Liquidity and bank profitability in WAEMU zone: a panel data analysis

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Abstract: This paper examines the impact of liquid assets on bank profitability by using panel data regression through 11 years period (2001 to 2011) for 38 banks in WAEMU. Bank profitability was assessed by both *ROE* and *ROA* while liquidity was rated by the share of liquid assets in total assets. Our findings revealed a concave parabolic functional form regarding the relationship between profitability and liquidity by confirming the nonlinear relationship and the assumption that both excess and lack of liquidity may be harmful to banks' profitability. The robustness was tested by resorting to control variables such as size, age and gearing. This led to the revelation of the adverse effects leverage can have on profitability as opposed to how favourable size could impact it. However, age does not influence bank profitability in WAEMU area. The estimated results also showed that the recent financial crisis has not fundamentally impacted the relationship between profitability and liquidity in the WAEMU.

Keywords: liquidity; profitability; return on assets; ROA; return on equity; ROE; WAEMU banks.

Reference to this paper should be made as follows: Mebounou, T.G.C., Karan, M.B. and Dannon, H. (2015) 'Liquidity and bank profitability in WAEMU zone: a panel data analysis', *Afro-Asian J. Finance and Accounting*, Vol. 5, No. 2, pp.113–134.

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1 Introduction

Many studies in economics and finance have focused on the thorny issue of bank liquidity. Most of these studies are unanimous on the importance and critical role which liquidity plays in the functioning of banking institutions. In this respect, liquidity is found to be vital for the stability in banking systems in particular and financial institutions in general (Dewally and Shao, 2014; Vogiazas and Alexiou, 2013; Chaplin et al., 2000) and according to Arena (2008) one of the driving factors likely to occasion a collapse of a bank's financial standing. Indeed, there is arguably common consensus on the underlying effects of the lack of liquidity on the banking system during the recent financial crisis that led many organisations to insolvency and bankruptcy.

Therefore, it doubtlessly highlights the integral role that the level of bank liquidity plays as a lever in the ability of banks to fund the economy through their lending policy. The shortage of liquidity in the system understandably leads to declines in the ability of banks to make credit available. In essence, banks which hold more illiquid assets on their balance sheets, increase asset liquidity and reduce lending (Cornett et al., 2011). In this context, bank liquidity seems to be positively correlated with the financing of the economy. Hence, compared to the financial intermediation role in transferring funds from the saving units to the investing units (Levine et al., 2000) we can assert that liquidity

management may play a major role in ensuring banking institutions in performing their fundamental objective of financing of the overall economy. Also, without this mission lying at the heart of what they do as business, commercial and investment banks could not generate income earned as interests received to guarantee their profitability.

Furthermore, commercial and investment banks are primarily for-profit organisations aimed at the maximisation of wealth for its shareholders. Several studies have therefore focused on the determinants of their profitability (Chaudhry et al., 1995; Molyneux and Thornton, 1992). Nevertheless, only a few of them have tried to establish the link between bank profitability and prudential measures imposed by regulators. Recently, some scholars have focused attention on the relationship between bank liquidity, one of the prudential ratios in bank sector, and its profitability. Significantly, the research carried out by Bordeleau and Graham (2010) is one of the few scientific investigations that have attempted to analyse the relationship between liquidity and bank profitability on the basis of a comparative study between Canada and the USA. At the end of their analysis, they suggested that more researches should be needed to carry on this topic in other geographic areas in order to achieve a general equilibrium model. However, despite this pioneering work, the relationship between liquidity and banks' financial performance is still vague and would be a true 'black box'. It is in this context that fits our paper which attempts to measure the impact of liquidity on the profitability of banks operating in the Sub-Saharan African monetary zone, the West Africa Economic and Monetary Union (WAEMU).

A key feature of this work is to focus on the WAEMU zone where banks are deemed excess liquid for nearly two decades (Lanha, 2003; Fouda Owoundi, 2009; Doumbia, 2009; Vigninou, 2012) contrary to what is often revealed in banking sector. In fact, following the collapse and widespread failure of the financial system of countries which are members of the WAEMU in the late 1980s, several reforms have been undertaken by the Central Bank of West African States (CBWAS) to make the banking system more efficient and stable. The implementation of the proposed measures generated excess liquidity for these banks. At the same time and paradoxically, the economy in general and businesses in particular are struggling to acquire funding for their investment, operation and sustainability. In WAEMU zone, Cisse (2009) and Fouda Owoundi (2009) have tried to find out the causes of that excess liquidity and its impacts on the financing of the economy. But, in our knowledge, there might be no research yet that tried to analyse the relationship between that excess liquidity and bank profitability in the WAEMU zone.

To contribute to the literature on the topic, our paper aims to examine the impact of liquid assets on bank profitability. Indeed, our study will be performed by using panel data analysis through 11 years period, from 2001 to 2011, for 38 banks. Our research will also assess the effect of the recent financial crisis on the relationship between bank profitability and liquidity in WAEMU zone. Then, our research will figure out whether there is a significant difference in the relationship between profitability and liquidity in the period 2001 to 2006 (the period before the crisis) and 2007 to 2011 (period of crisis and post-crisis).

The remainder of this paper firstly examines the relevant review of previous theoretical and empirical literature on the relationship between bank liquidity and its profitability. This is followed by the empirical framework as applied in this paper. Then, the empirical results will be examined and finally, conclusion will be drawn.

