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Monetary policy risk-taking transmission channel: A case of banking industry in Kenya

David Ndwiga*

Abstract

Using a Panel VAR model and annual bank level data for the period 2008–2022, this study investigated banks risk taking behaviour amid monetary policy tightening considering the role of banks' non-interest-bearing deposits and equity levels. Estimation results found monetary policy tightening and equity levels reduces the bank risk taking behavior thus evidence of monetary policy risk-taking transmission channel. However, the contrary was reported with regard to bank liability: - non – interest bearing deposit "pseudo assets". However, interaction between policy rate, equity and "pseudo assets" was found to increase bank risk appetite significantly. This study is important since under the risk-taking channel view, a change in the policy rate is immediately transmitted to money-market instruments of different maturity and to other short-term rates, such as interbank deposits and this quickly affects the interest rates that banks charge their customers for variable-rate loans, including overdrafts.

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1.0 Introduction

1.1 Background of the study

The pursuit of understanding of the linkage between financial markets and the real economy has dominated macroeconomists and policy makers ever since the advent of the global financial crisis of 2007/08. More importantly on this linkage is the growing literature on the relationship between monetary policy and banks risk taking behaviour.

The growth of the empirical works in this subject issue is underpinned on the conception that the excessive risk-taking behaviour by banks in the developed economies fueled the global financial crisis thus making the pursuit of monetary policy – bank risk taking behaviour nexus a matter of special and urgent interest (Matthias, N., and Matthias, 2018). Majority of the studies in this field however have modelled this relationship by using short term interest rates as proxy for monetary policy.

The stylized argument short-term interest rates and banks risk taking are negatively related. A contractionary monetary policy leads to tightening of the credit standards by commercial banks hence the rise in interest rates. This relationship has been confirmed by Gambacorta, (2018) and Paligorova and Santos (2012) in the US. However, despite this stylized fact on the short-term interest rates - banks risk taking nexus, the question is whether such relationship is always guaranteed? Understanding bank's risk-taking behaviour in the context of monetary policy development is of paramount importance. Economists have argued that the long period of relatively low policy rates and expansionary monetary policy was one of the primary sources for the financial system's fragile state before the Great Recession of 2008 (De Nicolò et al., 2010). Periods of low rates may cause banks not adequately adjust their expectations about future interest rates, assuming instead that rates will remain low for an extended period leading to origination of excessive amount of lower-quality credit.

Further, monetary policy developments may induce banks' excessive expansion of banks' balance sheets through leverage. An accommodative monetary policy

may results banks growing their balance sheets via collateralized borrowing. In this case, banks would strive to manage their leverage levels as measured by the ratio of total assets to equity (Adrian and Shin, 2010). The opposite scenario would be expected in times of monetary policy tightening. However, we note that this move by banks could have far-reaching implications in that growth of bank balance sheet through collateralized borrowing could build up financial imbalances over time. The implication is reduced market liquidity as well as declines in marked-to-market values and forced asset sales. We note that the existence of such a relationship is mostly dependent on the time factor. It's notable that the extent to which low or high interest rates are held will affect the nature of the relationship between interest rates and banks risk appetite. As pointed out by Jimenez et al (2008), holding interest rates low for a short period of time may improve the overall quality of banks' loan portfolios, but holding interest rates low for a prolonged period could increase loan default risk substantially over the medium term.

A reduction in the monetary policy rate causes banks to review their perception and tolerance of risk, resulting in a lower risk premium, which in turn amplifies the effect of the interest rate cut. However, economists have argued that the long period of relatively low policy rates and expansionary monetary policy was one of the primary sources for the financial system's fragile state before the Great Recession of 2008. On the other hand, the opposite case for monetary policy tightening would imply an increase in lending rates hence adversely affecting private sector credit growth (De Nicolò et al., 2010). As such practitioners are faced with balance challenge as to for how long central banks should hold policy rates at a given level such that credit risks in the banking industry are well managed and fagility in the financial systems in minimized if not averted.

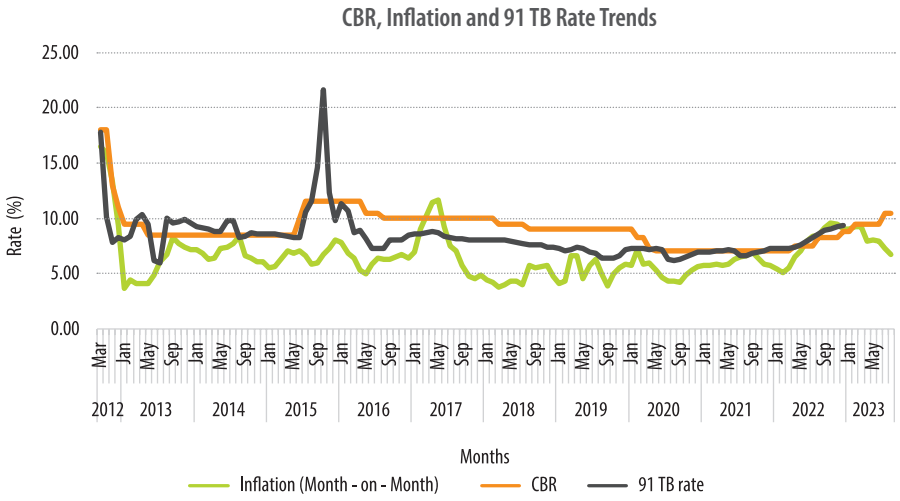
A look at the monetary policy risk transmission channel posits that the policy rate determines the bank's deposit rate and affects bank incentives to take risk through two opposite channels. First, there is a pass-through effect whereby higher deposit rate translate into higher lending rates. So the reward for the bank in case of success is higher. Second, there is the classical risk shifting effect associated with the higher cost of liabilities. However, regarding the pass-through effect channel, its strength, is hinged on the leverage/capital of banks. Going by this argument then the classical risk-shifting effect is stronger and minimizes the net effect of a change in the policy rate for the less capitalized banks (De Nicolò et al., 2010). This is similar to the bank lending channel postulated by Bernanke and Blinder (1988).

