very portion of replications the EG- wrongly applied.

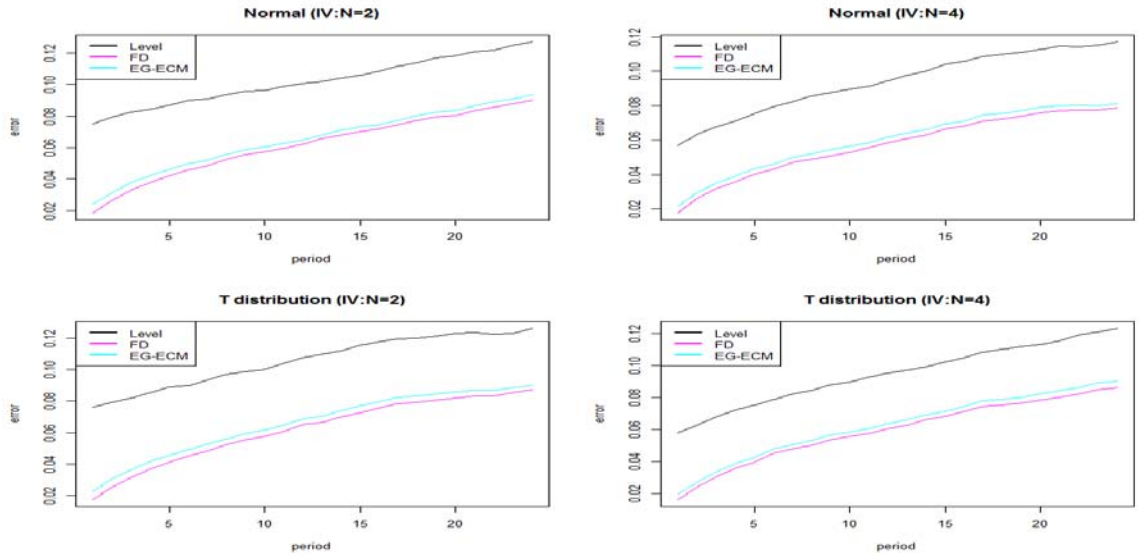


*Figure 7:* Percentage of 24-period mean forecasting error, 1000 replications

*Table 10:* Frequency of a co-integration relationship found, 1000 replications

| | Normal, $N$=2 | Normal, $N$=4 | T, $N$=2 | T, $N$=4 |
|---|---|---|---|---|
| Co-integration accept rate | 2.3% | 2.0% | 2.7% | 2.4% |

*f) Cointegratedl (1) processes*

In Simulation Four, the dependent and independent variables are non stationary and cointegrated.

*Simulation Four – DGP:*

$$y_t = (1+\delta)y_{t-1} + x_t\beta - \alpha x_{t-1} + \varepsilon_t \text{ and } x_t = x_{t-1} + e_t;$$

$$\varepsilon_t \sim i.i.d\ (0,1) \text{ and } e_t \sim i.i.d\ (0,\sigma_2),$$

*Table 9:* Estimations for correlated but un-cointegrated I(1) processes, $T=100$, 1000 replications

| Panel A: Mean estimation of model coefficients | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | | | | | | Student's T | | | | | |
| | $N=2$ | | | $N=4$ | | | $N=2$ | | | $N=4$ | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | -0.02 | 0.00 | 0.00 | -0.02 | 0.00 | 0.00 | -0.04 | 0.00 | 0.01 | -0.10 | 0.00 | -0.03 |
| beta_1 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| beta_2 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.89 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| beta_3 | | | | 0.93 | 0.93 | 0.93 | | | | 0.93 | 0.93 | 0.93 |
| beta_4 | | | | 0.95 | 0.95 | 0.95 | | | | 0.95 | 0.95 | 0.95 |
| delta | | | -0.22 | | | -0.29 | | | -0.27 | | | -0.29 |
| Panel B: Standard deviation of coefficients estimates | | | | | | | | | | | | |
| | Normal | | | | | | Student's T | | | | | |
| | $N=2$ | | | $N=4$ | | | $N=2$ | | | $N=4$ | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 1.00 | 0.01 | 0.32 | 1.16 | 0.02 | 0.30 | 1.32 | 0.02 | 0.34 | 1.60 | 0.02 | 0.54 |
| beta_1 | 0.13 | 0.02 | 0.05 | 0.16 | 0.03 | 0.06 | 0.13 | 0.02 | 0.05 | 0.15 | 0.03 | 0.06 |
| beta_2 | 0.13 | 0.02 | 0.05 | 0.15 | 0.03 | 0.06 | 0.14 | 0.03 | 0.05 | 0.15 | 0.04 | 0.05 |
| beta_3 | | | | 0.16 | 0.04 | 0.06 | | | | 0.16 | 0.04 | 0.07 |
| beta_4 | | | | 0.15 | 0.03 | 0.05 | | | | 0.16 | 0.03 | 0.06 |
| delta | | | 0.08 | | | 0.10 | | | 0.08 | | | 0.11 |
| Panel C: Frequency of coefficients estimates different from zero at 5% significance level | | | | | | | | | | | | |
| | Normal | | | | | | Student's T | | | | | |
| | $N=2$ | | | $N=4$ | | | $N=2$ | | | $N=4$ | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 77.4% | 4.7% | 10.6% | 70.3% | 4.5% | 10.6% | 76.4% | 5.6% | 12.3% | 69.1% | 4.0% | 10.2% |
| beta_1 | 100% | 100% | 100% | 99.9% | 100% | 100% | 100% | 100% | 100% | 99.8% | 100% | 100% |
| beta_2 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| beta_3 | | | | 100% | 100% | 100% | | | | 99.7% | 100% | 99.9% |
| beta_4 | | | | 100% | 100% | 100% | | | | 100% | 100% | 100% |
| delta | | | 2.3% | | | 2.0% | | | 2.7% | | | 2.4% |

Figure 7 further confirms this finding that although the FD approach outperforms the EG-ECM approach, the difference is small. Table 10 presents the frequency of a co-integration relationship found in each of the situations. The table shows only for a very small portion of replications the EG-ECM approach was wrongly applied.

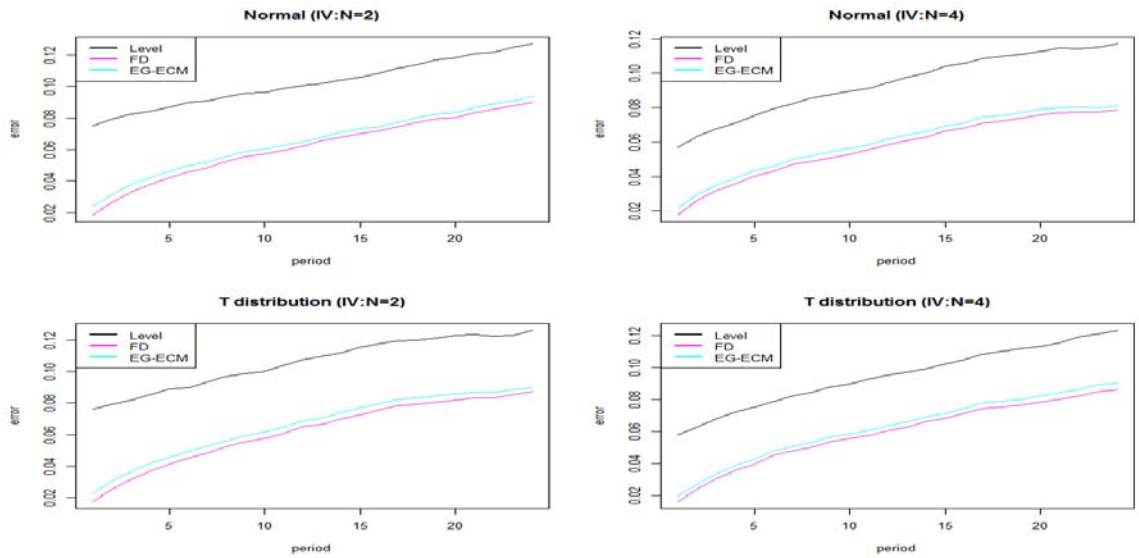


*Figure 7:* Percentage of 24-period mean forecasting error, 1000 replications

| Panel C: Frequency of coefficients estimates different from zero at 5% significance level | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | | | | | | Student's T | | | | | |
| | *N*=2 | | | *N*=4 | | | *N*=2 | | | *N*=4 | | |
| | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM | Level | FD | EG-ECM |
| Intercept | 6.7% | 0.0% | 0.8% | 6.8% | 0.0% | 0.7% | 6.8% | 0.0% | 1.0% | 8.0% | 0.0% | 0.8% |
| rho | 98.9% | 70.4% | | 97.5% | 68.0% | | 99.0% | 70.4% | | 96.8% | 67.5% | |
| beta_1 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| beta_2 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| beta_3 | | | | 100% | 100% | 100% | | | | 100% | 100% | 100% |
| beta_4 | | | | 100% | 100% | 100% | | | | 100% | 100% | 100% |
| beta_1_l | 98.6% | 66.2% | 16.8% | 94.6% | 57.3% | 17.0% | 98.7% | 64.3% | 16.4% | 94.7% | 55.8% | 13.8% |
| beta_2_l | 98.7% | 64.9% | 17.3% | 95.8% | 61.3% | 17.4% | 98.8% | 65.2% | 16.5% | 95.3% | 59.6% | 15.2% |
| beta_3_l | | | | 95.4% | 61.3% | 16.8% | | | | 95.4% | 59.2% | 15.1% |
| beta_4_l | | | | 95.1% | 60.3% | 17.0% | | | | 95.5% | 57.7% | 14.9% |
| delta | | | 86.5% | | | 89.4% | | | 88.3% | | | 90.8% |

The key finding is in Figure 8. The figure clearly shows that when the DGP includes both the short-run and long-run shocks, the EG-ECM approach outperforms the other two approaches significantly. Table 12 presents the frequency of a co-integration relationship found in each of the situations. The table shows the co-integration relationship is slightly under-detected[5].

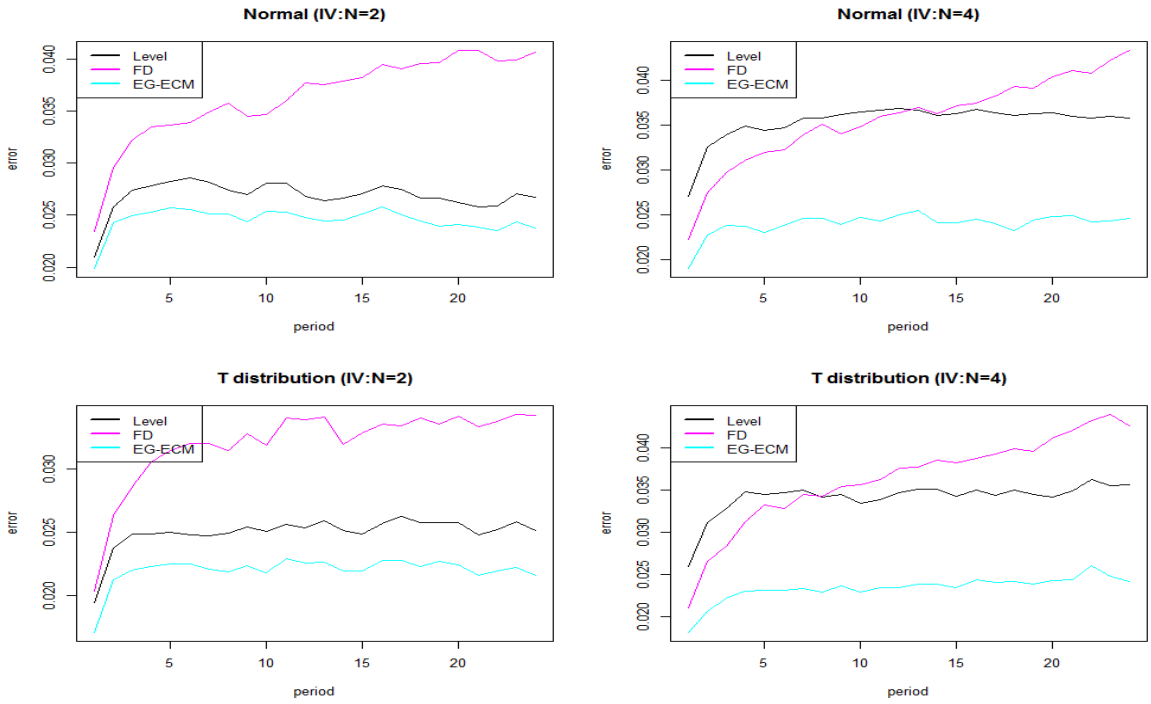


*Figure 8:* Percentage of 24-period mean forecasting error, 1000 replications

*Table 12:* Frequency of a co-integration relationship found, 1000 replications

| | Normal, *N*=2 | Normal, *N*=4 | T, *N*=2 | T, *N*=4 |
|---|---|---|---|---|
| Co-integration accept rate | 86.5% | 89.4% | 88.3% | 90.8% |

[5] We used the ADF test to test non-stationarity, and the Phillips-Ouliaries test to test co-integration.

In Simulation Four, our interest is limited to $\delta \in (-2,0]$, since for other values the processes will be integrated with higher orders, which is out of our scope. Figure 9 compares the mean 24-period-end forecasting error with different values of $\delta$ for the three approaches, and it shows that the EG-ECM approach has the best overall performance. When $\delta = -1$, this design reduces to the special case in Simulation Two, and when $\delta = 0$, this design corresponds to Simulation Three. Therefore, the figure confirms our results in Simulation Two and Three.

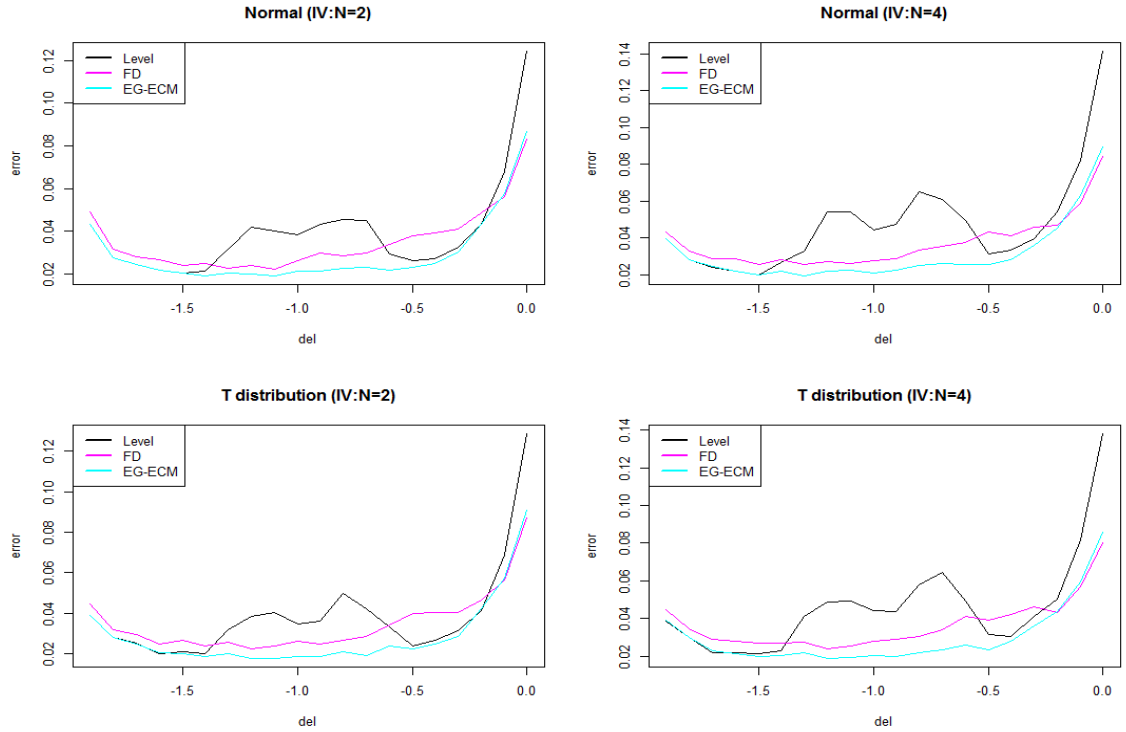


*Figure 9:* Percentage of mean 24-period-end forecasting error, 1000 replications

*g) Empirical applications*

In this section, we compare empirical performance of the FD approach and the EG-ECM approach using a simple example in CCAR deposits balance modeling. We ignore the first approach as the variables in levels exhibit clear non-stationarity. We aim to forecast US total checkable deposits using macroeconomic variables and stress scenarios given by the Federal Reserve Bank. There are 15 domestic and 13 international, in total 27, macroeconomic variables and three stress scenarios selected by the FED. To simplify the analysis, we only focus on the 15 domestic variables and the Severely Adverse scenario[6]. We collect the macroeconomic variables data from the Federal Reserve Board and the total checkable deposits balance data from St. Louis FED. The historical data span from 1990Q1 to 2016Q4 and the 2017 Severely Adverse scenario data span from 2017Q1 to 2020Q1. For the variables in growth rate, we convert them in level first[7].

The FD model selected is as follows:

$$\Delta cd_t = 0.03 + 0.002 * \Delta vix_t - 0.03 * \Delta trea\_3m_t \; 0.13 * \Delta djia_t - 0.007 * trea\_3m_t$$

(0.00)(0.00) (0.00)(0.00) (0.00)

where $cd_t$, $vix_t$, $trea\_3m_t$ and $djia_t$ are log of US total checkable deposits balance, log of Market Volatility Index, 3-month Treasury rate and log of Dow Jones Total Stock Market Index respectively, $\Delta$ is the first difference operator, and the values in parenthesis are *t*-values for the corresponding coefficients. The estimation results show that there are positive effects to deposits balance growth rate from market uncertainty and equity market index, but negative effects from short-term interest rate.

For the EG-ECM model, we selected the following independent variables: Mortgage rate, House

[6] The 15 domestic variables are: Real GDP growth, Nominal GDP growth, Real disposable income growth, Nominal disposable income growth, Unemployment rate, CPI inflation rate, 3-month Treasury rate, 5-year Treasury yield, 10-year Treasury yield, BBB corporate yield, Mortgage rate, Prime rate, Dow Jones Total Stock Market Index, House Price Index, Commercial Real Estate Price Index, and Market Volatility Index. The three stress scenarios are: Baseline, Adverse, and Severely Adverse

[7] The following variables are converted in level first: Real GDP growth, Nominal GDP growth, Real disposable income growth, and Nominal disposable income growth.

Price Index, Commercial Real Estate Price, and Market Volatility Index. We first applied three non-stationarity tests - the ADF test, the PP test and the KPSS test - for the four independent variables and then conducted the Phillips-Ouliaries test and the Johansen test with trace or max-eigen value to test the co-integration relationship between the dependent and independent variables. The Johansen tests allow more than one co-integrating vector to be detected by either trace statistics or maximum eigen value statistics. The test results are in Table 13.

The tests results show that all the variables are non-stationary except the variable, *vix*, which has conflicting test results. All the three co-integration tests demonstrate at least one co-integration relationship exists among the five variables. The EG-ECM approach concludes the following estimation equation:

$$\Delta cd_t = 0.01 - 2.9 * \Delta \text{mr.l1} + 0.001 * \Delta vix_t - 0.15 * (cd_{t-1} - 9.9 + 0.2 * mr.l1_{t-1} + 1.7 * hpi_{t-1}$$

(0.02)(0.02) (0.01)(0.02) (0.00)(0.00) (0.00)+1.2 * $crepi_{t-1} + 0.01 * vix_{t-1}$),(0.00)(0.00)

Where the values in the parentheses are *t*-values for the corresponding coefficients. Overall the EG-ECM estimation results indicate that in the long run when housing prices, market uncertainty and mortgage rate increase the total checkable deposits balance increases. When the checkable deposits balance derivate from the long term equilibrium, about 15% of the deviation will be corrected in the next quarter and heads towards the equilibrium level.

*Table 13:* Stationarity tests and co-integration tests

| Stationarity Test | | | | |
|---|---|---|---|---|
| Variable | ADF test | PP test | KPSS test | Description |
| cd | I | I | *** | Log of Total Checkable Deposits, Billions of Dollars, Non SA |
| mr.l1 | I | * | *** | Lag 1 of Mortgage rate |
| hpi | I | I | *** | Log of House Price Index (Level) |
| crepi | I | I | *** | Log of Commercial Real Estate Price Index (Level) |
| vix | I | *** | I | Market Volatility Index (Level) |
| Cointegration test | | | | |
| Phillips_Ouliaries test | | | | p=0.042 |
| Johansen test with max eigen | | | | p<0.01 for r=1, p>0.10 for r=2 |
| Johansen test with trace | | | | p<0.01 for r=1, p>0.10 for r=2 |

*, **, and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

To evaluate the predictive ability of the FD approach and the EG-ECM approach in CCAR deposits balance modeling, we first divide the historical data into two parts, the first part spanning from 1990Q1 to 2013Q1 and the second part spanning from 2013Q2 to 2016Q4. We first estimate models coefficients using the older data and then compare out-of-sample forecasts with the second part of the historical data. Compared with the conventional out-of-sample forecasting, to mimic CCAR deposits balance modeling exercises we assume the independent variables are observed. The upper panel of Figure 10 indicates that although the EG-ECM approach under-forecasts the total checkable deposits balance in the first six quarters compared the FD approach, but eventually it has better out-of-sample forecasting performance. The lower panel of Figure 10 exhibits forecasting performance of the two approaches for the 2017 Severely Adverse scenario given by the FED. It seems the EG-ECM approach has more conservative forecasting for the US total checkable deposits balance.

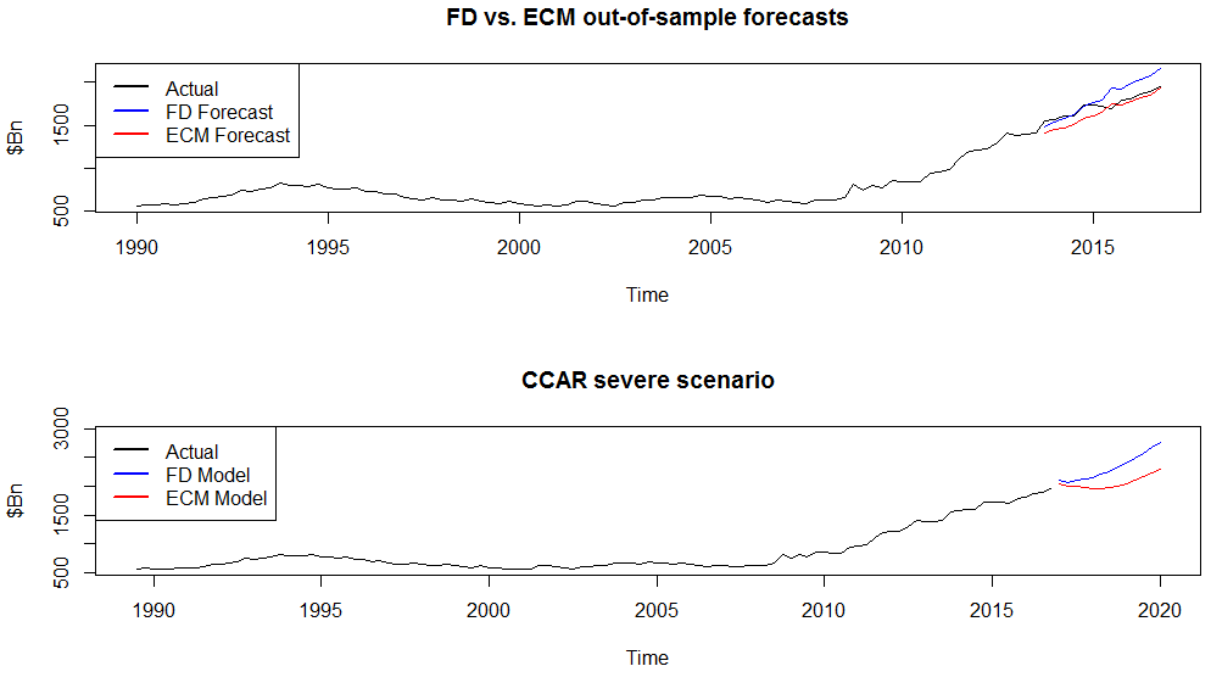


*Figure 10:* Forecasting performance of the FD approach and the EG-ECM approach

## III. Conclusions

In this paper, we carried out four different simulation designs: (i) non-correlated I(1) processes; (ii) correlated near-stationary I(0) processes; (iii) correlated but un-cointegrated I(1) processes; and (iv) co-integrated I(1) processes, and compared three different estimation approaches for each of the four designs respectively: (i) estimating in levels; (ii) testing unit roots at first and estimating in differences; and (iii) the Engle and Granger two-step approaches. In each simulation design, we further adopted four different DGP situations. Our results show that the EG-ECM approach has either the best performance in estimation of the coefficients and out-of-sample forecasting or very small difference from the best performance among these three approaches. The results from our CCAR deposit balance modeling exercises further highlights the importance of including both short-run and long-run shocks in the model specification.

There might be several directions for future research. First, the non stationary processes in our simulation sare only integrated with lag being one, and consequently we ignore the lags selection issue in the statistical tests and modeling. Second, as argued by many researchers that to estimate the ECM models the Engle and Granger two-step approach empirically performs worse than the methods in Johansen (1994) and in Pesaran, Shin and Smith (2001), one could compare the performance of these methods. Third, one of the significant features is volatility clustering for financial data. It would be valuable to introduce the generalized autoregressive conditional hetero scedasticity (GARCH) framework into the models as in Guo (2017b). Finally, our simulation exercises assume that the independent variables are given. It would be interesting to combine variables selection into our forecasting studies.

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# The Determinants of Financial and Operational Sustainability of Microfinance Institutions: Case Study of Clecam-Ejoheza Ltd

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*Abstract-* This research is about analysing the determinants of financial and operations sustainability of Microfinance institutions in Rwanda, particularly the case study of CLECAM-EJOHEZA ltd. The study evaluates the financial and operational sustainability of CLECAM-EJOHEZA Ltd through a financial analysis by ratios conducted on the financial statements of CLECAM-EJOHEZA Ltd for the period from 2010 to 2015. For instance, to accomplish the measurement of financial and operational sustainability of a company cited above, financial self-sufficiency ratio (FSS) and operational self-sufficiency ratio (OSS) were used as the dependent variables because the Microfinance Financial Reporting Standards recommends the use of financial self-sufficiency (FSS) and operational self-sufficiency (OSS) as measures of sustainability of the MFI.

*Keywords: microfinance, sustainability, financial sustainability, operational sustainability.*

*GJMBR-C Classification: JEL Code: G21*

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*Strictly as per the compliance and regulations of:*

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*Abstract-* This research is about analysing the determinants of financial and operations sustainability of Microfinance institutions in Rwanda, particularly the case study of CLECAM-EJOHEZA ltd. The study evaluates the financial and operational sustainability of CLECAM-EJOHEZA Ltd through a financial analysis by ratios conducted on the financial statements of CLECAM-EJOHEZA Ltd for the period from 2010 to 2015. For instance, to accomplish the measurement of financial and operational sustainability of a company cited above, financial self-sufficiency ratio (FSS) and operational self-sufficiency ratio (OSS) were used as the dependent variables because the Microfinance Financial Reporting Standards recommends the use of financial self-sufficiency (FSS) and operational self-sufficiency (OSS) as measures of sustainability of the MFI.

The dates used in the study have been collected using quantitative aspects and the study involves both primary and secondary data. Primary data was collected by soliciting the top management staffs of CLECAM-EJOHEZA Ltd particularly those involved in the financial department through an unstructured interview. But the secondary data which was used to analyze mfi–specific variables was collected from its financial reports available at the head office of CLECAM-EJOHEZA Ltd and to analyze external-specific variables the data was collected from MINECOFIN and BNR with documentary survey. Different tools such as SPSS and statistical aspect have been also used to give data the meaningful information for the research's readers.

The finding from the collected data depicted that CLECAM EJOHEZA Ltd is fairly operational sustainable but is not financially sustainable during the period from 2010 to 2015. Indeed, during the period from 2010 to 2015, total asset as well as other ratios or financial and operation indicators of CLECAM EJOHEZA Ltd have been fluctuating which explain both positively for some determinants of financial sustainability and negatively for other financial sustainability factors.

*Keywords: microfinance, sustainability, financial sustainability, operational sustainability.*

## I. Introduction

Nowadays, poor people are not benefited from formal financial systems across global. As referred by Brau and Woller, (2004) exclusion ranges from partial exclusion in developed countries to full or nearly full exclusion in lesser developed countries. Indeed, most of the poor population and small enterprises in Sub-Saharan Africa countries have very limited chance to access deposit and credit facilities and other financial services provided by formal financial institutions (Basu*et al,* 2004). Lack of access to credit is a major obstacle to growth in the continent. Therefore, Microfinance (henceforth MFIs) in the 20th century has been characterized by many new products and discoveries in the financial industry.

The aim of clients that microfinance serves represents the difference with many of other discoveries even as most of the new ideas target the smaller and richest part of the world population, microfinance reaches a large number of poorer people enabling them to access to financial services such as credit and deposits, insurance and others. This success on financial services has to be considered formal as there are many informal ways in which people tend to borrow for credit and save money for unexpected situations.

According to Iezza (2010), Microfinance has been accepted not only as a financial mean to target specific people but it realize also a social aspect contributing to poverty reduction, women empowerment, economic development and employment creation. However, thought Microfinance institutions have contributed positively to boost the countries' economics, especially in Rwanda, but they still experiencing some limitations and barriers. For instance, while a large body of research on financial institutions sustainability has been undertaken in the conventional banking industry in Rwanda: Muteteri (2015); Ugirase, (2013); Ukwibishaka (2010), rigorous empirical evidence on microfinance remains limited, largely due to lack of reliable data.

Moreover, it is rare or uncommon such study with regard to identification and assessment of factors that affect financial and operational sustainability has been conducted in Rwanda where the majority of MFIs are not well developed or small. The studies conducted in the areas of microfinance institutions in Rwanda are few in number and did not give such an emphasis on the factors considered to be determinants of financial and operational sustainability of microfinance institutions in Rwanda. Since it is believed that MFIs must be profitable for their healthy operation and attainment of the long term goal which is alleviation of poverty, this

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study will find out the MFIs specific, macroeconomic and industry-specific factors affecting their financial and operational sustainability and fills the gap in the context of Rwandan MFIs.

## II. Objectives

The general objective in this research is to ascertain and analyse the determinants of financial and operational sustainability of microfinance institutions in Rwanda. For the purpose of clarification, the study has the following specifics objectives:

- To analyse the determinants of financial sustainability of CLECAM-EJOHEZA Ltd,
- To assess the determinants of operational sustainability of CLECAM-EJOHEZA Ltd,
- To measure the relationship between the determinants of operational sustainability and the determinants of financial sustainability of CLECAM-EJOHEZA Ltd.