2 Liquidity and its prominence in banking profitability

Liquidity is a factor that must be carefully monitored because of its crucial role in the survival and sustainability in any organisation. Owing to its nature, the concept of liquidity may seem difficult to be understood. It is defined in many ways and leads to various interpretations depending on the specificity of the company or the dimension given to the analysis. In that sense, Crockett (2008) has pointed out that liquidity is easier to recognise than to define and then revealed three common ways to apprehend that concept. Firstly, the liquidity of financial instruments that reflects the ease with which they can be exchanged for money without loss of value. Secondly, it refers to market liquidity that is defined as the market's ability to trade a given volume of assets or securities without significantly affecting their prices. Finally, the concept deals with monetary liquidity related to the quantity of fully liquid assets circulating in the economy. This array of definitions therefore highlights the important role of liquidity in the operation of a business and the sensitivity of its survival.

Most economists consider liquidity to be the lifeblood of any institution. Campello et al. (2011) notified that the lack or scarce of liquidity may provoke fear and uncertainty. It may lead to more catastrophic scenarios such as default or bankruptcy which could definitely jeopardise the going concern. Moreover, the sensitivity of liquidity is particularly important for more highly leveraged entities such as banks because the failure of a single bank may endanger the entire financial system and therefore, the overall economy. Thus, researchers and practitioners in the field of finance have agreed that the recent financial crisis is a liquidity crisis. This unprecedented crisis has spared neither public finances nor private companies even less financial institutions such as banks. One of the saddest memories left by that crisis which has not yet been fully curbed is the bankruptcy of Lehman Brothers in September 2008 in the USA. Liquidity seems then to be very important for operating financial markets and the banking sector.

Bank's liquidity is controlled in most countries by strict banking regulations. In this vein, Rochet (2008) identified two essential motivations for regulating banks' liquidity which are divided into micro-prudential and macro-prudential components. In the one hand, it is associated with the protection of small depositors while in the other hand it is concerned with the protection of financial stability. Among the many tools used to measure the liquidity of banks, Basel Committee on Banking Supervision (2013) has highlighted two key indicators in order to harmonise existing standards. These are the liquidity coverage ratio (LCR) and net stable funding ratio (NSFR). In the WAEMU zone, the prudential framework for banks credit institutions has since 2000 defined a single liquidity ratio.

Owolabi and Obida (2012) figured out a positive relationship between liquidity and profitability through the study they achieved on listed manufacturing companies in Nigeria market. This conclusion is consistent with prior investigations in banking sector such as a positive relationship found between liquid assets and bank profitability for 90 banks in Europe, North America and Australia from 1972 to 1981 (Bourke, 1989). Based on the foregoing, we make our first hypothesis as follow:

H_1 Liquidity positively affects the profitability of banks in the WAEMU zone.

Although in the literature of corporate finance, maximising profitability seems to be the ultimate goal to achieve, it remains that special attention must be paid to the liquidity that often determines survival of any business. Indeed, Ozdincer and Ozyildirim (2008)

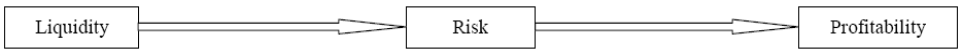
revealed that the defaulted banks in recent history are more related to liquidity problems than lack of profits. In this context, Niresh (2012) notified that too much attention on profitability may lead the firm into a pitfall by diluting the liquidity position of the organisation. Therefore, liquidity and bank's profitability influence each other (Olagunju et al., 2011).

Conversely, too much liquidity holding may erode bank's profitability. Indeed, excess liquidity could cause an accumulation of idle resources that would be unproductive assets or very low yielding assets because they are not invested for higher returns. In this vein, Smith (1980) revealed that excessive dependence on liquidity leads to the accumulation of idle funds which do not create any profit for the company. Similarly, low liquidity not only puts the company in a tricky default risk, it could also induce a serious threat to its profitability. In a situation of insufficient liquidity, the company may be forced to resort to very expensive sources of funding, which logically may seriously impair its profitability. Therefore, it is quite clear that lack and excess liquidity are both potential sources of profitability decline. A trade-off should be then found between the level of liquidity and profitability of the company. Based on the above rationale, we formulate our second hypothesis as follow:

H_2 Both low liquidity and excess liquidity negatively affect banks' profitability.

Furthermore, our second hypothesis may be underpinned on the liquidity-risk-return approach by referring to one of the basic assumptions of modern portfolio theory which is built on a trade-off between the risk and profitability (Markowitz, 1952). Indeed, in an efficient market, the fair price of an asset is determined based on the perceived risk and the expected profitability of the asset. Thus, the higher the risk the higher the level of return yielded by the asset because of the increase of risk premium. To get back to the relationship between liquidity and profitability, the risk (both low and excess liquidity holding) will be considered as a mediating variable. The liquidity level affects the level of risk which in turn affects profitability (see Figure 1).