A review if the monetary policy, measured by the CBR (policy rate) in Kenya indicates that rate has been by a large extent changing more often. Figure 1 indicates that from October 2008 to March 2010, the policy rate was within the CBK target band of 5%±2.50 basis point. However, June 2011 so the highest spike in the policy rate to a high of 18 percent but significantly dropped to around 8 percent mark in September 2013. The sharp rise in 2011 was occasioned by the need to anchor the high inflation by then. Further was the need for stabilization of the exchange rate was which in depreciation by then. The trend in the policy rate reveals a pause in the policy rate change from May 2020 to March 2022 where the rate was maintained

at 7 percent level. The pause of the rate could be informed by the need to spur credit extension to the household sector in the covid period. Further was the need to support private sector credit extension in periods immediately after covid to support recovery as well as government fiscal stimulation efforts.

However, since July 2022, the policy rate has been on rise signaling monetary policy tightening. This could infer into the need for the Central bank to anchor inflation amid rise in the global prices of goods especially necessities arising from the shocks in the global supply disruptions during the Covid period. The monetary policy tightening could be viewed to be in tandem with policy rate tightening among other central banks globally in a move to anchor inflation fueled by rising commodity prices in the global market a rise majorly attributed to global supply shocks caused by Covid. Therefore, given the frequent adjustment in the policy rate in the current economic times, an investigation into the way such adjustments are affecting bank risk taking via the risk taking channel which is more indirect as opposed to the direct bank lending channel is of importance. Of the importance here is the investigation into how the adjustments influence bank risk taking through adjustments in the bank balance sheet as this unearth the extent of banks responsiveness to monetary policy tightening given their balance sheet health.

Figure 1: Monetary policy evolution, Inflation and 91 TB Rates in Kenya, 2008 – 2013



A review of the relationship between CBR and inflation rate over time reveals that largely the policy rate has managed to anchor inflation within the recommended threshold by the Central Bank of Kenya apart from few incidences where the inflation rate has been over the threshold. The trend reveals the a hike in the rate and sustaining of the policy rate at a certain mark overtime is followed by successive reduction in the inflation rates for several month after implying that the policy rate pronounced at a certain time continues to transmit overtime hence an evidence of policy transmission lag. The relationship between CBR, Inflation and 91 treasury Bill rate indicates that the market is always ahead of the policy rate. A rise in the 91-treasury bill rate is likely to fuel inflation hence making the policy transmission lag last longer.

1.2 Problem statement

Understanding the monetary policy transmission channels especially in the credit markets is crucial in informing banks' responsiveness to monetary policy development. Currently the Central banks in the developed economies have been undertaking monetary policy tightening aimed at addressing the inflationary pressures arising from the supply shocks accessioned by the Covid 19 pandemic. From the literature, the two of the most discussed of these transmission channels are the bank lending channel proposed by Bernanke and Blinder (1988) and risk-taking channel emphasized by Disyatat (2011) and Jiménez et al. (2014). Under the bank lending channel, monetary policy tightening reduces the bank's reserves through reduced deposit. Given the commercial banks are unable to fully substitute between deposits and funding through the interbank market, tightening monetary policy lowers banks' lending. However, under the risk-taking channel monetary policy tightening makes risk assets less attractive and hence reduces collateral and assets values accordingly.

Therefore, this begs out the question begs as to what is the difference between the bank lending channel and risk-taking channel of monetary policy tightening?

This paper argues that in as much as the former channel is more explicit and direct through the effects on the bank deposits, the latter model is not that explicit and direct. Less empirical work on the risk-taking channel of monetary policy tightening does exist in comparison to the bank lending channel of monetary policy tightening which is extensively researched. Noting that risk-taking channel of monetary policy tightening is more indirect and implicit, empirical analysis is key in offering insights into this channel. Understanding the risk-taking channel of monetary policy tightening requires taking into account both the supply and demand side of the bank's balance sheet. This is informed by the fact that in deciding on the risk appetite levels amid policy tightening, banks could leverage on their equity which has a lower cost as opposed to borrowed funds for lending in case of policy rate tightening. This is because equity is cheaper compared to borrowed funds in the event of policy rate tightening. Similarly, banks could turn to use of non – interest bearing deposits (liability side) in the event of policy rate tightening to avert the high cost of securing loanable funds. Therefore, it's evident that the actual effect of policy rate tightening on credit supply by banks could be reduced if not muted by the banks' equity levels and non – interest bearing deposits. This is an indirect effect.

However, the question on for how long banks could leverage on their equity and liabilities levels to sustain their risk appetite level during the policy rate tightening periods. This argument is anchored on the proposition that credit supply by banks is dependent on how long the central bank will maintain the tightening since banks are obviously faced with equity levels and liabilities constraints at some point. It's is against this backdrop that this study seeks to examine the monetary policy risk-taking transmission channel within banking industry in Kenya in the context of banks balance sheet health (equity and liability health).

1.3 Research objectives

The study will seek to achieve the following objectives.

- To determine the effect of monetary policy tightening on the banks' risk – taking behaviour through bank equity in Kenya
- To determine the effect of monetary policy tightening on the banks' risk – taking behaviour through bank non – interest bearing deposits in Kenya

1.4 Research Hypothesis

- Monetary policy tightening has no significant effect on the banks' risk – taking behaviour through bank equity in Kenya.
- Monetary policy tightening has no significant effect on the banks' risk – taking behaviour through bank non – interest bearing deposits in Kenya.

1.5 Contribution of the study

The paper findings therefore would be crucial to Assets and Liability Management policy and decision making at bank level amid ongoing monetary policy tightening which is expected to exist for a while it attempts to manage the inflationary pressures in Covid 19 recovery period arising from supply shocks occasioned by Covid 19 pandemic. The interaction between the policy rate, bank equity and liability levels would be crucial in informing bank operations on how to manage bank equity and liability in the periods of successive policy tightening to sustain their lending while ensuring stability.

2.0 Literature Review

2.1 Theoretical Literature

In the study, the risk-taking channel is the main focus which is conceptualized as a bank supply-driven channel that operates by banks' increased appetite for risk manifested in lower compensation for risk. In this channel assuming that the loan quality remains unchanged, banks perceive loans to be less risky during monetary policy easing compared to tightening and are willing to originate more of these loans.

We therefore hypothesis that during monetary policy easing banks with strong risk appetite require relatively lower credit risk premia compared to other banks. In the study, the relationship between monetary policy and bank risk can be summarized as follows. The Central bank influences the operations of the commercial banks via the policy rate. As such the banks consider the effect of this policy rate in deciding on how to grow their loan book (Kim, 2014). This therefore implies that monetary policy will definitely affects bank's balance sheet through the effect on risk perceptions in so far as the risk accommodation in bank's lending activities is concerned. The long run effect is the changes in the balance sheet through possible alterations and revaluations.