## III. Literature Review

The literature explored various factors that can influence the sustainability of these institutions. This was done with a view of collecting views, prospective and opinions and understanding the factors affecting financial and operational sustainability of MFIs in Rwanda. Under this section, the theoretical and empirical evidences focusing on the determinants of microfinance institution financial and operational sustainability have been presented.

*a) Conceptual Framework*

This section of conceptual framework includes the definitions and clarifications of the key concepts of the concept model according to different authors. It is in this section where the concepts of microfinance, operational and financial sustainability of microfinance institutions are presented.

- Microfinance definition

Since the microfinance institutions have been launched, they are viewed in different ways by different authors (Arun, 2005; Brau & Woller, 2004, Drake & Rhyne, 2002; Stack & Thys, 2000). However, the concept or the meaning of the definitions is usually the same in which microfinance refers to the provision of financial services; primarily savings and credit to the poor and low income households that lacked to have access to commercial banks service. The popularly known institution which is Microfinance information exchange (MIX) added that microfinance institutions are the variety of financial services that target low-income clients, in particularly the women.

The above definitions shown that the clients of microfinance institutions are poor or have lower incomes and often have limited access to other financial services, therefore microfinance products tend to be for smaller monetary amounts than traditional financial services. Indeed, their services not only provide micro credit service for those who have lower incomes but also include loans, savings, insurance, and remittances. Consequently, these varied needs, and because of the industry's focus on the poor, microfinance institutions often use non-traditional methodologies, such as group lending or other forms of collateral not employed by the formal financial sector especially by banks.

*b) History of Microfinance in Rwanda*

The ideas and aspirations towards microfinance are not new. According to (Helms, 2006) Small, informal savings and credit groups have worked for centuries across the world, from Ghana to Mexico, India and beyond. In Europe, as early as the 15th century, the Catholic Church founded pawn shops as an alternative to usurious moneylenders. These pawn shops spread throughout the urban areas in Europe throughout the 15$^{th}$ century.

Indeed, these informal financial institutions have existed in Rwanda for long period ago. For instance, small self-help peasant organizations (tontines and ibimina) were used for agriculture, cattle breeding and in the purchases of domestic equipment for several years ago. The microfinance sector is however relatively young. Microfinance was first formalized with the creation of the first Banque Populaire du Rwanda (bpr) in 1975 by the Rwandan and Swiss governments. A few years later, the various Banques Populaires initiated in the country formed a Union des Banques Populaires (Mftransparency, 2011).

In additional, as referred by AQUADEV CENTRAL AFRICA, (2008) after the 1994 Genocide in Rwanda, the microfinance sector has known a dramatic progress through the support of relevant international and non-government organizations especially for humanitarians. These NGOs helped people by support of daily use of equipment, foods but had also the microcredit teaching program. But, during the above emergency period, in some cases the loans did not differ to grants or donations and sowed confusion among the population. Thus, leads to non-repayment culture that resulted in non-performing loans, and therefore had a negative impact on results of micro-finance institutions.

*c) Microfinance models*

In this section the most common lending approaches and microfinance credit models are described in order to give an overview of how the actual money lending technically is accomplished

- Solidarity group

The solidarity group model is also called “peer lending group” and normally consists of four to five individuals who group together to borrow a loan in solidarity. The members are self selected, based on

their reputation and relationship to each other. Useful here is the self screening and group pressures imposed upon every member of the group, urging each and every one of the borrowers to contribute his part in solidarity as mutually agreed and so ensures a rather secure loan recovery for the MFI. However, the whole group suffers possible consequences in case they fail to pay back the loan. Thus, in this model the MFI has less work to do since the borrowers of the groups have most of the responsibilities such as: forming the group and selecting the right members, administration and organization of repayment plan and scheduling group meetings and meetings with the loan officers from the MFI (Hazeltine & Bull, 2003).

- Village banking

Village banking describes a community-based credit and savings association, run by a village itself. The model was founded by John Hatch, the founder of the American NGO Finca (Felder-Kuzu, 2005). With this lending model, 25 to 50 low income members of a village, mostly women, join to take out a relatively large loan from a MFI and act as guarantors at the same time. After receiving the loan a self appointed village committee decides who gets smaller loans out of the group. Furthermore, this model enables saving deposits. According to Hazeltine & Bull, (2003) the role of the MFI is to assist only in administration and technical issues.

- Grameen model

The Grameen model was invented in 1976 by Professor Muhammad Yunus, the founder and managing director of Grameen Bank. The model proved to be successful and today is practiced in more than 250 outlets of Grameen Bank in more than 100 countries (Yunus, 1999). The Grameen model was copied and modified many times according to the respective needs of regional markets and clients. Therefore many other models are extensions of, or derived from, the Grameen Model.

Basically, new branch of the MFI is set up in a village with a field officer and some qualified workers, and therefore these employees support then up to 15 to 20 villages in the surrounding and are strive to make the local, poor people aware of the microfinance possibilities through word of mouth and personal advisory. Furthermore, the lending process is similar to the solidarity group approach. Groups of five are created. However in the beginning only two members of the group receive a loan and are monitored for one month. The credibility of the group will then be based on the repayment performance of the first two individuals (Hazeltine & Bull, 2003). If they are reliable and could pay back their loan, the remaining members qualify for a loan as well, since the group is jointly and severally liable for the single members.

- Individual model

The individual model is the most expensive and labour-intensive model for the MFI. Here clients have to be monitored and far more and deeper field research is necessary in order to choose the right clientele, especially because these people have no tangible collateral or credit history and in most cases are illiterate.

As referred by Hazeltine & Bull, (2003) sources of information for the field officer are the family, friends and leaders of the community. With this model, the loan is given directly to the borrower and it is his/her sole duty to pay back the full amount plus interest rates without financial support from a group in case he/she defaults. However, the assistance as well as payment schedules and business management training is generally provided by the MFI (Hazeltine & Bull, 2003).

*d) Determinants of MFI's sustainability*

As MFIs seek to reach as many poor people as possible in the long run to fulfil their goal to fight against the worldwide poverty, it became clear that this outreach is only possible on a sustainable and efficient basis. Sustainability in general means the ability of a program to continuously carry out activities and services in pursuit of its statutory objectives. For an ideal MFI this would mean the ability to continue operating as a development financial institution for the rural poor (Khandker & Khalily, 1995).

✓ Source of funding (Financing structure)

Financing structure is a financial tool that helps to govern how firms choose their funding structure. Most MFIs in the world started off as NGOs and had built substantial supply side competencies which makes funding structure had no relevance. However, with development and commercialization, MFIs are spanned off to become fully independent, the enigma of funding structure that will ensure sustainability becomes relevant. During any time of financial or banking crisis, when bailout aid is available, questions of capital structure become more salient.

Indeed, several elements of MFIs' funding sources have established to support the FMLs. For instance, Bogan (2009) mentioned that most MFIs start out as NGOs with a social vision, funding operations with grants and concessional loans from donors and international financial institutions that effectively serve as the primary sources of risk capital for the microfinance sector. It from this in recent years there has been increasing internal and external pressure for the MFIs to decrease dependence on subsidized or grant funding.

In additional, Debt to equity ratio plays an important role to measure firm leverage and believed as the drivers of MFIs sustainability and efficiency. However, Sustainability of MFIs does not depend only on debt to equity ratio but also on their saving mobilizing capacity. Deposit to loan ratio is an important indicator

for MFIs that mobilize deposits and it measures that portion of the MFIs' portfolio funded by deposits. Consequently, the higher the ratio the greater is the MFIs' capability to fund it loan portfolio from its deposits and enhances commercialization of microfinance operation.

*e) Macroeconomic factors*

Understanding the linkages between overall country's macroeconomic level and MFIs sustainability can make MFI evaluation more accurate and, further, can help to locate microfinance in the broader picture of economic development. Furthermore, understanding the macroeconomic impact on MFIs may also help a growing number of investment funds that target their financial resource toward MFIs, sometimes with the dual goal of earning returns for investors and achieving social impact. Evidences arise for strong relationship between MFI performance and the broader economy. Christian, et al. (2009) has explained that, MFIs are more likely to cover costs when growth is stronger; and MFIs in financially deeper economies have lower default and operating costs, and charge lower interest rates. There is also evidence suggestive of substitutability or rivalry. For example, more manufacturing and higher workforce participation is associated with slower growth in MFI outreach (Ahlin, Lin, & Maio, 2011). The suggestion of most of the previous empirical studies is that macroeconomic variables are based primarily upon an economic tradition, emphasizing the importance of external market factors in determining firm's success. These typically include inflation, GDP growth rate, GDP per capita, GNI per capital, population, unemployment rate and interest rate differentials. For example Vingo (2012) indicated that the common approach has been to study the impact of macroeconomic factors by investigating the impact of GDP growth and inflation on performance. The inflation indicator refers to a rise in the general level of prices of goods and services in an economy over a period of time. Overall, the country context appears to be an important determinant of MFI performance (Christian Ahlin, et al., 2009).

*f) Theoretical framework*

The theoretical framework, through a review of existing literature within the microfinance field, serves as a platform for the forthcoming empirical study. As explained in the previous section, microfinance institutions are considered to be a tool for poverty alleviation through improving access to finance and financial services.

There are two competing views to which goal of microfinance should be given higher priority in as far as poverty reduction is concerned. These are the institutionists (also known as financial system) and welf arists (poverty lending) approaches (Arun, 2005; Brau & Woller, 2004).

*g) Welfarists' Approach*

Brau & Woller, (2004) mentioned that the welfarists emphasize on poverty lending as measured by depth of outreach. That is, reaching not just a large number of clients (breadth of outreach) but a large number of poor clients also known as depth of outreach. It follows, therefore, that welfarists view microfinance as established for poverty reduction, their objectives being to empower the poorer of the economically active poor and thus, depth of outreach should be given a higher priority. Microfinance institutions should be, in as far as possible, able to serve as many as possible poor clients, even when it may appear not profitable. The deficit in operations should be filled with donors and government support or social investors (Woller et al, 1999). Taking the welfarists view abroad, many groups, especially NGOs argue that there is a trade-off between sustainability (profitability) and targeting the poor (outreach) because the poorest are cost ineffective to reach when profitability is considered and thus donor support (to support MFIs) is required to this end (Paxton, 2002). Their argument is that, to reach the poorest groups require small exclusively focused programs which cannot be sustainable and require on-going donor funding (Rhyne, 1998; Morduch, 1999).

*h) Institutionists Approach*

Institutionists on the other hand focus mainly on financial sustainability of microfinance institutions. According to Woller et al (1999) the Institutionists view financial deepening as the main objective of microfinance institutions. Here financial deepening refers to creating sustainable financial intermediation for the poor. Institutionists assert that the financial sustainability as measured by financial self-sufficiency (profitability) should be given higher priority by all MFIs (Brau & Woller, 2004). Their argument comes from the fact that in most cases donor dependence is not certain and thus, unless an MFI is able to sustain itself financially it will not be able to serve the poor in the long run.

*i) Subsidy and Poverty reduction approach theories*

Subsidy refers to financial resources received by an MFI at below market prices (Woller et al, 1999). Subsidy (also known as donation) may be received in monetary terms or in-kind. The role of subsidy in reaching the vast majority of poor people is seen differently under the two competing poverty reduction approach theories: the Institutionists and Welfarists theories.

The Institutionists approach the sustainability of MFIs from the institution point of view. Their argument is that, institutional sustainability of an MFI will be attained when the MFI is financially self-sufficient. That is, be able to operate without subsidization. The emphasis here is that, for sustainability, an MFI should be able to cover its

operating and financing costs with the program revenue (Brau & Woller, 2004).

Ideally, a financially viable financial program is one where all cost (delivery and post delivery) of credit, provision for loan losses, inflation, and return on investment are fully taken into account and covered by the interest rates charged on loans (Thapa et al, 1992).

With Institutionists approach, MFIs should make profit to attract private capital because subsidies or donor funds may dry up any time and the microfinance institution may cease from its operations (CGAP, 1995).

## IV. Research Methodology

This section of methodology sets to explain the research design and methodology, methods of data collection, data analysis techniques and also operational definition.

This study with the aims of ascertaining and analyzing the determinants of financial and operational sustainability of CLECAM-EJOHEZA Ltd will use the quantitative research approach by using time series research design to realize stated objectives. In line with this, quantitative research tests the theoretically established relationship between variables using sample data with the intention of statistically generalizing for the population under investigation. Therefore Ordinary least square (OLS) method particularly multiple regression models will be used to assess the significant determinants of financial and operational sustainability of CLECAM-EJOHEZA Ltd. To measure the financial and operational sustainability of CLECAM-EJOHEZA Ltd, financial self-sufficiency ratio (FSS)and operational self-sufficiency ratio (OSS) will be applied as the dependent variables because the Microfinance Financial Reporting Standards recommends the use of financial self-sufficiency (FSS) and operational self-sufficiency (OSS) as measures of sustainability of the MFI (Muriu, 2011).

*a) Source of data and methods of data collection*

In order to carry out any research activity; information should be gathered from proper sources. The sources of data for this research are almost secondary sources, but for the purpose of supporting the finding of the research, primary data was used to some extent. Primary data was collected by soliciting the top management staffs of CLECAM-EJOHEZA Ltd particularly those involved in the financial department through an unstructured interview. The secondary data which was used to analyze MFI–specific variables was collected from its financial reports available at the head office of CLECAM-EJOHEZA Ltd and to analyze external-specific variables the data was collected from MINECOFIN and BNR with documentary survey.

To evaluate the financial and operational sustainability of CLECAM-EJOHEZA Ltd, a financial analysis by ratios was conducted on the financial statements for the period under this research.

On the other hand, for measuring the impact of ascertained determinants on the financial and operational sustainability of CLECAM-EJOHEZA Ltd, the collected data were regressed and interpreted with the help of multiple regression analysis (significant test). To conduct this, we used SPSS software.

i. *Model specification*

Along with the use of inferential statistics, the researcher will apply two separate multiple regression models to analyze the sustainability of CLECAM-EJOHEZA Ltd. Many econometricians argued that one of the most useful aspects of a multiple regression model is its ability to identify the independent effects of a set of variables on a dependent variable. The study tests the impact of funding, firm characteristics, and macroeconomic variables on sustainability. Hence this study will involve two dependent variables and 15 independent variables for testing against each of these two dependent variables.

*b) Model estimation of financial self-sufficiency for sustainability*

To test whether the financial self-sufficiency of CLECAM-EJOHEZA Ltd is explained by the independent variables namely; Grant to asset ratio (GAR), Debt to Equity ratio (DER), operational expense ratio (OER), cost per borrower (CPB), GDP growth rate (GDP), Inflation (INF), deposit to loan ratio (DLR), and gross loan portfolio (GLP). The following regression model is estimated to carry out the analysis.

$$FSS_{\square} = \square_{\square} + \square_1 GAR_{\square} + \square_2 DER_{\square} + \square_3 OER_{\square} + \square_4 Log\,(CPB) + \square_5 GDP_{\square} + \square_6 INF_{\square} + \square_7 DLR_{\square} + \square_8 Log\,(GLP_{\square}) + \square_{\square}$$

Where $FSS_t$ is the observed financial self-sufficiency ratio of CLECAM-EJOHEZA Ltd at year t,
$\square_0$ is the constant term showing the value of FSS, when all the coefficient of the independent variables are zero,
$GAR_t$ is grants to assets ratio of CLECAM-EJOHEZA Ltd at time t,
$DER_t$ is the debt to equity ratio of CLECAM-EJOHEZA Ltd at time t,
$OER_t$ is the operating expense ratio of CLECAM-EJOHEZA Ltd at time t,
$CPB_t$ is cost per borrower of CLECAM-EJOHEZA Ltd at time t,
$GDP_t$ is the GDP growth rate of Ethiopia assigned to CLECAM-EJOHEZA Ltd at time t,
$INF_t$ is the rate of inflation of Ethiopia assigned to CLECAM-EJOHEZA Ltd at time t, and
$DLR_t$ is the deposits to loan ratio of CLECAM-EJOHEZA Ltd at time t,
$GLP_t$ is the gross loan portfolio of CLECAM-EJOHEZA Ltd at time t,
$\beta_s$ are the partial effect of independent variables in period t.
$\square_{\square}$ is the error term of CLECAM-EJOHEZA Ltd at time t.

## V. Results and Discussion

Under this section the researcher presented the financial indicators of CLECAM-EJOHEZA Ltd, analyzed its financial and operational sustainability and interpreted the findings. This section has two main parties: The first part presents, after an analytical adjustment, the financial analysis of CLECAM-EJOHEZA Ltd for its financial and operational sustainability; while the second part deals with model presentation and interpretation of the results about the determinants of the financial and operational sustainability of CLECAM-EJOHEZA Ltd.

*a) Financial Analysis of Clecam-Ejoheza Ltd*

From the financial reports of CLECAM-EJOHEZA Ltd, the researcher calculated and extracted useful financial ratios and indicators for they can permit the researcher to conduct a consistent analysis of the sustainability of CLECAM-EJOHEZA Ltd for the period under this study.

The objective in this section was to go through these financial ratios and indicators of CLECAM-EJOHEZA Ltd and interpret them for they can help the researcher to understand the true financial situation of CLECAM-EJOHEZA Ltd. The researcher compiled a number of ratios and indicators of CLECAM-EJOHEZA Ltd through the six categories as follows:

- Annual variation of financial indicators,
- Sustainability indicators,
- Profitability indicators,
- Portfolio quality indicators,
- Financial structure indicators,
- Efficiency and productivity indicators.

Because the researcher needed to calculate OSS and FSS to measure the sustainability of CLECAM-EJOHEZA Ltd, some accounts from the financial statements of CLECAM-EJOHEZA Ltd have been subject to a prior analytical adjustment for the true performance and sustainability analysis of CLECAM-EJOHEZA Ltd. By gathering more information on the funding resources of CLECAM-EJOHEZA Ltd, the researcher found that the MFI got subsidies from different partners of micro finance sector in Rwanda, subsidies received in cash as well as in kind. Furthermore, the study is mindful that CLECAM-EJOHEZA Ltd operates in Rwandan economic environment and hence affected by a number of factor affecting this environment notably the inflation rate, exchange rate, GDP growth rate, taxes, etc.

For these reasons, certain adjustments were applied on the financial statements of CLECAM-EJOHEZA Ltd notably the Subsidies Adjustments, Portfolio at risk Adjustment and Inflation Adjustments to reflect the true performance of CLECAM-EJOHEZA Ltd (or its ability to maintain its level of operation over the long term) by studying its ability to cover all costs.

i. *Adjustments for Subsidies*

To offset the effects of subsidies, the study distinguished Subsidized Cost of Funds Adjustment and In-kind subsidy Adjustment.

Subsidized Cost of Funds Adjustment consists of calculating the extra expense that CLECAM-EJOHEZA Ltd would incur if it were paying market rate for funding from commercial sources.

$$A1 = (AverageBorrowingsxMarketrateforBorrowing) - Interest \wedge FeeexpenseonBorrowings$$

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| $A_1$ | 3,315,351 | 1,642,595 | 7,925,773 | 7,017,323 | 13,017,394 | (860,608) |

However, if the result of the adjustment is negative, the adjustment is not applied. In other hand, the effect of this adjustment on financial statements of CLECAM-EJOHEZA Ltd is that it causes an increase in Financial Expense on Funding Liabilities. This increase in expenses will reduce Retained Earnings of the year.

In-kind subsidy Adjustments CLECAM-EJOHEZA Ltd received year after year In-kind subsidies, such as donated vehicles or computers or even directs payments of staff members' salaries by TERRAFINA and AQUADEV. Although these items do not have any effect on the MFI's cash flow, the omission of their actual cost obscures the true cost of operations. We really needed to know how dependent CLECAM-EJOHEZA Ltd is on such in-kind subsidies to continue operations.

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| $A_2$ | 34,011,800 | 34,484,291 | 9,646,858 | 63,755,760 | 42,889,486 | 74,125,277 |

ii. *Inflation Adjustment*

Rwandan economy is affected by inflation and so is the microfinance sector in general and CLECAM-EJOHEZA Ltd in particular. High inflation makes it difficult for MFIs to operate and has an erosive effect on an MFI's Equity. The purpose behind this inflation adjustment is to calculate the decrease in the real value (or purchasing power) of Equity of CLECAM-EJOHEZA Ltd due to inflation.

$A3.1 = (EquityxInflationrate)$ $A3 = (EquityxInflationrate) - (AssetsxInflationrate)$

$A3.2 = (AssetsxInflationrate)$

$A3 = A3.1 - A3.2$Or simply

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| A3.1 | 5,513,056 | 18,864,469 | 26,144,240 | 20,606,516 | 10,356,380 | 15,056,329 |
| A3.2 | 547,891 | 1,781,697 | 2,026,714 | 5,318,561 | 4,321,699 | 7,322,053 |
| A3 | 4,965,165 | 17,082,772 | 24,117,526 | 15,287,955 | 6,034,681 | 7,734,276 |

The effect of inflation adjustment on financial statements of CLECAM-EJOHEZA Ltd is that it causes an increase in Other Financial Expense and an increase in Net Fixed Assets. This increase in expense will reduce Retained Earnings of the year; revaluation of Net Fixed Assets will increase Total Assets. To balance these changes, the sum of these two effects is added to Adjustments to Equity in the balance sheet (SEEP Network, 2005).

*a) Portfolio at Risk Adjustments*

The research found that, in calculating the impairment loss allowance, CLECAM-EJOHEZA Ltd has been following and respecting the impairment loss allowance as per article 59 of the BNR regulation N0 02/2009 organizing Microfinance activities. Therefore, the adjustment proposed in this section is not needed.

*b) Sustainability of CLECAM-EJOHEZA Ltd*

Sustainability ratios are the most comprehensive of the ratios here, and reflect the MFI's ability to continue operating in the future (Nancy Natilson et al, 2001). The ratios recommended in this section are the most widely accepted in the microfinance industry, notably the Operational self-sufficiency ratio, the Return on Equity ratio and the Return on assets ratio (Micro Save, 2008).

The following table shows the sustainability indicators of CLECAM-EJOHEZA Ltd for the six years from 2010 to 2015.

*Table:* Sustainability Ratios of CLECAM-EJOHEZA Ltd 2010-2015

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Operational self-sufficiency Ratio | 106.0% | 123.0% | 122.9% | 93.0% | 103.4% | 96.3% |
| Financial self-sufficiency Ratio | 82.8% | 89.3% | 101.3% | 72.1% | 82.7% | 81.4% |
| Return on Equity Ratio | 5.3% | 13.6% | 11.4% | -4.5% | 6.2% | 2.4% |
| Return on Assets Ratio | 1.8% | 4.1% | 3.1% | -1.2% | 1.5% | 0.6% |

*Source: CLECAM-EJOHEZA Ltd Report (2010-2015)*

*c) Profitability of CLECAM-EJOHEZA Ltd*

Profitability is highly linked to sustainability. In other words, profitability is a stepping stone to financial sustainability (Schreiner, 2000). It has also been widely used as a measure of financial sustainability (Armendáriz & Morduch, 2007; Cull et al, 2007; Gonzalez, 2007; Adongo & Stork, 2006; CGAP, 2003; Woller & Schreiner, 2002)

The table bellow illustrate the ratios the research calculated under this section in order to present the profitability of CLECAM-EJOHEZA Ltd from the year 2010-2015.

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Net Income Ratio | 27.0% | 36.5% | 18.7% | 12.5% | 18.3% | 22.0% |
| Interest margin Ratio | 62.3% | 77.3% | 78.7% | 81.2% | 71.3% | 73.1% |
| Operating Income Ratio | 7.1% | 18.8% | 21.3% | -2.2% | 13.2% | 9.9% |
| Net Financial Income Ratio | 95.4% | 92.4% | 89.2% | 86.8% | 84.3% | 80.8% |
| Cost of funds Ratio | 1.9% | 2.2% | 2.4% | 3.3% | 4.0% | 5.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Operating Income Ratio | 7.1% | 18.8% | 21.3% | -2.2% | 13.2% | 9.9% |
| Net Financial Income Ratio | 95.4% | 92.4% | 89.2% | 86.8% | 84.3% | 80.8% |
| Cost of funds Ratio | 1.9% | 2.2% | 2.4% | 3.3% | 4.0% | 5.1% |
| Financial Expense Ratio | 4.6% | 7.6% | 10.8% | 13.2% | 15.7% | 19.2% |

*Source: CLECAM-EJOHEZA Ltd report (2010-2015)*

From these ratios it is clear that From these ratios the Profitability of CLECAM-EJOHEZA Ltd 2010-2015 was as follow
*CLECAM-EJOHEZA Ltd report (2010-2015)*

*d) CLECAM-EJOHEZA Ltd's Portfolio quality indicators*

The loan portfolio is for an MFI the largest asset and the quality of that asset and the risk it poses for the institution can be quite difficult to measure (Micro Rate and Inter-American Development Bank, 2003). The primary asset of CLECAM-EJOHEZA Ltd as an MFI is its gross loan portfolio. Portfolio quality is important to the financial success of any microfinance institution (SEEP Network, 2005). Drops in portfolio quality could mean a decline in customer satisfaction and, therefore, may presage a low retention rate resulting in higher costs to recruit new clients. It may also be signal problems in staff supervision and control. The researcher examined the quality of CLECAM-EJOHEZA Ltd's portfolio from several different perspectives to get a clearer picture of the situation by considering the following three ratios presented in this section together, because none of them alone is sufficient for effective analysis (Micro Save, 2008.)

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Current Loans | 64.9% | 87.6% | 79.1% | 78.7% | 84.7% | 85.8% |
| Portfolio at risk 1-29 days | 28.7% | 8.6% | 16.6% | 13.4% | 11.3% | 9.7% |
| Renegotiated Loans (current) | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Portfolio at risk 30 to 89 days | 1.8% | 1.3% | 1.5% | 1.9% | 1.2% | 1.7% |
| Portfolio at risk 90 to 179 days | 2.0% | 1.4% | 1.4% | 2.4% | 1.7% | 1.3% |
| Overdraft at risk 31 to 90 days | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Portfolio at risk >=180<365 days | 2.5% | 1.2% | 1.4% | 3.5% | 1.0% | 1.5% |
| Overdraft at risk >=90 <180days | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Renegotiated Loans (overdue for 1 day or more) | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Portfolio At Risk >30 days in arrears | 6.4% | 3.9% | 4.3% | 7.9% | 4.0% | 4.5% |
| Write-Off Ratio | 0.6% | 1.5% | 1.7% | 2.0% | 3.1% | 1.1% |
| Risk Coverage Ratio | 46.9% | 41.3% | 66.1% | 77.2% | 72.3% | 94.4% |

*Source: CLECAM-EJOHEZA Ltd report (2010-2015)*

Portfolio at risk is important because it indicates the potential for future losses based on the current performance of the loan portfolio. The PAR ratio is the most widely accepted measure of loan performance in the microfinance industry (MicroSave, 2008; CGAP, 2003).

PAR > 30 days is often used as the threshold beyond which loans are considered to be at higher risk. This ratio also includes Renegotiated Loans. This not only prevents hiding troubled loans through rescheduling or refinancing, but also indicates a higher level of risk associated with clients who have had repayment problems.

As for CLECAM-EJOHEZA Ltd, the table above reveals that the portfolio at risk with more than thirty days in arrears has been increasing and decreasing between 3.9% in 2011 and 7.9% in 2013. This is an indication of inefficiency in making collections because it went beyond the benchmark of 5% as per BNR regulation. The higher the PAR, the more inefficient the microfinance will be and, therefore, the less financially sustainable (Nyamsogoro, 2010).

On other hand, The Write-off Ratio indicates the past quality of the Gross Loan Portfolio. Write-offs are the greatest threat to an MFI because they result in a reduction in the MFI's assets and its current and future earning potential (Micro Save, 2008).

As for CLECAM-EJOHEZA Ltd, the writing off has been increasing in nominal values as well as in relative value as percentage of the average gross loan portfolio. This high ratio indicates not only a problem in the MFI's collection efforts but also a sign of poor analysis of the loan applications. One may think that CLECAM-EJOHEZA Ltd has been disbursing big loans to poor people that are unable to repay the loan or CLECAM-EJOHEZA Ltd had poor recovery mechanism to collect the money from its clients.

The Risk Coverage Ratio measures how adequate the Impairment Loss Allowance is to account for potential loan losses. Because the Impairment Loss

Allowance represents the institution's preparation for loan losses, the Risk Coverage Ratio is an approximate indicator of how prepared the MFI is to absorb loan losses in the worst-case scenario; that is, if all Portfolio at Risk > 30 days became uncollectible (SEEP Network,2005).

Although CLECAM-EJOHEZA Ltd ideally accounts for the risk of default, this does not mean that this ratio will be always 100 percent. The size of the Impairment Loss Allowance depends on the Portfolio Aging Schedule. For example, in the year 2015 where most past due loans are more than 180 days past due, the ratio was close to 100 percent (94.4%). However, in the year 2011 when most past due loans were fewer than 90 days past due, the ratio was far less than 100 percent (41.3%).

*e) Analysis of Financial Sustainability of CLECAM EJOHEZA Ltd*

The analysis of the financial sustainability of CLECAM-EJOHEZA Ltd was done by assessing the effects of the indicators of the financial sustainability on the sustainability of the microfinance institution. According to the theories and empirical studies in chapter two (Sileshi Mirani, 2015; Tilahum Aemiro Tehulu, 2013), Grant to asset ratio (GAR), Debt to Equity ratio (DER), operational expense ratio (OER), cost per borrower (CPB), GDP growth rate (GDP), Inflation (INF), deposit to asset ratio (DLR), and gross loan portfolio (GLP), has been considered as the independent variables to determine the factors affecting financial self-sustainability of MFIs in Rwanda. This study tried to analyze how these indicators of the financial self-sufficiency improve, enhance and impact the financial sustainability of CLECAM EJOHEZA Ltd. The researcher adopted an empirical methodology to determine the correlation between variables and has built a model to show statistically the effects that these indicators have on the financial self-sustainability of CLECAM-EJOHEZA Ltd.

The researcher has built a model (presented in the methodology) and run it using linear regression. The researcher used SPSS to run the equations and compute the correlations.

The following regression model was estimated to carry out the analysis. The model was also used by Sileshi Mirani (2015).

$FSS_{□} = □_{□} + □_1GAR_{□} + □_2DER_{□} + □_3OER_{□} + □_4Log(CPB)_{□} + □_5GDP_{□} + □_6INF_{□} + □_7DLR_{□} + □_8Log(GLP_{□}) + □_{□}$

The obtained result was summarised in the following table

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .885[a] | .783 | .739 | 7.96100% |

*Source: Extracted from primary data using SPSS*

Based on the regression result in above table, the study found that the estimated result of multiple regression analysis is at a satisfactory level where the R-squared is 78.3% and the Adjusted R-squared value is 73.9%, respectively. The value of the Adjusted R-squared revealed that there are good relationships between dependent and independent variables where all independent variables can explain about 73.9% of the financial self-sufficiency within the sample. However, the remaining 26.1% of the change in FFS regression model is explained by other factors which are not included in the regression line. Both the R-squared and the Adjusted R-squared values in this study are found to be higher (has more explanatory power) (Nyamsogoro, 2010).

