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Zimbabwean Commercial Banks Liquidity Risk Determinants after Dollarisation

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Abstract

The government of Zimbabwe adopted a multiple currency regime in January 2009 after a decade of economic decline. The new regime brought with it benefits to the economy and helped restart financial intermediation. Despite these benefits, many banks are facing challenges of liquidity risk. This paper empirically investigates the determinants of Zimbabwean commercial banks liquidity risk after the country adopted the use of multiple currencies exchange rate system. To do so, panel data regression analysis is used on monthly data from March 2009 to December 2012. From the panel data regression results, capital adequacy and size have negative significant influence on liquidity risk. As size increases, liquidity risk reduces. Spreads have positive influence on liquidity risk. Non-performing loans have a positive significant relationship with liquidity risk. Reserve requirement ratios and inflation were also significant in explaining liquidity risk during the studied period. For commercial banks to manage liquidity risk there is need to pay attention to bank capitalisation, the size of the bank and on the differences between the deposit rates and lending rates. There is also need for improved credit risk analysis if banks are to have good financial assets in the dollarised environment.

JEL classification numbers: G33, E42
Keywords: Zimbabwe, commercial banks, multiple currency regime, liquidity

1 Introduction

Following the 2000-2008 decade of economic decline, the government of Zimbabwe adopted the use of a multiple currency exchange rate system on 30 January 2009 (Ministry of Finance (MOF, 2009a). The system allowed trade to be conducted using major trading currencies. The new regime helped restore price stability and restart financial intermediation (MOF, 2010, RBZ, 2010). The month-on-month inflation ranged

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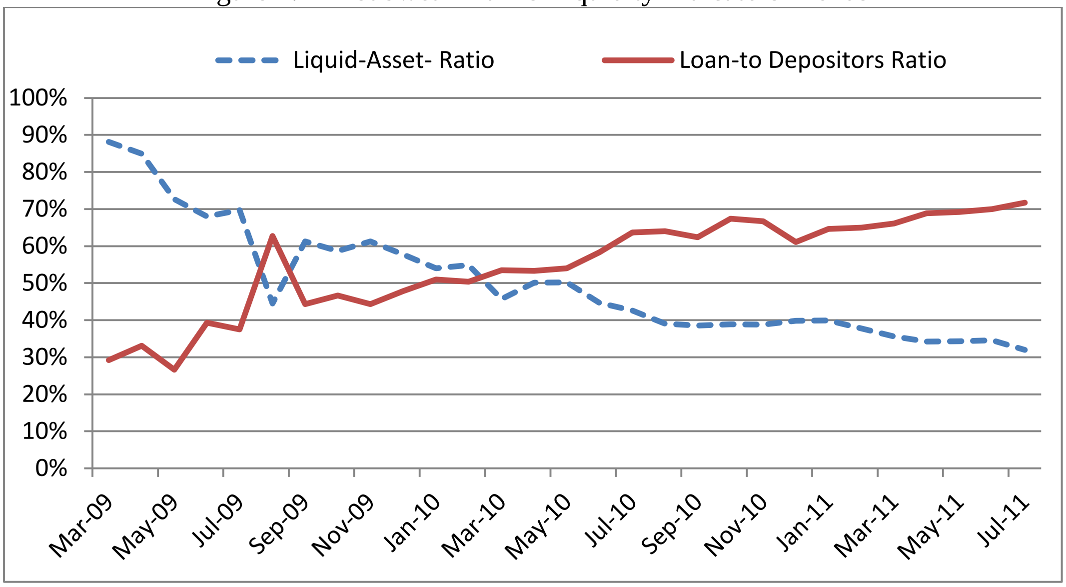
from negatives to slightly above one percent. In addition, with the adoption of the multiple currency system, banking deposits tripled and lending increased six-fold between March 2009 and December 2010 (RBZ, 2010). A research conducted by the International Monetary Fund (IMF) (2010) indicated that banks profitability had improved following more favorable economic environments during the new regime.

Despite the benefits of the multiple currency regime, commercial banks were exposed to liquidity risk. Figure 1 shows trends in liquidity indicators for the banking institutions.

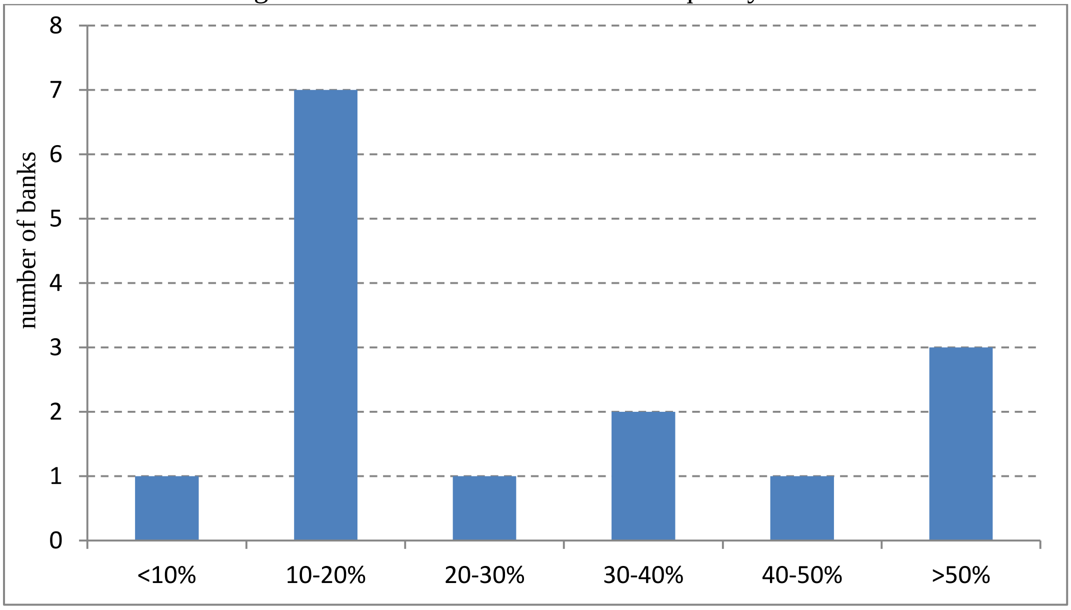
Figure 1: Zimbabwean Banks Liquidity Indicators Trends