The alterations in the bank balance sheet arising from the monetary policy changes can be revealed from both the assets and liability side of the balance sheet. For instance, change in a bank's portfolio composition from less-risky to more-risky assets arising from monetary policy changes will definitely imply changes in the bank balance sheet position. Based on this relationship, its expected that the banks will revert to their balance sheet to circumvent the effect the policy rate is likely to have on their lending. Therefore, its expected that banks will respond differently to the policy rate changes based on their balance sheet potions. It is therefore important to examined how the monetary policy affects banks operation considering the balance sheet position of the bank. Against this backdrop, the study sought to examine the risk-taking channel of the monetary policy among the Kenya banks. In so doing the study sought to unearth how the policy rate affects banks risk taking behavior and how the policy rates interaction with the bank equity and liability levels accelerate or decorrelate banks' risk appetite.

In linking bank lending (risk – appetite) to balance sheet in the context of the monetary policy stance at hand, Adrian and Shin (2010) suggest that banks expand their balance sheets (increase lending) through collateralized borrowing (transactions in which securities are provided as collateral) during periods of accommodative monetary policy and reduce them when monetary policy is tight. In conceptualizing and modelling risk-taking channel of monetary policy, this study relied on the Bernanke and Gertler (1995) work. According to Bernanke and Gertler (1995), The risk-taking channel is supply-driven and generated by a greater appetite for risk by banks when interest rates remain low for long time periods, but low interest rates also affect the demand for investments and credit, the quality of the pool of borrowers, and the volume of credit supplied.

2.2 Empirical Literature

Vast body of literature does exist regarding the nexus between monetary policy and bank risk. From the literature, its evident that adjustments in the policy rates will have different effects on the bank risk taking behaviour. Any reduction in the policy rate (monetary policy loosening) has effect on the assets valuations, incomes and cash flows hence affecting banks' estimation of the expected risk associated with lending (Borio and Zhu 2008; Adrian and Shin 2009a). Any monetary policy loosening would imply relaxation on bank credit standards hence boosting prices of financial assets. The result being downward revision of the probability of loan defaults hence more risk tolerance by banks. To ensure stability in the banking sector, tighter monetary policy has been advocates for in in good economic times. Diamond and Rajan (2009) asserts that in good times monetary policy should be kept tighter than strictly necessary based on economic conditions existing at the time, in order to diminish banks' incentives to take on liquidity risk.

From the empirical perspective, Jim´enez et al. (2014) examined effects of monetary policy stance in Spain for 1984–2006. The study objective was to examine whether the existing monetary policy stance had an impact on the level of risk of individual bank loans. The study findings were that low interest rates affect the risk of loan portfolio in two folds though in a contradictory manner. First, in the short run, low interest rates reduce the probability of default of the outstanding loans. In the medium term, however, due to higher collateral values and the search for yield, banks tend to grant riskier loans and, in general, to soften their lending standards: they lend more to borrowers with a bad credit history and with more uncertain prospects.

Ioannidou, Ongena, and Peydr´o (2009) examined the effect of monetary policy rates on bank loan pricing in Bolivia. The study findings were that low policy rates lend to high number of risky loans as the riskier borrowers enjoy reduced loan rates that is not in tandem with their risk profile. Similar findings were reported by Maddaloni and Peydr´o (2011) who found that monetary policy relaxation softens banks' credit standards hence increased bank risk taking. Further Kishan and Opiela (2012) found evidence for risk-pricing channel of monetary policy working via market discipline of debt holders. Further, Buch, Eickmeier, and Prieto (2011) reports an evidence for a risk-taking channel after a monetary policy loosening for small domestic banks.

An analysis of syndicated loan market by Paligorova and Santos (2012) explored the nexus between U.S. monetary policy increased risk-taking behavior. Their analysis compared the differences in all-in-drawn spreads and loan amounts for risky and less-risky borrowers originated by the same bank and/or by the same bank to the same firm across different monetary policy environments. They found that loan prices and sizes exhibit patterns that are consistent with the risk-taking channel: the difference in the all-in-drawn spreads between the loans to risky and less-risky borrowers decreases when interest rates remain lower relative to when they are higher.

However, its notable that vast of the existing empirical literature on the risk – taking monetary policy transmission channel focus on the policy rate and other monetary policy instruments on the bank risk taking behaviour. However, majority of the works are mute on the interaction of the monetary policy instruments with the bank's balance sheet variables that are likely to influence bank risk taking bahaviour. This study therefore sought to fill in this gap be including the interactions between the monetary policy rate and the bank equity and the interaction between policy rate and bank liability (Non – interest bearing deposits). By doing so, the study sheds light on how banks revert to their balance sheets to counter the effects of monetary policy tightening as continue advancing credit as long as such credit extension is within bank's reach.

3.0 Research Methodology

3.1 Empirical model

To examine the risk-taking channel of the monetary policy among commercial banks in Kenya. The paper proposes to use the Panel Vector Autoregressive (PVAR) model. The model will seek to estimate the effects of the bank liabilities and equity on the risk-taking appetite in the context of monetary policy developments. In this model, the bank risk taking is regressed on monetary policy development, bank equity measure, bank liability measure and the control variables.

For the Monetary policy development, central bank rate will be used. For the bank equity measure the tier 1 ratio was used. The application of tier 1 ratio is informed by the fact that banks with more equity, would be less responsive to monetary policy tightening and the opposite is true. This would imply banks with more equity would reduce by less their risk appetite in cases of monetary policy tightening compared to banks with less equity. Regarding the bank liability measure, the ratio of non – interest bearing deposits to total assets was used. The analogy here is that banks with more non – interest bearing deposits would reduce by less their risk appetite in cases of monetary policy tightening compared to banks with less non – interest bearing deposits.

We note that regarding the dependent variable:- bank risk taking appetite, two measures were applied. First is the paper will apply the loan loss provision to total loans ratio. This measure indicates the ability of the lender to bear loss arising from loan defaults with a higher ratio signalling lender's strong ability to bear loan losses. The second measure to be applied will be the bank minus z – score. This will be computed as follows:

$$\text{-Zscore} = - \frac{((\text{ROA}+\text{Equity}/\text{Assets}))}{\sigma\text{ROA}} \qquad (1)$$

To achieve the study objective interaction between the CBR variable and the bank equity on one hand and non – interest bearing deposits variable was adopted. These interactions was core in examining whether banks with more equity

are less responsive to monetary policy tightening regarding their risk-taking appetite compared to compared to banks with less equity as in the stylized facts by Disyatat (2011) and Jiménez et al. (2014). Further, this paper note that the interactions will be crucial in determining whether banks with more non – interest bearing deposits are less responsive to monetary policy tightening in their risk-taking appetite compared to compared to banks with less non – interest bearing deposits.