To apply the above mode to appropriate company to this study, the coefficients for the estimated model of determinants of financial sustainability of CLECAM-EJOHEZA Ltd has calculated

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 18.301 | 6.602 | | .393 | .016 |
| | GAR | -3.741 | 2.909 | -.324 | -1.286 | .020 |
| | DER | -7.074 | 4.500 | -.172 | -1.572 | .012 |
| | OER | -10.407 | 0.584 | .036 | -.340 | .035 |
| | CPB | -1.799 | .470 | -.691 | -.984 | .043 |
| | GDP | 1.851 | 3.859 | -.089 | .480 | .034 |
| | INF | -.545 | 1.407 | -.080 | -.387 | .021 |

| | | | | | |
|---|---|---|---|---|---|
| | DLR | .826 | .394 | .203 | 2.098 | .042 |
| | GLP | 6.334 | .000 | .137 | .430 | .029 |

*Source: Extracted from primary data using SPSS*

Estimated equation is

$$FSS = 18.301 - 3.741GAR - 7.074DER - 10.407OER - 1.799CPB + 1.851GDP$$

$$.393 - 1.286 - 1.572 - .340 - .984.480$$

$$-5.545INF + .826DLR + 6.334GLP$$

$$-.3872.098.430$$

Basing on the results in the table extracted from SPSS, the researcher found that all estimated parameters were statistically significant at 5% as long as all their probability values were less than 5%.

According to the results, the researcher found also that Grant to Asset ratio, Debt to Equity ratio, Operational Expense ratio, Cost per borrower and Inflation explanatory variables have negative effect (negative sign) on the Financial self-sufficiency of CLECAM-EJOHEZA Ltd while Deposit to Loan ratio GDP growth rate and Gross Loan Portfolio have a positive effect on the Financial self-sufficiency of CLECAM-EJOHEZA Ltd at 5% level of significance. All the expected signs agreed with the estimated signs.

The probability of their estimated parameters is less than 5%. Therefore the following interpretations were made:

When the grant to asset ratio increases by 1%all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd decreases by 3.741% and contrary when the grant to asset ratio decreases by 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd increases by 3.741%. Ravicz, et al (1998) claimed that microfinance initiatives can reduce, and even eliminate the need for subsidies if they achieve a significant volume of business so that they can be sustainable. Bogan (2009) claimed that the negative effect of grants was a particularly meaningful result given that it is consistent with a growing view that MFIs should rely less on grants, soft loans and other types of donor funds.

When the debt to equity ratio increases by 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd decreases of 7.074% and contrary if the debt to equity ratio decreases by 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd increases by 7.074%. Kyereboah (2007), also, found that highly leveraged microfinance institutions have higher ability to deal with moral hazards and adverse selection than their counterparts with lower leveraged ratio. This states that high leverage and profitability are positively correlated. Bogan et al (2007) conducted a study to ascertain whether capital structure affects the financial sustainability of an MFI. They found that microfinance institutions capital structure were associated with their financial sustainability. The study by Nyamsogoro (2010) indicates that there is a positive correlation coefficient between the capital structure and financial sustainability of microfinance institutions. The more an MFI is equity financed compared to other sources of finance, the more the improvements in its sustainability in other words, although how the capital has been structured affects the financial sustainability (Bogan et al, 2007) having different source of capital does not improve the financial sustainability of microfinance institutions.

When the operational expense ratio increases by 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd decreases by 10.407% and contrary when the operational expense ratio decreases by 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd increases by 10.407%. According to the research finding of Nyamsogoro (2010), the lower the ratio, all things being constant, will imply efficiency and the ratio strongly affects the financial sustainability of microfinance institutions. This indicates that, the more MFIs are efficient in reducing operating costs at a given level of outstanding loan portfolio, the more profitable they become and, therefore, maintain financial and operational self-sufficiency and ensure financially sustainable.

When the cost per borrower increases by 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd decreases by 1.799% and contrary when the cost per borrower decreases of 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd increases by 1.799%. This is in line with the result of the study made by Yoshi et al (2011), that the lower cost per borrower implies that an MFI is more efficient to reduce the borrowing cost. Therefore, MFIs with a lower ratio have a higher OSS, and negatively related to the FSS and OSS of a given MFI, leading to a negative sign for the coefficient.

When inflation rate increases of 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd decreases by 0.545% and contrary if the inflation rate decreases by 1% all other things being equal, the financial self sufficiency ratio of CLECAM-EJOHEZA Ltd increases by 0.545%. Gwas & Ngambi (2014) noted that the negative impact of inflation on sustainability indicated that repayment levels are usually weak and low in the presence of higher inflation rates. The study made by Ahlin & Lin (2006);

Bogan (2009) on the relationship of macroeconomic variables and efficiency, asserted that macroeconomic variables could have an effect on MFI efficiency.

## VI. Conclusion

This research under the topic "The determinants of Financial and Operational Sustainability of MFIs in Rwanda" analysed first the sustainability of CLECAM-EJOHEZA Ltd by focusing on the two indicators recommended by Microfinance Financial Reporting Standards as measures of sustainability of the MFI notably the financial self-sufficiency ratio (FSS) and the operational self-sufficiency ratio (OSS).

The analysis of financial statements along with the non financial indicators revealed that CLECAM EJOHEZA Ltd is fairly operational sustainable but is not financially sustainable during the period from 2010 to 2015. Based on the results under the section of result and discussions, it was clear that during this period the total asset as well as other ratios or financial and operation indicators of CLECAM EJOHEZA Ltd has been fluctuated across the years from 2010 to 2015. Furthermore, not all the determinants of operational sustainability explain positively the determinants of financial sustainability, the research found that the determinants of operational sustainability explain positively some determinants of financial sustainability and explain negatively some other financial sustainability factors.

## VII. Recommendations

Considering the analysis made by the researcher, the following recommendations were formulated and addressed to the different actors and the future researchers.

- ✓ CLECAM-EJOHEZA Ltd has to maintain a sufficient level of FSS ratio to ensure its financial sustainability. This because the empirical evidences showed that unless 100 % FSS ratio is reached, otherwise the long-term provision of credit services is destabilized and MFI opts on the continued necessity to rely on donor funds.
- ✓ It also recommended that the government have to play a central role in creating an encouraging environment for enabling MFIs to ensure their long-term sustainability, by maintaining the macroeconomic stability through appropriate monetary and fiscal policies. This has recommended based on that sustainability of CLECAM-EJOHEZA Ltd is affected by macroeconomic factors like GDP and Inflation.
- ✓ The researchers are recommend to bear in mind that this study has conducted based only to the data or information from CLECAM-EJOHEZA Ltd. Therefore, for future research the researchers have to conduct their studies on a group of MFIs that is more representative, thus they can analyze consistently this phenomenon and contribute significantly to the Rwandan microfinance sector. Furthermore, this study is limited to only quantitative aspect; it doesn't include the qualitative factors for the determinants of MFIs sustainability in Rwanda. The future researchers on the this topic are also recommended to do comprehensive study by considering other influencing factors using qualitative aspects.

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# Impact of Mobile Banking on Financial Performance of Unguka Microfinance Bank Ltd, Rwanda

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*Abstract-* This study is for providing an analysis of the impact of mobile banking in financial performance of Unguka Bank Ltd(2012-2016). It is analyzing in depth previous studies to review the effect of mobile banking in financial performance of Unguka Bank Ltd.

Both Quantitative and Qualitative research methods such as questionnaires and interview were used towards answering the research questions in order to generate primary data. Furthermore, the study tackled on second data for attaining the objectives of the study.The questionnaires were distributed to all senior and employees who have experience with mobile banking. The interview was also administered to managers in order to fully understand the topic under research. This interview, also aimed at compensating for the eventual shortcomings of the questionnaires.

*Keywords:* *mobile banking, financial performance, microfinance, profitability, revenue and liquidity.*

*GJMBR-C Classification:* *JEL Code: G00*


*Strictly as per the compliance and regulations of:*

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Both Quantitative and Qualitative research methods such as questionnaires and interview were used towards answering the research questions in order to generate primary data. Furthermore, the study tackled on second data for attaining the objectives of the study.The questionnaires were distributed to all senior and employees who have experience with mobile banking. The interview was also administered to managers in order to fully understand the topic under research. This interview, also aimed at compensating for the eventual shortcomings of the questionnaires.

On the basis of the data collected and interpreted, a number of findings and conclusions were made and presented. Findings revealed that mobile banking products offered by Unguka Bank Ltd some of which include, Fund Transfer between Accounts, Bill Payment, and order for cheque books and bank statements and mobile money. And these mobile banking products were found to have increased the revenue of Unguka ltd in the last three years.

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## I. Introduction

Mobile banking is an innovative service, which has been perpetuated by the development and diffusion of the mobile communication technology. Bangens &, (2008) look this innovative as "the financial services delivered via mobile net works and performed on a mobile phone. Indeed, this service provides much convenience and promptness to the banks' customers along with cost savings. Many banks and telecommunication companies are interested in expanding their market through mobile services such mobile banking and mobile money.

For instance, the traditional widespread method is giving way to mobile banking system. Some years ago, banking transactions have been carried through offline retail banking system but today the mobile banking system is proving to hold bright future trend in banking transactions through electronic banking (e-banking).

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As described by Bangens & Soderberg (2008) Mobile banking provides personalized, anytime - anywhere banking services which allowing it to be seen as the future banking approach.

Accordingly, Mobile phones affect the lives of billions of people around the globe, including the poor. As referred by (Oluwatayo, 2012), changing mobile technology has revealed opportunities and allowed nearly three billion people without bank accounts" to access financial services. The lack of opportunities to access financial services by vulnerable and poor groups has motivated innovation by financial institutions in a variety of ways and that includes the concept of mobile banking. The significance of mobile banking in this regard is that has been brought financial services to the previously 'unbanked' areas. However, "despite these obvious potential benefits of mobile banking, but according to Is mail and Masinge (2011) questions remain about whether mobile banking has an effect on financial performance of Microfinance Financial Institutions.

For instance, although the usage of mobile banking has been strong growth over the last few years, it is still in its infancy. Thus, there is a need to study and understand users' acceptance of mobile banking services in order to identify the factors affecting their intention to use mobile banking. Indeed, the previous related research that conducted by Goh, (2002) in Vietnam does not clearly illustrate the factors that may affect the adoption of mobile banking services. Furthermore, Considerable research has been carried on mobile banking, mobile money and MFIs. However, a clear picture of the relationship between mobile banking and financial performance of MFIs has not emerged from previous studies. Of course, the existing body of knowledge is not sufficient enough to explain the influence of mobile banking on the financial performance of micro finance institutions. Therefore, this study seeks to focus on Unguka Microfinance Bank Ltd in order to investigate those factors and the effects of using mobile banking on the performance of microfinance institutions in Rwanda.

## II. Objectives

The study was guided by the following specific objectives

1. To identify the volume of transactions and products of mobile banking services offered by Unguka Bank Ltd to its customers
2. To analyze financial performance indicators of Unguka Bank Ltd before and after adoption of mobile banking system.
3. To measure the relationship between transactions volume and products of mobile banking and the financial performance of Unguka Microfinance Bank Ltd.

## III. Literature Review

In this reviews of literature broad categories were derived which helped in identifying the critical impact of financial effect of mobile banking on the financial performance of MFIs in Rwanda. Indeed, things like theoretical framework that guided the study, financial effect of mobile banking and empirical literature have been addressed under this section.

*a) Conceptual Framework*

The conceptual framework model gives an overview of the research. The variables to be studied are the independent variables, dependent variables and moderating variables chosen for the study so that the relationship is established.

i. *Financial System in Rwanda*

Financial system is very important in the economy of any country and without reliable financial system, the economy cannot be sustainable and the business cannot be developed and successful.

The Rwandan financial system comprises Banks, Non-Bank Financial Institutions (NBFIs - mainly insurance and pension funds) and Microfinance Institutions (MFIs). All these organizations are regulated and supervised by the National Bank of Rwanda (BNR).

Instance, at the end of August 2015, the Rwandan banking industry included eleven commercial banks and six specialized institutions (including four microfinance banks, one development bank, and one cooperative bank).

Financial service providers tend to operate along major infrastructural development axes. Financial services are therefore unevenly distributed. In particular, rural areas are still underserved and competition remains limited, despite the huge improvements brought about by Umurenge SACCOs. Given their nature, SACCOs are seen as a positive element to reach full financial inclusion and do not constitute a threat for other microfinance institutions, as they operate in remote areas not otherwise covered, offering a very limited range of services at higher interest rates. It should be noted that there are plans to consolidate all SACCOs into a cooperative bank at national level, in an effort to ensure effective monitoring and improve efficiency in the microfinance sector (Micro Finanza Rating, 2015).

ii. *Regulation and Control*

The financial sector is supervised by the National Bank of Rwanda. The activity of supervising Microfinance Institutions (MFIs) is based on the Law n° 55/2007 of 30/11/2007 governing the Central Bank of Rwanda, the Law n° 40/2008 of 26/08/2008 establishing the organization of microfinance activities and its implementing Regulation n°02/2009 of 27/05/2009.

iii. *Microfinance Institutions*

Otero (1999) says in essence that microfinance is 'the provision of financial services to low-income poor and very poor self-employed people'. Schreiner and Colombet, (2001) on the other hand define microfinance as 'the attempt to improve access to small deposits and small loans for poor households neglected by banks.

Because of this ability of microfinance institutions to reduce poverty alleviation and enhance economic development by providing credit and savings services to those people earning low incomes. The attention has been raised to develop different arguments regarding microfinance performance.

Independent of the definition provided to microfinance it is a general agreement in the economic field that micro financing alleviates economic development. The money or funds that are provided by microfinance institutions in terms of credit and micro loans enables those who are poor to invest into productive activities that are bound to earn them income helping them boost their economic level and alleviate poverty in the entire economy. Microfinance institutions therefore are an opportunity for sustainable development.

A developed Micro finance system broadens access to funds; conversely, in an undeveloped financial system, access to funds is limited and Srikanth, (2013) argued that people are constrained by the availability of their own funds and have to resort to high cost informal sources such as money lenders

The rapid pace of technological change in the financial sector has led to the development of new products and forms of settling payments. For instance, from Kenya, mobile phone payment platforms such as M–Pesa dramatically changed the financial landscape by offering customers a simple efficient and cost-effective method of savings, transfer money and make payments. In addition, government regulations such as the Kenyan National Payment System have also spurred investments in technologies that facilitate the instantaneous flows of finances between institutions.

These technological changes i.e. introduction of new products like M-Pesa, agency and mobile banking, rolling of bank branches, ATMs among others have not

only brought new avenues for access of financial services but also impacted on the number of people accessing these services. Notably the introduction of mobile money coupled with its high penetration has enhanced access to finance and greatly contributed to financial inclusion albeit prudentially unregulated. Mobile technology has brought new possibilities to the continent. Across urban-rural and rich-poor divides, mobile phones now connect individuals, markets and services (Aker & Mbiti, 2010).

iv. *Microfinance and mobile Banking*

Prof. Mahammad Yunus the founder and Chairman of Grameen Bank identified that microfinance are growing dramatically not only in the provision of credit but also a wide range of financial services ranging from savings to insurance for the low income people. However, Kohen, Hopkins, & Lee, (2008) challenged him by stating that despite the exponential growth experienced in the last couple of years 'as well as the growing success in reaching the—"unbanked", many low income households still continue to lack access to formal or semi-formal financial services.

Currently, a major constraint to microfinance is the high cost of operating in remote areas. Many institutions are now working toward low-cost delivery options such as internet banking and cashless transactions to help the rural poor. In fact, it may not be the internet, but the mobile devices that could be a more efficient tool for such transactions. For people in such rural areas, using computers is often a problem due to faulty Internet connections and frequent power failures. Hence, providing Micro-Credits through a mobile platform (SMS-based) could be the best way to reach out to the poor in the rural areas.

Indeed, while countries such as the Philippines and Vietnam rely on a large microenterprise sector to fuel the economy, not many financial institutions, including rural banks, until recently, were enthusiastic and well equipped to service their needs. However, currently, the scenario is changing and there has been a growing market in the developing countries for lending services provided mostly by non-governmental organizations. The rapid growth in the recent years coupled with commercialization of microfinance services has led to the emergence of more innovative and creative delivery channels of financial services to the rural areas.

v. *The Performance Measurement of Microfinance Institutions*

Normally, the issue of performance evaluation is more crucial in financial firms like banks as they are mobilizing the resource of the society. MFIs also share similar properties with banks as they are regulated or supervised by a regulatory body due to the fact that they collect deposit. Nonetheless, with regard to measuring their performance, the situation is more complicated. MFIs face a double challenge: not only do they have to provide financial services to the poor, but they also have to cover their costs in order to avoid bankruptcy. Both dimensions must therefore be taken into account in order to assess their performance (Ferro Luzzi and Weber, 2006).

The term outreach covers a wider range of concepts beside the number of clients served by an MFI. To Lafourcade*t al*. (2005), outreach is the efforts of MFIs to extend microfinance services to the people who are underserved by financial institutions. Therefore, they can be seen as stable organization that are able to finance themselves so as to stay in the economy and put a long lasting positive impact on the living standards of the society. In other words, sustainability and profitability should be crucial measures which put the MFIs under scrutiny. However, the Rwandan's MFIs are still heavily relying on donations and debts in order to finance their business.

*b) Financial performance*

According to Al-Hussein *et al*. (2009), financial performance is explained as the degree to which financial objectives are being or has been accomplished. It is the process of measuring the results of a firm's policies and operations in monetary terms. It is used to measure firm's overall financial health over a given period of time and can also be used to compare similar firms across the same industry or to compare industries or sectors in aggregation.

On other hand, the profitability of commercial banks depends heavily on the net of income generating activities and the related activities expense. Due to the problem of profitability and stiff competition in the industry, commercial banks have changed their behavior of income sources, by increasingly diversifying into non-intermediation income generating activities as opposed to the traditional intermediation income generating activities. For a commercial bank to remain competitive there is need to develop and adopt new products and technology. Such products include use of technology i.e. internet banking and mobile phone banking (McKay & Pickens, 2010).

i. *Bank performance indicators*

Profit is the ultimate goal of commercial banks hence all the strategies designed and activities performed thereof are meant to realize this grand objective. To measure the profitability of commercial banks, there are variety of ratios used such as Return on Asset, Return on Equity and Net Interest Margin (Murthy & Sree, 2003).

Return on Equity (ROE) is a financial ratio that refers to how much profit a company earned compared to the total amount of shareholder equity invested or found on the balance sheet. A business that has a high return on equity is more likely to be one that is capable

of generating cash internally. Thus, the higher the ROE the better the company is in terms of profit generation While, Return on Asset measures the ability of the bank management to generate income by utilizing company assets at their disposal. In other words, it shows how efficiently the resources of the company are used to generate the income. It further indicates the efficiency of the management of a company in generating net income from all the resources of the institution.

ii. *CAMEL rating system*

CAMEL is an acronym for five components of bank safety and soundness: Capital adequacy, Asset quality, Management quality, Earning ability and Liquidity.

Karlyn (1984) defines the capital adequacy in term of capital-deposit ratio because the primary risk is depository risk derived from the sudden and considerably large scale of deposit with drawals. While Frost (2004) sees the asset quality as indicators that highlight the use of nonperforming loans ratios (NPLs) which are the proxy of asset quality, and the allowance or provision to loan losses reserve. Furthermore, Grier (2007), argue that "poor asset quality is the major cause of most bank failures". On other side, the same author defined management quality to be the single most important element in the CAMEL rating system because it plays a substantial role in a bank's success. However, it is subject to measure as the asset quality examination. The two remaining forces are earning ability which viewed by Grier (2007) as a consistent profit not only builds the public confidence in the bank but absorbs loan losses and provides sufficient provisions. It is also necessary for a balanced financial structure and helps provide shareholder reward. And then after liquidity that expresses the degree to which a bank is capable of fulfilling its respective obligations.

iii. *Mobile Banking*

Mobile banking has been defined by Porteous (2006) as a subset of electronic banking in which customers access a range of banking products, such variety of savings and credit instruments, via electronic channels. According to Venable Telecommunications (2008), mobile banking can be defined as financial transactions that are based on wireless handsets. Hence, it involves accessing and providing banking and financial services through a mobile device with the help of mobile telecommunication devices.

Mobile banking today is most often performed via SMS or the Mobile Internet, providing two different types of customer account access: a web-based interface and a simple text messaging interface. This therefore means the customer can bank virtually anywhere anytime.

c) *Mobile banking and financial performance*

Financial institutions have been in the process of significant transformation. The force behind the transformation of these institutions is innovation in information technology. Information and communication technology is at the Centre of this global change curve of mobile and internet banking. Strategic management in financial institutions demand that they should have effective systems in place to counter unpredictable events that can sustain their operations while minimizing the risks involved through technological innovations.

Mobile banking applications are continuously being developed and have now become banks" favorite channels for offering banking services. According to Coelho (2003), one of the main strategies for growth and a major focus for mobile network providers and the banking industry, is the mobile banking and the potential it offers in providing various services. For instance, the mobile banking applications would enable offering of real-time 2-way data transmission, banking services, among other services (Daniel, 1999).

i. *Mobile banking and Increasing Sales Vol*ume

One of the primary tasks of a distribution channel is to increase the volume of demand for products at profitable prices. This objective is arrived by increasing operational efficiency so that those losses are minimized that are caused by delays in catering to customer orders. Furthermore, a favourable reputation of the firm's logistical capacities may help generate additional orders. Mobile Banking can contribute to achieve this goal by following means anytime, anywhere access to banking services.

ii. *Mobile Banking Transactions Volume*

In recent years, banks, payment system providers, and mobile operators have begun experimenting with branchless banking models which reduce costs by taking small value transactions out of banking halls into local retail shops, where agents such as airtime vendors, gas stations, and shopkeepers, register new accounts, accept client deposits, process transfers, and issue withdrawals using a client's mobile phone then communicate transaction information back to the telecommunication provider or bank. This enables clients to send and receive electronic money wherever they have cell coverage. They need to visit a retail agent only for transactions that involve depositing or withdrawing cash (Salzaman*et al.,*2001).

iii. *Mobile Banking Products*

The terms M-banking, M-payments, M-transfer and M-finance refer collectively to a set of applications that enable people to use their mobile telephones to manipulate their bank accounts, store value in an account linked to their handsets, transfer funds or even access credit or insurance products.These have enhanced accessibility to financial service in both developed and developing world.

iv. *Theoretical Review*

In particular, this section looks at the financial intermediation theory which deals with the core function

of financial institutions which in intermediating between the surplus and the deficit units for sustained economic development.It also reviews the modern economics theory which holds that for a business to make returns, it has to obey the modern economics..

i. *Innovation diffusion theory*

Mahajan& Peterson (1985) defined an innovation as any idea, object or practice that is perceived as new by members of the social system and defined the diffusion of innovation as the process by which the innovation is communicated through certain channels over time among members of social systems. Diffusion of innovation theory attempts to explain and describe the mechanisms of how new inventions in this case internet and mobile banking is adopted and becomes successful (Edwin, 2014). The same author stated that not all innovations are adopted even if they are good it may take a long time for an innovation to be adopted. He also stated that resistance to change may be a hindrance to diffusion of innovation although it might not stop the innovation it will slow it down.

ii. *Financial intermediation theory*

Financial intermediation is a process which involves surplus units depositing funds with financial institutions who then lend to deficit units. Bisignano (1992) identified that financial intermediaries can be distinguished by four criteria. First, their main categories of liabilities or deposits are specified for a fixed sum which is not related to the performance of a portfolio. Second, the deposits are typically short-term and of a much shorter term than their assets. Third, a high proportion of their liabilities are chequeable which can be withdrawn on demand and fourthly, their liabilities and assets are largely not transferable. The most important contribution of intermediaries is a steady flow of funds from surplus to deficit units.

According to Scholtens & Van (2003), the role of the financial intermediary is essentially seen as that of creating specialized financial commodities. These are created whenever an intermediary finds that it can sell them for prices which are expected to cover all costs of their production, both direct costs and opportunity costs.

iii. *Modern economics theory*

Modern economics has gone far in discovering the various pathways through which millions of expectations of, and decisions by, individuals can give rise to emergent features of communities and societies like rate of inflation, productivity gains, and level of national income, prices, and stocks of various types of capital, cultural values, and social norms. According to Sohail and Shanmugham, (2003) there are two factors make economic theory particularly difficult. Those include individual decisions at any moment are themselves influenced by these emergent features, by past decisions learning, practice, and habit, and by future expectations. And then after the emergent features that can be well handled by existing economic theory and policy concern only fast-moving variables.

*e) Empirical Review*

Several studies have been conducted on the effects of mobile banking and the performance of commercial banks. For instance, Tchouassi (2012) conducted a study to find out whether mobile phones really work to extend banking services to the unbanked using empirical Lessons from Selected Sub-Saharan Africa Countries. Cleary, the study sought to discuss how mobile phones could be used to extend banking services to the unbanked, poor and vulnerable population. Thus, he noted that poor, vulnerable and low-income households in Sub Saharan Africa (SSA) countries often lacked access to bank accounts and faced high costs for conducting basic financial transactions. The study concluded that the mobile phone presented a great opportunity for the provision of financial services to the unbanked. In addition to technological and economic innovation, policy and regulatory innovation was needed to make these services a reality.

On other side, Donner & Tellez (2008) launched a study on mobile banking and economic development where they sought to link adoption, impact, and use. Through their study they come out with that offering a way to lower the costs of moving money from place to place and offering a way to bring more users into contact with formal financial systems, m-banking/m-payments systems could prove to be an important innovation for the developing world. However, the true measure of that importance required multiple studies using multiple methodologies and multiple theoretical perspectives before answering the questions about adoption and impact.

For instance, Wambari (2009) studied mobile banking in developing countries using a case of Kenya. This study sought to establish the importance of mobile banking in the day to- day running of small businesses in Kenya and to understand the challenges involved in using m-banking as a business tool and appreciate the advantages and disadvantages therein. This study elaborated that the adoption and use of mobile phones is product of a social process, embedded in social practices such as SMEs Practices which leads to some economic benefits.

Therefore, banks should focus on communicating information that emphasizes the relative advantage and usefulness of mobile banking compared to other banking channels like physical presence to the bank or using ATM machines. Banks must seek to reduce risk perceived by their customers by offering specific guarantees protecting them and taking their complaints seriously and urgently.

According to Koivu (2002) uptake of mobile phone in Kenya has been unprecedented. Mobile banking in Kenya affects performance of organization, behavior and decision making of the entire economy. The trend of continued reliance on mobile devices to execute monetary transaction is steadily gaining momentum. Mobile banking is one innovation which has progressively rendered itself in pervasive ways of cutting across numerous sectors of economy and industry.

i. *Effects of mobile banking on withdrawals and deposits*

Mobile banking has revolutionized the way people within the developing countries transfer cash and currently it is poised to provide of refined banking services that may build a true distinction to people's lives. This kind of banking can give good type of services starting from account data that should do with alerting the customers on the updates and transactions on their account through their mobile phones. People receive short messages on their phones informing them of their immediate transactions in their bank accounts. In addition, they assist in payments (utility bills), deposits, withdrawals, transfers, purchase airtime, request bank statements and perform thirteen different crucial banking tasks, bushed real time over their mobile phones (Vincent *et al.,* 2016)

ii. *Effects of mobile banking of funds transfer*

In 2006, Mari conducted a study on adoption of M banking in European nation. The study conducted a survey of 2006 customers of banks placed in land. The data inside the empirical study were collected by suggests that of a type armored to banking customers. The results from the study indicated that certain attributes of M banking influence its usage. The attributes include; relative advantage, compatibility, communication and tradability. The investigation of quality and risk of pattern M banking yielded no support as being barriers to adoption. The finding collectively disclosed that, technology perception and certain demographical variables of the customers have a serious impact on adoption. In a very completely different study titled "An empirical investigation of mobile banking adoption", conducted by (Vincent *et al.,* 2016), the results indicated that perceived relative advantage, simple use, compatibility, ability and integrity significantly influence perspective.

## V. Research Methodology

This section indicates various methods and techniques used by the researcher during the course of gathering relevant information from the field. The method that applied in this study was selected to use depending on specific research topic, along with research approach and philosophical position opted in the same study.

*a) Research design*

According to Kothari (2008), research design is the conceptual structure within which research is conducted, it constitutes the blueprint for the collection, measurement and analysis of data as such the design includes an outline of what the researcher did from writing the hypothesis and its operational implications to the final analysis of data.

The researcher used a descriptive research design, where qualitative and quantitative approaches are used. In quantitative approach the researcher employed data in form of numbers collected from employees on mobile banking and financial performance of MFIs. Qualitative is used through interviews in order to describe the activities and its impact of mobile banking on financial performance of MFIs.

*b) Target population*

All the items under consideration in any field of inquiry constitute a 'universe' or 'population'. It can be presumed that in such an inquiry when all the items are covered no element of chance is left and highest accuracy is obtained (Kothari, 2004).

The case study of this research was Unguka Microfinance Bank Ltd and the population was 67 employees and the questionnaire was administered to 50 employees composed by all 24 senior managers and 26 employees who have experience on mobile banking.

*c) Sample design & Sample technique*

A sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting items for the sample (Kothari, 2004). Sampling technique is used to choose the staff to be investigated and this followed Census and purposive whereby the researcher has taken the selected respondents composed by selected staff of different departments.

Purposive sampling procedure is used because the researcher believes it is convenient and time saving. The members are purposively selected depending on their ability to easily analyze and understand the problem of study.

*d) Data collection instrument*

Questionnaires and documentary review are the essential data instruments that helped the researcher to collect the necessary information to verify the research hypotheses by establishing the relationship between independent variables and dependent variables.

The questionnaire comprised of background questions about gender, age, education, working experience with Unguka Bank Ltd and structured questions were asked to collect the information from the respondents. Furthermore the structured questionnaire had multiple-choice questions in which the researcher

provided a choice of answers and respondents were asked to select one or more of the alternatives and open ended questions. The study also used 'Likert Scale' (considered on 1-5 points scale) to measure the respondents' perceptions based on few statements to perceive the impact of mobile banking on financial performance of Unguka Bank Ltd. The points of the scale indicate the degree of agreement '1' represents the lowest level of agreement or high disagreement, whereas '5' represents the highest level of satisfaction or high agreement.

On other hand, this research also reviewed literature from the case study organization.The documentation review included bank financial statement, annual reports and other reports from the bank. This method was chosen because; it is vital in providing background information and facts about mobile banking on performance of the bank before primary data could be collected.Indeed, before field data is collected, a wide collection of data had been collected and this was used to cross check with the primary data that is to be obtained by the field.