Figure 1 Risk as mediator between liquidity and profitability relationship



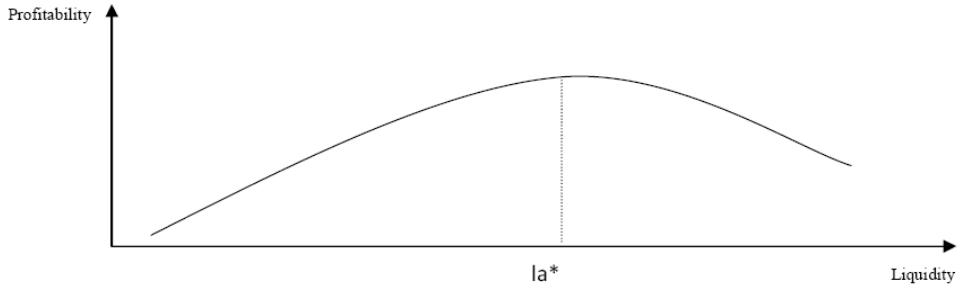
Source: Created by the authors

Indeed, the liquidity of the company influences its default risk. Companies that have an insufficient level of liquidity face credit or default risk which exposes them to a situation of insolvency and bankruptcy. These high-risk companies should then be constrained to generate a higher profit to ensure greater shareholder returns. Conversely, companies with high liquidity can have a low default risk and hence low profitability.

We also know that the regulators of the banking sector require a minimum liquidity threshold for banks and other financial institutions. Nevertheless, no maximum liquidity threshold is set up to preserve banks from adverse effects of excess liquidity although Shahchera (2012) warned about the existence of an optimal threshold above which the liquidity becomes harmful to the bank's profitability. In fact, the minimum liquidity threshold is stated in both Basel 3 and regulation applicable in the WAEMU zone but there is no maximum threshold. Beside the usual positive effect of liquidity on bank's profitability, Goddard et al. (2004) found mixed evidence of a negative relationship

between these two variables for European banks in the late 1980s and mid-1990s, respectively. In this context, Shahchera (2012) concluded that although profitability is improved for banks that hold some liquid assets, however, there is a point at which holding further liquid assets diminishes banks' profitability.

Figure 2 Liquidity-profitability curve



Source: Adopted from Bordeleau and Graham (2010)

He also revealed a nonlinear relationship between profitability and liquid asset holdings. Bordeleau and Graham (2011) have expressed this possible nonlinear relation in their econometric model by accounting for the square of the liquid asset ratio and its interrelation with other variables such as gross domestic product (GDP) growth and short-term funding (stfunding). They also provided Figure 2 to highlight the relationship between liquidity and profitability. All these seem to endorse the idea of the influence of liquidity on the profitability of banks or establish the impact of liquidity on bank financing to the economy but without identifying the optimal level of liquidity that maximises performance of banks.

3 Sample selection and descriptive statistics

Throughout this section, we firstly discuss our sampling method and required data sources; this is followed by the descriptive statistics.

3.1 Sampling and data sources

The empirical analysis is made from the data collected on the banks operating in the WAEMU. The data used are selected from the database of the CBWAS which is the only central bank in the WAEMU zone. From balance sheets and income statements published on the website of the CBWAS, we computed the main indicators useful for our study. We have also referred some data available in the annual reports of the WAEMU Banking Commission.

In 2011, the WAEMU had 121 credit institutions authorised and which was divided into 107 banks, including four branches and 14 financial institutions.[1] In our paper, we have chosen the banks operating before 2000 referring to the fact that the liquidity ratio currently used is contained in the prudential arrangements implemented from 2000. Hence, 53 banks should be included in our sample on the basis of this first criterion. In order to work on a balanced panel, we removed seven banks that have had missing data.

Finally, we removed from our sample any bank that as negative equity of at least one year in order to avoid any ambiguity in the interpretation of the *ROE*. Based on this criterion, six banks have been removed. Indeed, the *ROE* of a bank that has a loss and negative equity behaves exactly like the *ROE* of a bank with profit and positive equity. In the example below, bank B with a deficit has an equivalent *ROE* to bank A, which has a thriving financial situation.

Table 1 Example

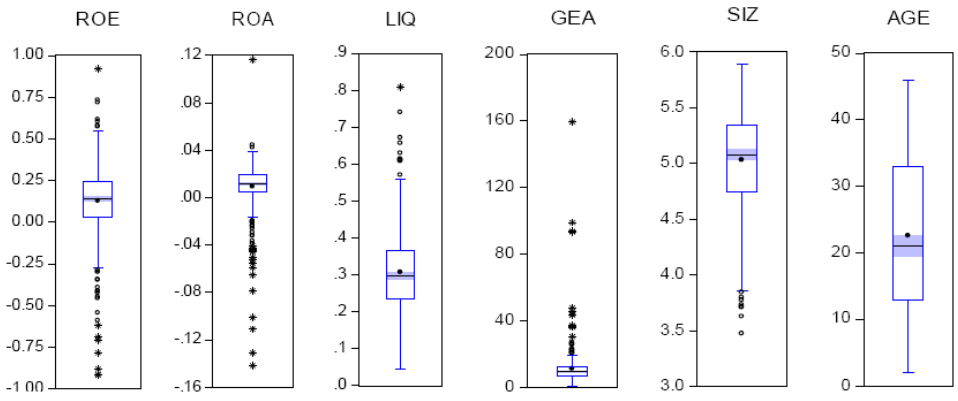
Banks	*Earning ($)*	*Equity ($)*	*ROE (%)*
A	90	1,000	9
B	–90	–1,000	9

Source: Created by the authors

Our sample finally included a total of 38 banks (Table 2 in Appendix 1) operating in the WAEMU formed by eight countries, namely Burkina Faso, Benin, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo. The data covered the period from 2000 to 2011 in essence 12 years. Since the computation of ROE_t requires the use of the profit or loss of year t and the equity of year t_{-1}, we finally have available data over 11 years. We have then formed a balanced panel of 418 inputs that consists of data from both cross-sectional and time series. The sample accounts for 35.41% of the banks of WAEMU representing 65.12% of the staff and 68.92% of the total balance sheet for all the banks. In our paper, we did not make the distinction between commercial banks and investment banks. Conversely, our sample did not include other financial institutions and their branches.