3.2 Econometric approach:

In developing the econometric model, the study is cognizant of policy rate affects changes in liquidity levels that in turn affects bank risk taking behaviour. Loose monetary policy stance encouraged banks to increase banks' actual risk position leading to excessive liquidity.

There are two main ways in which low interest rates arising from policy loosening may influence bank risk-taking. First, low interest rates affect valuations, incomes and cash flows, which in turn can influence how banks measure risk (Adrian and Shin, 2009a; Borio and Zhu, 2008). Second, low returns on investments, such as government (risk-free) securities, may increase incentives for banks, asset managers and insurance companies to take on more risk for behavioral, contractual or institutional reasons to meet a nominal return target (Rajan, 2005). Therefore, its clear that the policy stance advanced by the Central Bank will certainly affect bank's liquidity levels and consequently bank's risk appetite.

To analyse monetary policy risk-taking transmission channel in the Kenyan context and how the transmission affects the bank's risk taking, the study utilized detailed econometric approach. To start with, a bank level analysis was undertaken. Regarding the econometric model applied, a Panel VAR model was applied. In estimating the Panel VAR model, the study was cognizant of the fact that there are bank-specific characteristics that are likely to influence bank funding ability in case of monetary policy movements from the aspects of loan supply and loan demand movements arising from the policy shifts.

The specific Panel VAR model applied with the interactions is defined as follows:

$$Bank\ Risk_{i,t} = \alpha + \beta_1\, CBR_t + \beta_2\, Tier1Ratio_{i,t} + \beta_3\, NIB\ Deposits_{i,t} + \beta_4\, Tier1Ratio_{i,t} * CBR_t + \beta_5\, NIB\ Deposits_{i,t} * CBR_t + \beta_6\, X_{i,t} + \gamma_i + \varepsilon_{i.t} \quad (2)$$

The interaction of the policy rate with TIER 1 ratio was applied by Argimon, *et al* (2018) in examining the financial institutions' business models and the global transmission of monetary policy. The interaction of policy rate with TIER 1 ratio was based on the interaction that the policy rate will affect bank risk taking behaviour. TIER 1 ratio influences banks loan supply shifts. Therefore, policy rate changes may affect the bank's supply of credit through effect in the effect on Tier 1 ratio. On the other hand, the interaction between NIB deposits and the policy rate was anchored on the understanding that under monetary tightening, banks can use their non-interest-bearing deposits and capital as a buffer and banks with less leverage or more NIB deposits should react less to a monetary policy tightening. Thus, even though the NIB deposits could directly affect

bank lending, this direct effect is likely to be different with the changes in the policy rate hence the need for the interaction.

In this regard, the study controlled the share of deposits over total liabilities (DEP). Control for the share of deposits over total liabilities was informed by the thinking that banks with a large amount of deposits will adjust their deposit rates by less (and less quickly) than banks whose liabilities are mainly composed of variable-rate bonds that are directly affected by market movements. Moreover, we note that a bank will refrain from changing deposit conditions because, if the ratio of deposits to total liabilities is high, even small changes to their price will have a huge effect on total interest rate costs. Regarding the bank efficiency measure, the rationale for its control is hinged on the thinking the more efficient banks are also considered less risky by investors and have a higher capacity to tap funds in the market. Therefore, within the model, captured all the control variables applied. Other bank-specific characteristics controlled for that are not likely to affect bank loans supply and loan demand arising from monetary poly shift but are likely to affect bank risk were bank size proxied by the logarithm of the bank's total assets (bank size). We note that these bank-specific characteristics not only give insightful information on a bank's ability to insulate loan supply from monetary policy shocks (Kashyap and Stein 2000; Kishan and Opiela 2000) but also control for "too-big-to-fail" considerations, differences in bank business models, and capital regulation effects at bank level.

In order to explain how the non – interest bearing deposits funds bank risk taking behaviour, the study anchors this relationship based on the argument by Acharya and Naqvi (2012) who asserts that deposits play crucial role on funding liquidity and this may aggravate the risk-taking behavior of bank resulting to resulting in excessive loans and asset price bubbles. Such deposits play crucial role by acting as liquidity reserve

Acharya and Naqvi (2012) try to explain that sufficient liquidity may aggravate the risk-taking behavior of bank executives, resulting in excessive loans and asset price bubbles. They regard investors' deposits as bank liquidity, because in order to protect banks from run risk, banks need to take a certain proportion of deposits as liquidity reserve. Therefore, deposits are the main determinant of bank reserve, so they can choose deposits as bank liquidity. Khan, et al. (2017) asserts that deposit asset ratio whereby the deposits are inclusive of non – interest bearing deposits is a good proxy variable of funding liquidity risk. The higher the deposit asset ratio, the higher the funding liquidity of the bank and the lower the funding liquidity risk implying that deposit asset ratio leads to more lending by the bank hence increased risk appetite.

Another crucial, linkage in this study is how change in cost of liquidity leads to changes in cost of funds. In general, high liquidity risk banks experience more liquidity shocks and thus are more likely to become constrained, and thus pay higher interest rates for short-term funding. Banks differ in their liquidity risk due to the amount of liquidity buffer they have available, their liquidity management capabilities, or

the nature of their business models. Banks with high liquidity risk are more likely to demand immediacy of execution in the interbank market implying high cost of funds for them. When faced with liquidity risk, bank can choose between submitting market orders and limit orders. A market order guarantees the immediate execution at the best price available upon the order arrival (Alexander, Angelo and Jan, 2023). Therefore, banks with high liquidity risk are likely to demand immediacy, implying that they use market orders to lock in their funding. This increases funding costs, as market orders are costlier than limit orders. The model for the study handles this via incorporation of non-interest-bearing deposits which are viewed as a tool for trading off liquidity risk thus avoiding costlier funds in the market.

The study covered 2008 – 2022 period using annual data. Further, the study only covered the domestic market channel of monetary policy transmission. In this case the foreign market channel of monetary policy transmission whereby the policy affects credit market through effects in the foreign exchange will not be covered in this paper.