*e) Validity and reliability*

The validity of data was checked before processing the results. This helped to establish the reliability of the tools used in data collection. According to George & Malley (2003), "Cronbach's alpha is used as only one criterion for judging instruments or scales. It only indicates if the items "hang together"; it does not determine if they are measuring attribute. Therefore, scales also should be judged on their content and construct validity". George&Malley (2003) provide the following techniques:

*f) Data processing and analysis*

The researcher collected both secondary and primary data. For primary data the researcher used questionnaires to obtain quantitative and qualitative data for analysis which further were validated from analyzed results from secondary data quantitative analysis. Both quantitative and qualitative data are collected in this study. The quantitative data are analyzed using SPSS. The study used (ROA) and (ROE) as a measure of profitability of financial performance. In order to establish the relationship between Mobile banking and Financial Performance of Unguka Bank Ltd, the following regression model is applied,

$$Y = \beta 0 + \beta 1X1 + \beta 2X2$$

## VI. Results and Discussion

This section discusses the findings of the study in three main sub-sections corresponding to the objectives of the study. After the demographic information, the first sub-section describes the relationship between mobile banking transactions volume and financial performance indicators of Unguka Bank Ltd, the second sub-section discusses the relationship between mobile banking products and the financial performance of Unguka Microfinance Bank Ltd, and the third sub-section includes the analysis of the correlation between financial performance indicators and mobile banking transactions volume and mobile banking products.

*a) Demographic information*

Variables assessed for getting demographic data are age of respondents, gender, level of education and working experience with Unguka Bank Ltd. Obtained results through the study illustrated that all respondents were 50 members composed by 33 men who represent 66% and 17 women who represent 34% of all respondents. The respondents were concentrated between 25 and 44 years (80% of all respondents), the respondents who have more than 44 years were only (12%) while 8% have less than 25 years.

For the repartition of respondent based on education level, a big number of respondents have diploma level (62% of all respondents). The respondents with high school level were 20% and 14% for the respondents with undergraduate level of education while 4% have postgraduate level. Concerning working experience 2% have between 1-2 years, 30% between 2-3 years, 38% between 3-4 years and 28% have more than 5 years of experience with Unguka Bank Ltd.

*b) Relationship between financial performance indicators and mobile banking transactions volume in Unguka Bank Ltd*

i. *Financial performance indicators in Unguka Bank Ltd*

Financial performance indicators selected for this analysis are ROE, ROA, Revenue and Liquidity. Historical analysis of these indicators revealed its variations since 2012. The mobile banking system has been introduced in 2014. The study aimed to identify the contribution of this new system in the improvement of financial performance with the only four indicators mentioned above

ii. *Return on equity (ROE)*

Return on Equity (ROE) is the most important profitability indicator; it measures an MFI's ability to reward its shareholders' investment, build its equity base through retained earnings, and raise additional equity investment (Isabelle Barres et al, 2005).The return on equity ratios of Unguka Bank Ltd from 2012 to 2016 are shown bellow.

A business that has a high return on equity is more likely to be one that is capable of generating cash internally. Thus, the higher the ROE the better the company is in terms of profit generation. From the study findings above, the study established that Unguka Bank Ltd's Return on Equity was 5.4%, 6.60%, 2.30% and -10.70% respectively in 2013, 2014, 2015 and 2016.

ROE dropped deeply to 2.30% in 2015 to reach its lowest point in the study

In the light with the above authors, ROE which is the financial performance indicator is not showing a good performance and it seems that there is no effective good management in utilizing the shareholders capital period at -10.70% in the year 2016.

iii. *Return on Assets (ROA)*

The Return on Assets is an indication of how well an MFI is managing its asset base to maximize its profits (Ruth*et al.,*2008). The ratio includes not only the return on the portfolio, but also all other revenue generated from investments and other operating activities (Isabelle *et al.,* 2005). The study analyzed the consolidated financial performance of Unguka Bank Ltd during the study period.

From the study findings above, the study established that Unguka Bank Ltd Return on Assets is decreasing from 2014 up to 2016 respectively from 1.60% to -2.50% meaning that ROA decreased the year to year. This decrease of ROA could be attributed to many factors beyond this study as the performance of Unguka Bank Ltd in a function of more variables including the macroeconomic variables besides the mobile banking effects being looked at in this study.

In additional, the researcher found that Unguka Bank Ltd for the last year 2016 has known a decrease in net income largely caused by the increase of personnel expenses along with the increase of provision expenses due to the increase of NPL. The decrease of ROA cannot be attributed to the mobile banking system.

iv. *Liquidity*

The liquidity of Unguka Bank Ltd increased greatly under the period of study but for 2014 and 2016 slightly dropped. Once again the researcher cannot say that this decrease is due to mobile banking, it can be attributed partially to other factors

| | Year 2012 | Year 2013 | Year 2014 | Year 2015 | Year 2016 |
|---|---|---|---|---|---|
| Liquidity | 3,367,227,739 | 5,903,744,584 | 5,486,384,720 | 7,950,728,993 | 6,955,131,530 |

*Source: Extracted from Unguka Bank Ltd Factsheet 2012-2016*

The researcher is in agreement with Grier (2007) who emphasizes that "the liquidity expresses the degree to which a bank is capable of fulfilling its respective obligations". Banks makes money by mobilizing short term deposits at lower interest rate, and lending or investing these funds in long term at higher rates, so it is hazardous for banks mismatching their lending interest rate.

v. *Study of mobile banking transactions volume in Unguka Bank Ltd*

Under this section the study sought to establish whether Unguka Bank Ltd s had been offering mobile banking services for the last three years. All the respondents indicated that Unguka Bank Ltd has been offering mobile banking services to its clients for the last three years for several services such as deposits, over the counter withdrawals, and fund transfer.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Deposits | 50 | 1 | 4 | 1.88 | .849 |
| Withdrawals | 50 | 2 | 5 | 4.34 | .772 |
| Transfer | 50 | 1 | 3 | 1.36 | .598 |
| OVERALL MEAN | | | | 2.5 | |

*Source: Research Findings, 2017*

As depicted in this table of deposit by mobile banking, withdrawals, and level of transfer by mobile banking revealed that withdrawals are the main service provided by Unguka Bank Ltd to its customers using mobile banking. As given in the above table, the minimum answer of respondents is 2= Disagree while the highest answer for withdrawals is 5=strongly agree. The mean of the answers collected is 4.34 which is above 4=agree. This means that respondents are totally agreeing that the withdrawals are the most transactions made by customers through mobile banking.

c) *Relationship between mobile banking products and the financial performance in Unguka Microfinance Bank Ltd.*

The study requested the respondents to state their opinion about the Mobile banking products offered by Unguka Bank Ltd. The respondents indicated that Unguka Bank Ltd offered at different levels the products of Fund Transfer between Accounts, Bill Payment, order for cheque books and bank statements. Findings are summarised in the following table:

| | N | Min | Max. | Mean | Std. D |
|---|---|---|---|---|---|
| Funds transfer between accounts | 50 | 1 | 3 | 1.52 | .544 |
| Bill payment | 50 | 3 | 5 | 4.16 | .792 |
| Bank statement checking | 50 | 3 | 5 | 4.00 | .833 |
| Mobile Money | 50 | 2 | 5 | 3.20 | .670 |
| Book check order | 50 | 1 | 4 | 1.96 | .856 |
| Valid N (listwise) | 50 | | | | |
| OVERALL MEAN | | | | 3 | |

*Source: Research Findings, 2017*

In the above table, five variables analyzed revealed that Bill Payment, Bank Statement checking and Mobile Money are the most used mobile banking products with the mean of 4.16, 4.00, and 3.20 respectively. The overall mean for the 5 variables assessed is 3=neither disagree nor agree. But this mean has been decreased by the variable Fund transfer between accounts (mean=1.52) and Book check order (mean=1.96) indicating that these two products are not intensively used.

These findings leads to conclude that Bill Payment, Bank Statement checking, and Mobile Money are the most used mobile banking products which can have a positive impact to the financial performance since they make revenues in terms of commission the Bank received from them.

The researcher agrees with Karjaluoto, (2002) who argued that by complementing services offered by the banking system, such as cheque books, ATMs, Voice mail/landline interfaces, smart cards, point of sale networks and internet resources, the mobile platform offers a convenient additional method for managing money without handling cash.

*d) Analysis of the correlation between financial performance indicators and mobile banking transactions volume and mobile banking products*

The third objective of the study was the analysis of the correlation between financial performance indicators and mobile banking transactions volume and mobile banking products. To achieve this objective, a correlation analysis was conducted between three variables of the study: Mobile Banking transactions Volume, Mobile Banking Products and Financial Performance.

From the findings, the study concludes that the mobile banking transactions volume had a positive influence on the financial performance of Unguka Bank Ltd. Given that the secondary data used was for a short period of almost three years and customers being not accustomed to the mobile banking system, all the mobile banking services are not used for example withdrawal was the most used, deposits and transfers are used at a very low level.

The study also concluded that mobile banking products had a positive impact on the financial performance of Unguka Bank Ltd with bill payment intensively used and this has brought revenues from commissions paid by customers; but other products like transfer between accounts, bank statement, mobile money and book check order are not used at a satisfactory level. The opinions from the respondents showed that mobile banking has many advantages than the bank-based services in terms of customers' satisfaction and reduction of operating costs.

The study concludes that there is a positive correlation between financial performance indicators before and after the introduction of mobile banking. As seen in appendix the regression analysis it is shows that the $R2$ value of the independent variables has a low positive effect on the dependent variables. In the correlation analysis there are low significant relationship between the independent variables and the dependent variable. The main reason is the lack of experience by customers because mobile banking is newly introduced by Unguka Bank Ltd; then the effort must be made to sensitize the customers the benefits of mobile banking by stating granting loans at a low interest rate for those who sign up with mobile banking system

On the influence of mobile banking products on the financial performance of Unguka Bank Ltd, findings revealed that mobile banking products offered by Unguka Bank Ltd some of which include, Fund Transfer between Accounts, Bill Payment, and order for cheque books and bank statements and mobile money. These mobile banking products were found to have increased the Unguka Bank Ltd revenue in the last three years.

This study shows how the respondents have appreciated how customers do appreciate and embrace mobile banking system even if it is not yet at the satisfactory level. This could be attributed to the advantages offered by mobile banking which include convenience and flexibility.

## VIII. Conclusion and Recommendation

*a) Conclusion*

The study provided an analysis of the impact of mobile banking in financial performance of Unguka Bank Ltd. A wide selection of literature was reviewed on the effect of mobile banking in financial performance of Unguka Bank Ltd.

By using both Quantitative and Qualitative research methods, On the basis of the data collected and interpreted, a number of findings and conclusions

were made and presented. Almost all the respondents agreed on the importance of mobile banking in financial performance of Unguka Bank Ltd. Based on the findings, Unguka Ltd has to continue to improve mobile banking services in terms of the quality of services offered, to expand its services to all domains namely disbursement and collection of loans and increase client outreach for its performance in terms of profitability and sustainability. The study has also shown that there is positive correlation between financial performance indicators before and after the adoption of mobile banking system and shown the positive relationship between mobile banking transaction volume and products and financial financial performance of Unguka Bank Ltd.

*b) Recommendation*

The study recommends that Unguka Bank Ltdshould lower the transaction charges incurred by customers, introduce in mobile banking the repayment and disbursement service and ATM and improve the quality of mobile banking services so as to motivate them use the mobile banking services. This will increase the number of transactions and hence improve the financial performance of Unguka Bank Ltd.

It also recommends further research be conducted on the effects of mobile banking on the financial performance of banking institutions in Rwanda in order to provide in depth the challenges can be faced by Financial Institutions in adopting mobile banking.

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## Appendix

Table of Correlation analysis

| | | TRANSVOLUME | PRODUCTS | FINPERFORMANCE |
|---|---|---|---|---|
| TRANSVOLUME | Pearson Correlation | 1 | .292* | -.047 |
| | Sig. (2-tailed) | | .039 | .745 |
| | N | 50 | 50 | 50 |
| PRODUCTS | Pearson Correlation | .292* | 1 | .182 |
| | Sig. (2-tailed) | .039 | | .205 |
| | N | 50 | 50 | 50 |
| FINPERFORMANCE | Pearson Correlation | -.047 | .182 | 1 |
| | Sig. (2-tailed) | .745 | .205 | |
| | N | 50 | 50 | 50 |

*. Correlation is significant at the 0.05 level (2-tailed).

Analysis of Variance (ANOVA[b])

| Model | Sum of Squares | df | Mean Square | |
|---|---|---|---|---|
| 1 | Regression | 18.233 | 2 | 9.117 |
| | Residual | 393.147 | 47 | 8.365 |
| | Total | 411.380 | 49 | |

a. Predictors: (Constant), PRODUCTS, TRANSVOLUME

Regression analysis

| Model | | Unstandardized Coefficients | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound | |
| 1 | (Constant) | 9.936 | 3.521 | | 2.821 | .007 | 2.851 | 17.020 | |
| | TRANSVOLUME | -.243 | .330 | -.110 | -.737 | .465 | -.906 | .420 | |
| | PRODUCTS | .318 | .221 | .215 | 1.439 | .157 | -.127 | .764 | |

*a. Dependent Variable:FINPERFORMANCE From the data in the above table the established regression equation was: Y= 9.936 0.243X1 + 0.318X2*

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# Analysing the Promised Effect of Liberalization on Banking Sector Efficiency in Ghana

By Frank Prah

*Abstract-* This study assesses changes in banking sector efficiency in Ghana amidst deepening sector liberalization process. Using quarterly data from 2000q3 to 2011q4, data envelopment analysis was used to derive the overall technical efficiency, pure technical efficiency and scale efficiency for all licensed banks. Five alternative models were utilized. Generally, overall technical, pure technical and scale efficiencies reduced over time. The intensity and prevalence of scale inefficiency were higher than pure managerial inefficiency; increasing return to scale was more prevalent among scale inefficient banks than scale inefficiency. Finally, incidence of increasing returns to scale declined whereas decreasing returns to scale increased.

*GJMBR-C Classification:* *JEL Code: E50*

# Analysing the Promised Effect of Liberalization on Banking Sector Efficiency in Ghana

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## I. Introduction

The neo-classical hypothesis that prices in a free competitive market system holds the potency to ensuring efficiency in production and supply of goods and services, as well as efficiency in consumption through price stability and product availability, is the bedrock upon which financial sector liberalization policies were formulated. These policies were proposed and aggressively implemented in the 1980s in many developing economies that were identified to have been bedeviled with "financial repression" (McKinnon, 1972; Shaw, 1972). Since then, financial liberalization has become the major principle for financial sector policies.

The main aim of financial sector liberalization is to remove market rigidities in the form of monopolies and external controls in order to promote competition among firms. Improvements in competition are expected in turn to lead to efficient pricing and allocation of financial resources needed for economic growth and development. (Barajas et al., 1999; Leon, 2012) Increasing levels of competition and efficiency in the financial markets are thus expected, almost automatically, to be the outcome of deepening financial sector liberalization. Though it may be volatile, interest rates are expected to be downward trending while expanded product availability is assured to follow the policy (Caprio, Honohan and Stiglitz, 2001).

To this end, financial sector liberalization policies were adopted in Ghana in the late 1980s with the aim of creating a "free market" environment which was considered necessary for improving market competition and efficiency. Prah (2014) provides evidence to show that the market structure of the Ghanaian banking industry improved substantially during the last decade. Nevertheless, interest rates and availability of funds should be considered key indicators for gauging benefits from financial sector liberalization to consumers, especially in a previously "re-repressed" financial sector. This is because the ultimate promise of the liberalization theory is the emergence of an efficient market; a condition that should reflect in the prices and availability of goods and services produced in the market. In particular, the spread between lending and interest rates reflects how efficient a banking system is performing its traditional role which is financial intermediation.

Interest rates and related spreads in the Ghanaian money market have received significant level of attention in recent times by the Central Bank of Ghana, the Association of Ghana Industries (AGI) and other financial service consumer groups. Though the level of inflation has seen significant reduction during the past years, from an annual average of 32.9 per cent in 2001 to 8.68 per cent in 2011, the average lending rate charged by commercial banks has remained well above 20 per cent for more than two decades. The general feeling is that the cost of borrowing or the lending rates are just too high especially when compared with the corresponding deposits rates and the general level of prices in the economy. This raises the question of whether market efficiency is improving or worsening amidst the on-going sector liberalization.

In a review of studies on efficiency among financial institutions, Humphrey (1997) observed that liberalization might not always be efficiency and productivity enhancing. Thus it is important to examine from time to time whether liberalization policies being implemented are enhancing efficiency or not so that unintended negative effects are corrected while positive ones are consciously reinforced. In the light of this, it is necessary to ascertain empirically whether the Ghanaian banking sector efficiency has improved over the years that financial liberalization policies have been continuously implemented. This study therefore assesses the evolution of banking sector efficiency in Ghana from 2000 to 2011. The main hypothesis to be tested is that financial liberalization has led to a continuous improvement in banking sector efficiency in Ghana.

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## II. Market Performance of Deposit Money Banks in Ghana (1990 – 2012)

According to the Ghana Financial System Stability Assessment Update report (IMF, 2011), deposit money banks (DMB9 or commercial banks) in Ghana control more than 70 per cent of total assets of the entire financial system and more than 88 per cent of total assets of the Banking system. This makes DMBs the back bone of both the banking sector and the entire financial system. Thus, several studies on Ghana, such as Quartey and Prah (2008), have used the commercial banking sector as proxy for the financial system in Ghana.

*Table 1:* Performances of Deposit Money Banks in Ghana (2000 – 2012)

| Year | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Banks | 16 | 17 | 17 | 18 | 18 | 20 | 23 | 23 | 25 | 26 | 26 | 27 | 26 |
| Branches | 304 | 326 | 322 | 329 | 384 | 378 | 450 | 595 | 640 | 706 | 776 | 795 | 859 |
| Assets (% of GDP) | 44.0 | 41.1 | 39.4 | 37.6 | 39.1 | 38.6 | 27.3 | 32.9 | 34.5 | 38.1 | 37.5 | 36.1 | 37.5 |
| Loans(% of GDP) | 10.8 | 13.3 | 12.6 | 10.4 | 12.9 | 13.1 | 9.6 | 10.9 | 12.7 | 16.2 | 15.0 | 13.4 | 13.1 |
| Deposits(% of GDP) | 12.3 | 12.1 | 14.6 | 16.1 | 18.5 | 19.8 | 11.9 | 13.8 | 14.7 | 17.2 | 17.5 | 17.7 | 19.5 |
| **Composition of Income** | | | | | | | | | | | | | |
| Other Income | 17.9 | 7.7 | 11.9 | 9.4 | 9 | 8.5 | 7.8 | 7.6 | 12.7 | 11 | 7.1 | 12.3 | 11.9 |
| Commissions and Fees | 15.6 | 14.7 | 21.1 | 19.3 | 21 | 20.5 | 20.7 | 21.5 | 17.8 | 14.8 | 14.9 | 18.1 | 17.7 |
| Loans | 32.4 | 39.3 | 40.7 | 36.1 | 39.3 | 40.6 | 44.9 | 49.4 | 55.3 | 58.7 | 55.9 | 46.4 | 47 |
| Investments | 34.2 | 38.3 | 26.3 | 35.2 | 30.7 | 30.4 | 26.7 | 21.5 | 14.3 | 15.4 | 22.1 | 23.3 | 23.5 |
| **Liquidity and Capital Adequacy** | | | | | | | | | | | | | |
| Liquid Assets to Total Deposits | - | - | - | - | - | - | 36 | 37 | 38.8 | 41.1 | 37.3 | 38.4 | 33.6 |
| CAR | 11.4 | 14.7 | 13.4 | 9.3 | 15.3 | 16.2 | 15.8 | 15.7 | 13.8 | 18.2 | 19.1 | 17.4 | 18.6 |
| **Asset Quality** | | | | | | | | | | | | | |
| NPL Ratio | 11.9 | 19.6 | 22.7 | 18.3 | 16.1 | 13 | 7.9 | 6.9 | 7.7 | 16.2 | 17.6 | 14.1 | 13.2 |
| Loan Loss Provision to Gross Loan | 7.1 | 10 | 13.5 | 11.4 | 9.3 | 8.5 | 5.77 | 4.73 | 5.13 | 9.42 | 9.37 | 7.68 | 6.43 |
| **Earning Indicators** | | | | | | | | | | | | | |
| Gross Yield | 23.4 | 25.7 | 22.3 | 19.3 | 19.2 | 17.2 | 16 | 14.9 | 17 | 20.4 | 19.5 | 15.3 | 15.9 |
| Net Interest Margin/Gross Income | 40.3 | 50 | 47.9 | 49.3 | 50.7 | 51.6 | 51.8 | 46.1 | 41.3 | 39.4 | 50.1 | 46.8 | 48.5 |
| Profitability Ratio | 28.2 | 21.9 | 23.1 | 20.2 | 22.8 | 16.5 | 19 | 16.2 | 13.3 | 9.8 | 14.6 | 17.8 | 21.5 |
| Return on Assets (before tax) | 10.4 | 8.6 | 7.9 | 6.5 | 6.4 | 4.8 | *3.3* | *2.6* | *2.5* | *2.1* | *2.7* | *2.8* | *3.6* |
| Return on Equity (before tax) | 65.2 | 44.2 | 48.4 | 35.2 | 35.5 | 25 | *39.6* | *35.8* | *30.1* | *23.6* | *28.6* | *27.2* | *34.6* |
| **Operational Efficiency** | | | | | | | | | | | | | |
| Cost to Income | 71.8 | 78.1 | 78.95 | 79.8 | 81.65 | 83.5 | 81 | 83.9 | 86.9 | 90.1 | 85.4 | 82.4 | 78.7 |
| Operational Cost to Gross Income | 45.5 | 50.5 | 54.15 | 57.8 | 60.95 | 64.1 | 61.2 | 59.1 | 58.6 | 55.4 | 57.5 | 59.5 | 56.7 |
| Cost to Total Assets | 16.5 | 18.7 | 16.55 | 14.4 | 14.3 | 14.2 | 12.3 | 11.7 | 13.8 | 15.8 | 14.3 | 11.6 | 12.1 |
| Operational Cost to Total Assets | 10.5 | 12.1 | 11.3 | 10.5 | 10.7 | 10.9 | 9.3 | 8.3 | 9.3 | 9.7 | 9.6 | 8.4 | 8.8 |

*Source: Bank of Ghana, Financial Stability Report (various issues) and Ghana Statistical Services*

Several changes have occurred in the deposit money banking sector in recent years. As indicated in Table1, the number of licensed banks almost doubled between 1999 and 2012, with almost a threefold increase in the total number of branches operated by the banks. These indicate substantial expansion in coverage and access to banking services in the country. Also, the balance sheets of the sector have expanded substantially over time. Total assets increased from 19.4 per cent in 1990 to 37.3 per cent of GDP in 2012, albeit there were some intermittent fluctuations. Much of the increases were from domestic sources. The share of total outstanding credits to the private sector, public enterprises and the central government increased from 4.4 per cent in 1990 to 24.8 per cent of GDP in 2012. Improvements in credit advancements were accompanied by similar improvements in the mobilization of deposits. Deposits from the private sector increased more than half of total liabilities during the period under review.

However, a linear trend analysis shows that all major income components, except interest incomes on loans, had negative gradients. This means average income from those sources reduced. On the other hand, interest income on loans increased from 32.4 per cent of total income in 2000 to a peak of 58.7 per cent in 2009 before reverting to 47 per cent in 2012. Interest income on loans constituted about 45 per cent of total income from 2000 to 2012. This was followed by investment income (26.3%), commissions and fees (18.3%) and other income (10.4%) respectively.

Liquidity in the market has generally been unstable. Available data indicates that liquid assets to total deposits and total assets all increased from 2005 to 2009 but have since been reducing. Nevertheless, there has been a continuous improvement in equity resulting in the market capital adequacy ratio hovering above 10 per cent in the entire period except the minimum 9.3 per cent recorded in 2003. Even though the banks were

generally well capitalized, more efforts were still required to stem credit risk, especially during the latter part of the period. Non-performing loans to asset ratio reduced significantly from above 20 per cent in 2002 to below 10 per cent from 2006 to 2008. From 2009, however, the ratio remained above 13.2 per cent. The NPL was again more than 5 per cent above total gross loans. These have implications to efficiency and profitability in the sector.

A trend analysis of the various profitability indicators unanimously show that profitability generally decreased during the period under study. However, since 2010, there had been a greater tendency for industry profits to rise. For example, even though profitability ratio decreased from 28.2 per cent in 2000 to 9.8 per cent in 2009, the ratio improved afterwards to about 21.5 per cent in 2012. Comparing profitability trends to those of income and credit risk, it appears that during the last three years in the period, banks benefitted in terms of high returns for taking more risk.

Finally, a similar trend analysis of ratio measures for management efficiency was rather inconclusive. Whereas cost to income ratios indicate that, on average, management efficiency reduced over the period, cost to assets ratios indicated otherwise. This also underscores the need for more comprehensive measurement and analysis of efficiency, hence the objectives of this current study.

## III. Literature Review

The importance of financial system efficiency is well noted in the literature. Countries with efficient financial system are found to be less prone to financial crises, currency crises, and grow faster (Barajas et al., 1999; Caprio, Honohan and Stiglitz, 2001; and Leon, 2012). An inefficient financial system is believed to lead to the destruction of wealth, as consumers are forced to pay higher than optimal price for inevitable financial services. Such a system also directs funds to less efficient sectors of the economy leading to inefficient utilization of society's scarce financial resources. Therefore, improving the efficiency of the financial sector does not only improve fund utilization for growth, but also ensure effective redistribution of wealth from financial firms to their consumers.

Implementation of financial sector liberalization policies hinges on the assumption that removing market barriers will enhance competition in the market which would in turn lead to efficiency in pricing and production. Common among liberal economists and in many studies, efficiency is assumed to emerge automatically from competition. Thus many past studies on the market impact of liberalization have been based on measures of market competition. However, it is imperative to directly measure efficiency rather than to deduce it theoretically as a direct function of competition.

Literature on bank sector efficiency in Ghana is relatively limited and mainly based on Data Envelopment Analysis (DEA) to measure relative efficiency among banks. In one of the earliest empirical study on Ghana, Korsah et al. (2001) applies DEA within the intermediation frame work on annual data for some selected banks from 1988 to 1999. They established that bank efficiency improved but stagnated at the letter period. To extend this study, Akoena et al (2009) used annual data from 2000 to 2006 on 16 selected commercial banks to investigate the changes in technical efficiency and economies of scale of the banks and to test whether large banks were more efficient than small banks in anticipation of impending recapitalization requirements by the central bank. The study uses DEA and runs five different models within the production and intermediation approaches to DEA in banking sector. They established that the overall technical efficiencies of large and small banks were similar but scale efficiencies of small banks were found to be larger than big banks. From this finding, they cautioned the central bank against encouraging banks to get bigger, especially if the objective of the recapitalization was to improve efficiency among the banks.

Examining the relative efficiency of banks in Ghana during the year 2007 and to investigate the linkage between efficiency and profitability, Frimpong (2010) also used intermediation approach to DEA to estimate relative technical efficiency of 22 banks in Ghana, based on constant returns to scale (CRS) assumption. He found that only 4 banks were efficient. The 18 inefficient banks had inefficiency ranging from 33% to 89% and the sector's average technical efficiency (at CRS) was 74%. Among the 22 banks, domestic private banks were most efficient followed by foreign and state banks respectively. In a most recent study on Ghana, Adjei-Frimpong et al (2014) also used DEA under intermediation approach to analyses cost efficiency of the banking industry. Static and dynamic panel data models were further employed to ascertain the impact of size, capitalization, loan loss provision, inflation rate and GDP growth rate on efficiency. The data involved annual unbalanced panel of 25 banks from 2001-2010. From the empirical results, they concluded that Ghanaian banks are cost inefficient though well capitalized banks are less cost inefficient. They further established that bank size has no effect on cost efficiency, meaning large banks have no advantage over smaller ones. Loan loss provision was also found to not significantly determine cost efficiency of banks. On the other hand, GDP growth rate was found to negatively influence bank cost efficiency while lagged cost efficiency persisted over time.

Besides Ghana, several studies on bank sector efficiency have been conducted on other developing economies (Hauner and Peiris, 2005 for Uganda; Tahir et al, 2009 for Malaysia; Sathy, 2002 and Kumar and

Gulati, 2008 all for India; and Chen et al, 2005 for China). Similar studies on relatively advanced markets also exist in the empirical literature, such as Drake et al (2009) for Japan. Although DEA is the most utilized methodology in the bank efficiency literature, alternative methods have as well been used. For example, Park and Weber (2006) applied Luenberger (1992) distance function to measure technical efficiency changes among South Korean banks. Perhaps, the next most popular methodology to DEA in the literature is the Stochastic Frontier Analysis (SFA). Yet, Kablan (2007) combines DEA and SFA on banks in the West African Economic and Monetary Union, WAEMU. He establishes that the stochastic frontier measure gives similar efficiency evolutions to those by DEA.

This study seeks to contribute to the empirical literature on Ghana by improving on the earlier mentioned studies on Ghana in a number of ways. The most important is the recognition that financial liberalization is a process and thus must be assessed over time. This study believes that assessing changes in bank efficiency over time is a more appropriate means to assess the impact of financial liberalization than at a point time (exemplified by Frimpong, 2010). Though Korsah et al (2001), Akoana et al 2009) and Adjei-Frinpong et al (2014) all sought to analyses changes in efficiency over time, they rather restricted the sample to banks that had been operating for some number of years or banks on which data was available to the researchers. Even though these considerations were ethical, they fail to account for the fact that the DEA efficiency scores are defined only in relation to the set of banks used in the analysis. Therefore, a bank is DEA efficient relative to those included in the set but not to those omitted. Significantly different results could be obtained if the omitted banks were to be included in the sample since that would amount to estimating a different market frontier. Hence, a more comprehensive assessment of a policy impact on banks in operating within a common market, with exposure to common environmental factors such as regulatory regime and other policy intervention, should be based on all the banks in the same market. However, the cited studies failed to achieve this feet and may possibly have miscalculated the banks' relative efficiencies.

Also, Drake et al (2009) studies the Japanese banking system by combining all the three known approaches to modeling input-output variable set for DEA on banks, namely intermediation, profit and production approaches. They found significant differences in mean efficiency scores, dispersion of efficiency scores, and ranking of banks and sectors depending on the choice of model. This high degree of model dependency, they argue, has important implication to policy formulation. Each approach has distinctive policy orientation and thus different implied intervention to be adopted. Although Akoena et al (2009) found some evidence of model dependency they utilized only the intermediation and the production approach. None of the cited studies on Ghana has so far explored the combination of all three approaches.

Finally, some empirical studies embarked on a second stage DEA analysis which involves regression analysis to determine the factors explaining the differences in the observed relative efficiency scores among the units. Even though Adjei-Frinpong et al (2014) is the only sited study on Ghana in this regard, they admit that the data points were less than desired and thus interpreted their results with caution. One possible reason for a general short-fall of such regression analysis on Ghana is because of the small number of estimated data points for efficiency scores. Annual data used in all previous studies provided insufficient sample size which could have led to inconsistencies in the estimated parameters. To this end, this study seeks to contribute immensely to literature and empirical data by generating sufficient efficiency scores for regression analysis. In all, the current study estimates quarterly efficiency scores on all registered banks in Ghana, using all the three alternative approaches to DEA identified in the literature on banking studies and for all the three main returns to scale assumptions common in DEA (constant, variable and increasing return to scale).