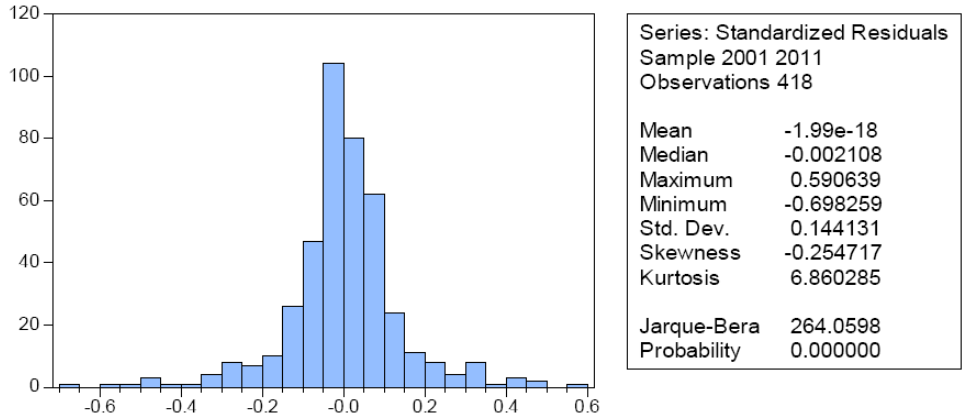
In the sample, although there are some banks belonging to the same banking group (for instance, ECOBANK, UBA), we wanted the banks considered separately. Each country has its own characteristics that affect the performance of banks operating in its territory. Since the age of the bank is also one of the control variables, banks belonging to the same group do not necessarily have the same age due to their different date of creation.

Figure 3 Variables box plots (see online version for colours)



Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)

Figure 4 Residual normality test (see online version for colours)



Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)

By observing the box plots (Figure 3) of each variable, we detected some outliers that have been replaced by their mean value or the up threshold for each bank. Outliers substituted by the mean values were selected on the basis of thresholds revealed by the box plots and their symmetry. Thus, the return on equity (*ROE*) used should be included between –60% and +60%, the return on assets (*ROA*) between –4% and +4%; liquidity ratios between 0% and 60%; leverage between 0 and 40, and the size between 3 and 6. The substituted values keep the algebraic sign of the original value.

3.2 Descriptive statistics

Table 3 (in Appendix 1) summarises the variables, their computation rules and some descriptive statistics (means, quartiles, and standard deviations) of our sample. We noticed that ROE presents a mean value of 13.43%, a median of 14.17% and a standard deviation of 18.33%. It is therefore apparent that WAEMU banks are generally profitable in the period 2001 to 2011 and 50% of banks have a ROE higher than 14.17%. Quartiles 3 and 4 also show that half of WAEMU banks present profitability between 3.44% and 24.63%. The standard deviation shows that there is a clear disparity between the values of ROE in our sample and their mean value. We then analyse this disparity by referring to dummy variable regression ($ROE_{it} = \lambda_0 + \lambda_1 DUM_{it} + \varepsilon_{it}$) that split our data into two main periods: period before the crisis (2001 to 2006), the period during the crisis and post crisis (2007 to 2011). Hence, Table 7 (in Appendix 2) reveals that statistically at the 5% level there is no significant difference between *ROE* of banks in period before the crisis and period during the crisis and post-crisis regardless of regression approach (pooled data, cross-section fixed effect or random effect). The disparity noticed seems to be more related to the specificities of every bank rather than time effect. Therefore, additional specification test should be carried out to choose the appropriate regression method.

Moreover, the liquidity ratio has a mean value of 30.73%, a median of 29.75% and a standard deviation of 11.59%. These statistics show that approximately third of bank assets in WAEMU include liquid assets (cash, interbank placements and current securities). The standard deviation showing the disparity between the liquidity ratios and

its mean value is not too excessive. Three quarters of banks have a liquid asset ratio greater than 23.74% and a quarter a ratio above 36.74%. Statistical tests of the regression ($Liq_{it} = \gamma_0 + \gamma_1 DUM_{it} + \varepsilon_{it}$) also show that there is no statistically significant difference between the liquidity ratios for the period 2001 to 2006 (the period before the crisis) and the period 2007 to 2011 (crisis and post-crisis) no matter the method used (pooled data, cross-section fixed effect or random effect).

Except *ROE* and *ROA* with strong correlation, correlation analysis table (Table 4 in Appendix 1) reveals no high correlation among our variables. However, since *ROE* and *ROA* are both employed to assess bank profitability, the strong correlation of these variables (*ROE* and *ROA*) should not affect our estimated results because they are separately used as dependent variables.

Moreover, before estimating our model based on panel data, we conducted additional tests to select the appropriate regression approach (fixed effects versus random effects). We have used the Fischer test (Table 5 in Appendix 1) to assess the global homogeneity of the structure of our data. Thus, Fischer coefficients calculated for the analysis of the equality of means of *ROE* categorised by years are not significant. We have concluded that the assumption of equality of time means is verified. However, Fischer coefficients calculated in the analysis of the equality of means of *ROE* categorised by banks are significant at 1%. The null hypothesis of individual equal Means is strongly rejected. So there is heterogeneity of *ROE* across banks confirming the existence of individual effects. There would be fixed or random individual effects. We finally realised the Hausman test which results (Table 6 in Appendix 1) show that we have a fixed effects model.