3.3 Measurement of study variables

Within the study, the variables to the model were defined and measured as follows:

Table 1: Definition and measurement of variables

Variable	Measurement
Bank Risk	Bank risk was computed using two measures as follows: • Loan loss provision computed as follows: $LLP = \frac{Loan\ loss\ provision}{Total\ loans}$ • 1/z – score where, z – score was computed using the following formula $LLP = \frac{(ROA + Equity/Assets)}{\sigma ROA}$
Tier 1 Ratio	Tier 1 ratio was computed from the bank balance sheet using the following formula. $Tier\ 1\ ratio = \frac{Core\ Capital}{Total\ risk\ weighted\ assets}$
NIB Deposits	Non-interest-bearing deposits were measured by demand deposits. In this case the natural logarithm of non-interest-bearing deposits was applied $NIBD = Ln(NIBD)$
CBR	CBR in the study was measured using the 12 months average CBR for every year
Deposits over total liabilities (DEP)	Deposits over total liabilities was computed from the bank balance sheet using the following formula. $DEP = \frac{Total\ Deposits}{Total\ Liabilities}$
Bank size	Bank size was computed from the bank balance sheet using the following formula. $Bank\ Size = Ln(Bank\ Size)$

3.4 Study Data:

The study utilised bank level data for banks operating in Kenya in the period between 2008 – 2022. For the bank level analysis, annual bank data for 2008 – 2022. The banks level data was obtained from the audited financial statements over years from Kenya Bankers Association database. However, monetary policy data (Central Bank Rate) was obtained from the Central Bank of Kenya.

4.0 Results Interpretation and Discussion

4.1 Descriptive statistics results

The data was analysed using Stata. The results indicate that the mean bank risk was estimated at 13.2026 with a standard deviation of 7.9152. since z-score measure is to relate a bank's capital level to variability in its returns so that one can identify how much variability in returns can be absorbed by capital without the bank becoming insolvent, A higher value of the z-score means lower bank risk. The results therefore indicate a reasonably lower bank risk for the period under the review. However, a look at the minimum and maximum zscore values indicate significant differences in the bank risk across the banks under analysis across the analysis period, a result supported by the standard deviation which indicates a reasonably high variation. Similar, results in terms of bank level differences were evidenced for risk two measured by loan loss provision to total loans ratio which averaged at 0.0813.

Regarding the bank equity measure, the Tier 1 ratio indicates a mean value of 0.2116 with a maximum of 0.7051 and a minimum value of -0.0127 thus an indication of significant differences in the bank risk across the banks under analysis across the analysis period. For the monetary policy, the average policy rate was estimated at 9.15 percent.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Skewness	kurtosis
Z score	**435**	**13.2026**	**7.9152**	**-1.0913**	**40.3390**	**0.7205**	**3.4513**
Risk2	435	0.0813	0.0833	-0.0064	0.7294	2.9190	15.645
Tier1 ratio	435	0.2116	0.1050	-0.0127	0.7051	1.2879	5.6328
CBR	435	9.1533	2.1571	6.0000	15.3000	1.2772	4.9820

Variable	Obs	Mean	Std. Dev.	Min	Max	Skewness	kurtosis
Bank size	435	17.5620	1.3735	14.6436	20.6942	0.2208	2.0400
DEP	435	0.9221	0.4448	0.2309	9.7993	1.8342	3.6636
NIB deposits	435	17.2056	1.4252	13.1216	20.3587	0.0710	2.2719
CBR * tier1 ratio	435	1.9385	1.0823	-0.0980	8.5169	1.6120	7.5251
NIBD * tier1 ratio	435	157.42	38.88	88.45	294.14	1.1296	4.6833

4.2 Correlation matrix

The correlation coefficient matrix indicates that bank risk both measured by the zscore and loan loss provision to total loans ratio is weakly correlated to monetary policy rate, tier1 ratio, non – intertest bearing deposits, bank size, deposits – liabilities ratio and the monetary policy interactions with tier1 ratio and non – intertest bearing deposits. Further, a review of the correlation coefficient reveals a weak relationship among the variables indicate weak correlation among the variables.

Table 3: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) zscore	1.000								
(2) Risk2	-0.290	1.000							
(3) Tier1 ratio	0.297	-0.080	1.000						
(4) CBR	-0.020	-0.153	0.006	1.000					
(5) Nib deposits	0.260	-0.304	-0.305	-0.020	1.000				
(6) Cbr tier1	0.245	-0.127	0.670	0.449	-0.279	1.000			
(7) Cbr nibd	0.069	-0.246	-0.097	0.643	0.307	0.328	1.000		
(8) Bank size	0.257	-0.276	-0.325	-0.027	0.677	-0.299	0.295	1.000	
(9) DEP	0.178	-0.038	0.093	-0.040	0.082	0.061	-0.015	-0.021	1.000

4.3 Unit root test

Prior to running the regressions, unit root test was conducted to determine the order of integration among the model variables. The Levin-Lin-Chu unit - root test was applied to conduct the unit root test. The results indicate that under the Levin-Lin-Chu unit - root test based on the adjusted t – statistics, all the variables stationary at level at 5 percent significance level. This is because their respective p – values are less than 5 percent significance level.

Table 4: Unit root test

Variables	Levin-Lin-Chu unit-root test		
	Unadjusted t statistic	Adjusted t* statistic	P - value
Zscore	-21.0839	-13.2553	0
Tier 1 Ratio	-14.9239	-6.5084	0
CBR	-18.9427	-10.2071	0
DEP	-23.7665	-16.5673	0
Efficiency	-17.3109	-7.5297	0
Bank size	-15.7083	-9.031	0
CAP	-100	-98.5191	0
NIBD	-19.4279	-13.2095	0
cbr * tier1 ratio	-19.6721	-11.0421	0
cbr * NIBRD	-18.304	-9.7199	0

4.4 Regression models results

The study sought to achieve two specific objectives namely: To determine the effect of monetary policy tightening on the banks' risk – taking behavior through bank equity in Kenya and secondly to determine the effect of monetary policy tightening on the banks' risk – taking behavior through bank non – interest bearing deposits in Kenya. In so doing the PVAR models were estimated using two measures of bank risk taking behavior. In the discussion of the regression results, attention is on the first equation model for the Panel VAR in which bank risk taking behavior is the dependents variable. The rest of the simultaneously estimated models are presented in the appendices. A review of the results for model 1 (**table 5**) where the bank risk taking behavior measured by zscore indicates that previous zscore (bank risk in the period) is has a negative and significant effect on the current bank risk taking behavior. The effect was found to be significant at 5 percent significance level.