## IV. Methodology

### a) Data

The current study is based on quarterly-bank unbalanced panel of all registered deposit money banks (DMBs) in Ghana from September 2000 to December 201. During the period, the number of banks increased from 17 in 2000 to 271. Also, there were three cases of take-over and one merger but each case is treated in the sample as a single entity in progress. New entrant banks are allowed to enter the data at as-and-when basis. Contrary to what is done in previous studies where banks are selected based on availability of data for the entire period under study, this study involves all banks even though with different data span. These data dynamics are allowed to play out naturally in the data rather than restrict the shape of the data to few banks. The study believes strongly that these dynamics are part of the complex process that affect the strategic decisions of competing banks and hence a product of a dynamic competitive market. Additionally, the changing data structure reflects the very object under study, namely banking sector liberalization. In all, a total of 979 observations on 30 different licensed DMBs were utilized. The data excludes all quasi-banking institutions and were sourced from Bank of Ghana.

New entrant banks are allowed to enter the data at as-and-when basis to reflect the changing influence they brought to the market frontier. This could lead to

the emergence of new frontier DMU's at different points in time. The data excludes all quasi-banking institutions that are not licensed to operate as "banks" in accord with the Ghana Banking Act, 2004.

*b) Definition and measurement of Efficiency*

Firm efficiency is generally conceived in terms of the ability to generate maximum output, or a set of outputs, with a given input, or set of inputs. It can also be defined by the ability to minimize total cost at a given output or sets of output. Farrell (1957) is credited with the pioneering work in the measurement of efficiency among firms in modern times. Modern methods of efficiency measurement employ frontier analysis which involves a systematic separation of 'best' performing institutions from the less performing ones based on defined objectives and standard. Based on a basic assumption that the production function or iso quant of the truly and fully efficient firm is known, a frontier, which establishes the criterion for separating an efficient firm from the non-efficient firm, is constructed. Firms on the frontier are considered efficient where as those below or within are regarded less-efficient. However, the assumption that the true isoquant or production function of the fully efficient firm is known is not borne out of reality. Rather, the theory requires that a production function or isoquant be constructed from an observed sample data.

Farrell proposed two competing groups of methodologies for constructing these relative frontiers. First, the parametric function approach involves an econometric estimation of a production or cost function that seeks to fit the data such that no observed coordinate of a firm in the input-output plane should lie either to the left or below the fitted line. The stochastic frontier approach is most sited example in the empirical literature. The most sited limitations of this group of techniques, however, has to do with the consequences of functional form misspecification and incorrect design of input-output matrix both of which are found to lead to inconsistency in the estimated parameters (Hassan, 2008).

The alternative option, the non-parametric approach, involves the construction of a piecewise-linear convex isoquant such that no observation lies within the frontier. The most utilized non-parametric method in the empirical literature is Date Envelopment Analysis (DEA). Hassan (2008) list several advantages of using DEA. First, by recognizing that firms have different production functions, the DEA does not impose a specific functional form for the frontier, thus overcoming the functional form misspecification problem with the parametric approach. It can be applied to problems involving multiple inputs and outputs, for measuring variable returns to scale as well as evaluating allocative efficiency.

Also, since the optimization process involved is applied to each firm, estimates of individual firm parameters are obtained which are useful for intra-industry analysis. Moreover, it can be used to evaluate the performances of different departments or branches of the same economic entity. Nevertheless, the DEA methodology has certain challenges the knowledge of which should guide how it is formulated and applied in empirical analysis. Before highlighting these limitations, though, it is fitting to present the theory behind this approach. The next section therefore presents the DEA framework and how the identified limitations are mitigated in this study.

*c) Data Envelopment Analysis*

The Date Envelopment Analysis is a mathematical programming framework used to calculate the relative efficiency of a set of decision making units (DMUs) by comparing the performance of each member of the set to the best practice in the set. The inefficiency of a particular DMU is derived by calculating how far it is from a peer regarded as efficient in the same set because it is on the frontier predefined by a specific standard. The mathematical derivation and explanations to the DEA procedure was originally developed by Charnes, Cooper and Rhodes (1978) but has since been extended into various forms and are well documented in both theoretical and empirical literature (Banker et al., 1984; Seiford and Thral, 1990; Lovell and Schmidt, 1993, and 1994; Ali and Seiford, 1993; Charnes et al., 1995 and Seiford, 1996 and Coelli 1996). Assuming that there are *N* similar units of DMUs that converts a matrix of *KxN* inputs, *X*, into *MxN* output, *Y*, the objective of DEA is to construct a non-parametric envelopment frontier over the observed data on output(s) and given input(s) such that no points lie within or below the frontier. To measure the efficiency of the best practice unit that lie on the frontier, Charnes et al. (1978) propose that the ratio of weighted outputs to weighted inputs for this unit be maximized subject to the constraint that similar ratios for all other DMUs in the set are less than or equal to one. This linear programming problem is defined mathematically by LP(1):

$$Max_{u,v} e^i = \frac{u_i' y_i}{v_i' x_i}$$

$$\text{St.} \qquad \text{.....LP(1)}$$

$$\frac{u_j' y_j}{v_j' x_j} \leq 1,\ j = 1,2,...,N$$

$$u, v \geq 0,$$

Where yi is a vector of output produced by DMUi using the input vector xi, and the corresponding efficiency measure is defined by ei. The solution to the problem involves choosing the optimal weights, u* and v*, that maximizes ei subject to the constraints. The fully efficient DMU is unknown and every unit in the set can be the ideal DMU. Therefore the optimization process is repeated for all DMUs in the set. The unit that attains an efficiency score of one (ei =1) satisfies the necessary condition to be DEA efficient whereas those with efficiency score of less than one (i.eei ≤ 1) are DEA inefficient.

By this process, the DEA methodology generates web-like linear combinations of outputs and inputs among the efficient DMUs such that virtual producers are created as reference points for calculating the inefficiency of all other DMUs in the same group. In this sense, the estimated efficiencies are "relative" (Hassan, 2008) and are strictly defined within a specific set of DMUs in a specified period of time.

However, the specification in PL(1) has infinite solution and hence infeasible since the problem is non-linear and fractional. Based on the theory of fractional linear programming, Normalizing the problem in LP(1) by setting input ratio for DMUi to 1 (i.e 1 ' ☐ i v x ), as suggested in Charnes et al (1978) and taking the dual generate a more simplified problem specified as

$$Min_{\theta,\lambda} \theta,$$

$$\text{St.} \qquad \text{.....LP(2)}$$

$$-y_i + Y\lambda \geq 0,$$

$$\theta x_i - X\lambda \geq 0,$$

$$\lambda \geq 0$$

$$i = 1,2....., N,$$

where θis the efficiency score and λ is Nx1 vector of constants. An efficient DMU has a DEA efficiency score as previously defined. The dual problem in LP (2) has lower number of restrictions than in LP(2) and is usually the preferred solution (Coelli, 1996).

*d) Key Issues with DEA Specification*

The LP (2) is specified for measuring technical efficiency as defined by Farrell (1957), which is the ability of DMUs, operating at constant returns to scale to obtain maximum set of outputs from a given set of inputs. It is also derived as an orientated model developed in Charne set al (1978) and Banker et al (1984) rather than as additive model (Charnes et al. 1985). The Farrell measure of technical efficiency involves the utilization of a piecewise linear frontier which often involve the situation where the frontier runs parallel to either the input or output axis or both. This means that, it is possible to find an efficient DMU that could reduce some inputs while maintaining its output level or vice versa. These excess inputs or shortfalls in outputs are called input slacks or output slacks respectively. Presences of slacks represent violations of the neoclassical production assumptions behind the definition of efficiency and which leads to deficiencies in the technical efficiency measure proposed by Farrell (Drake et al, 2009).

On the other hand, Koopman (1951) provides a stricter definition of a technically efficient DMU as one that operates on the frontier and has no slacks in input or output. Thus, in order to conduct a more accurate DEA efficiency measure, both the Farrell measure of technical efficiency and non-zero input/output slacks must be reported. This study adopts the orientated approach for dealing with slacks in the DEA of Ghanaian banks. The study adopts the multi *stage DEA* slack solution proposed in Coelli (1998) to overcome the limitations of the two-stage approach to orientated modeling for sealing with slacks. The methodology involves a sequence of radial movements to solving oriented DEAs which leads to unit-invariant efficiency scores and the selection of more appropriate peers. The relevance of slacks to this study has been occasioned by the facts that the study seeks to derive the stated advantages of DEA and insists on measuring

Koopman's technical efficiency for Ghanaian banks. If slacks were ignored, it could have led to wrongly assigning an inefficient DMU as efficient (Drake et al, 2009).

The LP (2) is found to be valid only when all DMUs in the relevant set are operating at constant returns to scale or at the optimal scale (Banker et al., 1984). When constant returns to scale is assumed, the Farrel measure of technical efficiency in LP(2) captures the *overall technical efficiency* (OTE), maximizing both the input-output mix (managerial or pure technical efficiency, PTE) as well as the size of operation (scale efficiency, SE) (Kumar and Gulati, 2008). However, when this assumption breaks down and DMUs operate at below optimal, LP (2) accounts for only pure technical efficiency. Since the banking sector in Ghana is not fully developed, the constant return to scale assumption is not plausible for all banks and hence LP (2) cannot be exclusively applied to such a market.

Several production constraints and market imperfections are found to exist in the Ghanaian banking sector (Prah, 2014; Bucks and Mathisen, 2005; Bawumia, Belnye and Ofori, 2005). Performing only the constant returns to scale DEA (CRS) will lead to a difficulty in determining the source of an observed relative inefficiency in a DMU; that is whether inefficiency was due to discrepancies in scale utilization (ie. scale efficiency, SE) or due to deficiencies in managerial ability to adopt the most appropriate input mix for the available scale of operation (ie. pure technical efficiency, PTE).

In order to decompose the overall technical inefficiency into the sources of inefficiencies, Banker et al. (1984) suggest that a convexity restriction be imposed as an additional constraint in LP (3). The resultant model is the variable returns to scale (VRS) version of the LP specified as

$$Min_{\theta,\lambda}\theta,$$

$$\text{St.} \qquad \text{.....LP(4)}$$

$$-y_i + Y\lambda \geq 0,$$

$$\theta x_i - X\lambda \geq 0,$$

$$\lambda \geq 0$$

$$NI'\lambda = 1$$

$$i = 1,2....., N,$$

where is an Nx1 vector of ones (1). The efficiency measure and all other variables remain unchanged. The efficiency score from the VRS model are greater than or equal to those derived from the CRS model. The two measures are mutually exclusive and non-additive. A divergence between the two measures means that the respective DMU has scale inefficiency (SE) defined by ' NI

$$SE = \frac{TE_{CRS}}{TE_{VRS}} \qquad \text{.....(10)}$$

Estimates of LP (3), LP (4) and equation (10) generate estimates for the overall technical efficiency (OTE) scores under the CRS assumption, the pure technical efficiency (PTE) scores under the VRS assumption, and the scale efficiency (SE) scores as the difference between CRS and VRS scores. As mentioned earlier, all efficiency measures are bounded by zero and 1. A bank is considered DEA efficient if it attains an efficiency score of 1 or DEA inefficient if the score is less than 1. An efficient bank is considered *overall* (or fully) technical efficient (OTE) if it is both *pure technical* (PTE) and *scale efficient* (SE). Such a bank serves as the bench mark or best practice for other banks in the same market both in terms of management's ability to organize inputs in the right mix (PTE) and for choosing the right scale of production (SE). On the other hand, a bank may be either pure technically (PTE) inefficient or scale (SE) inefficient or both.

Finally, the nature of scale inefficiency can be determined by determining whether the scale inefficient DMU lies either on the increasing returns to scale or on the decreasing returns to scale side of the VRS frontier. This is achieved by imposing a Non-Increasing Returns to Scale (NIRS) assumption to the model as follows:

$$Min_{\theta,\lambda}\theta,$$
$$\text{St.} \qquad \text{.....LP(6)}$$
$$-y_i + Y\lambda \geq 0,$$
$$\theta x_i - X\lambda \geq 0,$$
$$\lambda \geq 0$$
$$NI'\lambda \leq 1$$
$$i = 1,2....., N,$$

where all variables are defined as previously. The LP (6) is similar to LP (4) in all aspects except that the NIRS restriction $(NI'\lambda \leq 1)$ replaces the VRS restriction $(NI'\lambda = 1)$.

The NIRS efficiency score is greater than or equal to the VRS score and is compared to the VRS score to determine the nature of scale inefficiency. If they are equal then the estimated scale inefficiency is a decreasing return to scale; otherwise it is an increasing return to scale. Kumar and Gulati (2008) explain the implication of scale inefficiency to a bank. A scale inefficient bank due to decreasing returns is deemed too large and thus operating at a 'supra-optimum' scale. On the other hand, a scale inefficient bank due to increasing return to scale or economies of scale is considered too small to fully utilize the available scale of operation and hence operating below its optimal level. Finally, a bank operating at constant return to scale is operating at its optimal scale and hence considered scale efficient. Based on the foregoing, the study runs LP(3), LP(4) and LP(6) to determine the relative efficiencies for all registered banks in a period.

*e) Choice of Input and Output Variables*

One important advantage of the DEA methodology is the flexibility with which alternative variables can be selected as inputs or outputs especially with feasible managerial control in mind. Unfortunately, this advantage introduces a lot more sensitivity in the efficiency measure and renders the estimated efficiency scores susceptible to the choice of input-output variables. There is no consensus in the literature as to what constitutes inputs and outputs of a bank. Berger and Humphrey (1992) reviewed DEA efficiency studies on financial institutions and the various methods used to identify inputs and output variables. They identified three different groups of approaches in the empirical literature, namely *production (value added), intermediation (asset)* and *user cost (profit)* approaches, the most popular of which are the first two. Though both are derived from the neoclassical microeconomic theory of the firm applied to banking, they differ on what constitute the major role of a bank (Kumar and Gulati, 2008).

The production approach, pioneered by Benston (1965), perceives banks as production houses of services, including deposits and loans accounts, utilizing capital and labour. Hence outputs under this approach are measured by the number and type of accounts or transactions performed on deposits, loan services, and other specialized services. Usually, due to data limitations, the number of deposits and loan accounts are used as proxies for total services output of a bank. Inputs are defined by the components of total operating costs needed to generate and maintain the accounts. This approach does not include interest expenses as inputs.

The intermediation approach, on the other hand, considers banks as financial intermediaries that mobilize deposits and other liabilities to generate loans, securities and other interest earning assets. Thus loans and investments are considered as outputs whereas inputs include deposits and interest expenses in addition to operating costs.

Perhaps the most important difference between the production and the intermediation approaches can be derived from how bank deposits are treated. The former considers deposits as output while the latter treats deposits as an input. Nevertheless, irrespective of how deposit is treated it is important to state that production and intermediation approaches are alternative to each other and that they lead to different policy outcomes (Tortosa-Ausina, 2002). Moreover, even though Berger and Humphrey (1992) suggests that the intermediation approach is best suited for studying bank level efficiency rather than at branch level, they concede that neither the intermediation approach nor the production approach fully captures the dual role of a bank, namely as service provider and as financial intermediary. This observation suggests that the production approach must be seen as measuring how efficient a bank meets the service needs of its customers. The intermediation approach, however, may reflect how banks perform their traditional role as defined in the Keynesian macroeconomic theory, namely providing intermediation for effective use of national resources for growth.

However, commercial banks are profit making organizations just like other businesses in the product market. This means that efficiency assessment must recognize that banks have profit making objectives that may differ from that of customers or the regulator (Leithner and Lavell, 1998). The *profit approach* seeks to capture the profit maximization goal of banks. It is believe that the profit approach could help account for, not only the profit objectives of banks, but also the unmeasured changes in the quality of banking services that are reflected in pricing (Berger and Mester, (2003). Outputs under this approach include assets and liabilities that contribute to revenue whereas inputs are operational costs plus other assets and liabilities that contribute to cost. This approach differs from the previous two approaches in the way in which deposit is handled. Deposits are not considered as inputs since it is a function of labour and capital which are already included as inputs. Deposits are rather considered to have both expenditure and output characteristics. Leithner and Lavell (1998) argue that non-interest income captures the output aspect of deposits whereas the expenditure aspects are captured by interest expense component of net interest income and operational costs.

Because of the high sensitivity of efficiency scores to the selected set of inputs and outputs, it is common to find different combinations of input-output sets in a single study as a way of controlling for efficiency score sensitivity and for generating specific policy outcome. For example, Berger and Humphrey (1992, 1997) used different but overlapping sets of input-output variables that covered all the three approaches. Similarly, Drake et al. (2009) tests whether there are differences in the efficiency scores when the three alternative methodologies are used. They found significant evidence to accept the hypothesis. In the case of Ghana, however, only one input-output set was estimated by Korsah et al. (2001), using the production approach, Frimpong (2010) and Adjei-Frimpong (2014), both of which use the intermediation approach. Akoena et al (2009), on the other hand, estimated five (5) different sets of variables, four for intermediation approach and one for production approach. Though some of the input-output combinations overlap with the profit approach, the study did not explicitly capture the profitability objective of banks. Following Drake et al (2009), the current study improves literature on Ghana by utilizing all the three identified approaches to DEA in banking studies.

Drawing experience from past studies, the current study utilizes variations of all the three alternative theoretical approaches to selecting input-output in DEA on banking sector. Two sets of models are estimated for both the intermediation and the profit approaches, while a single model is estimated for production approach. The five models are listed in Table2. The variables are defined in Table 3.

*Table 2:* Selected Input-Output Variable for DEA on Ghanaian Banks

| Approach | | Output | Input |
|---|---|---|---|
| Intermediation | Model 1 | Total Loans, Total Investments, Non-Interest Income | Total Operating Cost, Total Deposits, Total Provisioning |
| | Model 2 | Net Interest Income, Non-Interest Income | Total Operating Cost, Total Deposits, Total Provisioning |
| Profit | Model 3 | Net Interest Income, Non-Interest Income | Total Operating Cost, Total Provisioning |
| | Model 4 | Total Investment, Total Loans | Total Operating Cost, Total Provisioning |
| Production | Model 5 | Total Loans, Total Deposits, Non-Interest Income | Total Operating Cost, Interest Expenditure, Total Provisioning |

*Source: Author*

*f) Other Measurement Issues*

Apart from considering which theoretical framework to use for selecting variables for the DEA analysis, several other important factors were considered in order to improve the accuracy of the estimated efficiency scores. Modern banks grow and compete by diversifying activities other than balance sheet activities. Berger and Mester (1997) emphasize the need to account for off-balance sheet activities that impact profitability of a diversified bank. Also, banks are expected to manage and incur risk as part of their activities. Failure to adequately account for risk in DEA is shown to have significant impact on the relative efficiency scores (Drake and Hall, 2003). According to Fare et al (2004), using bank equity as quasi-fixed inputs

is sufficient to account for both risk-based and capital requirement and the risk-return trade-off that bank owners face. Akoena et al (2009) thus include equity as input in the intermediation model. Also, the importance of considering non-performing loan provisioning as a cost has been well articulated in the Bassel II accord for bank regulation. In view of this, Drake et al. (2009) included loan loss provisioning as input in all the three alternative theoretical approaches.

Another relevant consideration is that the choice of variable set should be consistent with the assumption that the set of DMU under study undertake homogeneous activities and have identical reporting formats (Korsah, 2001). Moreover, analyzing input variable sets with different correlation structures, Hassan (2008) establishes that omitting a relevant variable causes inconsistency in the efficiency scores and is worse when there is a negative correlation structure. This problem is identified especially for models that use input orientation. Hassan proposes the use of correlation test to select input variables that jointly ensure that relevant inputs have been exhaustively accounted for. Don and Param (2002) establish that efficiency scores are sensitive to including inappropriate variables and to unwittingly omitting important variables in the DEA model, especially in large samples and under different scale assumptions.

*Table 3:* Summary Statistics of Input-Output Variables (GH¢')

| Variable | Definition | Mean | S.D | Max | Min |
|---|---|---|---|---|---|
| Total Loans | Loans, Overdrafts and Other advances | 140,168,346 | 179,835,655 | 1,325,123,410 | 200 |
| Total Deposits | Deposits from all private customers | 219,809,674 | 288,703,243 | 2,047,607,321 | 76,105 |
| Total Investments | stocks, bonds and other securities | 80,323,195 | 126270265 | 1212993275 | 87035 |
| Net Interest | Interest income less interest expenditure | 3,726,305 | 7,006,509 | 106,189,000 | 3,122 |
| Non-Interest Income | Fees, commissions and earnings other than interest income | 2,623,720 | 6,246,148 | 156,096,844 | 282 |
| Total Operating Cost | Expenditure on staff salary and other emoluments, training, occupancy, travels, administration and other operating expenses | 3,366,431 | 66,59,140 | 99,420,500 | 32,727 |
| Interest Expenditure | Interest expenses on all interest bearing liabilities | 1,907,414 | 2,297,742 | 26,943,145 | 6 |
| Total Provisioning | Provisions against bad debts, depreciation and other provisions required by regulation | 2,033,577 | 22,045,117 | 679,635,000 | 636 |
| Equity | Share holders' equity investment | 40,512,319 | 52,942,840 | 622,648,998 | 7842 |

*Source: Author's calculations*

Finally, apart from the factors discussed previously, selecting variables as inputs or outputs is also dependent on data availability and whether variables are measured in currency units or in real units; for example, whether to use the number of accounts or the value of accounts (Tahir, et al., 2009). For the reasons that banks are multiservice firms that incur different costs on various accounts and mostly compete to increase their currency amount of market shares, Kolari and Zardkoohi (1987) advocate for currency units as the best common denominator for measuring inputs and outputs. Based on this consideration and for convenience, this study measures all variables in Ghanaian currency unit.

## V. Empirical Results

*a) Industry Overall Technical Efficiency*

The LP(3), which assumes constant returns to scale, was run for all the five models in each quarter in order to measure the relative overall technical efficiency (OTE) for each of the banks that operated during that period. This means new and independent frontiers were estimated in each quarter. The mean OTE scores, covering all operating banks were calculated for each quarter and for each of the five models. Similarly, the percentage of the total number of banks that were OTE efficient in each period was derived from each model. Graphical presentations of the industry level results are shown in Figure1 while the numerical summary for the entire period are presented in Table 4.

Figure 1 show trends in the average OTE scores from each model. The trends were found to be negatively sloping for all models. This implies that the average intensity of overall technical efficiency declined during the study period. Similarly, the number of OTE efficient banks trended downwards, indicating that the prevalence of OTE inefficiency among banks generally increased over time. The empirical results were consistent for all the five models even though the level of severity varied among the models.

In terms of the number of banks that were OTE efficient, model 1 suggests that the highest number of

OTE efficient banks ever recorded in the entire period was about 77 per cent of the total number of banks. The average for the entire period, though, ranged between about 47 per cent (Model 1) and 24 per cent (Model 4). Especially, Model 4 suggests that, at some point in time, as many as about 94 per cent of the total number of banks in the industry were OTE inefficient. Therefore, results from the five models suggest that the prevalence of OTE inefficiency among the banks and during the study period ranged between 76 per cent and 53 per cent of the total number of banks in the industry. That is, more than 50 per cent of the banks were found to be OTE inefficient in almost each quarter of the period.

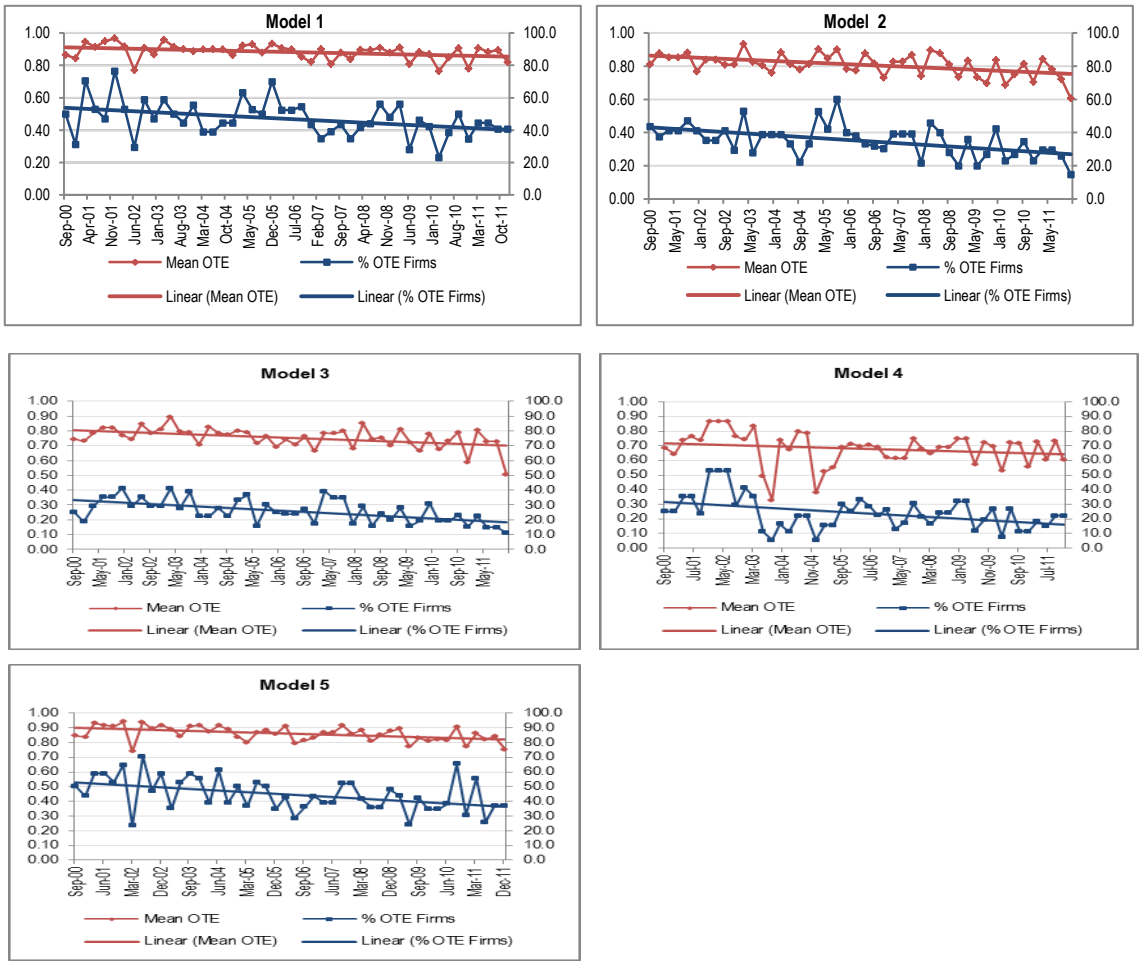


*Figure 1:* Evolution of Industry Overall Technical Efficiency (2000q3-2011q4)

*Table 4:* Summary of Industry Overall Technical Efficiencies (2000q3-2011q4)

| | Mean | SD | Min | Max | $R_{OTE,PTE}$ | $R_{OTE,SE}$ |
|---|---|---|---|---|---|---|
| Model 1 | | | | | | |
| OTE Score | 0.88 | 0.05 | 0.76 | 0.97 | 0.80 | 0.86 |
| No of OTE Banks (%) | 46.99 | 10.94 | 23.08 | 76.47 | 0.64 | 0.99 |
| Model 2 | | | | | | |
| OTE Score | 0.81 | 0.07 | 0.61 | 0.93 | 0.84 | 0.66 |
| No of OTE Banks (%) | 35.08 | 9.36 | 14.81 | 60.00 | 0.48 | 0.92 |
| Model 3 | | | | | | |
| OTE Score | 0.75 | 0.07 | 0.50 | 0.90 | 0.78 | 0.70 |
| No of OTE Banks (%) | 25.94 | 7.94 | 11.11 | 41.18 | 0.44 | 0.88 |
| Model 4 | | | | | | |
| OTE Score | 0.68 | 0.11 | 0.33 | 0.87 | 0.83 | 0.87 |
| No of OTE Banks (%) | 24.03 | 11.41 | 5.56 | 52.94 | 0.67 | 0.97 |
| Model 5 | | | | | | |
| OTE Score | 0.86 | 0.05 | 0.74 | 0.94 | 0.82 | 0.80 |
| No of OTE Banks (%) | 44.79 | 11.42 | 23.53 | 70.59 | 0.73 | 0.98 |

*Source: Author's calculations*

The overall results for sector OTE from the five models provide evidence to show that, both the level and the incidence of overall technical efficiency in the Ghanaian banking sector reduced during the period of study. The incidence of OTE inefficiency was found to dominate intensity of OTE inefficiency. At least a fifth of the banks were both scale and pure technically inefficient at each point in time. Irrespective of the choice of model, the results indicate that the level of OTE inefficiency was inefficient as low as 3 per cent below optimal capacity in some of the times, but was also as high as 67 per cent in other times. Though declining efficiency was consistent among the models, the steepness of the decline was sensitive to the choice of model. Model sensitivity of DEA was also established in Akoena et al (2009) and Drake et al (2009).

*b) Industry Pure Technical Efficiency*

As explained in the methodology, the overall technical efficiency or otherwise can be decomposed into two sources, namely pure technical efficiency (PTE) and scale efficiency (SE), though these components are non-additive. In order to obtain the PTE scores, LP (4) was run for all the five models and in each quarter. The results are reported in Table 5and Figure 2.

From the Figure, liner trends in all cases show that the averages PTE scores and the number of PTE efficient banks reduced over time, similar to those found for OTE. Table 5shows that the industry's average PTE inefficiency for the entire period ranged from about 5 per cent to 17 per cent with corresponding standard deviation range of 0.03 – 0.07 across the five models. The general conclusion here is that both the intensity and the incidence of pure technical efficiency all reduced during the study period. The results though were sensitive to the choice of model.

