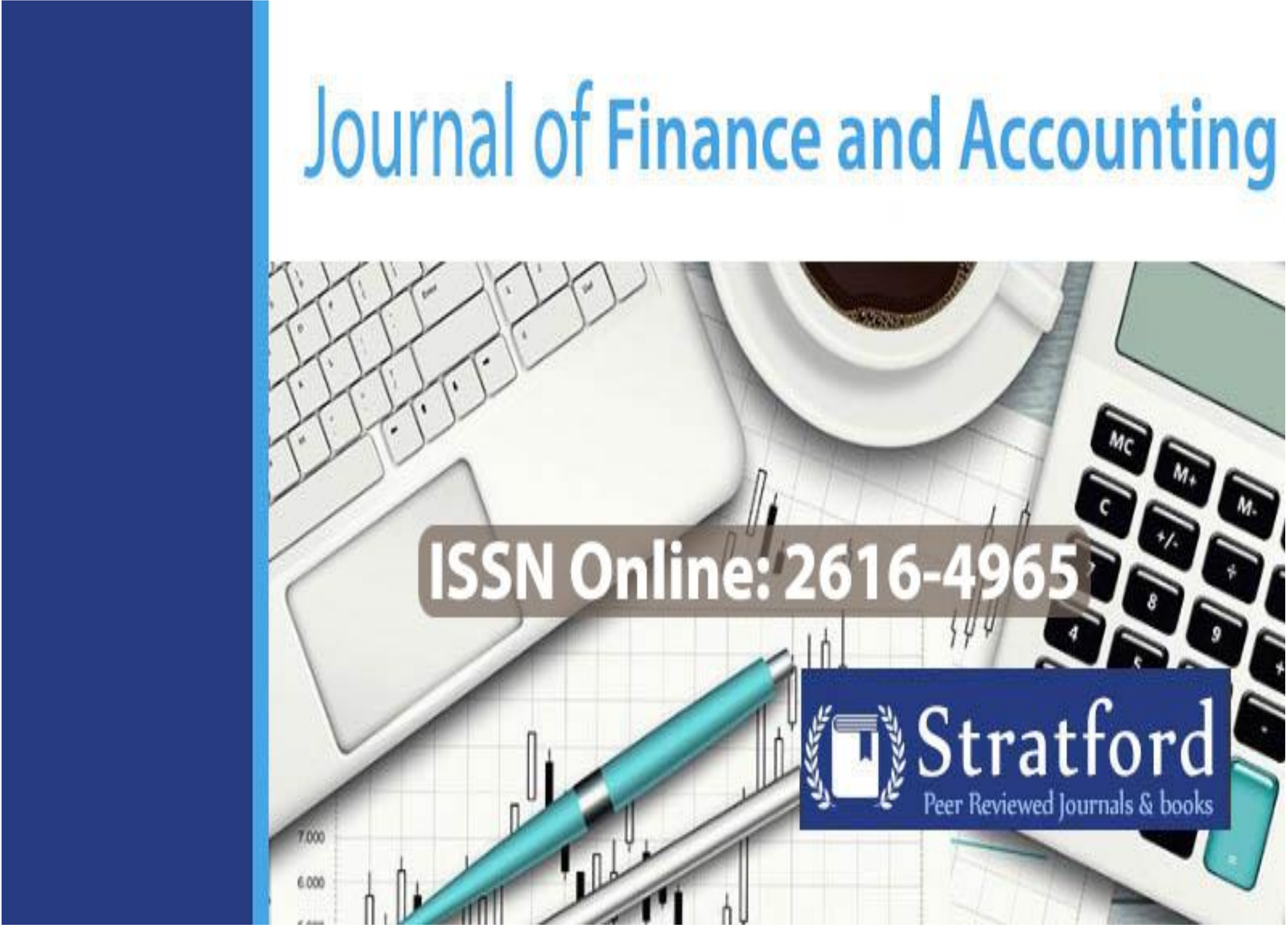


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# The Role of Maturity Gaps and Short-Term Market Interest Rates on Interest Rate Risk Exposure in Commercial Banks in Kenya

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## Abstract

Commercial banks engage in maturity transformation and the term premium compensates them for bearing the associated duration risk. They are thus exposed to interest rate risk which is the bank's financial condition to adverse movements in interest rates and represents one of the key forms of risk that banks face as financial intermediaries. The study investigated the role of maturity gaps and short-term market interest rates on interest rate risk exposure in commercial banks in Kenya. This study adopted a panel data research design in methodology to analyze the critical interest rate risk drivers across the banking sector in Kenya. The study period covered 2005-2015. The study was informed by Expectations Hypothesis theory. Correlational research design was used and captured both cross-sectional and longitudinal dimensions of the effects of the variables under investigation that is Maturity gaps ratio (MGRs) and Interest Rate Sensitivity Ratio (IRSRs). The Interest rate risk (IRR) was expressed as a function of maturity gaps, interest rate sensitivity ratio and short-term market interest rates. STATA software was used as the tool for data manipulation. The findings indicated that that a rise in Maturity Gap 2, Maturity Gap 3, Maturity Gap 4, Maturity Gap 5, Interest Rate Sensitivity Ratio 2, Interest Rate Sensitivity Ratio 3, Interest Rate Sensitivity Ratio 4, 91DayTbill and 182DayTbill led to a decrease in the interest rate risk exposure for the commercial banks. However, an increase Maturity Gap 1, Interest Rate Sensitivity Ratio 1, Interest Rate Sensitivity Ratio 5 and 364DayTbill led to an increase in the interest rate risk exposure for the commercial banks. The study recommends that banks should have interest rate risk measurement frameworks that capture all material sources of interest rate risk and that measure the effect of interest rate changes in ways that are consistent with the scope of their activities. The assumptions underlying the system should be clearly understood by risk managers and bank management. Further, banks must establish and enforce operating limits and other practices that maintain exposures within levels consistent with their internal policies. The findings

are important in formulation of policies and strategies for enhancing maturity transformation in the banking industry in the country.