Regarding the effect of the monetary policy, the results reveal that an increase in the policy rate reduces the bank risk taking behavior with the effect being statistically significant. This evidence the existence of monetary policy risk-taking transmission channel. A review of the effect of equity on the bank risk appetite, results indicate that increase in bank equity measured by the Tier 1 ratio reduces bank risk taking appetite significantly. However, on the liability side, bank liability measure (non – interest bearing deposits) was found to increase bank risk – taking appetite significantly indicating that "pseudo assets" effectiveness in enhancing banks' lending amid policy tightening. As such during the policy tightening, banks would prefer NIBD as they are cheaper compared to interest bearing deposits.

However, interesting results are evident upon interacting the policy rate with the bank equity and bank liability measures. The interaction of policy rate and bank equity measure reveal an increasing effect on the bank risk appetite. The effect was found to be significant at 5% significant level. These results assert that banks can use their bank equity levels to lower the risk appetite through the monetary policy stance at hand. As such higher bank equity levels cause banks to be less responsive to monetary policy tightening. However, its notable that such less responsiveness to monetary policy tightening is dependent on the time length within which the tightening persists. Similar results of increased bank risk appetite are reported for policy rate interaction with pseudo assets. Therefore, the non – interest bearing deposits plays crucial role in enhancing bank lending during policy tightening periods thus making banks less responsiveness to policy tightening.

Table 5: PVAR model for bank risk measured by z-score

Zscore	Coef.	z - statistics
Zscore (-1)	-0.231** (0.079)	-2.950
Tier1 ratio	-1.719** (0.737)	-2.330
Nib deposits	2.261*** (0.356)	6.350
Cbr	-0.410** (0.143)	-2.870
Cbr * tier1	0.282*** (0.060)	4.720
Cbr * nibd	0.019** (0.008)	2.410
Bank size	2.336*** (0.340)	6.870
DEP	4.748*** (0.667)	7.120

Note: Significance level, *** p<.01, ** p<.05, * p<.1, Standard errors in parenthesis

A review of the results for model 2 (**Table 6**) where the bank risk taking behavior measured by loan loss provisions to total loans ratio indicates that previous risk is has a positive and significant effect on the current bank risk taking behavior. The effect was found to be significant at 5 percent significance level. Regarding the effect of the monetary policy, the results reveal that an increase in the policy rate reduces the bank risk taking behavior significantly. This implies that during monetary policy tightening period, banks would have lower ratios of non-performing loans and set aside less money for loans that don't repay (low loan provision to total loans). A review of the effect of equity on the bank risk appetite, similar results for the Z score model are upheld. Bank measured by the Tier 1 ratio was found to reduces bank risk taking appetite significantly. However, on the liability side, bank liability measure (non – interest bearing deposits) was found to increase bank risk – taking appetite significantly indicating that "pseudo assets" effectiveness in enhancing banks' lending amid policy tightening. As such during the policy tightening, banks would prefer NIBD as they are cheaper compared to interest bearing deposits.

However, interesting results are evident upon interacting the policy rate with the bank equity and bank liability measures. The interaction of policy rate and bank equity measure (CBR * tier1 ratio) reveal an increasing effect on the bank risk appetite. The effect was found to be significant at 5% significant level. These results assert that banks can use their bank equity levels to lower the risk appetite through the monetary policy stance at hand. As such higher bank equity levels cause banks to be less responsive to monetary policy tightening. However, its notable that such less responsiveness to monetary policy tightening is dependent on the time length within which the tightening persists. Similar results of increased bank risk appetite are reported for policy rate interaction with pseudo assets. Therefore, the non – interest bearing deposits plays crucial role in enhancing bank lending during policy tightening periods thus making banks less responsiveness to policy tightening.

Table 6: PVAR model for bank risk measured by Loan loss provision to total loans ratio

	Coef.	z - statistics
LLP (-1)	0.685*** (0.053)	12.970
Tier1 ratio	-0.336*** (0.062)	-5.440
Nib deposits	0.042** (0.014)	3.000
Cbr	-0.011** (0.006)	-1.870
Cbr * tier1	0.020*** (0.004)	4.570
Cbr * nibd	0.001 (0.009)	1.000
Bank size	0.048*** (0.013)	3.700
DEP	0.021* (0.012)	1.770

Note: Significance level, *** p<.01, ** p<.05, * p<.1, Standard errors in parenthesis

The study findings on the monetary policy transmission on the risk-taking behavior of banks agree with the majority of the literature discussing the risk-taking channel of monetary policy, such as Ioannidou et al. (2014). Also, the results are in line with most recent studies regarding the evidence of bank risk-taking channel, as the study of Segev (2020) who demonstrates the existence of such a channel for the Unites States by using loan-level data, or the study of Neuenkirch and Nöckel (2018) who provide evidence on the negative relation between low interest rates and bank risk-taking for the Eurozone.

In the two models, the results reveal that bank size is positively associated with bank Z-score and loan loss provisions. This result is in line with Agoraki et al. (2011) and Delis and Kouretas (2011) and it means that bigger banks exhibit lower levels of bank risk-taking, since they can benefit from better risk management schemes. Similar findings are reported by Altunbas et al. (2012), who found that well-capitalized banks are also considered less risky by the market. This result is expected because the market may integrate favorable information when a bank is well-capitalized since a higher level of capitalization may serve as a stronger buffer and enhance the risk profile.

4.5 Stability condition test

A model stability test was conducted for the tow PVAR models estimated. The results are presented in table and **figure 4.1**. The results indicate that the model fulfilled models are stable since the all the eigenvalues lie inside the unit circle hence the PVAR models satisfies stability condition.