The average number of PTE inefficient banks ranged from a minimum of about 29 per cent by model 1 to a maximum of about 54 per cent by model 3, and with corresponding standard deviation range of 6.99 per cent and 9.75 per cent respectively. From all models, the industry pure technical efficiency was generally very high, almost at 100% at some points in time. For example, Model 1 estimated a maximum PTE score of 0.99. Yet, model 4 suggests that the level of inefficiency was sometimes as low as 45 per cent

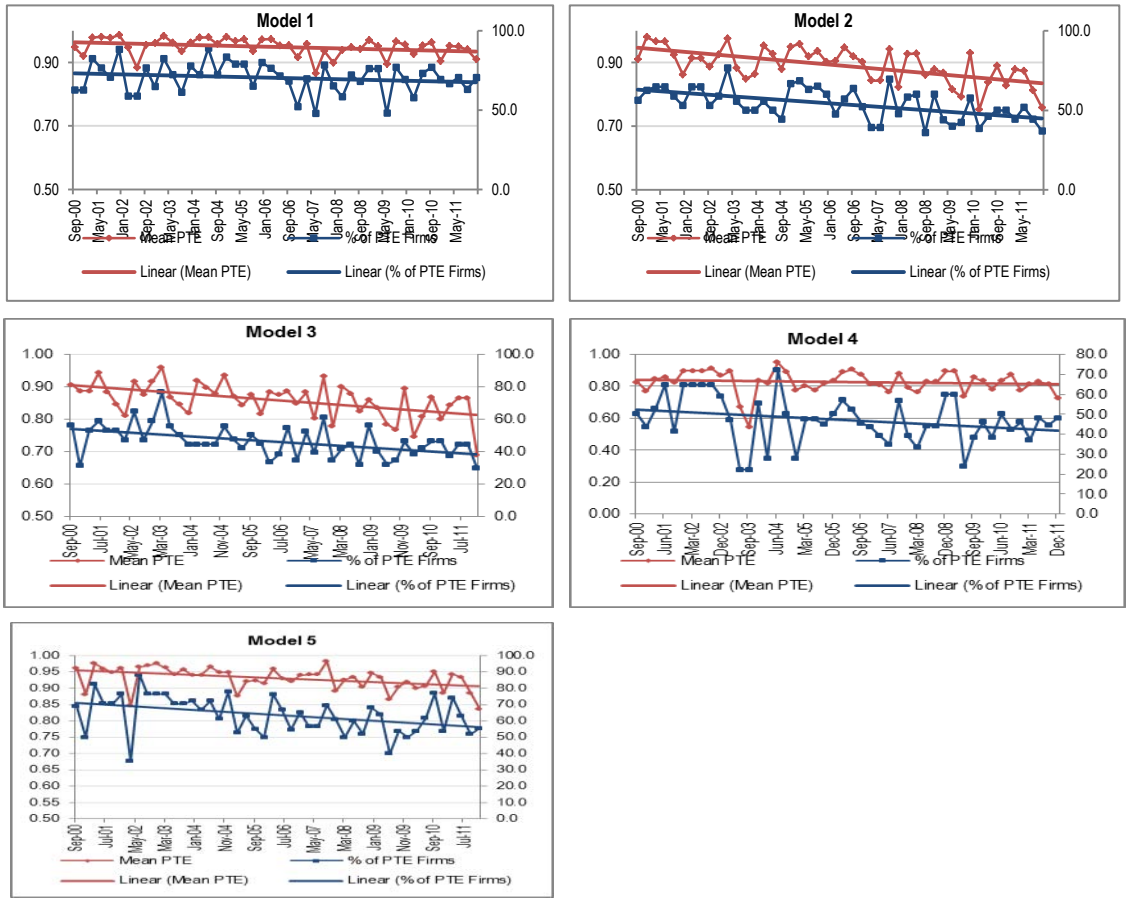


*Figure 2:* Evolution of Industry Pure Technical Efficiency (2000q3-2011q4)

*Table 5:* Summary of Industry Pure Technical Efficiencies (2000q3-2011q4)

| | Mean | SD | Min | Max | $R_{OTE,PTE}$ |
|---|---|---|---|---|---|
| Model 1 | | | | | |
| PTE Score | 0.95 | 0.03 | 0.87 | 0.99 | 0.39 |
| No of PTE Banks (%) | 70.33 | 9.48 | 47.83 | 88.89 | 0.64 |
| Model 2 | | | | | |
| PTE Score | 0.89 | 0.06 | 0.75 | 0.98 | 0.16 |
| No of PTE Banks (%) | 53.99 | 9.87 | 36.00 | 76.47 | 0.48 |
| Model 3 | | | | | |
| PTE Score | 0.86 | 0.05 | 0.69 | 0.96 | 0.78 |
| No of PTE Banks (%) | 46.20 | 9.75 | 29.63 | 76.47 | 0.44 |
| Model 4 | | | | | |
| PTE Score | 0.83 | 0.07 | 0.55 | 0.95 | 0.83 |
| No of PTE Banks (%) | 46.90 | 11.89 | 22.22 | 72.22 | 0.67 |
| Model 5 | | | | | |
| PTE Score | 0.93 | 0.03 | 0.84 | 0.98 | 0.82 |
| No of PTE Banks (%) | 63.44 | 11.39 | 35.29 | 88.24 | 0.73 |

*Source: Author's calculations*

*c) Industry Scale Efficiency*

Next, equation (5) was applied to the results from LP (3) and LP (4) to derive scale efficiency (SE) scores for the banks in each quarter. These are reported in Figure3 and Table6. Like previous results, the linear trends show that both the average SE efficiency scores and the number of SE efficient banks all reduced during the period. In particular, trends in the number of scale efficient banks were generally lower and associate with trends show that both the average SE efficiency scores

and the number of SE efficient banks all reduced during the period. In particular, trends in the number of scale efficient banks were generally lower and associate with higher short term volatile in comparison with those of PTE.

From the Table, the average level of scale inefficiency in the industry over the entire period ranged from 7.0 per cent for Model 1 and 18 per cent for model 4. Additionally, the average number of banks that were SE inefficient ranged between about 52 per cent and about 75 per cent with standard deviation of 12.72 and 13.37 respectively.

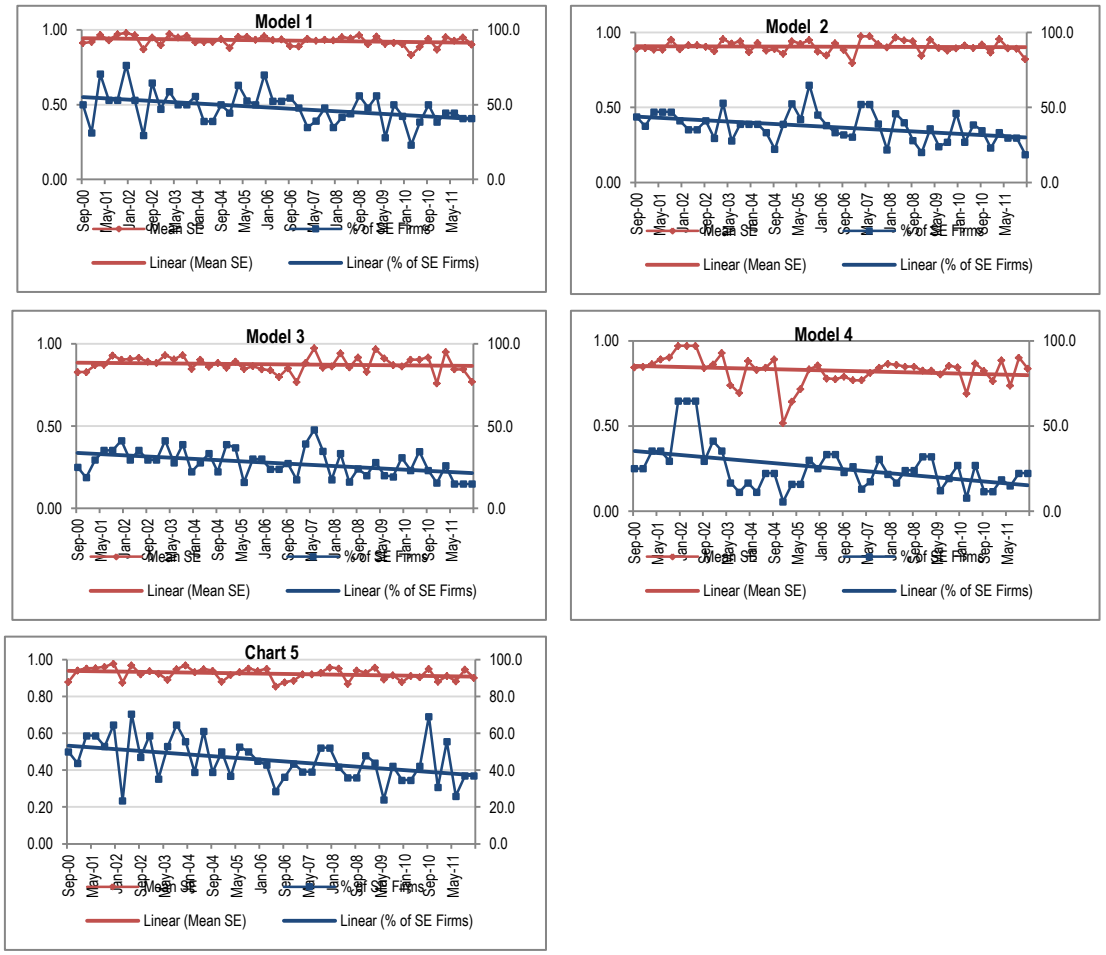


*Figure 3:* Evolution of Industry Scale Efficiency (2000q3-2011q4)

*Table 6:* Summary of Industry Scale Efficiencies (2000q3-2011q4)

| | Mean | S.D. | Min | Max | $R_{OTE,SE}$ | $R_{PTE,SE}$ |
|---|---|---|---|---|---|---|
| Model 1 | | | | | | |
| SE Score | 0.93 | 0.03 | 0.83 | 0.98 | 0.35 | 0.11 |
| % of SE Firms | 47.84 | 11.03 | 23.08 | 76.47 | 0.99 | 0.63 |
| Model 2 | | | | | | |
| SE Score | 0.91 | 0.04 | 0.80 | 0.98 | 0.48 | 0.76 |
| % of SE Firms | 36.99 | 10.01 | 18.52 | 65.00 | 0.92 | 0.37 |
| Model 3 | | | | | | |
| SE Score | 0.88 | 0.05 | 0.76 | 0.97 | 0.70 | 0.11 |
| % of SE Firms | 27.45 | 8.39 | 14.81 | 47.83 | 0.88 | 0.36 |
| Model 4 | | | | | | |
| SE Score | 0.82 | 0.08 | 0.52 | 0.97 | 0.87 | 0.47 |
| % of SE Firms | 25.27 | 13.37 | 5.56 | 64.71 | 0.97 | 0.59 |
| Model 5 | | | | | | |
| SE Score | 0.92 | 0.03 | 0.86 | 0.98 | 0.80 | 0.32 |
| % of SE Firms | 45.30 | 11.65 | 23.53 | 70.59 | 0.98 | 0.72 |

*Source: Author's calculations*

*d) Industry Pure Technical Efficiency versus Scale Efficiency*

Comparing the level of intensity between PTE and SE, it is not readily clear as to which of the two contributed more to the changes in industry OTE. From Table 5 and Table 6, Model 1 estimates an average PTE score of 0.95 against an SE average score of 0.93. Similarly, Model 4 and Model 5 estimate the average PTE score at 0.83 and 0.93 against SE scores of 0.82 and 0.92 respectively, all in favour of PTE. Thus these three models suggest that SE contributed more to the observed overall technical inefficiency. On the other hand, Models 2 and 3 recorded average PTE scores of 0.91 and 0.88 against SE scores of 0.89 and 0.86 respectively, all in favour of SE. Thus, the two models rather assume that PTE explains more of the observed bank OTE inefficiency. Therefore, it is not clear enough to determine from the mean efficiency scores as to which of the two sources best explains the observed changes in the sector OTE.

Also, correlation analysis between OTE and its two components could not help either. As shown earlier, the correlation results from models 1, 3 and 5 indicate stronger association between mean OTE scores and mean PTE scores. However, Model 2and Model 4 indicate stronger correlation between mean OTE scores and the mean SE scores. This lack of consensus among the five models, and even between models from the same theoretical approach, reflect the weakness in the use of mean scores for efficiency discrimination among firms over a considerable period of time. Arithmetic mean is known to be susceptible to extreme numbers. A graphical analysis indicated that PTE and SE dominated each other at different times, a situation the mean measure may have failed to properly account for.

Nevertheless, the clouds settle when the comparison is done using incidence of inefficiency rather than efficiency intensities. In all five cases, the number of banks that were PTE efficient was higher than for SE. That is, the observed decline in OTE occurred because there were more prevalent cases of SE inefficiency than the prevalence of PTE inefficiency among the banks. This conclusion is further corroborated by correlation analysis between incidence of OTE and its components. The correlation between the number of OTE efficient banks and the number of SE efficient banks were stronger than the correlation between the number of OTE and PTE efficient banks. Furthermore, the linear graphs for the number of PTE efficient banks lay above that for SE in all the five cases. Thus, the higher incidence of scale inefficiency must have contributed more to the observed OTE inefficiencies.

*e) The Nature of Industry Scale Inefficiency*

In order to determine whether the observed scale inefficiencies occurred because the banks were operating at increasing returns to scale (IRS) or decreasing returns to scales (DRS), LP (6) was run for all the five models in each quarter. The two types of inefficiencies cannot coexist in a bank but should be absent together if the bank is OTE efficient and hence operates at constant returns to scale. For each quarter, the number of banks that were scale inefficient was divided into cases of IRS and DRS. The results are shown in Figures 4 and Table 7.

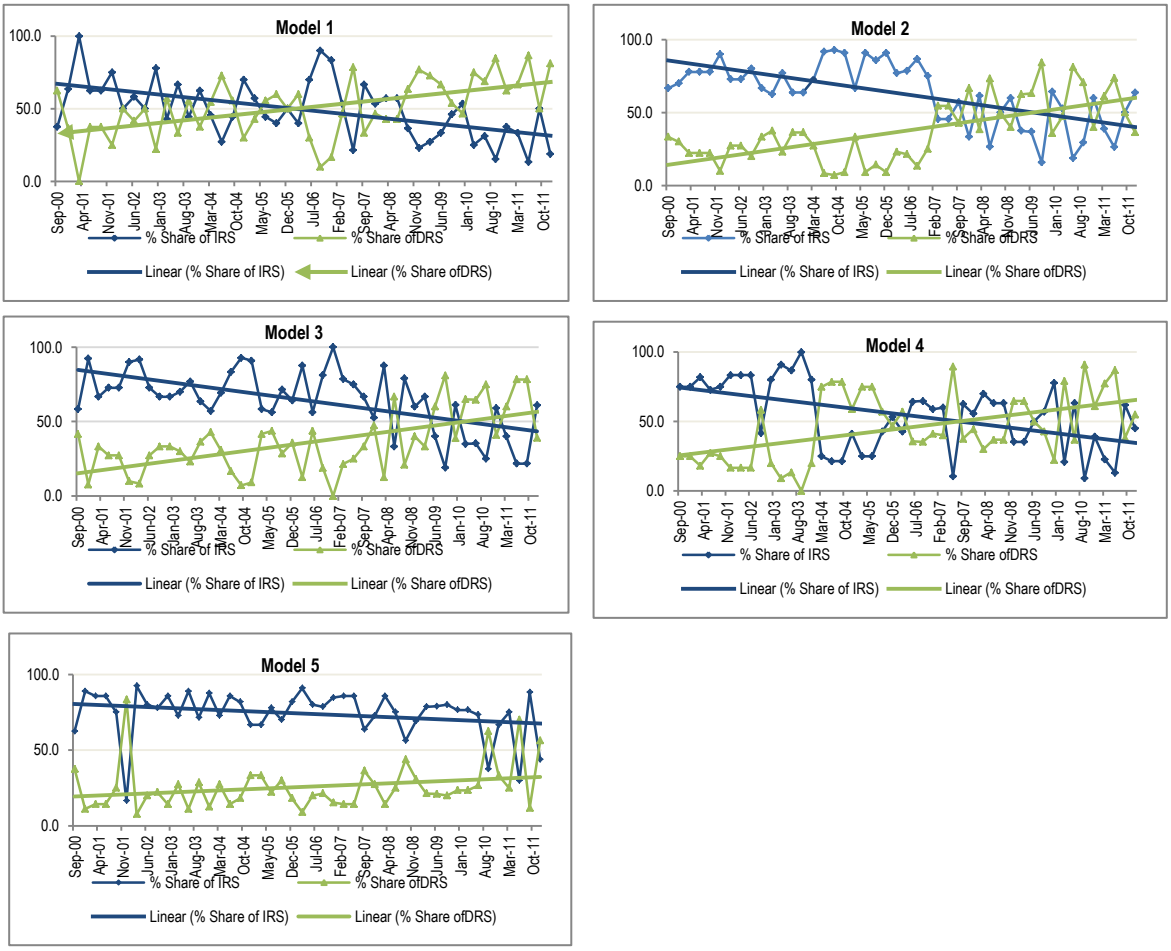


*Figure 4:* Changes in the Sources of Industry Scale Inefficiency (2000q3-2011q4)

*Table 7:* Nature of Industry Scale Inefficiencies (2000q3-2011q4)

| | Mean | S.D. | Min | Max |
|---|---|---|---|---|
| **Model 1** | | | | |
| Number of SIE Banks (%) | 19.22 | 10.31 | 0.00 | 37.00 |
| o/w Share of IRS in SIE | 47.79 | 38.85 | 0.00 | 100.00 |
| o/w Share of DRS in SIE | 48.51 | 38.88 | 0.00 | 100.00 |
| **Model 2** | | | | |
| Number of SIE Banks (%) | 23.11 | 10.59 | 2.00 | 40.00 |
| o/w Share of IRS in SIE | 61.30 | 33.66 | 0.00 | 100.00 |
| o/w Share of DRS in SIE | 38.70 | 33.66 | 0.00 | 100.00 |
| **Model 3** | | | | |
| Number of SIE Banks (%) | 72.55 | 8.39 | 52.17 | 85.19 |
| o/w Share of IRS in SIE | 64.09 | 20.69 | 19.05 | 100.00 |
| o/w Share of DRS in SIE | 35.91 | 20.69 | 0.00 | 80.95 |
| **Model 4** | | | | |
| Number of SIE Banks (%) | 74.48 | 13.31 | 35.29 | 94.44 |
| o/w Share of IRS in SIE | 54.56 | 24.18 | 9.09 | 100.00 |
| o/w Share of DRS in SIE | 45.44 | 24.18 | 0.00 | 90.91 |
| **Model 5** | | | | |
| Number of SIE Banks (%) | 54.7 | 11.4 | 29.4 | 76.5 |
| o/w Share of IRS in SIE | 74.1 | 15.7 | 16.7 | 92.3 |
| o/w Share of DRS in SIE | 25.9 | 15.7 | 7.7 | 83.3 |

*Source: Author's calculations Note: o/wimplies 'of which'*

Observations from the charts reveal dynamic changes in the scale of operations in the Ghanaian banking industry. First, all the models indicate that the number cases of increasing returns to scale (IRS) reduced over time. On the other hand, cases of decreasing returns to scale (DRS) trended upward. This evidence implies that while the number of banks that were operating below their optimal scale was falling, banks that were operating at supernormal scale were increasing in number.

One possible reason could be due to the increased recapitalization requirements that were imposed on the banks on two separate occasions during the study period. It could also be due to the effects of market consolidation through mergers and acquisitions. Since the sizes of banks in the sector vary markedly, policies to expand the size of the industry, especially given the prevailing size of demand, may have pushed those that were too small in size towards their optimal levels but at the expense of driving the already large ones beyond their optimal scale.

The results in the Table show that, except model 1, the average percentage share of IRS in the total number of cases for scale inefficiencies was higher than that of DRS. The share of IRS in all cases of SE inefficiency ranged from 54.56 (model 4) to 74.1 per cent (model 5) of the total cases of scale inefficiency. It can also be observed from the Table that there were times when the shares were 100 per cent either because all the cases of scale inefficiencies were due only to IRS (models 1, 2, 3, and 4) or exclusively due to DRS (1, and 2). Model 5 estimated neither of such situations. Generally, though, the results indicate that the industry was scale inefficient because most of the scale inefficient banks operated below their optimal scale (IRS).

Secondly, IRS generally dominates DRS in the early part of the period. With time, however, DRS linear trends undercut and rise above IRS. The result for Model 5 was an exception. Yet it suffices to derive from here that the nature of the observed rising scale inefficiency in the Ghanaian banking sector changed in form from being IRS led to a dominant DRS situation. Also, reducing IRS and increasing DRS mean that relatively fewer and fewer of the banks were operating below their optimal scale while more and more were operating above their optimal scale in the course of time.

In all, the industry grew above its optimal scale. All things being equal, it may prove to be more prudent for future policy interventions to take other forms than to add to the number of banks, since the industry is growing above its optimal scale. Otherwise, any future expansionary policy should be targeted at expanding the size of those operating below their optimal scale rather than a blanket policy to all banks. Similar sentiment was expressed in Akoena et al (2009).This could help curb both IRS and DRS and hence help improve the overall technical efficiency in the sector.

## VI. Conclusion

The empirical results in this study show that irrespective of the choice of model, industry overall technical, pure technical and scale efficiencies generally decreased over time. Based on this result, the study fails to accept the hypothesis that bank sector efficiency in Ghana improved over time. Specifically, the following conclusions are made from the empirical results on the evolution of bank sector efficiency in Ghana.

1. That the overall technical efficiency of the banking sector in Ghana reduced during the period.
2. That the reduction in the overall technical efficiency resulted from decline in both pure managerial efficiency (PTE) and scale efficiency (SE).
3. That compared to pure technical inefficiency, the level and prevalence of scale inefficiency was dominant among the banks during the period.
4. That the observed scale inefficiency was mainly due to the relatively high prevalence of increasing returns (IRS) to scale among the banks and in most of the time than for decreasing returns to scale (DRS).
5. That the number of cases of IRS reduced with time but at the expense of rising prevalence of decreasing returns to scale.

A key policy derivation from the study is that more attention needs to be given to helping banks to choose more appropriately their scale of operation. While some individual banks may need to expand further to achieve this, a blanket expansion policy, however, will be detrimental to the industry as a whole. Akoena et al (2009) alluded to a similar concern which the current study has provided additional evidence to support. With rising cases of decreasing returns to scale, blanket expansionary policy would increase the number of banks operating beyond their optimal scale. This and could increase losses in the market. Given that most of the banks operating at decreasing return to scale were relatively old and likely more reputed, blanket expansion could increase instability in the sector. A segmented market that allows banks to operate at more convenient capital outlay and hence more convenient scale may be one possible solution to the problem.

Though the universal banking policy has helped level the common playing field, it is also likely that the accompanied recapitalization requirements may have compelled some of the banks to expand their scale of operation beyond their optimal level. A policy which strategically segments the market to allow banks to choose just the appropriate scale for specific lines of business they have the most interest and expertise, while not compromising on competition, may help contain scale inefficiencies.

In particular, new entrant banks should be allowed to grow at a pace that commensurate with the range of banking businesses they believe to have the right expertise. Such banks should not be "forced" to start at too big a scale just to meet capital requirements that are needed for the complete range of banking business beyond what it is capable or within its immediate strategic plan. In some jurisdictions, segmenting the banking sector into national, regional, city and community banks could provide a more compact bouquet of services to meet the spectrum of consumers in Ghana.

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# Appendices

## *Appendix 1:* Detailed Results from model 1

| Period | No of Banks | Mean Efficiency Scores | | | Number of Efficient Banks (% of total) | | | Sources of Scale Inefficiency (SIE) | |
|---|---|---|---|---|---|---|---|---|---|
| | | OTE | PTE | SE | OTE Banks | PTE Banks | SE Banks | IRS (% of SIE) | DRS (% of SIE) |
| Sep-00 | 16 | 0.86 | 0.95 | 0.91 | 50.0 | 62.5 | 50.0 | 37.5 | 62.5 |
| Dec-00 | 16 | 0.84 | 0.92 | 0.92 | 31.3 | 62.5 | 31.3 | 63.6 | 36.4 |
| Mar-01 | 17 | 0.95 | 0.98 | 0.97 | 70.6 | 82.4 | 70.6 | 100.0 | 0.0 |
| Jun-01 | 17 | 0.91 | 0.98 | 0.93 | 52.9 | 76.5 | 52.9 | 62.5 | 37.5 |
| Sep-01 | 17 | 0.95 | 0.98 | 0.97 | 47.1 | 70.6 | 52.9 | 62.5 | 37.5 |
| Dec-01 | 17 | 0.97 | 0.99 | 0.98 | 76.5 | 88.2 | 76.5 | 75.0 | 25.0 |
| Mar-02 | 17 | 0.92 | 0.95 | 0.97 | 52.9 | 58.8 | 52.9 | 50.0 | 50.0 |
| Jun-02 | 17 | 0.77 | 0.88 | 0.87 | 29.4 | 58.8 | 29.4 | 58.3 | 41.7 |
| Sep-02 | 17 | 0.91 | 0.96 | 0.95 | 58.8 | 76.5 | 64.7 | 50.0 | 50.0 |
| Dec-02 | 17 | 0.87 | 0.96 | 0.90 | 47.1 | 64.7 | 47.1 | 77.8 | 22.2 |
| Mar-03 | 17 | 0.96 | 0.98 | 0.97 | 58.8 | 82.4 | 58.8 | 42.9 | 57.1 |
| Jun-03 | 18 | 0.91 | 0.96 | 0.95 | 50.0 | 72.2 | 50.0 | 66.7 | 33.3 |
| Sep-03 | 18 | 0.90 | 0.93 | 0.96 | 44.4 | 61.1 | 50.0 | 44.4 | 55.6 |
| Dec-03 | 18 | 0.89 | 0.96 | 0.92 | 55.6 | 77.8 | 55.6 | 62.5 | 37.5 |
| Mar-04 | 18 | 0.90 | 0.98 | 0.92 | 38.9 | 72.2 | 38.9 | 45.5 | 54.5 |
| Jun-04 | 18 | 0.90 | 0.98 | 0.92 | 38.9 | 88.9 | 38.9 | 27.3 | 72.7 |
| Sep-04 | 18 | 0.90 | 0.96 | 0.94 | 44.4 | 72.2 | 50.0 | 44.4 | 55.6 |
| Dec-04 | 18 | 0.86 | 0.98 | 0.88 | 44.4 | 83.3 | 44.4 | 70.0 | 30.0 |
| Mar-05 | 19 | 0.92 | 0.97 | 0.95 | 63.2 | 78.9 | 63.2 | 57.1 | 42.9 |
| Jun-05 | 19 | 0.93 | 0.97 | 0.95 | 52.6 | 78.9 | 52.6 | 44.4 | 55.6 |
| Sep-05 | 20 | 0.88 | 0.93 | 0.94 | 50.0 | 65.0 | 50.0 | 40.0 | 60.0 |
| Dec-05 | 20 | 0.93 | 0.97 | 0.96 | 70.0 | 80.0 | 70.0 | 50.0 | 50.0 |
| Mar-06 | 21 | 0.91 | 0.97 | 0.93 | 52.4 | 76.2 | 52.4 | 40.0 | 60.0 |
| Jun-06 | 21 | 0.90 | 0.95 | 0.94 | 52.4 | 71.4 | 52.4 | 70.0 | 30.0 |
| Sep-06 | 22 | 0.85 | 0.95 | 0.89 | 54.5 | 68.2 | 54.5 | 90.0 | 10.0 |
| Dec-06 | 23 | 0.82 | 0.92 | 0.89 | 43.5 | 52.2 | 47.8 | 83.3 | 16.7 |
| Jun-07 | 23 | 0.81 | 0.87 | 0.93 | 39.1 | 47.8 | 39.1 | 21.4 | 78.6 |
| Sep-07 | 23 | 0.88 | 0.94 | 0.94 | 43.5 | 78.3 | 47.8 | 66.7 | 33.3 |
| Dec-07 | 23 | 0.84 | 0.90 | 0.93 | 34.8 | 65.2 | 34.8 | 53.3 | 46.7 |
| Mar-08 | 24 | 0.90 | 0.94 | 0.95 | 41.7 | 58.3 | 41.7 | 57.1 | 42.9 |
| Jun-08 | 25 | 0.89 | 0.95 | 0.94 | 44.0 | 72.0 | 44.0 | 57.1 | 42.9 |
| Sep-08 | 25 | 0.91 | 0.94 | 0.97 | 56.0 | 68.0 | 56.0 | 36.4 | 63.6 |
| Dec-08 | 25 | 0.88 | 0.97 | 0.91 | 48.0 | 76.0 | 48.0 | 23.1 | 76.9 |
| Mar-09 | 25 | 0.91 | 0.95 | 0.96 | 56.0 | 76.0 | 56.0 | 27.3 | 72.7 |
| Jun-09 | 25 | 0.81 | 0.89 | 0.91 | 28.0 | 48.0 | 28.0 | 33.3 | 66.7 |
| Sep-09 | 26 | 0.88 | 0.97 | 0.91 | 46.2 | 76.9 | 50.0 | 46.2 | 53.8 |
| Dec-09 | 26 | 0.87 | 0.96 | 0.91 | 42.3 | 69.2 | 42.3 | 53.3 | 46.7 |
| Mar-10 | 26 | 0.76 | 0.93 | 0.83 | 23.1 | 57.7 | 23.1 | 25.0 | 75.0 |
| Jun-10 | 26 | 0.85 | 0.95 | 0.89 | 38.5 | 73.1 | 38.5 | 31.3 | 68.8 |
| Sep-10 | 26 | 0.91 | 0.96 | 0.94 | 50.0 | 76.9 | 50.0 | 15.4 | 84.6 |
| Dec-10 | 26 | 0.78 | 0.90 | 0.87 | 34.6 | 69.2 | 38.5 | 37.5 | 62.5 |
| Mar-11 | 27 | 0.91 | 0.95 | 0.95 | 44.4 | 66.7 | 44.4 | 33.3 | 66.7 |
| Jun-11 | 27 | 0.88 | 0.95 | 0.93 | 44.4 | 70.4 | 44.4 | 13.3 | 86.7 |
| Sep-11 | 27 | 0.89 | 0.94 | 0.95 | 40.7 | 63.0 | 40.7 | 50.0 | 50.0 |
| Dec-11 | 27 | 0.82 | 0.91 | 0.90 | 40.7 | 70.4 | 40.7 | 18.8 | 81.3 |