Source: Reserve Bank of Zimbabwe 2011

Two liquidity ratios presented above: the liquidity ratio and the loan to deposit ratio. The higher the liquidity ratio, the lower the loan to deposit ratio (and *vise versa*). In March 2009, the liquidity ratio for banks was high at 88.1%. The loan to depositors' ratio was low at 29.2%. Progressively, banks liquidity ratio decreased leading to increase in the loan to depositors' ratio. In June 2011, the liquidity ratio was at 34.6% and the loan to deposit ratio was at 70%. The low liquidity ratios and the high loan to deposit ratio signaled illiquidity of some banks. Furthermore, the problems of liquidity risk by some banks can be deduced from the distributions of the prudential liquidity ratio as presented in figure 2.

Figure 2: Distribution of Prudential Liquidity Ratio



Source: Reserve bank of Zimbabwe 2011

As at June 2011, one bank had a liquidity ratio of below 10%. Seven banks had liquidity ratios of below 20%. These positions are major areas of concern because international practices among dollarised economies generally require a minimum of 25% or higher. There were and still are problems of low liquidity ratios by many banks in the multiple currency regime and an increase in many banks' overall exposure to liquidity risk. Despite the benefits of the new regime, vulnerabilities still exist in the financial sector with most banks still liquidity constrained.

Liquidity risk management is part of the larger risk management framework of the financial services industry which concerns all financial institutions. Failure to address the issue may lead to dire consequences, including banking collapse. By extension, liquidity risk leads to the instability of the financial system. Notwithstanding this, when looking at studies that have been done on risk management, there are fewer studies to discuss liquidity risk. For a long time, considerable effort has been put in designing bank capital regulation. The Basel I Accord (BIS, 1988) set out the regulatory standards on market risk and credit risk. The Basel II Accord (BIS, 2004) in addition took into account operational risk and not liquidity risk. However, liquidity risk is one of the major reasons banks have failed. It is an ingredient that makes banks safer institutions yet little attention has been given to it. Despite the abundant literature on the well functioning of the banking sector, there is limited study on liquidity and liquidity risk management. Studies to date have looked at liquidity risk management (Aspachs et al., 2005, Anas and Mounira, 2008, Bingham et al., 2003, Karcheva, 2006, Valla and Saes-Escorbiac, 2006, Vodova, 2011). All these studies looked at commercial banks liquidity management in developed nations and only after a banking crisis. This paper therefore seek to investigate the determinants of Zimbabwe commercial banks liquidity risk from 2009-2011. The study on commercial banks liquidity risk in Zimbabwe adds to the body of knowledge and closes this gap.

2 Preliminary Notes – Literature Revie

Bank liquidity is the ability by the bank to fund increasing assets and meet obligations when due, without incurring unacceptable losses (Bessis, 2009). Failure by the banks to manage liquidity brings about liquidity risk. Liquidity risk covers all risks associated with a bank failing to meet its obligations timeously or only being able to do so by emergency borrowing at high cost (BIS, 2009).

2.1 Measurement of Liquidity and Liquidity Risk

It is important then to understand how liquidity and liquidity risk are measured. The known and potential cash needs have to be quantified. The main approaches to measuring liquidity risk are stock approaches, cash flow analysis and an unadjusted (hybrid) maturity mismatch.

The stock-based approaches look at liquidity as a stock. By comparing the balance-sheet items, the approaches aim to determine a bank's ability to reimburse its short-terms debts obligations as a measurement of the liquid assets amount that can be promptly liquidated by the bank or used to obtain secured loans. The most commonly used approaches based on stock are the long-term funding ratio and the cash capital position.

In the cash-flow based approaches, the essence of liquidity risk is cash flow (Machiraju, 2008). Generally, banks control their liquidity principally by managing the structure of the respective maturities of assets and liabilities so as to generate adequate net cash flows Liquidity needs are usually determined by the construction of a maturity ladder that comprises expected cash inflows and outflows over a series of specified time bands. The difference between the inflows and outflows in each period, that is excess or deficit of funds, provides a starting point from which to measure a bank's future liquidity excess or shortfall at any time (Vento and Ganga, 2009, Schertler, 2010). An institution should regularly estimate its expected cash flows instead of focusing only on contractual periods during which cash may flow in or out.