**Keywords:** *Maturity Gap Ratio, Interest Rate Risk Sensitivity Ratio, Interest Rate Risk Exposure, Short-Term Market Interest Rates & Commercial Banks*.

## 1. Introduction

Interest rate risk is the exposure of a bank's financial condition to adverse movements in interest rates. It represents one of the key forms of risk that banks face as financial intermediaries. (Drechsler, Savov & Schnabl, 2018). Excessive interest rate risk can pose a significant threat to a bank's earnings and capital base. Changes in interest rates affect a bank's earnings by changing its Net Interest Income (NII) and the level of other interest sensitive income and operating expenses. Changes in interest rates also affect the underlying value of the bank's assets, liabilities and off-balance sheet instruments because the present value of future cash flows change when interest rates change (Liu, Chang & Shiu, 2019). Accordingly, an effective risk management process that maintains interest rate risk within prudent levels is essential to the safety and soundness of banks.

Maturity gap is a measurement of interest rate risk for risk-sensitive assets and liabilities. In effect, if interest rates change, interest income and interest expense change as the various assets and liabilities are repriced (De Franco, Monnier & Rulik, 2017). The maturity gap model helps to measure the potential changes in net interest income from changes in overall interest rates. Teichert (2018) observes that, the interest rate risk (IRR) of banks is a topic of current high relevance for three main reasons namely; current developments in monetary policy, in economic research and in banking regulation. On economic research, Teichert (2018) also notes three developments that make IRR of banks also a topic of high relevance; First the emergence of research on the influence of monetary policy on banks' taking of IRR, Secondly the shift to the new paradigm of banks as quintessential risk takers also of IRR, and lastly the modern understanding of banking gaining momentum which includes banks taking of IRR naturally through their maturity transformation function.

Most jurisdictions follow the interest rate risk in the banking book (IRRBB) model, which is based on the Basel Committee's guidance set out in the 2004 Principles for the management and supervision of interest rate risk. Interest rate risk on the banking book (IRRBB) is defined as the current or prospective risk to the bank's capital and earnings arising from adverse movements in the interest rates that affect the institutions banking book positions (BIS, 2016). Zagonov (2011) expresses interest rate risk as the risk that fluctuations in market interest rates, adversely impact an intermediary's financial condition. Such adverse impacts come from different, often complementary or offsetting sources, giving rise to different approaches for assessing and managing interest rate exposure. Interest rate risks primarily emanate from the asset transformation function of financial institutions, which involves intermediating between lenders and borrowers (Svoboda, Reuse, Rüder & Opala, 2018).

The Financial Stability Oversight Council (2013) defines maturity gap as the weighted-average time to maturity of financial assets less the weighted-average time to maturity of liabilities. It further defines maturity transformation as an activity in which a financial intermediary issues shorter-term liabilities to fund longer-term assets (Abor, Gyeke & Mensah, 2019).

Short-term interest rates are the rates at which short-term borrowings are effected between financial institutions or the rate at which short-term government paper is issued or traded in the market (Kim, 2019). Short-term interest rates are generally averages of daily rates, measured as a percentage. Short-term interest rates are based on three-month money market rates where available and typical standardized names are "money market rate" and "treasury bill rate" (Gurova, Lazarova & Gurov, 2019).

Interest rate risk in Kenya commercial banks has been a major component of market risk. The major factors that lead to increased interest rate risk are the volatility of interest rates and mismatches between the interest reset dates on assets and liabilities (KBA, 2018). Consequently, the concern exists at present that credit institutions have relaxed their asset-liability management practices and are less protected than ever against rising interest rates (Central Bank Report, 2018). Due to the crisis-induced liquidity constraints, many financial institutions have been forced to shorten the maturity of their liabilities and are accordingly exposed to greater refinancing risk (KBA, 2018). The evidence of increased interest rate risk, combined with heightened regulatory attention, poses a fundamental question of how well prepared the financial corporations for changes in the interest rate environment are and what the most effective means are of managing interest rate risk.

In addition, there is a paucity of data on the re-pricing intervals of banks assets and liabilities. While there has been a considerable study of the pricing of some types of deposits and loans, such information is hardly complete (Gomez, Landier, Sraer & Thesmar, 2020). The extent to which bank customers take advantage of the options embedded in some bank contracts is hard to assess because of a lack of data on such behavior. While there is considerable literature on the impact of interest rate risk management, few studies have focused on the emerging markets, with most studies conducted in the western developed economies. Moreover, due to methodological differences and time horizons, past studies have yielded somewhat conflicting empirical outcomes (Mbua, 2017). In particular, the literature on interest rate risk exposure and the role of maturity gaps and short-term market rates among commercial banks in emerging markets such as Kenya remains scant. Understanding the relationship that exist is important in fostering improved performance of the sector that play a major role in the economy growth in the country. Thus, this study investigated the relationship of maturity gaps and short-term market interest rates on interest rate risk exposure in commercial banks in Kenya. The objective of the study was to investigate the role of maturity gaps and short-term market interest rates on interest rate risk exposure in commercial banks in Kenya.