*Appendix 2:* Detailed Results from model 2

| Period | No of Banks | Mean Efficiency Scores | | | Number of Efficient Banks (% of total) | | | Sources of Scale Inefficiency (SIE) | |
|---|---|---|---|---|---|---|---|---|---|
| | | OTE | PTE | SE | OTE Banks | PTE Banks | SE Banks | IRS (% of SIE) | DRS (% of SIE) |
| Sep-00 | 16 | 0.81 | 0.91 | 0.89 | 43.8 | 56.3 | 43.8 | 66.7 | 33.3 |
| Dec-00 | 16 | 0.88 | 0.98 | 0.90 | 37.5 | 62.5 | 37.5 | 70.0 | 30.0 |
| Mar-01 | 17 | 0.85 | 0.97 | 0.89 | 41.2 | 64.7 | 47.1 | 77.8 | 22.2 |
| Jun-01 | 17 | 0.85 | 0.97 | 0.89 | 41.2 | 64.7 | 47.1 | 77.8 | 22.2 |
| Sep-01 | 17 | 0.88 | 0.92 | 0.95 | 47.1 | 58.8 | 47.1 | 77.8 | 22.2 |
| Dec-01 | 17 | 0.77 | 0.86 | 0.89 | 41.2 | 52.9 | 41.2 | 90.0 | 10.0 |
| Mar-02 | 17 | 0.84 | 0.91 | 0.92 | 35.3 | 64.7 | 35.3 | 72.7 | 27.3 |
| Jun-02 | 17 | 0.84 | 0.91 | 0.92 | 35.3 | 64.7 | 35.3 | 72.7 | 27.3 |
| Sep-02 | 17 | 0.81 | 0.89 | 0.90 | 41.2 | 52.9 | 41.2 | 80.0 | 20.0 |
| Dec-02 | 17 | 0.81 | 0.93 | 0.87 | 29.4 | 58.8 | 29.4 | 66.7 | 33.3 |
| Mar-03 | 17 | 0.93 | 0.97 | 0.96 | 52.9 | 76.5 | 52.9 | 62.5 | 37.5 |
| Jun-03 | 18 | 0.83 | 0.88 | 0.93 | 27.8 | 55.6 | 27.8 | 76.9 | 23.1 |
| Sep-03 | 18 | 0.81 | 0.85 | 0.94 | 38.9 | 50.0 | 38.9 | 63.6 | 36.4 |
| Dec-03 | 18 | 0.76 | 0.86 | 0.87 | 38.9 | 50.0 | 38.9 | 63.6 | 36.4 |
| Mar-04 | 18 | 0.88 | 0.95 | 0.93 | 38.9 | 55.6 | 38.9 | 72.7 | 27.3 |
| Jun-04 | 18 | 0.81 | 0.93 | 0.88 | 33.3 | 50.0 | 33.3 | 91.7 | 8.3 |
| Sep-04 | 18 | 0.78 | 0.88 | 0.89 | 22.2 | 44.4 | 22.2 | 92.9 | 7.1 |
| Dec-04 | 18 | 0.81 | 0.95 | 0.86 | 33.3 | 66.7 | 38.9 | 90.9 | 9.1 |
| Mar-05 | 19 | 0.90 | 0.96 | 0.94 | 52.6 | 68.4 | 52.6 | 66.7 | 33.3 |
| Jun-05 | 19 | 0.85 | 0.92 | 0.93 | 42.1 | 63.2 | 42.1 | 90.9 | 9.1 |
| Sep-05 | 20 | 0.90 | 0.94 | 0.95 | 60.0 | 65.0 | 65.0 | 85.7 | 14.3 |
| Dec-05 | 20 | 0.78 | 0.90 | 0.87 | 40.0 | 60.0 | 45.0 | 90.9 | 9.1 |
| Mar-06 | 21 | 0.77 | 0.91 | 0.85 | 38.1 | 47.6 | 38.1 | 76.9 | 23.1 |
| Jun-06 | 21 | 0.88 | 0.95 | 0.93 | 33.3 | 57.1 | 33.3 | 78.6 | 21.4 |
| Sep-06 | 22 | 0.82 | 0.92 | 0.88 | 31.8 | 63.6 | 31.8 | 86.7 | 13.3 |
| Dec-06 | 23 | 0.73 | 0.90 | 0.80 | 30.4 | 52.2 | 30.4 | 75.0 | 25.0 |
| Mar-07 | 23 | 0.83 | 0.84 | 0.98 | 39.1 | 39.1 | 52.2 | 45.5 | 54.5 |
| Jun-07 | 23 | 0.83 | 0.84 | 0.98 | 39.1 | 39.1 | 52.2 | 45.5 | 54.5 |
| Sep-07 | 23 | 0.87 | 0.94 | 0.92 | 39.1 | 69.6 | 39.1 | 57.1 | 42.9 |
| Dec-07 | 23 | 0.74 | 0.82 | 0.90 | 21.7 | 47.8 | 21.7 | 33.3 | 66.7 |
| Mar-08 | 24 | 0.90 | 0.93 | 0.97 | 45.8 | 58.3 | 45.8 | 61.5 | 38.5 |
| Jun-08 | 25 | 0.88 | 0.93 | 0.95 | 40.0 | 60.0 | 40.0 | 26.7 | 73.3 |
| Sep-08 | 25 | 0.81 | 0.86 | 0.94 | 28.0 | 36.0 | 28.0 | 50.0 | 50.0 |
| Dec-08 | 25 | 0.74 | 0.88 | 0.85 | 20.0 | 60.0 | 20.0 | 60.0 | 40.0 |
| Mar-09 | 25 | 0.83 | 0.87 | 0.95 | 36.0 | 44.0 | 36.0 | 37.5 | 62.5 |
| Jun-09 | 25 | 0.73 | 0.82 | 0.90 | 20.0 | 40.0 | 24.0 | 36.8 | 63.2 |
| Sep-09 | 26 | 0.70 | 0.79 | 0.88 | 26.9 | 42.3 | 26.9 | 15.8 | 84.2 |
| Dec-09 | 26 | 0.84 | 0.93 | 0.89 | 42.3 | 57.7 | 46.2 | 64.3 | 35.7 |
| Mar-10 | 26 | 0.69 | 0.75 | 0.91 | 23.1 | 38.5 | 26.9 | 52.6 | 47.4 |
| Jun-10 | 26 | 0.75 | 0.84 | 0.90 | 26.9 | 46.2 | 38.5 | 18.8 | 81.3 |
| Sep-10 | 26 | 0.81 | 0.89 | 0.92 | 34.6 | 50.0 | 34.6 | 29.4 | 70.6 |
| Dec-10 | 26 | 0.70 | 0.83 | 0.87 | 23.1 | 50.0 | 23.1 | 60.0 | 40.0 |
| Mar-11 | 27 | 0.84 | 0.88 | 0.96 | 29.6 | 44.4 | 33.3 | 38.9 | 61.1 |
| Jun-11 | 27 | 0.78 | 0.87 | 0.89 | 29.6 | 51.9 | 29.6 | 26.3 | 73.7 |
| Sep-11 | 27 | 0.72 | 0.81 | 0.89 | 25.9 | 44.4 | 29.6 | 50.0 | 50.0 |
| Dec-11 | 27 | 0.61 | 0.76 | 0.82 | 14.8 | 37.0 | 18.5 | 63.6 | 36.4 |

*Appendix 3:* Detailed Results from model 3

| Period | No of Banks | Mean Efficiency Scores | | | Number of Efficient Banks (% of total) | | | Sources of Scale Inefficiency (SIE) | |
|---|---|---|---|---|---|---|---|---|---|
| | | OTE | PTE | SE | OTE Banks | PTE Banks | SE Banks | IRS (% of SIE) | DRS (% of SIE) |
| Sep-00 | 16 | 0.74 | 0.91 | 0.83 | 25.0 | 56.3 | 25.0 | 58.3 | 41.7 |
| Dec-00 | 16 | 0.73 | 0.89 | 0.83 | 18.8 | 31.3 | 18.8 | 92.3 | 7.7 |
| Mar-01 | 17 | 0.79 | 0.89 | 0.87 | 29.4 | 52.9 | 29.4 | 66.7 | 33.3 |
| Jun-01 | 17 | 0.82 | 0.94 | 0.87 | 35.3 | 58.8 | 35.3 | 72.7 | 27.3 |
| Sep-01 | 17 | 0.82 | 0.88 | 0.93 | 35.3 | 52.9 | 35.3 | 72.7 | 27.3 |
| Dec-01 | 17 | 0.77 | 0.85 | 0.90 | 41.2 | 52.9 | 41.2 | 90.0 | 10.0 |
| Mar-02 | 17 | 0.74 | 0.81 | 0.91 | 29.4 | 47.1 | 29.4 | 91.7 | 8.3 |
| Jun-02 | 17 | 0.84 | 0.92 | 0.92 | 35.3 | 64.7 | 35.3 | 72.7 | 27.3 |
| Sep-02 | 17 | 0.79 | 0.88 | 0.89 | 29.4 | 47.1 | 29.4 | 66.7 | 33.3 |
| Dec-02 | 17 | 0.81 | 0.92 | 0.88 | 29.4 | 58.8 | 29.4 | 66.7 | 33.3 |
| Mar-03 | 17 | 0.90 | 0.96 | 0.93 | 41.2 | 76.5 | 41.2 | 70.0 | 30.0 |
| Jun-03 | 18 | 0.79 | 0.87 | 0.91 | 27.8 | 55.6 | 27.8 | 76.9 | 23.1 |
| Sep-03 | 18 | 0.79 | 0.85 | 0.93 | 38.9 | 50.0 | 38.9 | 63.6 | 36.4 |
| Dec-03 | 18 | 0.71 | 0.82 | 0.85 | 22.2 | 44.4 | 22.2 | 57.1 | 42.9 |
| Mar-04 | 18 | 0.83 | 0.92 | 0.90 | 22.2 | 44.4 | 27.8 | 69.2 | 30.8 |
| Jun-04 | 18 | 0.78 | 0.90 | 0.86 | 27.8 | 44.4 | 33.3 | 83.3 | 16.7 |
| Sep-04 | 18 | 0.78 | 0.88 | 0.88 | 22.2 | 44.4 | 22.2 | 92.9 | 7.1 |
| Dec-04 | 18 | 0.80 | 0.94 | 0.85 | 33.3 | 55.6 | 38.9 | 90.9 | 9.1 |
| Mar-05 | 19 | 0.79 | 0.87 | 0.89 | 36.8 | 47.4 | 36.8 | 58.3 | 41.7 |
| Jun-05 | 19 | 0.71 | 0.84 | 0.85 | 15.8 | 42.1 | 15.8 | 56.3 | 43.8 |
| Sep-05 | 20 | 0.76 | 0.88 | 0.86 | 30.0 | 50.0 | 30.0 | 71.4 | 28.6 |
| Dec-05 | 20 | 0.69 | 0.82 | 0.85 | 25.0 | 45.0 | 30.0 | 64.3 | 35.7 |
| Mar-06 | 21 | 0.74 | 0.88 | 0.84 | 23.8 | 33.3 | 23.8 | 87.5 | 12.5 |
| Jun-06 | 21 | 0.71 | 0.88 | 0.80 | 23.8 | 38.1 | 23.8 | 56.3 | 43.8 |
| Sep-06 | 22 | 0.76 | 0.89 | 0.85 | 27.3 | 54.5 | 27.3 | 81.3 | 18.8 |
| Dec-06 | 23 | 0.66 | 0.85 | 0.77 | 17.4 | 34.8 | 17.4 | 100.0 | 0.0 |
| Mar-07 | 23 | 0.78 | 0.88 | 0.88 | 39.1 | 52.2 | 39.1 | 78.6 | 21.4 |
| Jun-07 | 23 | 0.78 | 0.80 | 0.97 | 34.8 | 39.1 | 47.8 | 75.0 | 25.0 |
| Sep-07 | 23 | 0.80 | 0.93 | 0.86 | 34.8 | 60.9 | 34.8 | 66.7 | 33.3 |
| Dec-07 | 23 | 0.68 | 0.78 | 0.86 | 17.4 | 34.8 | 17.4 | 52.6 | 47.4 |
| Mar-08 | 24 | 0.85 | 0.90 | 0.94 | 29.2 | 41.7 | 33.3 | 87.5 | 12.5 |
| Jun-08 | 25 | 0.74 | 0.88 | 0.86 | 16.0 | 44.0 | 16.0 | 33.3 | 66.7 |
| Sep-08 | 25 | 0.75 | 0.82 | 0.92 | 24.0 | 32.0 | 24.0 | 78.9 | 21.1 |
| Dec-08 | 25 | 0.70 | 0.86 | 0.83 | 20.0 | 56.0 | 20.0 | 60.0 | 40.0 |
| Mar-09 | 25 | 0.81 | 0.83 | 0.97 | 28.0 | 40.0 | 28.0 | 66.7 | 33.3 |
| Jun-09 | 25 | 0.72 | 0.78 | 0.91 | 16.0 | 32.0 | 20.0 | 40.0 | 60.0 |
| Sep-09 | 26 | 0.66 | 0.77 | 0.87 | 19.2 | 34.6 | 19.2 | 19.0 | 81.0 |
| Dec-09 | 26 | 0.78 | 0.90 | 0.86 | 30.8 | 46.2 | 30.8 | 61.1 | 38.9 |
| Mar-10 | 26 | 0.67 | 0.75 | 0.90 | 19.2 | 38.5 | 23.1 | 35.0 | 65.0 |
| Jun-10 | 26 | 0.73 | 0.81 | 0.90 | 19.2 | 42.3 | 34.6 | 35.3 | 64.7 |
| Sep-10 | 26 | 0.79 | 0.87 | 0.92 | 23.1 | 46.2 | 23.1 | 25.0 | 75.0 |
| Dec-10 | 26 | 0.59 | 0.80 | 0.76 | 15.4 | 46.2 | 15.4 | 59.1 | 40.9 |
| Mar-11 | 27 | 0.80 | 0.84 | 0.95 | 22.2 | 37.0 | 25.9 | 40.0 | 60.0 |
| Jun-11 | 27 | 0.73 | 0.86 | 0.84 | 14.8 | 44.4 | 14.8 | 21.7 | 78.3 |
| Sep-11 | 27 | 0.73 | 0.86 | 0.84 | 14.8 | 44.4 | 14.8 | 21.7 | 78.3 |
| Dec-11 | 27 | 0.50 | 0.69 | 0.77 | 11.1 | 29.6 | 14.8 | 60.9 | 39.1 |

*Appendix 4:* Detailed Results from model 4

| Period | No of Banks | Mean Efficiency Scores | | | Number of Efficient Banks (% of total) | | | Sources of Scale Inefficiency (SIE) | |
|---|---|---|---|---|---|---|---|---|---|
| | | OTE | PTE | SE | OTE Banks | PTE Banks | SE Banks | IRS (% of SIE) | DRS (% of SIE) |
| Sep-00 | 16 | 0.68 | 0.83 | 0.84 | 25.0 | 50.0 | 25.0 | 75.0 | 25.0 |
| Dec-00 | 16 | 0.64 | 0.77 | 0.85 | 25.0 | 43.8 | 25.0 | 75.0 | 25.0 |
| Mar-01 | 17 | 0.74 | 0.84 | 0.86 | 35.3 | 52.9 | 35.3 | 81.8 | 18.2 |
| Jun-01 | 17 | 0.76 | 0.86 | 0.89 | 35.3 | 64.7 | 35.3 | 72.7 | 27.3 |
| Sep-01 | 17 | 0.74 | 0.82 | 0.90 | 23.5 | 41.2 | 29.4 | 75.0 | 25.0 |
| Dec-01 | 17 | 0.87 | 0.90 | 0.97 | 52.9 | 64.7 | 64.7 | 83.3 | 16.7 |
| Mar-02 | 17 | 0.87 | 0.90 | 0.97 | 52.9 | 64.7 | 64.7 | 83.3 | 16.7 |
| Jun-02 | 17 | 0.87 | 0.90 | 0.97 | 52.9 | 64.7 | 64.7 | 83.3 | 16.7 |
| Sep-02 | 17 | 0.76 | 0.91 | 0.84 | 29.4 | 64.7 | 29.4 | 41.7 | 58.3 |
| Dec-02 | 17 | 0.74 | 0.87 | 0.86 | 41.2 | 58.8 | 41.2 | 80.0 | 20.0 |
| Mar-03 | 17 | 0.84 | 0.90 | 0.93 | 35.3 | 47.1 | 35.3 | 90.9 | 9.1 |
| Jun-03 | 18 | 0.49 | 0.67 | 0.74 | 11.1 | 22.2 | 16.7 | 86.7 | 13.3 |
| Sep-03 | 18 | 0.33 | 0.55 | 0.69 | 5.6 | 22.2 | 11.1 | 100.0 | 0.0 |
| Dec-03 | 18 | 0.74 | 0.84 | 0.88 | 16.7 | 55.6 | 16.7 | 80.0 | 20.0 |
| Mar-04 | 18 | 0.68 | 0.82 | 0.83 | 11.1 | 27.8 | 11.1 | 25.0 | 75.0 |
| Jun-04 | 18 | 0.80 | 0.95 | 0.84 | 22.2 | 72.2 | 22.2 | 21.4 | 78.6 |
| Sep-04 | 18 | 0.79 | 0.89 | 0.89 | 22.2 | 50.0 | 22.2 | 21.4 | 78.6 |
| Dec-04 | 18 | 0.38 | 0.78 | 0.52 | 5.6 | 27.8 | 5.6 | 41.2 | 58.8 |
| Mar-05 | 19 | 0.52 | 0.80 | 0.64 | 15.8 | 47.4 | 15.8 | 25.0 | 75.0 |
| Jun-05 | 19 | 0.55 | 0.78 | 0.72 | 15.8 | 47.4 | 15.8 | 25.0 | 75.0 |
| Sep-05 | 20 | 0.69 | 0.82 | 0.83 | 30.0 | 45.0 | 30.0 | 42.9 | 57.1 |
| Dec-05 | 20 | 0.71 | 0.84 | 0.85 | 25.0 | 50.0 | 25.0 | 53.3 | 46.7 |
| Mar-06 | 21 | 0.70 | 0.89 | 0.78 | 33.3 | 57.1 | 33.3 | 42.9 | 57.1 |
| Jun-06 | 21 | 0.71 | 0.90 | 0.78 | 28.6 | 52.4 | 33.3 | 64.3 | 35.7 |
| Sep-06 | 22 | 0.69 | 0.87 | 0.79 | 22.7 | 45.5 | 22.7 | 64.7 | 35.3 |
| Dec-06 | 23 | 0.62 | 0.81 | 0.77 | 26.1 | 43.5 | 26.1 | 58.8 | 41.2 |
| Mar-07 | 23 | 0.62 | 0.81 | 0.77 | 13.0 | 39.1 | 13.0 | 60.0 | 40.0 |
| Jun-07 | 23 | 0.61 | 0.76 | 0.81 | 17.4 | 34.8 | 17.4 | 10.5 | 89.5 |
| Sep-07 | 23 | 0.75 | 0.88 | 0.84 | 30.4 | 56.5 | 30.4 | 62.5 | 37.5 |
| Dec-07 | 23 | 0.68 | 0.79 | 0.87 | 21.7 | 39.1 | 21.7 | 55.6 | 44.4 |
| Mar-08 | 24 | 0.65 | 0.76 | 0.86 | 16.7 | 33.3 | 16.7 | 70.0 | 30.0 |
| Jun-08 | 25 | 0.69 | 0.83 | 0.85 | 24.0 | 44.0 | 24.0 | 63.2 | 36.8 |
| Sep-08 | 25 | 0.69 | 0.83 | 0.85 | 24.0 | 44.0 | 24.0 | 63.2 | 36.8 |
| Dec-08 | 25 | 0.75 | 0.89 | 0.82 | 32.0 | 60.0 | 32.0 | 35.3 | 64.7 |
| Mar-09 | 25 | 0.75 | 0.89 | 0.82 | 32.0 | 60.0 | 32.0 | 35.3 | 64.7 |
| Jun-09 | 25 | 0.57 | 0.74 | 0.80 | 12.0 | 24.0 | 12.0 | 50.0 | 50.0 |
| Sep-09 | 26 | 0.72 | 0.86 | 0.85 | 19.2 | 38.5 | 19.2 | 57.1 | 42.9 |
| Dec-09 | 26 | 0.70 | 0.83 | 0.84 | 26.9 | 46.2 | 26.9 | 77.8 | 22.2 |
| Mar-10 | 26 | 0.53 | 0.78 | 0.69 | 7.7 | 38.5 | 7.7 | 20.8 | 79.2 |
| Jun-10 | 26 | 0.72 | 0.84 | 0.87 | 26.9 | 50.0 | 26.9 | 63.2 | 36.8 |
| Sep-10 | 26 | 0.72 | 0.87 | 0.82 | 11.5 | 42.3 | 11.5 | 9.1 | 90.9 |
| Dec-10 | 26 | 0.56 | 0.77 | 0.76 | 11.5 | 46.2 | 11.5 | 39.1 | 60.9 |
| Mar-11 | 27 | 0.73 | 0.81 | 0.89 | 18.5 | 37.0 | 18.5 | 22.7 | 77.3 |
| Jun-11 | 27 | 0.61 | 0.83 | 0.74 | 14.8 | 48.1 | 14.8 | 13.0 | 87.0 |
| Sep-11 | 27 | 0.74 | 0.82 | 0.90 | 22.2 | 44.4 | 22.2 | 61.9 | 38.1 |
| Dec-11 | 27 | 0.60 | 0.73 | 0.84 | 22.2 | 48.1 | 22.2 | 45.0 | 55.0 |

*Appendix 5:* Detailed Results from model 5

| Period | No of Banks | Mean Efficiency Scores | | | Number of Efficient Banks (% of total) | | | Sources of Scale Inefficiency (SIE) | |
|---|---|---|---|---|---|---|---|---|---|
| | | OTE | PTE | SE | OTE Banks | PTE Banks | SE Banks | IRS (% of SIE) | DRS (% of SIE) |
| Sep-00 | 16 | 0.85 | 0.96 | 0.88 | 50.0 | 68.8 | 50.0 | 62.5 | 37.5 |
| Dec-00 | 16 | 0.84 | 0.88 | 0.94 | 43.8 | 50.0 | 43.8 | 88.9 | 11.1 |
| Mar-01 | 17 | 0.93 | 0.98 | 0.95 | 58.8 | 82.4 | 58.8 | 85.7 | 14.3 |
| Jun-01 | 17 | 0.92 | 0.96 | 0.95 | 58.8 | 70.6 | 58.8 | 85.7 | 14.3 |
| Sep-01 | 17 | 0.91 | 0.95 | 0.96 | 52.9 | 70.6 | 52.9 | 75.0 | 25.0 |
| Dec-01 | 17 | 0.94 | 0.96 | 0.98 | 64.7 | 76.5 | 64.7 | 16.7 | 83.3 |
| Mar-02 | 17 | 0.74 | 0.85 | 0.88 | 23.5 | 35.3 | 23.5 | 92.3 | 7.7 |
| Jun-02 | 17 | 0.94 | 0.96 | 0.97 | 70.6 | 88.2 | 70.6 | 80.0 | 20.0 |
| Sep-02 | 17 | 0.89 | 0.97 | 0.92 | 47.1 | 76.5 | 47.1 | 77.8 | 22.2 |
| Dec-02 | 17 | 0.92 | 0.98 | 0.94 | 58.8 | 76.5 | 58.8 | 85.7 | 14.3 |
| Mar-03 | 17 | 0.89 | 0.96 | 0.92 | 35.3 | 76.5 | 35.3 | 72.7 | 27.3 |
| Jun-03 | 18 | 0.84 | 0.94 | 0.89 | 52.9 | 70.6 | 52.9 | 88.9 | 11.1 |
| Sep-03 | 18 | 0.91 | 0.96 | 0.95 | 58.8 | 70.6 | 64.7 | 71.4 | 28.6 |
| Dec-03 | 18 | 0.92 | 0.94 | 0.97 | 55.6 | 72.2 | 55.6 | 87.5 | 12.5 |
| Mar-04 | 18 | 0.88 | 0.94 | 0.93 | 38.9 | 66.7 | 38.9 | 72.7 | 27.3 |
| Jun-04 | 18 | 0.92 | 0.97 | 0.95 | 61.1 | 72.2 | 61.1 | 85.7 | 14.3 |
| Sep-04 | 18 | 0.89 | 0.95 | 0.94 | 38.9 | 61.1 | 38.9 | 81.8 | 18.2 |
| Dec-04 | 18 | 0.84 | 0.95 | 0.88 | 50.0 | 77.8 | 50.0 | 66.7 | 33.3 |
| Mar-05 | 19 | 0.80 | 0.88 | 0.92 | 36.8 | 52.6 | 36.8 | 66.7 | 33.3 |
| Jun-05 | 19 | 0.87 | 0.92 | 0.93 | 52.6 | 63.2 | 52.6 | 77.8 | 22.2 |
| Sep-05 | 20 | 0.88 | 0.92 | 0.95 | 50.0 | 55.0 | 50.0 | 70.0 | 30.0 |
| Dec-05 | 20 | 0.86 | 0.92 | 0.94 | 35.0 | 50.0 | 45.0 | 81.8 | 18.2 |
| Mar-06 | 21 | 0.91 | 0.96 | 0.95 | 42.9 | 76.2 | 42.9 | 90.9 | 9.1 |
| Jun-06 | 21 | 0.79 | 0.93 | 0.86 | 28.6 | 66.7 | 28.6 | 80.0 | 20.0 |
| Sep-06 | 22 | 0.81 | 0.92 | 0.88 | 36.4 | 54.5 | 36.4 | 78.6 | 21.4 |
| Dec-06 | 23 | 0.83 | 0.94 | 0.89 | 43.5 | 65.2 | 43.5 | 84.6 | 15.4 |
| Mar-07 | 23 | 0.87 | 0.94 | 0.92 | 39.1 | 56.5 | 39.1 | 85.7 | 14.3 |
| Jun-07 | 23 | 0.87 | 0.94 | 0.92 | 39.1 | 56.5 | 39.1 | 85.7 | 14.3 |
| Sep-07 | 23 | 0.92 | 0.98 | 0.93 | 52.2 | 69.6 | 52.2 | 63.6 | 36.4 |
| Dec-07 | 23 | 0.86 | 0.89 | 0.96 | 52.2 | 60.9 | 52.2 | 72.7 | 27.3 |
| Mar-08 | 24 | 0.88 | 0.93 | 0.95 | 41.7 | 50.0 | 41.7 | 85.7 | 14.3 |
| Jun-08 | 25 | 0.81 | 0.93 | 0.87 | 36.0 | 60.0 | 36.0 | 75.0 | 25.0 |
| Sep-08 | 25 | 0.85 | 0.90 | 0.94 | 36.0 | 52.0 | 36.0 | 56.3 | 43.8 |
| Dec-08 | 25 | 0.88 | 0.95 | 0.93 | 48.0 | 68.0 | 48.0 | 69.2 | 30.8 |
| Mar-09 | 25 | 0.89 | 0.93 | 0.96 | 44.0 | 64.0 | 44.0 | 78.6 | 21.4 |
| Jun-09 | 25 | 0.77 | 0.87 | 0.89 | 24.0 | 40.0 | 24.0 | 78.9 | 21.1 |
| Sep-09 | 26 | 0.83 | 0.91 | 0.92 | 42.3 | 53.8 | 42.3 | 80.0 | 20.0 |
| Dec-09 | 26 | 0.81 | 0.92 | 0.88 | 34.6 | 50.0 | 34.6 | 76.5 | 23.5 |
| Mar-10 | 26 | 0.82 | 0.90 | 0.91 | 34.6 | 53.8 | 34.6 | 76.5 | 23.5 |
| Jun-10 | 26 | 0.82 | 0.91 | 0.90 | 38.5 | 61.5 | 42.3 | 73.3 | 26.7 |
| Sep-10 | 26 | 0.91 | 0.95 | 0.95 | 65.4 | 76.9 | 69.2 | 37.5 | 62.5 |
| Dec-10 | 26 | 0.77 | 0.89 | 0.88 | 30.8 | 53.8 | 30.8 | 66.7 | 33.3 |
| Mar-11 | 27 | 0.86 | 0.94 | 0.91 | 55.6 | 74.1 | 55.6 | 75.0 | 25.0 |
| Jun-11 | 27 | 0.82 | 0.93 | 0.88 | 25.9 | 63.0 | 25.9 | 30.0 | 70.0 |
| Sep-11 | 27 | 0.84 | 0.89 | 0.95 | 37.0 | 51.9 | 37.0 | 88.2 | 11.8 |
| Dec-11 | 27 | 0.75 | 0.84 | 0.90 | 37.0 | 55.6 | 37.0 | 43.8 | 56.3 |

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# Impact of Microfinance Loans on Paddy Production among Small Holder Farmers in Sri Lanka

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*Abstract-* The objectives of this study are to analyze the impact of microfinance loans on paddy production among smallholder farmers and to identify the differences in paddy production who are the borrowers and non – borrowers of micro finance loans from micro finance institutions in Sri Lanka. For the above purposes, primary data were collected through a structured questionnaire considering six divisional secretariat divisions in Jaffna district, Sri Lanka for the period of 2014 – 2015. A total of 93 respondents were selected randomly from loan beneficiaries and non – loan beneficiaries from the study area. The collected data were analyzed thorough various econometrics techniques such as, frequency analysis, independent sample t test, simple regression using dummy variable and log – log regression model. Results of independent sample t test proves that there are differences in average production of paddy among the borrowers and non – borrowers while log – log model reveals that usage of fertilizer has negatively affect on paddy production, but other four inputs namely, seed, cost of labour, machinery and size of cultivated land positively impact on production of paddy who are the farmers received loans from micro finance institutions in Sri Lanka. Overall results suggest that loan beneficiaries who were received loans relatively better in accessing markets for paddy cultivation, and usage of inputs and also adoption of improved farming technologies in Jaffna district, Sri Lanka.

*Keywords: microfinance loans, borrowers and non-borrowers, cobb-douglas regression, farming technologies.*

*GJMBR-C Classification: JEL Code: G21*


*Strictly as per the compliance and regulations of:*

# Impact of Microfinance Loans on Paddy Production among Small Holder Farmers in Sri Lanka

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*Keywords: microfinance loans, borrowers and non-borrowers, cobb-douglas regression, farming technologies.*

## I. Introduction

Rice is the staple food of Sri Lanka where small farmers grow it for both subsistence and commercial purposes. Generally small farmers are cultivating paddy production in their own land or rented land and even go for share cropping system to earn their subsistence income to maintain their standard of living. Lack of financial capabilities and pressure from the poverty force them to take microcredit loans from banks and other financial institutions to cultivate and harvest their agricultural crops specially paddy and other field crops. Consequently, poor farmers may be perpetually trapped in poverty due to lack of funds for purchasing inputs and productive investment in farming. Farmers cannot enter into the formal credit systems due to mortgage, high formality and unavailability of bank branches in the remote areas. Thus, those credits are more helping to them in improve the agricultural production activities. The term microfinance refers to the provision of a broad range of financial services such as deposits, loans, payment services, money transfers, and insurance to poor and low-income households and their micro enterprises for enhancing their production activities. The idea of providing credits to poor farmers is as a tool for increasing their income, their production and thereby reducing poverty. Microfinance institutions offer financial services to farmers without mortgage and doing less procedural formalities as compared to formal banking channel in one hand and at a reasonable interest rate as compared to informal credit systems. Thus, microfinance institutions were introduced and viewed as an alternative source of financial services in rural areas in Jaffna district and as a result, the microcredit systems are much popular among small farmers in the above area. The micro credits may contribute to increase the productivity by enabling them to purchase necessary inputs for paddy production and also may help to finance for those activities which adds the value to the output of paddy.

There is a wide range of institutions specially, co- operative societies, local and international Non-Governmental Organizations (NGOs), commercial banks including both state-owned and private and development banks such as the Regional Development Banks (RDBs) and the Sanasa Development Banks (SDBs) that are involved in providing microfinance loans to low income groups in Jaffna district. In addition, Bank of Ceylon, people's bank, the Government's Samurdhi savings and other financial institutions (MFIs) also provide the microfinance loan to farmers and most of those banks provide microfinance to farmers based on the interest and guarantee of two or four borrowers.

The objectives of this study are to analyze the impact of microfinance loans on paddy production among smallholder farmers and to identify the differences in paddy production who are the borrowers and non – borrowers of micro finance loans from micro finance institutions in Sri Lanka.

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## II. Literature Review

Alam (1988) has analyzed the role of targeted credit programs in promoting employment and productivity of the poor in Bangladesh. His study revealed that the users of microfinance can bring 81.5 percent of their cultivable land under high yield variety production compared to 76 percent of the non-users. Feder (1990) has studied on the relationship between credit and productivity in Chinese agriculture and based on his finding, credit is being cited as an important factor in agricultural production systems in China.