The stock approach in determining a bank's liquidity adequacy thus requires an analysis of the current liquidity position, present and anticipated asset quality, present and future earnings capacity, historical funding requirements, anticipated future funding needs, and options for reducing funding needs or obtaining additional funds. The flow approach, in contrast, treats liquid reserves as a reservoir where the bank assesses its liquidity risk by comparing the variability in inflows and outflows to determine the amount of reserves that are needed during a period.

The hybrid approaches combine elements of the cash flow matching and of the liquid assets approaches. Here, every credit institution is exposed to unexpected cash in and cash outflows, which may occur in the future because of unusual deviations in the timing or magnitude of liquidity risk. This would require a considerable larger quantity of cash than the amount needed for bank projects. For this reason, the bank tries to match cash expected and unexpected outflows in each time bucket against a combination of contractual cash inflows, plus inflows that can be generated through the sale of assets, repurchase agreement or other secured borrowing. Unencumbered assets, which are used as collateral in financing transactions securing access to adequate funding sources (e.g. interbank lines of credit, discount facilities with central banks, etc.) and most liquid assets are typically counted in the shortest time buckets, while less liquid assets are counted in later time buckets.

The two most popular ratios used in academic literature are the loan-to-deposit ratio and the liquid asset ratio, where the higher the loan-to-deposit ratio (or the lower the liquid asset ratio) the less able a bank is to meet any additional loan demands (Shen et al., 2009, Moore, 2010). Both these indicators have their short-comings. The loan-to-deposit ratio does not take into account the other assets that may be available for conversion into cash to meet demands for withdrawals or loans. The liquid assets ratio ignores the flow of funds from repayments, increases in liabilities and the demand for bank funds (Moore, 2010). For this reason, we summarise the various ratios that can be used in measuring bank liquidity and liquidity risk in table 1.

Table 1: Various Forms of Liquidity Ratios

Liquidity Ratios
Readily marketable assets as percentage of total assets
Volatile liabilities as percentage of total liabilities
Volatility coverage (readily marketable assets as percentage of volatile liabilities)
Bank run (readily marketable assets as percentage of all deposit-type liabilities)
Customer loans to customer deposits
Interbank loans as percentage of interbank deposits
Net loans and investments as percentage of total deposits
Demand deposits as percentage of customer deposits
Deposits with maturities longer than three months as percentage of customer deposits
Less than 90 days deposits as percentage of customer deposits
Certificates of deposits as percentage of customer deposits
Ten largest deposits as percentage of customer deposits

Adopted from Levine (1997), Koch and McDonald (2000), Howells and Bain (2002), Gabbi (2004) and Matz and Neu (2007,)

The key liquidity ratios can be computed and then compared from say period one, period two and the current period and compare to a set benchmark. Lucchetta (2007) researched on European countries with the liquidity measure by different liquidity ratios. Machiraju (2008) looked at liquidity being measured by temporary investment ratios and volatile liability dependency ratio. For evaluation of liquidity positions of Czech commercial banks, Vodova (2011) used four different liquidity ratios, liquid assets/ total assets; liquid assets/ deposits+short term borrowing; loans/ total assets and loans/ deposits+ short term financing.

Liquidity ratios can be used to measure bank liquidity and illiquidity. Nevertheless, Poor and Blake (2005) revealed that it was not enough to measure liquidity or illiquidity by using liquidity ratios. The point in the case was of South East Bank which failed due to liquidity risk but had used in excess of thirty liquidity ratios to measure bank liquidity. In addition, Shen et al (2009) shows that beyond sheer liquidity ratios, there is need for banks and researchers to develop a new view of liquidity and liquidity risk measurement. From the literature reviewed, it is clear that no agreement exists on the proper measurement of liquidity. But the main approaches to measure liquidity include a stock approach, a cash flow analysis and a hybrid approach. After identifying the liquidity risk proxy it is important to understand the various determinants of liquidity risk.

2.2 Determinants of Bank Liquidity

The underlying variables driving the exposures of banks to liquidity risk can be dynamic. For banks to manage liquidity risk, it is important that they are able to identify and monitor various causes. Liquidity risk can originate from internal banking factors. These are referred to as bank specific. Similarly liquidity risk may emanate from external sources. The causes of liquidity risk are presented in table 2.

Table 2: Internal and External Factors Leading to Liquidity Risk Problems

Internal Banking Factors	**External Banking Factors**
High off-balance sheet exposures.	Very sensitive financial markets and depositors.
The banks rely heavily on the short-term funding.	External and internal economic performances.
A gap in the maturity dates of assets and liabilities.	Low/slow economic performances.
The banks' rapid asset expansions exceed the available funds on the liability side.	Decreasing depositors' trust on the banking sector.
Concentration of deposits in the short-term tenor.	Non-economic factors (political unrest, etc.).
Less allocation in the liquid government instruments.	Sudden and massive liquidity withdrawals from depositors.
Fewer placements of funds in long-term deposits.	Unplanned termination of government deposits.