4 Model specification and results

We recall that the objective of our work is to analyse the influence of liquid assets on bank profitability. Through the methodological approach used to achieve this goal and test our hypotheses, we present the econometric model and our analysis approach. Then, estimated results[2] will be discussed and finally we will check the robustness of our findings.

4.1 Econometric model specification and analysis approach

Berríos (2013), and Bordeleau and Graham (2010) are among various researchers that referred to regression analysis to assess the relation between liquidity and bank profitability. Also, *ROE* or *ROA* ratios are often used to assess profitability in the in the field of finance (Shen et al., 2009; Hoffmann, 2011; Abbadi and Abu-Rub, 2012; Uremadu, 2012; Goddard and Molyneux, 2004). In this vein, we also refer to regression analysis by using *ROE* as our first explained variables. The *ROA* will later be used as a controlled variable to test the robustness of the model.

The main exogenous variable in our model is the liquid asset ratio which we estimate by the share of liquid assets in the total assets. Ideally, we would like to proxy for the liquidity ratio by using the liquidity ratio included in the banking prudential disclosure in force in WAEMU zone. Since we do not access this information although our several attempts, we compute the liquidity ratio by using information available in balance sheet. We also recall that there is no only one way to assess liquidity because the literature

revealed different ways or approaches to measure liquidity (Bord and Santos, 2014; Berríos, 2013; Dewally and Shao, 2014; Bordeleau and Graham, 2010; Vogiazas and Alexiou, 2013).

We begin our regression model by assuming the simply linear relationship between the dependent variables (*ROE* or *ROA*) and the explanatory variable (*Liq*) as summarised in the first equation:

$$ROE_{it} = \beta_0 + \beta_1 Liq_{it} + \mu_{it} \tag{1}$$

We also use the square of liquidity ratio to account for the possible nonlinear relationship between liquidity and profitability. For this, we firstly included only the square of *Liq* as the only explanatory variable after referring to both *Liq* and its square in the same model as indicated by the following equations:

$$ROE_{it} = \beta_0 + \beta_2 Liq_{it}^2 + \mu_{it} \tag{2}$$

$$ROE_{it} = \beta_0 + \beta_1 Liq_{it} + \beta_2 Liq_{it}^2 + \mu_{it} \tag{3}$$

Later, we include a dummy variable in our model to distinguish the periods before 2007 crisis from the other periods. Finally, this dummy variable was interacted with the liquidity variable. The regression model is presented as follow:

$$ROE_{it} + \beta_0 + \beta_1 Liq_{it} + \beta_2 Liq_{it}^2 + \beta_3 Dum_{it} + \beta_4 Dum_{it} Liq_{it} + \beta_5 DumLiq_{it}^2 + \mu_{it} \tag{4}$$

Besides, liquid asset ratio that is considered to be the main explanatory variable in this study, other macroeconomic and microeconomic have been used as bank profitability explanatory variables (Baneto and Gregorio, 2011). Hence, to assess the robustness of our equation, we had recourse to control variables related to banking specificity to account for cross-sectional differences. The control variables include bank size (Banz, 1981; Reinganum, 1981)[3] measured by the natural logarithm of the total asset, age and gearing.[4] The regression model including these variables is specified as follow:

$$ROE_{it} = \beta_0 + \beta_1 Liq_{it} + \beta_2 Liq_{it}^2 + \beta_6 Gea_{it} + \beta_7 Siz_{it} + \beta_8 Age_{it} + \mu_{it} \tag{5}$$

ROE is the return on equity, *Liq* is the liquid asset ratio, *Dum* is Dummy variable (*Dum* = 1 for the period before 2007 and 0 otherwise), β_0 is the intercept, β_i is the partial regression coefficients and μ is the stochastic disturbance term (it reflects other factors affecting bank financial performance, such as macroeconomic factors we have ignored in our model and other specific individual effects or evidence related to idiosyncratic shock.), i (i = 1, 2, …, 38) stands for the i^{th} bank or the cross-section identifier, and t (t = 1, 2, …, 11) stands for the time index or the time identifier.

4.2 Results

This section analyses the empirical results of the model estimations using *ROE* and *ROA* as the dependent variables which are regressed on the liquid asset ratio and liquidity asset ratio square. The estimated results of equation (1) (Table 8 in Appendix 2) do not confirm the existence of a linear relationship between *ROE* and *Liq*. Indeed, β_1 (slope coefficient of *Liq*) is not significant at even 10% level. However, the estimated result of equation (2) shows that β_2 (slope coefficient of Liq^2) is significant at 5% level. Moreover, the adjusted

R-squared of the linear model [equation (1)] is lower than one of the nonlinear model [equations (2) and (3)]. These results confirm the existence of a nonlinear relationship between *ROE* and *Liq*. Furthermore, the estimated results of equation (3) that simultaneously included *Liq* and Liq^2 as explanatory variables revealed that the coefficient β_1 (slope coefficient of *Liq*) and β_2 (slope coefficient of Liq^2) are both significant at the 5% level. Moreover, we have seen an increase in the significance of β_1 and β_2 compared to the results of the estimates of equations (1) and (2) where *Liq* and Liq^2 variables are considered separately in the model. In addition, the estimated value of β_2 (slope coefficient of Liq^2) has a negative sign. This shows that the relationship between *ROE* and *Liq* is a concave parabolic function. These results confirm the assumption about a nonlinear relationship between profitability and liquid asset holdings (Shahchera, 2012; Bordeleau and Graham, 2010). It also corroborates the existence of a threshold level at which holding further liquid assets diminishes banks' profitability. So, we cannot ascertain that liquidity positively affects banks' profitability all the time. Therefore, banking regulators should no longer focus only on the minimum level of liquidity. They should also indicate the up threshold which should not be exceeded.