The study tested the following hypothesis;

**$H_{01}$;** There is no significant interest rate risk among listed commercial banks in Kenya

**$H_{02}$:** There is no significant relationship between maturity gap ratio (MGs) and interest rate risk exposure among listed commercial banks in Kenya

**$H_{03}$:** There is no significant relationship between interest rate sensitivity gap ratio (IRSGs) and interest rate risk exposure among listed commercial banks in Kenya

## 2 Literature review

### 2.1 Expectations Hypothesis

The expectations theory was proposed by Lucas in 1972 and attempts to predict what short-term interest rates will be in the future based on current long-term interest rates. The expectations theory argue that the shape of the yield curve is created by ignoring systematic factors and that the term structure of interest rates is solely derived by the market's current expectations. The yield curve is shaped from market expectations about future rates and from the higher premium required of investors looking to invest in bonds with longer maturities (Lucaz, 1972). Cox, Ingersoll and Ross (2005) explain that there are various versions of the expectations hypothesis. These place predominant emphasis on the expected values of future spot rates or holding period returns. In its simplest form, the expectations hypothesis postulates that bonds are priced so that the implied forward rates are equal to the expected spot rates (Guidolin & Thornton, 2018).

Based on the assumption that investors regard bonds of different maturities to be perfect substitutes, the expectations hypothesis postulates that the interest rate on a long-term bond will equal an average of the short-term interest rates that people expect to prevail over the life of the long-term bond (Menik, Patrick & Kamdem, 2019). Towards this end, what makes long-term bonds different from the short-term bonds are the inflation and interest rate risks. The expectations theory essentially assumes away inflation and interest rate risks (Mishkin, 2007).

The interest rate on the long-term bond ($i_{nt}$) is the average of the interest rates on short-term bonds expected over the life of the long-term bond. More generally, for *n*-period bonds,

$$i_{nt} = \frac{i_t + \quad i_{t+1}^e + i_{t+2}^e + \cdots + i_{t+(n-1)}^e}{\mathrm{n}}$$

Where,

$i_t$ = today's interest rate on a one –year bond;

$i_{t+1}^e$ = the expected interest rate on a one-year bond in year (time t + 1)

According to the expectations theory, long-term interest rates are all averages of expected future short-term rate. If $i_t$ changes so will $i_{nt}$ for $n$ = 2, 3, 4... Thus, interest rates of different maturities will move together explaining the fact that interest rates on bonds of different maturities tend to move together over time. In addition, an average smoothens out large volatilities implying that, if the current short-term rate changes (say, the expected short rate of just the next year), it will have a minimal impact on a long-term rate ( the 10-year rate). Thus, short-term rates are more volatile (Mishkin, 2007).

However, the expectations theory cannot explain why long-term yields usually are higher than short-term yields, in other words, why the yield curve is usually upward sloping. If the short-term rates are low now, they are expected to go up in the future resulting in an upward-sloping yield curve (Shareef & Shijin, 2016). On the other hand, if the short rates are high now, they are expected to go down in the future, and the yield curve will be downward sloping. Now, at a given point in time, short-term yields are as likely to be high as they are to be low. Therefore, they are as likely to go up as they are to go down in the future (Bulkley, Harris & Nawosah, 2011). That means that the expectations theory predicts that the yield curves are as likely to be upward sloping as they are to be downward sloping. Thus, the expectations theory cannot explain why the yield curve is usually upward sloping (Mishkin, 2007).

The theory of expectations hypothesis is relevant as it informs investors in making decisions based upon a forecast of future interest rates. Expectations theory attempts to predict what short-term interest rates will be in the future based on current long-term interest rates. The theory uses long-term rates, typically from government bonds, to forecast the rate for short-term bonds. In theory, long-term rates can be used to indicate where rates of short-term bonds will trade in the future.

### 2.2 Net Interest Margin and Net Interest Rate

Chaudron, Haan and Hoeberichts (2020) analyzed the banks' net interest margins and interest rate risk. This study investigated the effects of a flattening of the yield curve and decreasing interest rates on the net interest margin (NIM) of 41 Dutch banks during the period 2008Q1 to 2016Q2. The results showed that the residual part increased when the yield curve flattened and interest rates fell, while total NIM remained constant. The banks managed to keep net interest margins more or less constant by compensating for a loss in income from maturity transformation.

Claessens *et al.* (2018) while using a dynamic fixed-effects panel model found a negative effect of low interest rates on banks' net interest margin. In a sample of 47 countries, the authors find that a one percentage point lower interest rate reduces the net interest margin by 8 basis points. The effect of an interest rate reduction is larger at low interest rates, and another additional effect is found when interest rates are low for long. Focusing on banks in the Netherlands, earlier research by Chaudron (2018) shows that net interest margins of Dutch banks are contrary to conventional wisdom and fairly insensitive to changes in interest rates and the slope of the yield curve. Tan (2019) finds that banks with high deposit ratios, which are expected to be more affected by negative interest rates, increase their lending volumes to maintain profitability.

Bhati, Bashir, Abbas and Mirza (2018) investigated the determinants of net interest margin of commercial banks in Pakistan that covers the period of 10 years 2006 to 2015. By using secondary data apply random effect regression to a panel of 22 commercial banks of Pakistan. The study consisted of dependent variable NIM, Independent variables, control variables and macroeconomic variables. The estimation results showed that operating expenses and bank deposits have positive and significant effect on net interest margin of the commercial banks in Pakistan. The study also found that the leverage, credit risk, liquidity risk, opportunity cost, having negative and significant relationship with the net interest margin. From macroeconomic variables GDP and inflation have negative and insignificant relation with the net interest margin.