Source: Ismal (2010)

From the above summary, liquidity is caused by exogenous and endogenous factors.
Agenor et al (2004) estimated a demand function for commercial bank liquidity (lq) as a function of customer characteristics and the macroeconomic environment. Mueller (1998), Tobin (2003), and Crowley (2007) noted that the specific characteristics of commercial banks that are usually theorised to have an impact on liquidity include; the size of the bank, ownership pattern, the quality of the loan portfolio, capital adequacy, overhead costs, operating expenses, and shares of liquid and fixed assets.

Bank size is used to gauge the possibility of economies of scale in banking. Banks that enjoy economies of scale incur a lower cost of gathering and processing information, resulting in greater financial flexibility. Similarly, banks with a large branch network can penetrate deposit markets and mobilise savings at a lower cost. To account for bank size, two measures are adopted, the bank's financial standing and network size. The first variable in bank size is the log of total assets. The second variable relates to the number of branches (Poorman and Blake, 2005, Shen et al., 2009).

Aspachs and Tiesset (2005) in a study of English banks assumed that the liquidity ratio as a measure of liquidity should be dependent on the following factors, (with estimated influence on bank liquidity in parenthesis), probability of obtaining the support from lender of last resort, which should lower the incentive for holding liquid assets (-); interest margin as a measure of opportunity costs of holding liquid assets (-); bank profitability, which is according to finance theory negatively correlated with liquidity (-); loan growth, where higher loan growth signals increase in illiquid assets (-); size of bank (?); gross domestic product as an indicator of business cycle (-); short term interest rate, which should capture the monetary policy effect (-).

The research done by Fielding (2005) on Egypt commercial banks considered the determinants of liquidity to be the level of economic output (+); discount rate (+); reserve requirements (?); cash to deposit ratio (-); Rate of depreciation of the black market exchange rate (+); impact of economic reform (-); and violent political incidence (+). The approach was entirely unique because it took into consideration political risk as an important factor in explaining the liquidity of the bank.

Lucchetta (2007) researched on European countries and showed that liquidity should be influenced by behaviour of the bank on the interbank market and a positive relationship attained. The more liquid the bank is, the more it lends in the intermarket. Interbank rate was included as an explanatory variable as a measure of incentives of banks to hold liquidity. Monetary policy interest rate was included as a measure of bank's ability to provide loans to customers. Share of loans on total assets and share of loan loss provisions on net interest revenues were taken both as a measure of risk-taking behaviour. Bank size was measured by logarithm of total bank assets.

Bunda and Desquilbert (2008) analysed the determinants of liquidity risk of banks from emerging economies. The liquidity ratio as a measure of banks' liquidity was assumed to be dependent on total assets as a measure of the size of the bank (-); the ratio of equity to assets as a measure of capital adequacy (+); the presence of prudential regulation, which means the obligation for banks to be liquid enough (+); the lending interest rate as a measure of lending profitability (-); the share of public expenditures on gross domestic product as a measure of supply of relatively liquid assets (-); the rate of inflation, which increases the vulnerability of banks to nominal values of loans provided to customers (-); the realization of a financial crisis which could be caused by poor bank liquidity (-) and the exchange rate regime, where banks in countries with extreme regimes were more liquid than in countries with intermediate regimes.

Shen et al (2009) looked at 12 Advanced Economies. In their study, the following were included as explanatory variables; (i) size (ii) square of size (iii) less risky liquid assets (iv) risky liquid assets (v) external funding dependence (vi) supervisory power index (vii) private monitoring index (viii) overall bank activities and ownership restrictiveness (ix) annual percent change of GDP (x) lagged variable of annual percent change of GDP and (xi) inflation.

Vodova (2011) looked at commercial bank liquidity for the republic of Czech. In this study both bank specific variables and macroeconomic variables were used as explanatory variables and are: (i) share of own capital on total assets of the bank (+); (ii) share of non-performing loans on total volume of loans provided by the bank (-); (iii) return on equity: the share of net profit on own capital of the bank (-); (iv) logarithm of total assets of the bank (+/-); (v) dummy variable for realization of financial crisis(-); (vi) growth rate of gross domestic product (-); (vii) inflation rate (+); (viii) interest rate on loans (-); (ix) interest rates on interbank transactions (-); (x) difference between interest rates on loans and interest rates on deposits (-); (xi) monetary policy interest rates (-) and (xii) unemployment rate (-)

The studies that have been reviewed above show that commercial banks' liquidity is determined by both bank specific factors (e.g. profitability, size of the bank, capital adequacy, risk of the bank), macroeconomic factors (such as gross domestic product, different types of interest rates, change in regulation and political incidents.) and supervisory (e.g. government regulation, reserve requirements ratio, official supervisory power index and private monitoring index).

There are broadly three types of data that can be employed in quantitative analysis of financial problems: time series data, cross-sectional data and panel data (Brooks, 2008). Time series data are data that have been collected over a period of time on one or more variables. Cross-sectional data are data on one or more variables collected at a single point in time. Panel data have the dimensions of both time series and cross-sections. According to Baltagi (2008), panel data regression differs from a regular time series or cross-section regression in that it has a double subscript on its variables *i*, denoting cross section dimension and and *t* denoting time i.e.

$$y_{it} = \alpha + X_{it}^{'}\beta + u_{it} \qquad i = 1,.........N; \qquad t = 1,.........T \tag{1}$$

Y_{it} indicates the dependent variables while X_{it} determines the vector of k explanatory variables.