Table 4.6: PVAR model stability test

Model 1 – Zscore Model			Model 2		
Real Eigenval-ues	Imaginary Eigenvalues	Modulus	Real Eigenvalues	Imaginary Eigenvalues	Modulus
0.987259	0	0.987259	1.010018	0	1.010018
0.827377	0	0.827377	0.67419	0.074645	0.67831
0.503987	0.532209	0.732973	0.67419	-0.07464	0.67831
0.503987	-0.53221	0.732973	0.004091	-0.52776	0.527775
0.432039	-0.1599	0.46068	0.004091	0.527759	0.527775
0.432039	0.1599	0.46068	0.449473	0	0.449473

Figure 2: Model 1 stability test (Roots of the companion matrix)

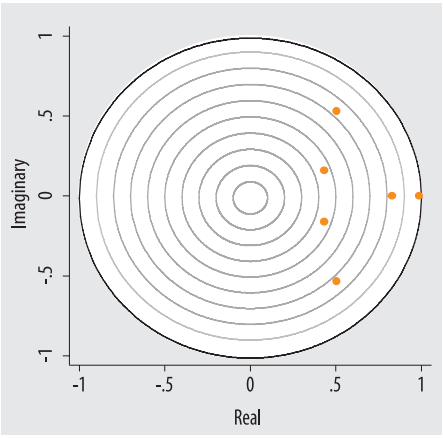
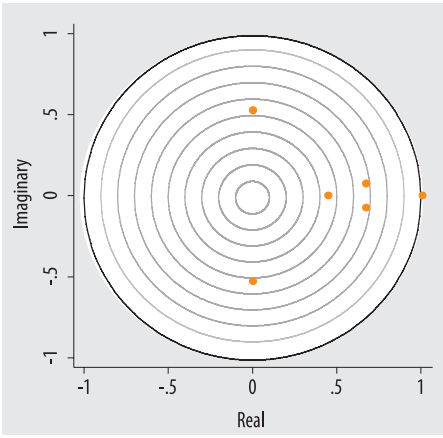


Figure 3: Model 1 stability test (Roots of the companion matrix)



4.6 Impulse response function analysis

Upon PVAR estimation using a Cholesky decomposition, the Impulse Response Function were obtained. The IRF for bank risk measured by zscore indicates that a one standard shock in CBR leads to a sharp rise in risk taking upto period 2 -3 years to a peak of 1.4 units upon which it continually decays to 0 in 6th to 7th period after which it starts to rise gradually. The IRF for bank risk and interaction between CBR and Tier 1 ratio indicates that one standard shock in (CBR *Tier 1) leads to a sharp decline in the bank risk upto -0.8 in period 4 before gradually rising to 0 in period 7. For interaction between CBR and NIBD, one standard shock in (CBR *NIBD) leads to a sharp decline in the bank risk up to -0.8 units in period 4 before gradually rising and stabilizing to 0 in period 7. Further, one standard shock in NIBD leads to a sharp rise in bank risk to l0.2 in period 3 and afterwards decaying and stabilizing at -0.2 units. Fir Tier 1 ratio, one standard shock in Tier1 leads to a rise in bank risk to 0.9 units in period 2 and afterwards decaying to a low of -0.5 units in period 5 later on stabilizing at 0 units in period 8.

Figure 4: Impulse – Response Functions Graphs

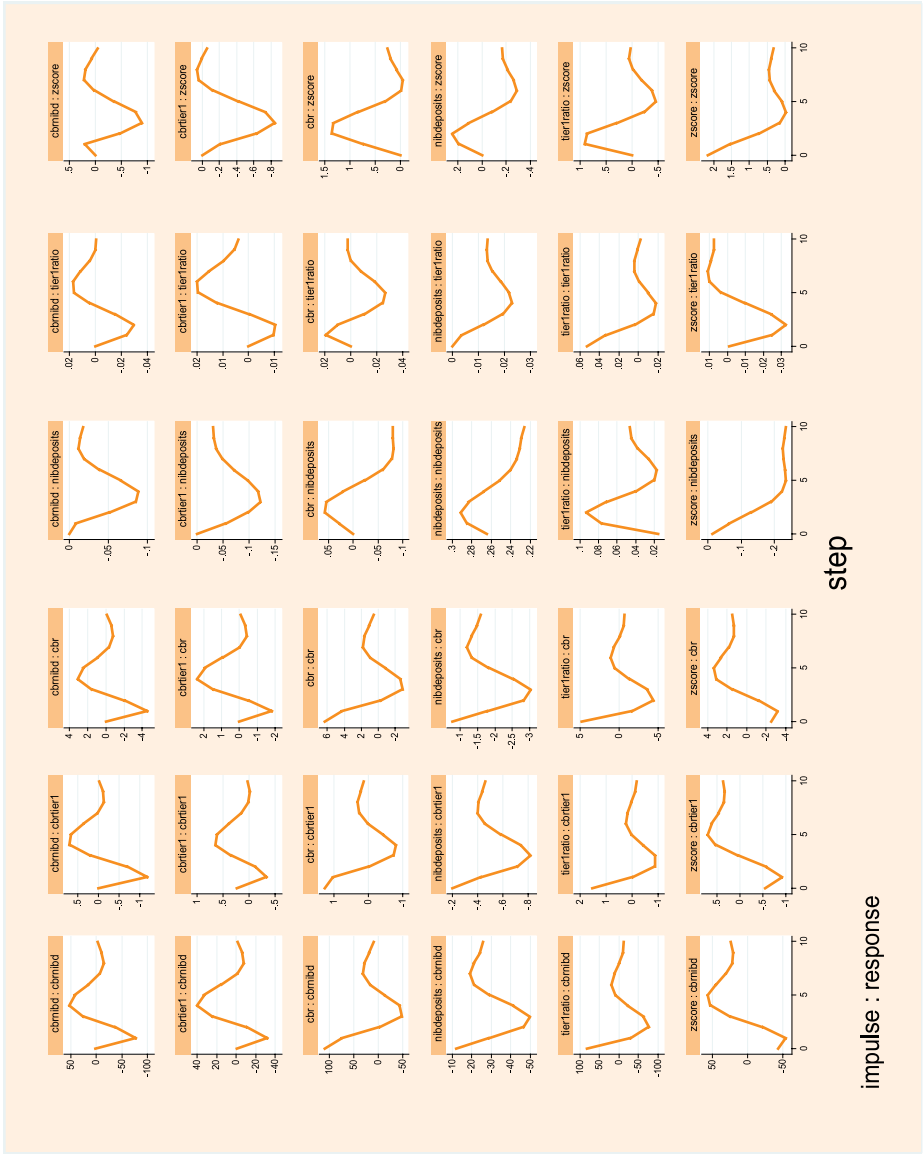
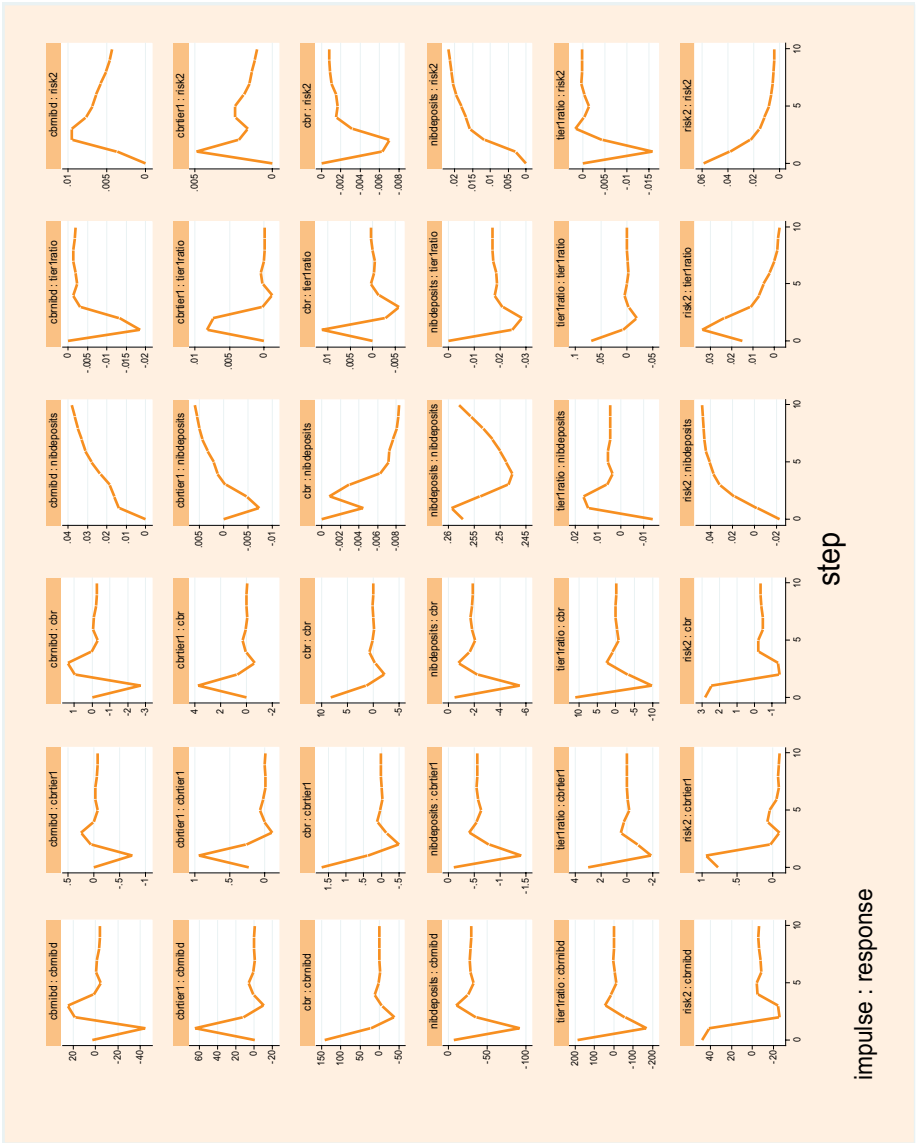