Sjah (2005) has identified the effect of loan provision on farming activities and he suggests credit used by farmers had little noticeable impact on improving agricultural income in Indonesia. Svay Sopheana, ChovElen, LengBunhor, Touch Visalsok, and Nigel Finch (2006) have examined the effect of microfinance on agricultural occupation: The case study in battambang province, Australia. Their results revealed that most households used micro-credit for buying agricultural equipments and it was found that microfinance contributes to increased income, household consumption and savings for households Australia.

Olagunju.I.F (2007) has examined the impact of credit use on research productivity of sweet potatoes farmer in Osun- State, Nigeria and he concluded that the farmers having credit have more output than non-credit farmers.

Nosiru,M.O.(2010) studied on microcredit and agricultural productivity in ogun State, Nigeria. They used Cobb-Douglas production function to analyze microcredit and agriculture productivity and they found that land size and capital are important variables affecting agricultural output positively among microcredit non-beneficiaries. Ashaolu, O.F.Momoh, S.Phillip, B.B and I.A.Tijani (2011) analyzed microcredit effect on Agricultural Productivity: A Comparative analysis of rural farmers in Ogun State, Nigeria. Their findings revealed that total cost per hectare of credit user farmers is higher than that of non-credit user farmers in the country.

Frank Girabi and Agnes Elishadai Godfrey Mwakaje (2013) have examined the impact of microfinance on agricultural productivity by smallholder farmers in Tanzania with the case study of Iramba District. Their findings revealed that, credit beneficiaries realized high agricultural productivity compared to the non-credit beneficiaries and credit beneficiaries have relatively better production than non- beneficiaries. Khan Mehedi Hasan, Md. Masum Billah, Sk. Sharafat Hossen and Tasnim Murad Mamun (2014) have evaluated the effect of microcredit on agricultural output: Evidence from Rural Bangladesh. Base on the Cobb-Douglas production function, they showed that microcredit beneficiaries produce 15% more rice than that of non-beneficiary group significantly. Aminu Sulemana, Samuel Appiah Adjei (2015) has analyzed the microfinance impact on agricultural production in developing countries: A study of the pru district in Ghana and found that microfinance is positively related to agricultural production and shows a significant impact on output level in the country.

## III. Methodology

Micro finance is one of the major instruments in agricultural sector which helps to improve the productivity by improving farming technologies. In this background, this study has examined the impact of microfinance loans on paddy production among the farmers who are cultivating in Jaffna district, Sri Lanka. This study has used the respondents as a sampling framework considering six divisional secretariat divisions in Jaffna district covering 93 farmers with the two categories such as loan beneficiaries and non- loan beneficiaries who are involved in paddy cultivation. A structured questionnaire was used to collect the data which includes the information relevant to production of paddy, details of inputs including costs of seed, machinery, and costs of labour, usage of fertilizer and size of land.

*a) Methods of data analysis*

In the beginning, frequency analysis and descriptive statistics of the variables were analyzed and based on that, basic characters of each variable could be explained. Further, Independent sample t test, simple regression using dummy variable, log – log regression and quadratic model also applied in the study.

i. *Frequency statistics*

Frequency statistics is the basic tools to explain the features of the variables and thus frequency of loan beneficiaries and non – loan beneficiaries was analyzed.

ii. *Independent sample t test*

To identify whether there is any difference in average production of paddy among small holder farmers, independent sample t test was used.

iii. *Simple regression model*

To identify the impact of receiving micro finance on production of paddy, simple regression model using dummy variable was applied in the study.

In this case, production of paddy considered as dependent variable and micro finance loans treated as independent variable which is categorized into two such as I for loan borrowers and 0 for non- borrowers from micro finance institutions. The regression model can be written as:

$$Q = \beta_0 + \beta_1 D_1 + u$$

Where:

Q - Production of paddy in Kg

$\beta_0$ - constant

$\beta_1$ - coefficient of dummy variable
$D_i$ - dummy variable of microfinance
0 for non- borrower
1 for borrower
u - Error term.

iv. *Log – log regression model*

To examine the impact of microfinance on paddy production, log – log regression model was used.

$$\text{Ln } Q_i = \beta_0 + \beta_1 \text{ Ln } X_{1i} + \beta_2 \text{Ln } X_{2i} + \beta_3 \text{ Ln } X_{3i} + \beta_4 \text{ Ln } X_{4i} + \beta_5 \text{ Ln } X_{5i} + u$$

Where:
Ln Q = Log of paddy yield in Kg
$\beta_0$ - constant
$\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$, $\beta_5$ are the coefficients of each independent variable.
$X_1$ = Seed
$X_2$ = Fertilizer
$X_3$ = Wage for labour
$X_4$ = Machinery expenses
$X_5$ = Size of land

In case of the log- log model, it can be used to explain the impact of each explanatory variable on the dependent variable in terms of percentage as well as the elasticity of output with respect to each independent variable.

v. *Quadratics model of fertilizer*

Quadratic function is used quite often in applied economics to capture the decreasing or increasing marginal effect. To find out the maximum amount of paddy production by usage of fertilizer, the researcher has used quadratic model which is considered paddy production as dependent variable and fertilizer as independent variable. The model as given by:

$$Q = \beta_0 + \beta_1 X_1 + \beta_2 X_2^2 + u$$

Where:
Q = Production of paddy
$X_1$ = Usage of fertilizer
$X_2$ = Squared of fertilizer
u = Error term

## IV. Results and Discussions

According to the frequency of borrowers and non- borrowers among small holder farmers, out of 93, 72% of them were received loans and 28% of them not received loans from micro finance institutions in the study area. The results are given in the table 01.

*Table 01:* Results of frequency test for credit and non-credit users

| | Frequency | Percentage |
|---|---|---|
| Credit user | 67 | 72 |
| Non-credit user | 26 | 28 |
| Total | 93 | 100 |

An investigation on how the loans was used in paddy production was done by the frequency analysis and its results show that 22% of the farmers from loan beneficiaries used their loans to purchase of seed and pesticides and to pay for wages while only 1% of them used it for purchase of land.

*Table 02:* Frequency of usage of loans on various purposes

| Activity | Frequency | Percentage |
|---|---|---|
| Purchase of land | 01 | 1 |
| Purchase of Fertilizer | 10 | 15 |
| Purchase of seed and pesticides | 15 | 22 |
| Purchase of farming equipment | 06 | 10 |
| Pay for wage | 15 | 22 |
| Repay the previous loan | 10 | 15 |
| Others | 10 | 15 |
| Total | 67 | 100 |

15% of the beneficiaries used the loans to repay their previous loans and thus they were unable to purchase many other inputs to increase the production. Independent sample t test was applied to identify the whether there is a difference in production of paddy among borrowers and non-borrowers. This test is useful to compare the mean values of production among borrowers and non-borrowers.

*Table 03:* Results of independent sample t test

| | Levene´s test for equality of variance | | t-test for equality of means | | | | |
|---|---|---|---|---|---|---|---|
| | F | Sig | t | df | Sig(2tailed) | Mean Difference | Std Error Difference |
| Equal variance assumed | 4.045 | .047 | -4.915 | 91 | .000 | -798.617 | 162.479 |
| Equal variance not assumed | | | -6.341 | 82.260 | .000 | -798.617 | 125.944 |

According to the results of independent sample test, significant value is less than 0.01 proves that there is a difference in average production among the borrowers and non-borrowers of microfinance loans. Based on the mean value, the farmers who were received loans from microfinance institutions able to produced 798.617 more production than who were not received the loans suggests that micro finance loans help them to raise their production. Apart from the independent sample t test, simple regression using dummy variable also applied to identify the impact of micro finance loans on production paddy in Jaffna district. The simple regression results were displaced in the following table.

*Table 04:* Results of Simple regression using dummy variable

| Variables | β | Std. Error | Standardized coefficients | t | Sig |
|---|---|---|---|---|---|
| Constant | 1168.846 | 137.909 | | 8.475 | 0.000 |
| Micro finance | 798.617 | 162.479 | 0.458 | 4.915 | 0.000 |

Based on the above regression results, the farmers who were received loans they were able to use those loans to purchase inputs which lead to increase the average production by nearly 799 kg than the farmers who are not received the loans. Also standardized coefficient of micro finance indicates that 45% of microfinance loans were contributes to the production of paddy in Jaffna district and all the results are statistically significant at 1% level.

Quadratic regression is very useful to identify the increasing or decreasing marginal returns of a variable input in a production process. In this study, usage of fertilizer was considered as one of the variable inputs to find out the maximum usage of fertilizer the farmer able to use. After the maximum usage of fertilizer, as the farmer uses more and more fertilizer, the production will not increase further because of diminishing marginal returns. Based on quadratic model, the following estimated regression model was obtained.

$$\text{Production} = 1347.081 + .064X_1 - 0.0000074\ X_1^2$$

Based on the above regression result shows that $\beta_1$ is positive and $\beta_2$ is negative which imply that usage of fertilizer has diminishing effect on production. In the beginning, as fertilizer has increased production also increased and then reached the maximum level and there after it has declined. To find out the maximum usage of fertilizer, the following formula is used.

$$X^* = \beta_1 / (2\beta_2)$$
$$= 0.064 / 2(0.00000748)$$
$$= 429.53$$

It suggests that, production of paddy is maximized where the farmer use the fertilizer at nearly 430 kg and after that even the usage of fertilizer has increased, production will not be increased.

Finally, to identify the impact of microfinance on production of paddy among the farmers who received loans, log – log model was applied. The estimated results were exhibit in the table below.

*Table 05:* Log- log regression results for borrowers

| Variables | β | Std. Error | Standardized coefficients | t | Sig |
|---|---|---|---|---|---|
| Constant | 445.351 | 208.581 | | 2.135 | .037 |
| Seed | .008 | .017 | .045 | .471 | .039 |
| Fertilizer | -.014 | .008 | -.170 | -1.776 | .081 |
| Wage | .035 | .009 | .392 | 4.045 | .000 |
| Machinery | .020 | .009 | .246 | 2.225 | .030 |
| Land | 19.512 | 5.183 | .401 | 3.765 | .000 |

R Square: 0.586
Adjusted R Square: 0.552

Above table shows that all variables are statistically significant at1%, 5% and 10% and out of them, payment for wage and size of land have more statistically significant influence on paddy production than other variables. Further, standardized coefficients show that wages and size of land have more contributed to the yield of paddy in the study area. In the log – log model the coefficient of each variable represents the elasticity and seed input has inelastic while land has more elastic. As size of land increases by one percent, paddy yield will increase by 19 percent keeping other factors held constant. Thus, the result reveals that, the farmers who received loans from the institutions, they used those funds to purchase land and pay the wages for labors.

## V. Conclusions

This study examines the impact of the microfinance loans on paddy production among small hold farmers in Jaffna district, Sri Lanka. Out of 93 farmers, 72% of them received loans and 28 % of them not received any loans from microfinance institutions. Results of independent sample t test suggest that on average production of paddy is higher for the farmers who were receive the loans by nearly 798Kg compared to non- beneficiaries in Jaffna district, Sri Lanka. Apart from the independent sample t test, simple regression using dummy variable for loan beneficiaries and non-beneficiaries, microfinance significantly positive impact on production of the farmers who were received loans and they were able to use it for purchase of various inputs which leads to raise their production of paddy in the study area. According to log – log model reveals that, size of cultivated land and payments for labors are significantly affect on production even they spend only 1% on purchase of land, it is the major contributor to the production of paddy in Jaffna district, Sri Lanka.

Finally, based on the results, it can be concluded that loans given the microfinance institutions have significantly impact on the paddy sector in the above district in Sri Lanka. Due to the loans, the farmers were able to apply new techniques in production by purchasing and using inputs, it helps them to increases the production of paddy than the non – beneficiaries. So, micro finance loans are playing a vital role in increasing production of paddy and thus farmers should be encouraged to practice new production techniques in their farming with the usage of microfinance loans. On the other side, it should be monitored by the institutions whether the loans are properly and efficiently used by the borrowers in their farming and cultivation activities. As the loans given by them, if they adopt flexible rate of interest and the maturity period for repay their loans, it may help farmers to get the funds easily than other institutions. These kinds of practices may encourage the farmers to involve in their production in the effective way which lead to raise the contribution of agricultural to the gross domestic product in the economy of Sri Lanka.

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# Prudential Capital Regulation Impact on Tunisian Bank Behavior

By Inene Kanzari

*Abstract-* The purpose of our paper is to analyze the behavior of banks in terms of capital and risk in front of the prudential capital regulation constraints. Our study is based on a panel of Tunisian banks over the period 1996-2014. The findings show that the capital adequacy requirements affect significantly and negatively the capital and positively the risk which adjust simultaneously.

*Keywords:* *prudential capital regulation, capital, risk, panel and simultaneous equations.*

*GJMBR-C Classification:* *JEL Code: G21*


*Strictly as per the compliance and regulations of:*

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## I. Introduction

In an environment as turbulent as that which characterizes the present world economy, developed and developing countries seek to establish a financial system which can adapt and absorb all the disturbances that may affect it. To achieve this goal, all efforts are directed towards understanding or even mastering the relations that can take place between the trilogy: capital, risk and regulation.

It seems interesting to examine the banks behavior in terms of capitalization and risk since prudential reform is in the process of being applied. The international adoption of the Basel I and Basel II agreements on capital adequacy rules or minimum capital standards, presents one of the main financial innovations known by the banking sector since the nineties. The agreement was published by Basel committee on banking. Indeed, the 1988 Basel Accord published by Basel Committee on Banking Supervision, was amended to take into consideration the market risk in addition to credit risk. Basel II agreement introduced three pillars: supervisory review process, market discipline and minimum capital standard. It implies the incorporation of the operational risk into risk capital norm. Through Basel III, especially after the last financial crisis, the new standardization guidelines are being applied in many countries: the accord seeks the improvement of the regulation. It is based on three pillars, similar to Basel II, and introduces a leverage ratio as a supplement to the capital requirements. It addresses the quality, consistency and transparency of the capital base. Also, it covers mico-prudential and macro-prudential elements.

The analysis of bank reactions to the directives I and II relating to the capital standard is important in order to anticipate the expected implications of Accords III and the application of the new capital ratio.

Our paper is organized as follow: section 2 presents an overview of studies that have focused on the theme of our study. At the section 3 level, the methodology followed is illustrated. In section 4, empirical results and interpretation are presented.

## II. Literature Review

Studies that seek to analyze the behavior of banks in the presence of capital regulation are ambivalent. Referring to a portfolio approach, Kahane (1977) asserted that the use of regulatory practices, the requirement for a minimum level of capital and the constraint of the composition of the asset portfolio can only be beneficial if they are combined. Koehn and Santomero (1980) have shown that, under regulatory capital standards, changes in capital and portfolio risk are positively correlated. According to the authors, a risk-averse bank, faced with an increased capital requirement, will try to invest more in riskier assets.

Kim and Santomero (1988) have concluded that capital regulation can be effective if and only if the weights used in the calculation of the capital ratio are proportional to the risks. They proposed a risk-adjusted capital ratio. As to Blum (1999), he suggests, within a dynamic framework, that the rules of capital adequacy can increase the risk of a bank. According to Jacques and Nigro (1997), the rule of regulatory standards designated to minimize the likelihood of bankruptcy pushes banks to choose high-risk assets.

The study of Shrieves and Dahl (1992) constitutes a pioneer work which tried to analyze the effect of the regulatory pressure on the capitalization and the risk-taking. Several works have been based on the econometric specification developed and modeled by these authors who characterized the risk-capital relation by a simultaneity effect. According to the authors, this relation depends on the underlying economic rationality, the algebraic sign and the impact of regulatory pressure on changes in capital and banking risk. Indeed, by studying a sample of US commercial banks for the period 1983-1987, the authors concluded that there was a significantly positive simultaneous relationship between the change in capital and that of risk and that regulatory pressure can

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contribute to increase the level of capital and limit the bank risk taking.

Jacques and Nigro (1997) have contributed to the study of the regulatory standards impact on bank capital and portfolio risk. They analyzed the case of commercial banks during the first year of implementation of these standards (risk-adjusted capital ratio). They concluded that banks with capital ratios in excess of the minimum required, respond by increasing the capital ratio and reducing their portfolio risk. In a work in 2001, carried out over the period 1991 to 1996, the authors reached the same conclusion.

In regards to Aggrawal and Jacques (1998), they carried out a study on commercial banks over the period 1990-1993 to analyze the effect of corrective action (PCA) on bank capital and risk, and conclude that in front of regulation, banks increase their capital ratio and reduce their portfolio risk. Jackson and al (1999) concluded that capital regulation, inducing banks to maintain higher capital ratios than they would otherwise have held in the regulation absence, constitutes limited definitive evidence.

Rime (2001), based on Shrieves and Dahl methodology has studied the Swiss banks reaction to capital constraints over the period 1989-1995. The results show that regulatory pressure drives banks to increase their capital without affecting the level of risk taking.

According to Kabir (2002) who examined the effect of capital regulation on commercial banks for developing countries, the results showed that such regulations did not lead to an increase in capital ratios. But, they have reduced the bank portfolio risk.

Murinde and Yaseen (2004) studied the banking case in the Middle East and North Africa (MENA) regions over the period 1995-2003.They concluded that the Basel Accord in terms of capital adequacy as regulatory pressure did not push the banks to increase their capital but it positively affected the risk level. Van Roy (2005) tried to analyze the reactions of the big countries banks following the Basel agreement advent. He concluded that undercapitalized banks generally increased their capital but not their risks. According to the Basel II agreement, the standardized approach to risk is similar to the Basel I. In this context, works interesting to bank response to the need for minimum capital, while relying on the notion of risk-adjusted assets, are rare.

Zhang, Wu and Liu (2008) and Awdeh, ElMoussawi and Machrouh (2011) works have been based on the Shrieves and Dahl (1992) principle. Concerning the first work, on the basis of a sample of Chinese banks over a period from 2004 to 2006, the results showed that the change in capital is negatively correlated with that at the level of risk. The second work results, while focusing on the case of 41 Lebanese commercial banks from 1996 to 2008, have shown that a greater capital requirement is linked to an increase in the level of risk.

Sobreira and De Paula (2010) considered prudential regulation as an international movement involving and reacting to competitive advantages of banks internationally active. Basel accord implies establishing policies for behavior of banks and calling for the disclosure of information to avoid direct intervention, mainly after amendment, and to allow banks to innovate and to increase their relationships.

Francis and Osborne (2012) suggest that regulation has led to an active bank behavior in the context of risk management. To satisfy regulatory requirements, the bank can resort to arbitration, a technique that has exploited the gaps and anomalies of the Basel Accord.

The study of Lee and Chin (2013), realized between 2004 and 2011, has shown the relevance of the Leverage ratio and the capital adequacy ratio relating to the prudential requirement.

According to Bhatta (2015), financial institutions are in better situation if they have higher level of equity. This level allows to banks to absorb losses, repay deposits in a timely manner, to manage risk and behavior. He advanced: “A higher capital requirements might also constrain the lending capacity of a bank”.

Tanda (2015) argue that capital regulation acts as an external force in the bank capital and risk levels determination. Bank’s decisions can be influenced by changes in the regulatory framework.

Louati, Abida and Bojelbene (2015), in order to compare the behavior of islamic and conventional banks in relation to the capital adequacy standard, they studied a MENA sample during the period 2005-2012. Their study’s results show that capital regulatory requirements have a significant impact on the credit behavior of the two types of banks.

Bougatef and Mgadmi (2016), interested to banks in the MENA region during 2004 – 2012, concluded that prudential regulation has failed to reduce the level of risk and to increase the level of capital.

Ashraf, Arshad and Hu (2016) argued that risk-based capital requirements have been reinforced in the new Basel III Accord to counter excessive bank risk taking behavior. Ashraf and al, on the basis of a panel of commercial banks, have found that same banks having risk-based capital ratios either lower or higher than the regulatory required limits, have decreased portfolio risk in response to stringent risk-based capital requirements. According to Chen (2016), bank capital regulation is a key determinant of the levels of capital held by banks

## III. Methodology

*a) Model and variables*

Our work is, mainly, inspired by the study of Rime (2001) on the basis of Shrieves and Dahl (1992)

pioneer work. Indeed, according to the authors changes in capital and risk levels can be decomposed into a discretionary adjustment and a change due to exogenous factors. These variations are assumed proportional to the difference between the targeted levels and those existing during the period t-1. Thus, these variations, in terms of capital and risk during the period t, are based on the targeted levels, the delayed levels and exogenous factors.

It should be noted, at this level, that the objective of prudential capital regulation is to limit bank risk taking. This assumes that an increase in the level of capital may lead to a reduction in the level of risk. According to Shrieves and Dahl (1992), we assume that capital and risk decisions are determined simultaneously and we seek to analyze, on the basis of the following simultaneous equations model, if prudential regulation, in terms of capital adequacy, has an effect on capital and risk and if there is a significant relationship between capital and risk.

$$VCAP_{i,t} = a_0 + a_1 REG_{i,t-1} + a_2 ROA_{i,t} + a_3 SIZE_{i,t} + a_4 VRISK_{i,t} - a_5 CAP_{i,t-1} + \varepsilon_{i,t,}$$

$$VRISK_{i,t} = b_0 + b_1 REG_{i,t-1} + b_2 NPA_{i,t} + b_3 SIZE_{i,t} + b_4 VCAP_{i,t} - b_5 RISK_{i,t-1} + \nu_{i,t,}$$

According to the previous model, we are interested to the following variables:

VCAP and VRISK represent, respectively, changes in capital and risk levels.

*CAP:* Defined as the ratio of total capital to risk-adjusted assets. This definition became interesting following the consideration of credit, market and operational risks by the Basel agreement.

*RISK:* Defined as the ratio of risk-adjusted assets to total assets. Indeed the risk is mainly determined by the allocation of assets to the different risk categories that the weightings correctly reflect.

*REG:* Regulatory pressure can be apprehended by several measures that reflect the adjustment of the bank's solvency ratio to the regulatory standard. We opt fora simple approach where regulatory pressure is approximated by 1 if the minimum threshold required by regulation is not met and 0 otherwise. This approaches is adopted by Shrieves and Dahl (1992), Rime (2001) and Bougatef and Mgadmi (2016).

*SIZE:* Size can influence risk and capital levels. Indeed, the large banks are more willing to maintain less capital since they have a better ability to increase them if necessary. Again, they are more active and can diversify their portfolio, and therefore reduce their risk. This variable is measured by the logarithm of the bank total assets.

*ROA:* The return on the bank's assets is included as an explanatory variable in the capital equation. The realized profits, measured as the return on the asset, can have a positive effect on the banks capital. Banks may prefer the increase of capital by incorporation of the result than the issuance of new shares.

*NPA:* This variable is approximated by an indicator on the quality of assets; the ratio of new provisions to total assets. Banks with low quality assets are assumed to have a higher risk. Therefore, this variable is included in the risk equation.

Our work is interested to the Tunisian banks behavior during the period 1996-2014. Concerning the prudential standard is 5% for the period1996-1998 and 8% for the period1999-2012.According to the Tunisian Central Bank, banking regulation has modified the prudential standard concerning the solvency ratio. Indeed, it has demanded respect for the value of de 9% starting from 2013 and 10% starting from 2014.

*b) Descriptive analysis*

We notice that, by referring to the table 1, the change in bank capitalization amounts to an average of0.002 with respective maximum and minimum values of 0.759 and -0.795. Regarding the risk, the banks show an average variation of 0.053, a maximum value about 0.991 and a minimum value of -0.714. Banks recorded a volatility of 0.082 and 0.243, respectively, for capital and risk changes. Move to the regulatory level, an average of 0.184 is displayed with a deviation of0.388. ROA and NPA ratios have respective averages of 0.008 and 0.0107. We note, also, according to the coefficients which appear at the table 2, that the correlation between most variables is relatively low.

*Table 1:* Descriptive statistics

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Vcap | 190 | .0027211 | .082802 | -.795 | .759 |
| Reg1 | 190 | .1842105 | .38868 | 0 | 1 |
| Tail | 190 | 14.77773 | .6293032 | 13.526 | 15.985 |
| Vrisq | 190 | .0535211 | .2436956 | -.714 | .991 |
| Cap | 190 | .1068474 | .068609 | -.05 | .857 |
| Npa | 190 | .0107105 | .0108845 | -.008 | .102 |
| Roa | 190 | .0081579 | .0122982 | -.104 | .035 |
| Risq | 190 | .7665 | .1860421 | -.261 | 1.176 |

*Table 2:* Correlation matrix

| Variabls | Vcap | Reg1 | Tail | Vrisq | Risq | Roa | Cap | Npa |
|---|---|---|---|---|---|---|---|---|
| Vcap | 1.0000 | | | | | | | |
| Reg1 | 0.1157 | 1.0000 | | | | | | |
| Tail | -0.0235 | -0.1284 | 1.0000 | | | | | |
| Vrisq | -0.1338 | -0.0152 | 0.2338 | 1.0000 | | | | |
| Risq | 0.0823 | 0.0308 | -0.3673 | 0.2141 | 1.0000 | | | |
| Roa | 0.0932 | -0.2341 | -0.0965 | 0.0420 | 0.0231 | 1.0000 | | |
| cap | -0.6213 | -0.4405 | 0.1297 | 0.0000 | -0.3533 | 0.1308 | 1.0000 | |
| Npa | -0.1203 | 0.1703 | 0.0066 | -0.0546 | 0.0397 | -0.8401 | -0.0585 | 1.0000 |

At the level of this study, we will try to see if the endogenous variables are adjusted simultaneously by using the simultaneous equations and the double least square method which takes account of this simultaneity. A regression in panel data is applied. The Hausman test makes it possible to check whether it is a fixed (I) or random (II) effect.

## IV. Results and Interpretation

The estimation of models (table 3) allows us to choose the fixed effect for the two equations.

*Table 3:* Model estimation

| VCAP | | | VRISK | | |
|---|---|---|---|---|---|
| Variables | (I) | (II) | Variables | (I) | (II) |
| Vrisk | -0.073 | -0.058 | Vcap | -0.547 | -0.518 |
| | (-3.76)*** | (-3.01)*** | | (-2.91)*** | (-2.54)** |
| Reg | -0.023 | -0.033 | Reg | 0.113 | 0.044 |
| | (-1.70)* | (-2.46)** | | (2.51)** | (0.98) |
| Roa | 0.661 | 1.230 | Npa | -1.749 | -2.376 |
| | (1.69)* | (3.18)*** | | (-1.18) | (-1.51) |
| Size | 0.037 | 0.015 | Size | 0.304 | 0.156 |
| | (3.47)*** | (1.89)* | | (8.16)*** | (5.11)*** |
| Cap | -1.052 | -0.900 | Risk | 0.625 | 0.495 |
| | (-13.75)*** | (-12.04)*** | | (6.32)*** | (5.10)*** |
| Constant | -0.429 | -0.127 | Constant | -4.931 | -2.611 |
| | (-2.73)*** | (-1.06) | | (-8.37)*** | (-5.38)*** |
| *N* | 180 | 180 | *N* | 180 | 180 |
| Wald Chi2 | 208.75 | 161.62 | Wald Chi2 | 96.75 | 39.12 |
| Prob> Chi2 | 0.0000 | 0.0000 | Prob> Chi2 | 0.0000 | 0.0000 |
| $R^2$ | | | $R^2$ | | |
| Within | 0.5580 | 0.5359 | With in | 0.3362 | 0.2952 |
| Between | 0.0209 | 0.0336 | Between | 0.0916 | 0.0144 |
| Overall | 0.4539 | 0.4816 | Over all | 0.1741 | 0.1979 |
| Hausman | | 29.66 | Hausman | | 49.97 |
| Prob> Chi2 | | 0.0000 | Prob> Chi2 | | 0.0000 |

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

The results show that capitalization and risk taking are interdependent and adjust simultaneously. Focusing on the first equation, we note that the regulatory pressure acts negatively and significantly on the change in capital. It results in a decrease in capitalization. Banks with solvency ratios below the prudential standard increase their equity less rapidly than other banks, hence the weakness of regulatory incentives. This report does not confirm those of Rime (2001) and Zhang and al (2008).As for ROA and Size ratios, they affect positively and significantly the capital change. In accordance with Zhang and al (2008) and Awdeh and al (2011), the banks increase their equity by resorting to profits and not by issuing new shares. Large institutions with easier access to capital markets hold more of these funds than small ones. By passing to the second equation, we find that the regulatory pressure affects positively and significantly the risk change: banks risk taking, under regulatory constraints, increase rapidly, compared to other banks. This confirms the contributions of Saadaoui (2010) and Awdeh, El Moussawi and Machrouh (2011).Concerning the provisioning of banks, the relative ratio appears to have no significant effecton risk variation (Rime (2001)).The results suggest that large banks assume more risk. They are not able to lead an efficient risk management through diversification. This confirms the conclusions of Jacques and Nigro (1997), Zhang and al (2008) but not those of Murinde and Yaseen (2004) and Awdeh (2011).

## V. Conclusion

This study aimed at analyzing the bank reaction to the prudential regulation by focusing on the capital and risk taking is based on a sample of Tunisian banks over the period 1996-2014.Through a panel methodology and a simultaneous equations model, the results show that the capital adequacy requirements affect significantly and negatively the capital and positively the risk. The level of capitalization and risk taking are interdependent and adjust simultaneously.

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## TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

**1. Choosing the topic:** In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

**2. Evaluators are human:** First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

**3. Think Like Evaluators:** If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

**4. Make blueprints of paper:** The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

**5. Ask your Guides:** If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

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**22. Never start in last minute:** Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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**24. Never copy others' work:** Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

**25. Take proper rest and food:** No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

**26. Go for seminars:** Attend seminars if the topic is relevant to your research area. Utilize all your resources.

**27. Refresh your mind after intervals:** Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

**28. Make colleagues:** Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

**29. Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

**30. Think and then print:** When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

**31. Adding unnecessary information:** Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

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**33. Report concluded results:** Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

**34. After conclusion:** Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

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**Key points to remember:**

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

**Final Points:**

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

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**General style:**

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

**Title Page:**

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

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The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

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- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
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- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

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The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

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- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

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- Explain materials individually only if the study is so complex that it saves liberty this way.
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- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

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- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

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- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
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The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
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- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
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- Do not present the similar data more than once.
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Approach

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- If you desire, you may place your figures and tables properly within the text of your results part.

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- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

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| Topics | Grades | | |
|---|---|---|---|
| | **A-B** | **C-D** | **E-F** |
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| ***Introduction*** | Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited | Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter | Out of place depth and content, hazy format |
| ***Methods and Procedures*** | Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads | Difficult to comprehend with embarrassed text, too much explanation but completed | Incorrect and unorganized structure with hazy meaning |
| ***Result*** | Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake | Complete and embarrassed text, difficult to comprehend | Irregular format with wrong facts and figures |
| ***Discussion*** | Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited | Wordy, unclear conclusion, spurious | Conclusion is not cited, unorganized, difficult to comprehend |
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