Various procedures were used by various researchers when estimating liquidity risk. Fielding (2005) used panel regression analysis on analysing bank liquidity in Egypt. On England, Aspachs and Tiesset (2005) used panel regression analysis. Karcheva (2007) used non-parametric statistics methods when analysing liquidity management in Ukraine. Lucchetta (2007) used panel regression analysis on European banks. Bunda and Desquilbert (2008), used panel data regression analysis to analyse determinants of liquidity risk of banks from emerging economies. Shen et al (2009) on 12 Advanced Economies used panel data instrumental variable regression. Schertler (2010) used dynamic panel data regression on German Banks. Ismal (2010) used Auto Regressive Distributed Lag (Dynamic) model in estimating Islamic banks liquidity in Indonesia. Vodova (2011) looked at commercial bank liquidity for the republic of Czech using panel data used a fixed effect regression analysis.

It is evident that most researchers used panel regression analysis on commercial banks liquidity risk determinants. The main consideration was that banks are heterogeneous. If one considers only time series analysis or cross sectional analysis and not controlling for the heterogeneity, there would be risk of obtaining biased results. The use of panel data thus controls for firms' heterogeneity. Brooks (2008) showed that panel data gives more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency. Panel data is able to study the dynamics of adjustment. Cross sectional distributions that look relatively stable hide a multitude of changes. Panel data are better able to identify and measure effects that are simply not detectable in pure cross-section or pure time series. Panel data allows the construction and test more complicated behavioral models than purely cross-sectional or time series data (Wooldridge, 2002, Hsiao, 2003, Brooks, 2008, Baltagi, 2008).

2.2 Theoretical Construction of the Liquidity Risk Model

The goal of commercial banks is to maximise the bank's value as defined by its profitability and risk level (Ismal, 2010). This section develops the commercial banks liquidity risk model.

2.2.1 Conventional banks behaviour models in the competitive banking industry

There are various models of bank behaviour in economic literature. From them all, we use models of Freixas and Rochet (1999), Diamond (2007) and Ismal (2010). Diamond (2007) described a bank's liquidity condition model where deposits were placed in short-term tenors and bank loans were placed in long term tenors. An illustration of two types of investors who might terminate their deposits at time T=1 and time T=2 of three investment periods (T= 0,1,2). On the other hand, there was a demand for liquidity from entrepreneurs at time T=1, to be consumed at time T=2. The bank could provide more liquid assets by offering demand deposits to execute the investment to provide for liquidity from entrepreneurs, and at the same time investing in illiquid assets (Diamond, 2007). More appealing has been the model developed by Freixas and Rochet (1999). The main focus was on the bank's liquidity on the asset and liability sides. There are four assumptions to their model relating to competitive banking deposits which are (i) banks are risk neutral, (ii) banks are price takers (iii) banks maximise profit as a motive to balance liquidity on asset and liability, and (iv) there is full information.
The model formulates a bank's profit as the output of total revenues from asset side minus total expenditures from liabilities side as follows:

$$\pi = r_L L + rM - r_D D - C(D,L) \tag{2}$$

where π is bank's profit; r_L is interest on loans; L is total outstanding loans; r is the money market rate; r_D is the interest on deposits; D is the total deposits; C is the total cost involved in managing both deposits and loans. M is the bank's net money market position and is formulated as:

$$M = (1-\alpha)D - L \tag{3}$$

α is compulsory reserves required by the Central Bank.
Using equation (1) and equation (2) π can be rewritten as:

$$\pi(D,L) = (r_L - r)L + [r(1-\alpha) - r_D]D - C(D,L) \tag{4}$$

Maximum profit is the first order condition of equation (3) such that:

$$\frac{\partial \pi}{\partial L} = (r_L - r) - \frac{\partial C}{\partial L}(D,L) = 0 \text{ and } \frac{\partial \pi}{\partial D} = [r(1-\alpha) - r_D] - \frac{\partial C}{\partial D}(D,L) = 0 \tag{5}$$

Equation 3 and equation 4 mean that maximum profit is the condition where volume of loans and deposits are adjusted in such a way that $(r_L - r)$ and $[r(1-\alpha) - r_D$ equals

marginal costs. For a bank, an increase in r_D will decrease the deposits and an increase in r_L will increase the supply of loans. According to Freixas and Rochet (1999), if there are different banks (n = 1,……,N) with typical deposits (D^n) and loans (L^n), and total amount of securities (T-Bills)(B) held, the functions of household saving and demand for investment from corporations are as follows:
Saving of household:

$$S(r_D) = B + \sum_{n=1}^{N} D^n (r_L, r_D, r) \quad (6)$$

Demand for investment from companies:

$$I(r_L) = \sum_{n=1}^{N} L^n (r_{L,} r_D, r) \quad (7)$$

Interbank Market:

$$\sum_{n=1}^{N} L^n (r_L, r_D, r) = (1-\alpha) \sum_{n=1}^{N} D^n (r_L, r_D, r) \quad (8)$$