Landier, Sraer and Thesmar (2013) conducted a study on banks' exposure to interest rate risk and the transmission of monetary policy. The study asserted that while banks have, on average, positive levels of income gap, there is substantial heterogeneity in the cross-section of banks in how exposed they are to interest rate risk. In a first step, the study showed that the sensitivity of bank profits to interest rates increases significantly with their income gap, even when banks use interest rate derivatives. In a second step, the study showed that the income gap also predicts the sensitivity of bank lending to interest rates, both for commercial and industrial loans and for mortgages. Quantitatively, a 100 basis point increase in the Fed funds rate leads a bank at the 75th percentile of the income gap distribution to increase lending by about 1.6 percentage points annually relative to a bank at the 25th percentile. The study concluded that banks' exposure to interest rate risk is an important determinant of the lending channel.

Andries, Cocriş and Pleşcău (2015) examined the impact of monetary policy on bank risk-taking and the influence of the recent financial crisis on this relation. The study used a dataset of 571 commercial banks from Eurozone and analyze the relation on the period from 1999 to 2011, with

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emphasize on the period 2008 to 2011. The study used non-performing loans, loan loss provisions and Z-score as measures for bank risk-taking, while for monetary policy the proxies are short-term interest rates (computed using a Taylor rule) and long-term interest rates. The study determines the relation between the two by taking into account some specific control variables and analyze it using an entity fixed-effects model and Generalized Method of Moments, alternatively. Empirical results point to a negative relation between interest rates and bank risk-taking. In addition to this, results showed that the crisis has led to an additional negative impact on the relation between interest rates and bank risk-taking for the turmoil period 2008-2011.

Zarruk (2019) presented an alternative theoretical model of net interest margins for a banking firm that maximizes an expected utility of profits that relies on the "cost of goods sold" approach. Uncertainty is introduced to the model through the deposit supply function that contains a random element. Zarruk posits that under a reasonable assumption of decreasing absolute risk aversion, the bank's spread increases with the amount of equity capital and decreases with deposit variability. Risk-averse firms lower the risk of profit variability by increasing the deposit rate.

Angbazo (2017) developed an empirical model, using call report data for different size classes of banks for the period between 2008 and 2016, incorporating credit risk into the basic NIM model, and finds that the net interest margins of commercial banks reflect both default and interest-rate risk premia and that banks of different sizes are sensitive to different types of risk. Angbazo found that among commercial banks with assets greater than $1 billion, net interest margins of money-center banks are sensitive to credit risk but not to interest-rate risk, whereas the NIM of regional banks are sensitive to interest-rate risk but not to credit risk. In addition, Angbazo finds that off-balance-sheet items do affect net interest margins for all bank types except regional banks. Individual off-balance-sheet items such as loan commitments, letters of credit, net securities lent, net acceptances acquired, swaps, and options have varying degrees of statistical significance across bank types.

Saporoschenko (2002) examined the association between the market and interest rate risks of various types of Japanese banks and a set of on-balance sheet financial characteristics. According to his findings, the degree of interest rate exposure is significantly and positively related to the bank size, the volume of total deposits, and the ratio of deposits to total assets, although the maturity gap measure does not have a significant impact on the level of bank's IRR.

## 3. Conceptual Framework and Methodology

### 3.1 Theoretical Framework

Figure 1 presents the inter-relationship of variables in the study. The dependent variable is the Interest Rate Risk (IRR) while the independent variables are Maturity Gaps Ratio (MGs), Interest Rate Sensitivity Ratios (IRSRs) and short term market interest rates.