The estimated results of equation (4) (Table 9 in Appendix 2) show that β_3 (slope coefficient of *Dum*), β_4 (slope coefficient of *Dum*Liq*) and β_5 (slope coefficient of $Dum*Liq^2$ it) are not significant even at 10% level. Thus, we can infer that there is no difference in the relation between profitability and bank liquidity in the period before the crisis (2001 to 2006) and crisis and post crisis period (2007 to 2011). It follows that the recent financial crisis has not had a major impact on the relation between profitability and liquidity in the WAEMU zone.

4.3 Robustness checks

In this section, we checked the robustness of the previous findings by testing a variety of alternative estimated specifications. First, *ROA* was used as an alternative measure of bank profitability. The estimated results of equations (1) to (3) using *ROA* as the dependent variable confirmed those obtained with the *ROE* with one exception. Indeed, with the *ROA*, the estimation of equation (1) showed a significance of β_1 (slope coefficient of *Liq*) presaging a linear relationship between *ROA* and *Liq*. But giving the increased significance of the slopes coefficients in the nonlinear models, we can easily conclude that the nonlinear relationship, specifically the concave parabolic function better explains the relationship between profitability and liquidity of WAEMU banks.

However, the estimation of equation (4) when *ROA* is used as an alternative measure of bank profitability revealed that β_1 (slope coefficient of *Liq*) and β_2 (slope coefficient of Liq^2) were not significant at 10% level. However, the previous findings remained consistent because β_3 (slope coefficient of Dum), β_4 (slope coefficient of *Dum*Liq*) and β_5 (slope coefficient of $Dum * Liq_{it}^2$) are not significant, confirming the lack of difference in the relationship between profitability and bank liquidity in the period before the crisis (2001 to 2006), during the crisis and post-crisis period (2007 to 2011).

As a second robustness test of the relationship between profitability and bank liquidity, we introduced three new explanatory variables (*Gea*, *Siz* and *Age*) in the equation (3). We get the equation (5) estimated results (Table 10 in Appendix 2). When *ROE* was considered as the independent variable, we found that β_2 (slope coefficient of Liq^2) was significant at 10%, while β_1 (slope coefficient of *Liq*) is no longer so. However,

the coefficients β_1 and β_2 maintained their signs. This result confirms the concave parabolic shape of the functional relationship between liquidity and profitability of WAEMU banks. We should also notice that β_1 or β_2 lose their consistency when we use *ROA* as dependent variable although their signs remain the same.

Regarding the additional variables added to the model, β_6 (slope coefficient of *Gea*) with negative sign is highly significant at the 1% whatever the dependent variable of interest (*ROE* or *ROA*). It implies that leverage negatively impacts profitability of banks in the WAEMU. Indeed, the higher the bank debt, the lesser is bank profitability. β_7 (slope coefficient of *Siz*) with positive sign was significant at the 5% level when *ROE* was used as the dependent variable. It therefore follows that the size positively affects the profitability of banks of WAEMU. In other words, the more the bank is large, the more its profitability increases. However, this coefficient is not significant even at the 10% when we use the alternative dependent variable *ROA*. Whatever the dependent variable, β_8 (slope coefficient of *Age*) is not significant at 10%. This result shows that age does not influence bank profitability in WAEMU area.

5 Conclusions

This paper has referred to panel data regression as a research tool in measuring the ways that liquid assets impact banks' profitability. The investigation is based on a balanced panel data of 38 commercial banks operating over a period of 11 years starting from 2001 to 2011 in the Sub-Saharan African monetary zone, the WAEMU. As a key component of the investigation, the profitability of the institutions concerned was assessed by both *ROE* and *ROA* while liquidity was rated by the share of liquid assets (cash, interbank placements and current securities) in total assets.

Underpinning the findings, different estimated results of regression reveal a concave parabolic functional form regarding the relationship between profitability and liquidity by confirming the nonlinear relationship and the assumption that the existence of excess liquidity or the lack thereof could negatively impact bank profitability. This evidence is consistent with the findings of Shahchera (2012), and Bordeleau and Graham (2011) and therefore confirmed the assumption in which there is a point beyond which holding further liquid assets erode banks' profitability, all else equal. The estimated results also show that the recent financial crisis has not had a major impact on the relationship between profitability and liquidity in the WAEMU zone.

Control variables such as *ROA*, size, age and gearing played key roles in scoring the robustness of the estimated results. Robust checks have confirmed the findings in general with a few exceptions. Indeed, the substitution of *ROE* by *ROA* has confirmed the existence of a concave parabolic functional relationship between profitability and liquidity of WAEMU banks. The same trend has been also confirmed with the introduction of three other control variables (*Gea*, *Siz* and *Age*) although we have seen a decrease in the significance of the slope coefficients (β_1 and β_2). Furthermore, our findings have revealed that leverage negatively impacts profitability while size positively affects the profitability of banks in the WAEMU. The results have also showed that age does not influence bank profitability in WAEMU area.

The concave parabolic functional form revealed in the relationship between profitability and liquidity implies that both excess and short of liquidity are harmful for

banks' profitability. Hence, regulators of the banking sector should require both minimum and maximum liquidity threshold for banks and other financial institutions. This requirement should help banks and other financial institutions' managers to prevent the negative effects of both excess and lack of liquidity on profitability.