According to Ismal (2010), equation 7 assumes that aggregated position in the interbank market is zero $(M = 0)$ and r is a controlled variable set by the Central bank. By modifying equation 4 by these assumptions $(C_L \equiv \gamma L$ and $C_D \equiv \gamma D)$ such that $r_L = r + \gamma L$ and $rD = r(1-\alpha) - \gamma_D$ and putting them together into equation 5, equation 6 and equation 7, the equilibrium equations with maximum profit and optimum liquidity balance are:

$$S[r(1-\alpha) - \gamma D] - \frac{1(r + \gamma L)}{1-\alpha} = B \quad (9)$$

$$I(r + \gamma L) = \sum_{n=1}^{N} L^N (r_L, r_D, r) = (1-\alpha) \sum_{n=1}^{N} D^n (r_L, r_D, r) \quad (10)$$

Freixas and Rochet (1999) highlighted that equation 8 explains that liquidity n the liability side of the bank is determined b y a reserve coefficient (α) or by open market operation (B) on the equilibrium levels of r_L and r_D. On the other hand, the demand for investment from companies is influenced by cost of managing deposits and loans besides the money market interest rate. As a result, equation 9 is driven by a set of interest $(r_L, r_D$ and $r)$ in addition to the cost of managing loans, total deposits and liquidity reserves required by the Central Bank.

2.2.2 Reserve management models

Reserve management models deal with a bank's funding or liquidity risk to manage this type of risk and in deciding how much cash and other liquid assets they should hold, banks internalize the fact that they can withdraw funds either from the interbank market or the central bank in case of unexpected contingencies (Agenor et al., 2004). There are various models of liquidity reserves for banks in economic literature. Amongst all, Baltensperger (1980) and Agenor et al (2004) suit the purpose of this study. To start with, a simple model by Baltensperger (1980) is considered. Assume that there is only one representative bank whose deposits D are given exogenously. The bank must decide upon the level of liquidity, non-interest-bearing reserve assets R, and non-reserve assets, which take the form of illiquid loans, L. its balance sheet is given by:

$$R + L = D \tag{11}$$

Reserves are necessary because the bank is exposed to liquidity risk. Deposit flows $u \in (u_L, u_H)$ occur randomly according to a density function $\phi = \Phi'$. When the net outflows of cash exceed the reserves, $u \geq R$ the bank must face illiquidity costs that are taken to be proportional to the reserve deficiency max $(0, y - R)$. This means then in the case of illiquidity the bank must borrow the missing reserves at a penalty rate q, with $q > r_L$, where r_L is the interest rate on loans. With r_D denoting the deposit rate, the bank's profit is thus:

$$\pi = r_L L - r_D D - q \max(0, u - R),$$

which implies that the bank's expected profit is:

$$E\pi = r_L L - r_D D - q\int_R^{uH} (u - R)\phi(u)du, \tag{12}$$

Using equation 10:

$$E\pi = (r_L L - r_D)D - r_L R - q\int_R^{uH} (u - R)\phi(u)du, \tag{13}$$

Assuming risk neutrality, the optimal level of reserves is determined so as to maximize expected profits. The necessary condition is thus:

$$\frac{\partial E(\pi)}{\partial R} = -r_L + q\{1 - \Phi(R)] = 0 \quad \text{that is}$$

$$R^* = \Phi^{-1}\left(\frac{q - r_L}{q}\right) \tag{14}$$

According to Agenor et al (2004), equation 14 implies that the marginal opportunity cost of holding an extra unit of reserves r_L, is equated to the marginal reduction in liquidity costs. Optimal reserves decrease with the lending rate r_L and increase with the penalty rate q. According to the early literature of Baltensperger (1980), Santomero (1984), and Swank (1996), reserve management models deal with a bank's funding or liquidity risk. Therefore for the purpose of this research, the simple reserves model in equation 14 is extended in several directions, following in part Shen et al (2009), Vodova (2011). To account for Zimbabwean commercial bank liquidity risk, there is a link between bank specific, macroeconomic and supervisory factors.

3 Method of Estimation

Based on the theoretical construction of the liquidity risk models, a panel regression model was employed. A panel regression model is developed following in part Agénor et al 2004; Aspachs and Tiesset, 2005; Bunda and Desquilbert, 2008; Shen et al (2009). The panel regression model developed is:

$$LQR_{it} = c_i + \sum_{b=1}^{B} \beta_b \prod_{it}^{b} + \sum_{s=1}^{S} \sigma_s \prod_{it}^{s} + \sum_{m=1}^{M} \lambda_m \prod_{it}^{m} + \varepsilon_t \qquad (15)$$

Where LQR_{it} is the liquidity risk of the *i*th bank at time *t*, with *i* = 1… N; t = 1…T_i. $\prod_{it}^{b}, \prod_{it}^{s}, \prod_{it}^{m}$ are bank specific, macroeconomic and supervisory variables respectively. The most important task was to choose the appropriate explanatory variables for commercial banks in Zimbabwe in the multiple currency environment. Extending equation (4) to reflect the variables, the model is formulated as follows:

$$LQR_{it} = c_i + \beta_1 CAD_{it} + \beta_2 SIZE_{it} + \beta_3 SPREADS_{it} + \beta_4 NPL_{it} + \sigma_1 RRR_t + \lambda_1 INFL_t + \varepsilon_i \qquad (16)$$

where

LQR_{it} is the liquidity risk at bank *i* at time *t*

CAD_{it} is the capital adequacy ratio at bank *i* at time *t*

$SIZE_{it}$ is the natural logarithm of total assets at bank *i* at time *t*

$SPREADS_{it}$ is the difference between interest rate loans and interest rates on deposits at bank *i* at time *t*

NPL_{it} is non-performing loans at bank *i* at time *t*

RRR_t is the reserve requirement ratio that captures the regulatory effects at time *t*

$INFL_t$ is the inflation rate at time *t* that captures the macroeconomic effects

t = March 2009 to December 2012, (monthly data) c_i is the constant for each bank (fixed effects). β represent bank specific factors coefficients, λ is market factor coefficient.