Figure 5: Impulse – Response Functions Graphs - Loan Loss Provisions (LLP)



5.0 Conclusion and Policy Implications

5.1 Conclusion

The study sought to examine the Monetary policy risk-taking transmission channel in the Kenya's banking industry. Specifically, the study examined the effect of monetary policy tightening on the banks' risk – taking bahaviour through bank equity in Kenya and the effect of monetary policy tightening on the banks' risk – taking bahaviour through bank non – interest bearing deposits in Kenya. This was informed by the fact that whenever the policy rate in changed the effect of such a change on the bank's risk taking bahaviour will be informed by bank's assets and liability side.

A Panel VAR was applied in estimating how the policy rate change affects bank's risk taking bahaviour. Two measures of bank's risk taking bahaviour were applied namely: bank zscore and Loan Loss Provisions. The model results confirm the existence of risk-taking monetary policy transmission channel in the Kenyan banking industry. Estimation results for both zscore and LLP model yields similar results: An increase in the policy rate reduces the bank risk taking behavior with the effect being statistically significant. This evidence the existence of monetary policy risk-taking transmission channel. A review of the effect of equity on the bank risk appetite, results indicate that increase in bank equity measured by the Tier 1 ratio reduces bank risk taking appetite significantly. However, on the liability side, bank liability measure (non – interest bearing deposits) was found to increase bank risk – taking appetite significantly indicating that "pseudo assets" effectiveness in enhancing banks' lending amid policy tightening. As such during the policy tightening, banks would prefer NIBD as they are cheaper compared to interest bearing deposits.

Interacting the policy rate with the bank equity and bank liability measures reveals that an interaction of policy rate and bank equity increases bank risk appetite significantly. These results assert that banks can use their bank equity

levels to lower the risk appetite through the monetary policy stance at hand. As such higher bank equity levels cause banks to be less responsive to monetary policy tightening. However, its notable that such less responsiveness to monetary policy tightening is dependent on the time length within which the tightening persists. Similar results of increased bank risk appetite are reported for policy rate interaction with pseudo assets. Therefore, the non – interest bearing deposits plays crucial role in enhancing bank lending during policy tightening periods thus making banks less responsiveness to policy tightening.

5.2 Policy Implications.

Based on the findings, a number of policy pronouncements are proposed. First is the implication the monetary policy stance it has on the bank's risk appetite via the bank equity (Tier 1 ratio). The study found that the interaction between CBR and Tier 1 ratio was found to be significant in explaining the risk-taking monetary policy transmission channel. Therefore, the study results reveal that bank can leverage on its equity levels to overcome the lending restriction that might be paused by monetary policy tightening. Therefore, banks should ascribe to relook on their capital structure to be more equity funded as opposed to be debt funded.

Secondly is the policy implication on the effectiveness of the monetary policy. The study found that pseudo assets measured by the NIBD increase bank risk appetite during the period of policy tightening. This finding points into the need for bank's proactiveness in mobilizing non – interest bearing deposits to build up on their loanable funds during the periods of policy tightening.

Third is on the effectiveness of the monetary policy in reducing the banks appetite. The policy rate tightening was found to reduce bank risk appetite but the interaction of policy rate with bank's balance sheet assets and liability items posit reduced responsiveness to policy. This implies that a change in the policy rate is immediately transmitted to money-market instruments of different maturity and to other short-term rates, such as interbank deposits and this quickly affects the interest rates that banks charge their customers for variable-rate loans, including overdrafts. In addition are the bank innovations whereby not all policy changes warrant banks hiking the lending rates especially for existing loans for the fear that a performing loan may turn into non – performing. In this case banks would rather lengthen the loan tenure as opposed to hiking the loan rate.

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