In this paradoxical area where the economy is experiencing funding problems while banks are deemed excess liquid, these results will contribute to draw the attention of the regulators of the WAEMU's banking system on the fact that excess liquidity is a destructive component of the economic value. Indeed, excess liquidity prevents WAEMU banks from increasing both their *ROA* and *ROE* due to the accumulation of idle assets subjected to low economic and financial returns. Related to the fact that excess liquidity prevents banks from supplying credits, companies in the WAEMU often face the thorny issue of funding their profitable projects and this leads to the wipe out of the maximisation of the investments' economic value added.

Moreover, it would be interesting to highlight some possible extensions to our research. The first approach would be to use liquidity ratios as provided in the WAEMU prudential arrangements to do the same analysis. Also, given that liquidity is not the only prudential banking indicator, it is important to analyse the impact of other prudential ratios on banks' performance. All these should allow future research to better explain in systematic way the impact of banking prudential regulation on the operation and performance of banks in general, and those of the WAEMU in particular.

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Notes

1 This data are available in the 2011 annual report published by the WAEMU Banking Commission.

2 The estimated results of each equation should be considered significant till 10%.

3 Banz (1981) and Reinganum (1981) revealed in their studies that returns vary with firm size.

4 The finding of Abbadi and Abu-Rub (2012) revealed that leverage has a negative effect on market value of the bank, a positive and strong relationship between market value and ROA and bank deposits to total deposits.

Appendix 1

Sampling details and descriptive statistics

Table 2 Sample's summary

Countries	*All banks in WAEMU zone*			*Banks selected for the sample*					
	Number of banks	*Staff*	*Total balance sheet (10^6 FCFA)*	*Number of banks*	*%*	*Staff*	*%*	*Total balance sheet (10_6 FCFA)*	*%*
Benin	13	2,150	1,882,605	3	23.08	916	42.60	1,029,337	54.68
Burkina Faso	12	1,851	1,902,124	6	50	1743	94.17	1,362,281	71.62
Cote d'Ivoire	23	5,543	4,226,948	7	30.43	3322	59.93	3,066,926	72.56
Guinea-Bissau	4	-	-	-	-	-	-	-	-
Mali	13	2,729	2,042,069	7	53.85	1993	73.03	1,525,798	74.72
Niger	11	1,191	706,081	5	45.45	831	69.77	566,302	80.20
Senegal	19	4,136	3,362,813	6	31.58	2848	68.86	2,261,889	67.26
Togo	12	1,722	1,037,338	4	33.33	929	53.95	635,267	61.24
Total	107	19,322	15,159,978	38	35.41	12582	65.12	10,447,800	68.92

Source: Created by the authors using WAEMU Banking Commission report 2011

Table 3 Variables summary and descriptive statistics

Symbol	*Definition*	*Computation rules*	*Mean*	*Median*	*Quartile 1*	*Quartile 3*	*Std. dev.*
ROE	Return on equity	$\text{ROE} = \frac{\text{Net income}}{\text{Total shareholders' equity}}$	0.134321	0.141656	0.03443	0.24628	0.183293
ROA	Return on assets	$\text{ROA} = \frac{\text{Net income}}{\text{Total assets}}$	0.010126	0.011931	0.00467	0.01909	0.018299
Liq	Liquidity ratio	$\text{Liq} = \frac{\text{Interbank placements} + \text{Cash} + \text{Current securities}}{\text{Total assets}}$	0.307322	0.297541	0.23736	0.36742	0.115880
Gea	Gearing	$\text{Gea} = \frac{\text{Total debts}}{\text{Total shareholders' equity}}$	10.54783	9.470004	6.97415	12.32673	6.890732
Siz	Size	The size is measured by the natural logarithm of the total asset	5.030702	5.080124	4.74665	5.34249	0.433265
Age	Age	This variable refers to the age of a bank at each point of time	22.57895	21.00000	13.00000	32.75000	11.84552

Source: Created by the authors using CBWAS data (2000 to 2011)

Table 4 Correlation test summary

	ROE	*ROA*	*LIQ*^{2}	*GEA*	*SIZ*	*AGE*
ROE	1.000000					
ROA	0.799866	1.000000				
LIQ	0.059553	–0.054251				
GEA	–0.179918	–0.176085	–0.110031	1.000000		
SIZ	0.247073	0.302338	–0.125013	0.114934	1.000000	
AGE	–0.089373	0.021283	–0.204931	–0.055655	0.342044	1.000000

Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)

Table 5 Homogeneity tests

Test of equality of means of ROE categorised by values of banks (individual effect)			
Method	*df*	*Value*	*Probability*
Anova F-test	(37, 380)	6.159207	0.0000
Welch F-test*	(37, 132.583)	20.61805	0.0000
Analysis of variance			
Source of variation	*df*	*Sum of sq.*	*Mean sq.*
Between	37	5.252025	0.141947
Within	380	8.757576	0.023046
Total	417	14.00960	0.033596
Test of equality of means of ROE categorised by values of years (time effect)			
Method	*df*	*Value*	*Probability*
Anova F-test	(10, 4 07)	0.629751	0.78 85
Welch F-test*	(10, 162.44)	0.616606	0.7982
Analysis of variance			
Source of variation	*df*	*Sum of sq.*	*Mean sq.*
Between	10	0.213468	0.021347
Within	407	13.79613	0.033897
Total	417	14.00960	0.033596

Note: *Test allows for unequal cell variances.

Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)

Table 6 Effects specification tests

Test cross-section fixed effects			
Effects test	*Statistic*	*d.f.*	*Prob.*
Cross-section F	6.419606	(37,375)	0.0000
Cross-section Chi-square	205.097727	37	0.0000
Test cross-section random effects: correlated random effects – Hausman test			
Test summary	*Chi-sq. statistic*	*Chi-sq. d.f.*	*Prob.*
Cross-section random	13.839372	5	0.0167

Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)

Appendix 2

Estimated results of equations

Table 7 Estimated results with dummy variable

	ROE			*LIQ*		
	Pooled	*Cross-section fixed effect*	*Cross-section random effect*	*Pooled*	*Cross-section fixed effect*	*Cross-section random effect*
Intercept (λ_0 or Υ_0)	0.148268***	0.148268***	0.148268***	0.300675***	0.300675***	0.300675***
t-statistic	(11.16375)	(13.49701)	(7.363774)	(35.77206)	(45.11589)	(22.50599)
Prob	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DUM	–0.025569	–0.025569*	–0.025569*	0.012186	0.012186	0.012186
t-statistic	(–1.421865)	(–1.719040)	(–1.719040)	(1.070790)	(1.350485)	(1.350485)
Prob	0.1558	0.0864	0.0864	0.2849	0.1777	0.1776

Notes: ***Coefficient significant at 1%; **coefficient significant at 5%; *coefficient significant at 10%.

Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)

Table 8 Estimated results with banks fixed-effects of equations (1) to (3)

	ROE			*ROA*		
	Equation (1)	*Equation (2)*	*Equation (3)*	*Equation (1)*	*Equation (2)*	*Equation (3)*
Intercept	0.172575***	0.160908***	0.066607	0.016578***	0.013952***	0.006342
t-statistic	(6.386507)	(11.17491)	(1.336933)	(6.093736)	(9.634959)	(1.263509)
Prob	0.0000	0.0000	0.1820	0.0000	0.0000	0.2072
LIQ	–0.124477		0.564053**	–0.020996**		0.045516
t-statistic	(–1.472179)	-	(1.976473)	(–2.466380)	-	(1.583060)
Prob	0.1418		0.0488	0.0141		0.1142
LIQ2		–0.246533**	–0.979503**		–0.035473***	–0.094619**
t-statistic	-	(–2.151396)	(–2.524364)	-	(–3.078265)	(–2.420422)
Prob		0.0321	0.0120		0.0022	0.0160
Observations	418	418	418	418	418	418
Adjusted R-squared	0.316122	0.320510	0.325681	0.304453	0.310527	0.313256
Prob (F-statistic)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Prob (cross-section F)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Prob (cross-section Chi-square)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Notes: ***Coefficient significant at 1%; **coefficient significant at 5%; *coefficient significant at 10%.

Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)

Table 9 Estimated results with banks fixed-effects of equation (4) including dummy variable

	ROE	*ROA*
Intercept	0.014217	0.008328
t-statistic	(0.168397)	(0.979080)
Prob	0.8664	0.3282
LIQ	1.184853**	0.057166
t-statistic	(2.114832)	(1.012716)
Prob	0.0351	0.3118
LIQ2	–2.226382**	–0.134828
t-statistic	(–2.459960)	(–1.478594)
Prob	0.0143	0.1401
DUM	0.048049	–0.004467
t-statistic	(0.502655)	(–0.463827)
Prob	0.6155	0.6430
DUM*LIQ	–0.702528	–0.010094
t-statistic	(–1.136923)	(–0.162140)
Prob	0.2563	0.8713
DUM*LIQ2	1.436549	0.046879
t-statistic	(1.482610)	(0.480203)
Prob	0.1390	0.6314
Observations	418	418
Adjusted R-squared	0.329530	0.317100
Prob (F-statistic)	0.000000	0.000000
Prob (cross-section F)	0.000000	0.000000
Prob (cross-section Chi-square)	0.000000	0.000000

Notes: ***Coefficient significant at 1%; **coefficient significant at 5%; *coefficient significant at 10%.

Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)

Table 10 Estimated results with banks specific variables (Gea, Siz and Age)

	ROE	*ROA*
Intercept	–0.0407400	–0.034854
t-statistic	(–1.485333)	(–1.206700)
Prob	0.1383	0.2283
LIQ	0.315767	0.024193
t-statistic	(1.175676)	(0.855353)
Prob	0.2405	0.3929
LIQ2	–0.625517*	–0.063403
t-statistic	(–1.697698)	(–1.634067)
Prob	0.0904	0.1031
GEA	–0.012257***	–0.000877***
t-statistic	(–8.360193)	(–5.683052)
Prob	0.0000	0.0000
SIZ	0.148942**	0.011562
t-statistic	(2.232448)	(1.645655)
Prob	0.0262	0.1007
AGE	–0.004777	–0.000201
t-statistic	(–1.219469)	(–0.486066)
Prob	0.2234	0.6272
Observations	418	418
Adjusted R-squared	0.435151	0.371500
Prob (F-statistic)	0.000000	0.000000
Prob (cross-section F)	0.000000	0.000000
Prob (cross-section Chi-square)	0.000000	0.000000

Notes: ***Coefficient significant at 1%; **coefficient significant at 5%; *coefficient significant at 10%.

Source: Created by the authors using e-views 6.0 and CBWAS data (2000 to 2011)