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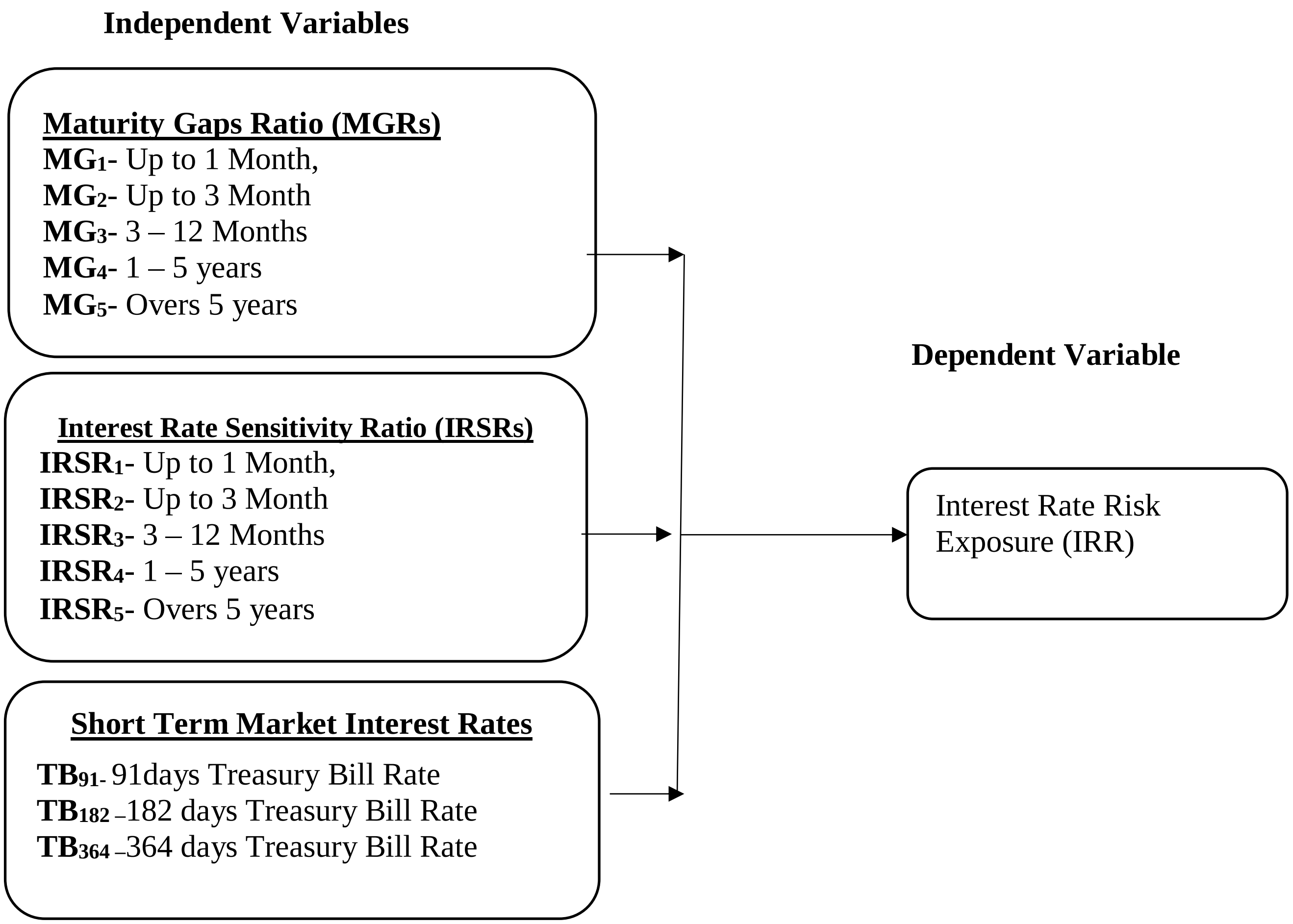


**Figure 1: Theoretical Framework**

Source: Own formulation based on Stone (1974), Jareno (2008) and Soto *et al*. (2009)

The maturity Gaps are proxied by maturity gap ratios (MGRs) ratios and the Interest Rate Sensitivity Ratios (IRSRs) for the respective repricing gap (0 to 1 month, 1-3 months, 3-12 months, 1-5yrs, and over 5yrs). The ratio presents the Risk Sensitive Assets (RSA) over the risk sensitive liabilities (RSL). The ratio differs from the Interest Rate Sensitivity Ratios IRSRs since they are weighted with the total assets for the bank and thus presenting a more representative picture in comparison to other banks.

The Interest Rate Sensitivity is proxied by the Interest Rate Sensitivity Ratios (IRSRs) for the respective gaps (0 to 1 month, 1-3 months, 3-12 months, 1-5yrs, and over 5yrs). The Interest Rate Sensitivity Ratios presents the Risk Sensitive Assets (RSA) over the risk sensitive liabilities (RSL) of the specific banks.

Short Term Market interest rates are represented by CBK Treasury Bill rates (91 days, 182 days and 364 days) and Inter-bank rates (IBRs). Short-term interest rates are generally averages of daily rates, measured as a percentage. Short-term interest rates are based on three-month money market rates where available and typical standardized names are "money market rate" and "treasury bill rate.

### 3.2 Empirical Framework

A two-stage procedure was adopted in the proposed study, similar to the approach by Soto *et al* (2009), to model the relationship between interest risk exposure, maturity gaps and short-term market interest rates in commercial banks in Kenya. In the first stage, the sensitivity of bank stock returns to changes in interest rates was estimated by OLS in the framework of the traditional two-factor model postulated by Stone (1974). The bank stock return generating process is a multiple factor model. Stone (1974) chooses a two factor (Index) model, in which the known factors are the return on an equity index and the return on a bond index. The consideration of the bond index is based upon the observation that it captures a component of systematic risk which Stone calls interest rate risk (Stone, 974).

The model can thus be expressed as follows:

$$\boldsymbol{R_{it} = \alpha_i + \beta_i R_{mt} + D_i \Delta I_t} + \mathcal{E}_{\boldsymbol{it}}$$

Where

$R_{it}$ denotes the return of bank *i*'s stock in period *t*,

$R_{mt}$ denotes the return on the market portfolio in period *t*,

$\Delta \boldsymbol{I_t}$ the change in the interbank rate in period *t*,

$\mathcal{E}_{\boldsymbol{it}}$ the error term for period *t*.

$\alpha_i$ Market beta (for i=0)

$D_i$ Coefficient of Interest rate term

$\beta_i$ Coefficient on the Market portfolio (Market Beta)

In the model, the coefficient on the market portfolio return $\boldsymbol{\beta_i}$ , is a measure of the market risk (market beta) which describes the sensitivity of the return on *ith* bank stock to general market fluctuations. $\boldsymbol{D_i}$ the coefficient of interest rate term which reflects the sensitivity of the return on *ith* bank stock to movements in interest rates while controlling for changes in the return on the market. Hence, it can be interpreted as a measure of *ith* bank interest rate exposure. Hirtle (1997), Czaja et al. (2006), and Reily *et al*. (2007) point out this coefficient as an estimate of the empirical duration of ith bank equity. A negative empirical duration implies that the value of the bank equity tends to decrease when the interest rate rise, while a positive duration implies the opposite.