The dependant variable LQR captures liquidity risk. Following Shen et al (2009) that researchers need to employ alternative liquidity risk measures besides liquidity ratio. The study then captures liquidity risk with the financing gap ratio (LQR). The financing gap ratio is the ratio of financing gap to total assets. It is the difference between bank's loans and customer deposits. The ratio indicates the extent to which a bank's deposit structure funds the loan portfolio. The higher the ratio the more reliance that a bank has on non-deposit sources of funding to fund the loan portfolio. A high ratio suggests potential vulnerability to credit-sensitive funds providers at less favourable points in the credit and economic cycles.

Bank specific variable include capital adequacy ratio (CAD), size of the bank (SIZE), difference between interest rates on loans and interest rates on deposits (SPREADS), non-performing loans (NPL). Supervisory effects have been captured by the reserve requirement ratio (RRR). Macroeconomic variables are captured by inflation (INFL). Fixed effects model is used to estimate equation

3.1 Data Sources and Characteristics

The study uses monthly data from March 2009 to December 2012 from 15 Zimbabwean commercial banks. Data was collected from the bank's annual reports and financial statements, Survey of Banks data base and the Reserve Bank of Zimbabwe monetary policy statements. Secondary cross sectional time series in nature had the advantage that it was almost free from human errors or manipulation and did not have an element of subjectivity, since it had not been smoothened, interpolated or extrapolated. But it is not hundred percent biases free since the figures are averages which are estimates.

4 Main Findings

The cross-sectional time series data was checked to determine whether it abided to econometric *a priori* postulation. The following diagnostic tests were carried out. Panel unit root tests were used to check for stationarity of data. Multicollinearity arises from the perfect linear relation among regressors as this result in inflated standard errors and consequently inaccurate parameter estimations. As a rule of thumb, the pair wise or zero order correlation coefficient is said to be high if in excess of 0.8, (Gujarati, 2004). The researcher used the correlation matrix to detect the presence of severe multicollinearity. The data was tested for heteroscedasticity. The Breusch-Pagan test was applied to the regression to detect the presence of heteroscedasticity. Assuming homoscedastic disturbances when heteroscedasticity is present will still result in consistent estimates of the regression coefficients, but these estimates will not be efficient, (Baltagi 2008). The Ramsey reset test was conducted to ascertain whether the model was correctly specified. This test detects if there are variables that have been omitted, included variables that are not supposed to be included, testing the functional form of the model. A Hausman test was carried out on the selection of the fixed effect model visa vis the random effects. See Appendix 4 for the diagnostic tests

The regression results of the model are presented in table 4.

Table 4: Regression Results: Fixed Effects and Random Effects Regression (LQR)

Variable	**Fixed effects**	**Random effects**
C	1.0599	1.2769
	(0.2636)	(0.2498)
CAD	-0.2634***	-0.2797***
	(0.0212)	(0.0199)
SIZE	0.8431***	0.8943***
	(0.001)	(0.3076)
SPREAD	-0.0047***	-0.0044***
	(0.0014)	(0.0011)
NPL	0.2577***	0.2618***
	(0.0122)	(0.0119)
RRR	-0.3519***	-0.3995**
	(0.1750)	(0.1737)
INFL	-0.0303***	-0.0308***
	(0.0098)	(0.0098)

R^2	Within	0.62	0.62
	Between	0.61	0.64
	Overall	0.60	0.62
F(6, 459)=124.09 Prob>F=0.0000			Wald chi2(6)=763.80 Prob>chi2=0000

Note: The starred coefficients are significant at 1% (***), 5% (**) and 10% (*).

4.2Interpretation of Results

Having run the liquidity risk model, it is important to interpret the meaning of the results. The relationships are discussed in turn:

4.2.1 Capital adequacy ratio (CAD)

Capital adequacy is a significant determinant of liquidity risk on commercial banks in Zimbabwe. The finding is in line with the expectation that capital adequacy has a negative relationship with liquidity risk. This conforms to theory that capital has positive effect on bank performance. Banks with sound capital position have more time and flexibility to deal with problems because of unexpected loss. Besides, well capitalised banks face lower costs of going bankrupt as a result of reduced cost of funding or less need for external funding which increases performance. Banks that are capitally adequate are not prone to liquidity risk. Banks with sufficient capital adequacy should be liquid too. The finding is in line with previous studies (Vodova, (2011;)

4.2.2 Size

The size of the institution as measured by the total assets was able to significantly determinant of Zimbabwean commercial banks liquidity risk.

4.2.3 Spreads

Spreads have a negative relationship with liquidity risk in Zimbabwe during the multiple currency regime.