In this study, the proxy for the market portfolio ($\boldsymbol{R_{mt}}$) was the NSE 20 share index which represents the most actively traded stocks among them bank stocks. The stock data was gathered from the NSE database. With respect to the interest rate data ($\boldsymbol{I_t}$**)**, daily data of the average three-month rate of the CBK inter-bank rate was used.

The empirical duration $\boldsymbol{D_i}$ is only a partial measure of IRR, since changes in interest rates also affect the return on the market and through that channel, bank stock returns. In order to get a total measure of banks' interest risk rate exposure and following Lynge and Zumwalt (1980), Hirtle (1997), Fraser *et al*, (2002) and Czaja *et al*, (2006), the market return variable is orthogonalized. Orthogonalization involves transforming a set of variables into a new set of uncorrelated (orthogonal) variables. The process is equivalent to replacing each successive variable by its residuals from a least squares regression on the previous variable. When this method is used on the predictors in a regression problem, the resulting variables have the same summary as do the original variables.

The second stage in the analysis involved regressing the empirical durations generated in stage one with market rates and maturity gaps (Fraser et al., 2002; Saporoschenko, 2002; Reichert and Shyu, 2003; Yong et al., 2009).

Using the panel regression model, the equation for Interest Rate Risk Exposure (Specific model) can be written as:

**Regression Equation:**

$IRR_{it}=\beta_0+ \beta_1 MG_{1\,it} + \beta_2 MG_{2\,it} + \beta_3 MG_{3\,it} + \beta_4 MG_{4\,it} + \beta_5 MG_{5\,it} + \beta_6 IRSR_{1\,it} + \beta_7 IRSR_{2\,it} + \beta_8 IRSR_{3it} + \beta_8 IRSR_{4\,it} + \beta_9 IRSR_{5\,it} + \beta_{11} TB_{91\,it} + \beta_{12} TB_{182\,it} + \beta_{13} TB_{364\,it} + \mathcal{E}_{it}$

Where

$\beta_i$ for i=0-14, are the regression coefficients, *it* = time period and $\mathcal{E}_{it}$= error term

To test whether the model includes irrelevant variables, the exclusion restriction test was relied upon, and to test the exclusion of relevant variables or use of incorrect function form, REST (Regression Equation Specification Error test) was applied.

Analyzing the data encompassed scrutinizing the data in ways that disclose identifiable pattern, trends, and relationships. Pearson correlation analysis was conducted to establish the relationship between the independent and dependent variables. Panel data analysis is used to analyze two-dimensional panel data, which has both cross-sectional and longitudinal aspects. The maturity gaps were obtained from the annual reports of each bank, indicating the average period of maturity for assets and liabilities, generally bucketed in repricing periods of 0-1month, 1-3month, 3-12months, 1-5yrs and over 5yrs.

A panel data analysis was adopted in this investigation, to review the effects of maturity gaps and short-term interest rates on interest rate exposure of commercial banks in Kenya over a 10-year period between 2005-2015. This approach captured both cross-sectional and longitudinal dimensions of the effects of the variables under investigation that is Maturity gaps ratios, IRSRs and short term market interest. The population of the study consisted of all banks listed on the Nairobi Stock Exchange in Kenya for the period 2005-2015.

Estimating the regression model when the assumptions of the linear regression are violated runs the risk of obtaining biased, inefficient, and inconsistent parameter estimates (Brooks, 2008). Consequently, the Stationarity Test (Dickey Fuller Test, Phillips-Perron tests), Hausman Test, Heteroscedasticity and Multicollineraity test were conducted to ensure proper regression model.

## 4. Findings and Discussions

### 4.1 Descriptive Statistics

The market stock returns for the 10 banks listed in the NSE for the period 2005 to 2015 are presented in Annexe 1. The results indicated that KCB Bank stock returns had a mean of 27.20, variance of 214.20, with minimum of 5.67 and maximum of 65.00. The Skewness value was 0.794***, Kurtosis at -0.281*** and the Jarque Bera (JB) value was 589 which indicated a goodness-of-fit in the data. The stock returns for Equity Bank had a mean of 23.87, variance of 145.06, a minimum of 3.17 and maximum of 59.00. The Skewness value was 0.769***, Kurtosis at -0.212*** and the Jarque Bera value was 659. Co-operative Bank stock returns had a mean of

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9.57, variance of 14.06, a minimum of 3.57 and maximum of 18.96. The Skewness value was 0.592***, Kurtosis at -0.423*** and the Jarque Bera value was 539. The stock returns for Barclays Bank Kenya had a mean of 14.36, variance of 10.77, a minimum of 7.43 and maximum of 23.25. The Skewness value was 0.333***, Kurtosis at -0.85*** and the Jarque Bera value was 328. The Standard Chartered bank of Kenya (Stanchart) stock returns had a mean of 187.53, variance of 3701.69, a minimum of 99.91 and maximum of 319.50. The Skewness value was 0.508*** Kurtosis at -0.998*** and the Jarque Bera value was 450.

The stock returns for Diamond Trust Bank had a mean of 79.51, variance of 3451.75, a minimum of 15.23 and maximum of 250.00. The Skewness value was 1.248***, Kurtosis at 0.748*** and the Jarque Bera value was 555. The Stanbic Bank Kenya stock returns had a mean of 70.72, variance of 959.55, a minimum of 25.00 and maximum of 300.08. The Skewness value was 0.982*** Kurtosis at 1.375*** and the Jarque Bera value was 285. The stock returns for NIC bank had a mean of 27.52, variance of 219.63, a minimum of 7.42 and maximum of 72.25. The Skewness value was 0.706***, Kurtosis at -0.369*** and the Jarque Bera value was 692. The stock returns for National Bank Kenya had a mean of 22.44, variance of 54.56, a minimum of 8.56 and maximum of 44.27. The Skewness value was 0.312***, Kurtosis at -0.706*** and the Jarque Bera value was 335. Lastly, the stock returns for Housing Finance Kenya had a mean of 19.37, variance of 78.78, a minimum of 6.40 and maximum of 51.31. The Skewness value was 0.618***, Kurtosis at -0.617*** and the Jarque Bera value was 314. This statistic was distributed as a chi-squared with two degrees of freedom and the significance at the 1%, implied that the data is normally distributed.

The study conducted the descriptive statistics for stock returns and Interbank Rate. The period had an observation of 2, 772 daily entries and the results are shown in Annexe 2.

The sensitivity of bank stock returns to changes in interest rates was estimated by OLS in the framework of the traditional two-factor model postulated by Stone (1974). The coefficient on the market portfolio return Beta (**β**) is a measure of the market risk (market beta) which describes the sensitivity of the return on bank stock to general market fluctuations. D the coefficient of interest rate term which reflects the sensitivity of the return on bank stock to movements in interest rates while controlling for changes in the return on the market. The results are as shown in Annexe 3.

The results indicated that the mean sensitivity of the return was 1.448969 with a median 1.450000 and a Std. deviation of 3.804491. The minimum value for the sensitivity of the return -35.2450 and maximum of 29. The mean value for the market risk (market beta) was 0.547805 with a median 0.550 and a Std. deviation of 0.2629338. The minimum value for the sensitivity of the return -.3100 and maximum of 1.3450. The mean $R^2$ was 0.213977 with a minimum of 0.0010 and a maximum of 0.78.

### 4.2 Regression Analysis for Sensitivity of Bank Stock Returns

The sensitivity of bank stock returns to changes in interest rates was estimated by OLS in the framework of the traditional two-factor model postulated by Stone (1974). The return generating process is a multiple factor model. The regression analysis for sensitivity of bank stock returns is as shown in Annexe 4.

The coefficient of determination Rsquare for the first period was 0.1921. The model indicates that market portfolio and change in ΔInterbank rates explains 19.21% of the variation in bank stock returns. The findings further confirm that the regression model indicated that ΔInterbank rates had a positive relationship with bank stock returns with a coefficient of (β= -0.6178931, p=0.006) supported by Wald chi2(2)=6591.19. The coefficient of interbank rate (-0.6178931) was used to compute the interest rate risk for the first period since the coefficient was a partial measure of interest rate risk (IRR).

The model was laid out as:

$$\boldsymbol{R_{it} = 48.20814 + 18.74612R_{mt} - 0.6178931\Delta I_t}$$

### 4.3 Regression Analysis

The second stage in the analysis involves regressing the empirical durations generated in stage one with maturity gaps and market rates. This analysis was aimed to provide insight both into the contribution of these variables taken out from basic financial statements as indicators of IRR to banks' overall interest rate exposure. Annexe 5 presents the regression model.

The coefficient of determination R Square was 52%. The model indicates that maturity gaps ratio (MGRs), Interest Rate Sensitivity Ratios (IRSRs) and short term market interest rates explains 52% of the variation in IRR. The $R^2$ value of the model estimated is 52 %, indicating that the variables considered are able to explain a non-trivial portion of the interest rate exposure of commercial banks for the period of study. The overall model was significant at 0.000<0.05. The results further indicated that during the first period, the maturity gaps MG2 (β= -0.019, p= 0.030), MG3 (β= -0.013, p= 0.001), MG4 (β= -0.034, p= 0.000), MG5 (β= -0.006, p= 0.000), were negatively and significantly related to IRR. However, MGI (β= 0.020, p= 0.039) had a positive relationship with interest rate risk.

The results further indicated that during the first period, the Interest Rate Sensitivity Ratios IRSR2 (β= -0.004, p= 0.011), IRSR3 (β= -0.007, p= 0.011) and IRSR4 (β= -0.006, p= 0.001) were negatively and significantly related to IRR. However, IRSR1 (β= 0.003, p= 0.0052) and IRSR5 (β= 0.004, p= 0.006) had a positive relationship with interest rate risk.

The short term market interest rates 91DayTbill (β= -0.123, p= 0.000), 182DayT-bill (β= -0.131, p= 0.000) were negatively and significantly related with interest rate risk while and 364DayT-bill (β= 0.020, p= 0.000) was positively and significantly related with interest rate risk. This implied that a rise in MG2, MG3, MG4, MG5, IRSR2, IRSR3, IRSR4, 91DayTbill and 182DayTbill led to a decrease in the interest rate risk exposure for the commercial banks. However, an increase MG1, IRSR1, IRSR5 and 364DayTbill led to an increase in the interest rate risk exposure for the commercial banks.