4.2.4 Non-performing loans (NPL)

As expected, a rise in non-performing loans increases liquidity risk of the bank. Non-performing loan is a loan that is not earning income and full payment of principal and interest is no longer anticipated, or the maturity date has passed and payment in full has not been made. There is a positive influence of non-performing loans on liquidity risk. Since non-performing loans portfolio indicate the quality of total portfolio and that of the bank’s lending decision (Van Grueining and Bratavonic, 2003), banks in Zimbabwe generally are facing liquidity risk problems as a result of non-performing assets.

4.2.5 Reserve requirement ratio (RRR)

The reserve requirement ratio is where the central bank regulates that each commercial bank sets the minimum reserves it must hold of the customer deposits rather than lend out. It is normally in the form of cash stored physically in a bank's vault or deposits made with a central bank. High reserve requirements reduce the bank's illiquidity. The reserve requirement ratio is significant in explaining liquidity risk in the multiple currency regime.

4.2.6 Inflation (INFL)

Inflation significantly influenced liquidity risk in Zimbabwean commercial banks when there was use of multiple currency. This could be because inflation rates have been very low since the advent of the multiple currency era with some months reporting negative inflation rates.

5 Conclusion

The aim of the study was to identify the determinants of Zimbabwe commercial banks liquidity risk after the adoption of the multiple currency regime in 2009. Since the banking institutions are operating in a challenging environment, fundamental measures must be taken to strengthen liquidity risk management. This is possible when banks and regulators are aware of the main drivers to liquidity risk and address them accordingly. We used the financing gap ratio as a measure of liquidity risk. From the panel data regression results, capital adequacy and size have negative significant influence on liquidity risk. As size increases, liquidity risk reduces. Spreads have positive influence on liquidity risk. Non-performing loans have a positive significant relationship with liquidity risk. Commercial banks and regulators in Zimbabwe need to consider capitalisation, the size of the banks and spreads in management of liquidity risk. There is need for improved credit risk analysis if banks are to have good financial assets given the operating environment. Reserve requirement ratios and inflation were also significant in explaining liquidity risk when there was use of multiple currencies in Zimbabwe.

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Appendices

Appendix 1: Variables Description

Category	**Symbol**	**Calculation**
Liquidity Risk	**LQR**	Financing gap ratio is the ratio of financing gap to total assets. Financing gap is the difference between bank's loans and customer deposits.
Capital Adequacy Ratio	**CAD**	Tier one capital plus tier two capital divided by risk weighted assets
Size	**SIZE**	Total Assets
Spreads	**SPREADS**	Difference between Interest Rates on Loans and Interest Rates on Deposits
Non-performing Loans	**NPL**	Ratio of non-performing loans to total loans
Reserve Requirement ratio	**RRR**	As stipulated by the Reserve bank of Zimbabwe
Inflation Rate	**INFL**	Monthly Consumer Price Index (CPI)

Appendix 2: Model Diagnostic Tests

(i) Unit Root Tests

Panel data unit root tests were done. The results are presented below:

Unit Root Tests

VARIABLE	**STATISTIC**	**Z**	**P-VALUE**
LQR	0.0005	-37.0121	0.0000
CAD	0.7668	-5.7975	0.0000
SIZE	0.6646	-9.9587	0.0000
SPREADS	0.7668	-5.7975	0.0000
NPL	0.00358	-36.8774	0.0000
RRR	0.8501	-2.4020	0.0082
INFL	0.3301	-23.5867	0.0000

The variables are stationary in levels as confirmed by the p-values. There was no problem of non-stationarity.

(ii) Multicollinearity

The results of the correlation matrix are presented below:

	LQR	CAD	SIZE	SPREADS	NPL	INFL	GDP
LQR	1.0000						
CAD	-0.0957	1.0000					
SIZE	-0.0440	0.0204	1.0000				
SPREADS	0.2889	0.0743	0.2820	1.0000			
NPL	0.0690	0.0439	0.524	0.155	1.0000		
RRR	-0.3077	-0.1830	-0.3189	-0.6184	0.0323	1.0000	
INFL	0.1440	-0.0027	0.1314	-0.0172	-0.0172	-0.2631	1.0000

(iii) Model Specification Tests

H_0: model has no omitted variables

F(3, 458) = 1.96

Prob > F = 0.1189

The above result shows that the model was correctly specified and the null hypothesis is accepted to say that the model has no omitted variables.

(iv) Heteroscedasticity

The Breusch Pagan / Cook-Weisberg test for heteroscedasticity was used to check for the problem of heteroscedasticity. The following are the results.

Ho: Constant variance

Variables: fitted values of liquidity risk

chi2(1) = 0.96

Prob > chi2 = 0.3268

The null hypothesis is that the error variances are all equal against the alternative that the variances are not constant. The results show that there is no heteroscedasticity. Similarly like in the first model, it is possible to run the fixed effects model or random effects model.

(v) Hausman Test for Fixed or Random Effects Model

The Hausman test was used to make a decision on whether to use the fixed effects model or the random effects model. The following results were obtained:

chi2 (6) = (b-B) ‘ [V_b-V_B) ^ (-1)] (b-B)

= 6.74

Prob>chi2 = 0.3460

The null hypothesis of the Hausman test is that the two estimation methods are both acceptable and would yield the same coefficients. From the result above, the null hypothesis is accepted since the differences between the