The regression equation was modeled as;

$$\mathbf{IRR = 0.274 + 0.020MG_1 - 0.019MG_2 - 0.013MG_3 - 0.034MG_4 - 0.006MG_5 + 0.003IRSR_1 - 0.004IRSR_2 - 0.007IRSR_3 - 0.006IRSR_4 + 0.004IRSR_5 - 0.123TB_{91} - 0.131TB_{182} + 0.020TB_{364}}$$

This implied that a rise in MG2, MG3, MG4, MG5, IRSR2, IRSR3, IRSR4, IRSR5 led to a decrease in the interest rate risk for the commercial banks by the coefficient values. However, an increase MG1 and IRSR1 led to an increase in the interest rate risk exposure for the commercial banks by the coefficient values.

This is consistent with Claessens *et al.* (2018) who applied a dynamic fixed-effects panel model found a negative effect of low interest rates on banks' net interest margin results indicated the

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effect of an interest rate reduction is larger at low interest rates, and another additional effect is found when interest rates are low for long. This is also consistent with Fraser et al. (2002) who found that individual bank IRR is significantly affected by several bank-specific characteristics. In particular, interest rate exposure was negatively related to the equity capital ratio, the ratio of demand deposits to total deposits, and the proportion of loans granted by banks. In contrast, IRR is greater for banks that generate most of their revenues from noninterest income, probably because a substantial portion of the noninterest income reflects securities related activities such as underwriting, advising and acquisitions.

Yong et al. (2007) on the relationship between interest rate and exchange rate risks and the derivative activities of Asia-Pacific banks, controlling for the influence of a large set of on-balance sheet banking activities found that the level of derivative activities is positively associated with longterm interest rate exposure but negatively associated with short-term interest rate exposure. Nevertheless, the derivative activity of banks has no significant influence on their exchange rate exposure.

Saporoschenko (2002) on the association between the market and interest rate risks of various types of Japanese banks and a set of on-balance sheet financial characteristics found that the degree of interest rate exposure is significantly and positively related to the bank size, the volume of total deposits, and the ratio of deposits to total assets, although the maturity gap measure does not have a significant impact on the level of bank's IRR. According to Gambacorta and Mistrulli (2004), the impact of maturity transformation within the bank lending channel found that banks with higher exposure to IRR decrease lending more drastically. The authors are the first to use a very detailed measure of the maturity gap, apart from the one-year repricing gap.

### 4.4 Hypothesis Testing

The first hypothesis to be tested was that:

> **$H_{01}$; There is no significant relationship between maturity gap ratio and interest rate risk exposure among listed commercial banks in Kenya**

The hypothesis was tested by using multiple linear regression and determined using p-value. The acceptance/rejection criteria was that, if the p value is less than 0.05, we reject the $H_0$ but if it is more than 0.05, the $H_o$ is not rejected. The results indicated that all the maturity gaps MGRI (β= 0.020, p= 0.039), MGR2 (β= -0.019, p= 0.030), MGR3 (β= -0.013, p= 0.001), MGR4 (β= -0.034, p= 0.000), MGR5 (β= -0.006, p= 0.000), were significantly related to IRR. We therefore reject the null hypothesis at 5% significance level that there is no significant relationship between maturity gap ratio and interest rate risk exposure among listed commercial banks in Kenya.

The second hypothesis to be tested was that:

> **$H_{02}$: There is no significant relationship between interest rate risk sensitivity ratio and interest rate risk exposure among listed commercial banks in Kenya**

The hypothesis was tested by using multiple linear regression and determined using p-value. The acceptance/rejection criteria was that, if the p value is less than 0.05, we reject the $H_0$ but if it is more than 0.05, the $H_o$ is not rejected. The results indicated that all the Interest Rate Sensitivity Ratios IRSR1 (β= 0.003, p= 0.0052), IRSR2 (β= -0.004, p= 0.011), IRSR3 (β= -0.007, p= 0.011), IRSR4 (β= -0.006, p= 0.001) and IRSR5 (β= 0.004, p= 0.006) were significantly related to IRR.

We therefore reject the null hypothesis at 5% significance level that there is no significant relationship between maturity gaps and IRR exposure among listed commercial banks in Kenya.

The third hypothesis to be tested was that:

**$H_{o3}$: There is no significant relationship between short-term market interest rates and interest rate risk exposure among listed commercial banks in Kenya**

The hypothesis was tested by using multiple linear regression and determined using p-value. The acceptance/rejection criteria was that, if the p value is less than 0.05, we reject the $H_0$ but if it is more than 0.05, the $H_o$ is not rejected. The results indicated that the short term market interest rates 91DayTbill (β= -0.123, p= 0.000), 182DayT-bill (β= -0.131, p= 0.000) and 364DayT-bill (β= 0.020, p= 0.000) were significantly related with interest rate risk. We therefore reject the null hypothesis at 5% significance level that there is no significant relationship between short term market rates and IRR exposure among listed commercial banks in Kenya.

## 5. Conclusion

The study investigated the role of maturity gaps and short-term market interest rates on interest rate risk exposure in commercial banks in Kenya. A two-stage procedure was adopted in the proposed study. In the first stage, the sensitivity of bank stock returns to changes in interest rates was estimated by OLS in the framework of the traditional two-factor model. The second stage in the analysis involves regressing the empirical durations generated in stage one with maturity gaps and market rates. This analysis was aimed to provide insight both into the contribution of these variables taken out from basic financial statements as indicators of IRR to banks' overall interest rate exposure.

We show that a rise in MG2, MG3, MG4, MG5, IRSR2, IRSR3, IRSR4, 91DayTbill and 182DayTbill led to a decrease in the interest rate risk exposure for the commercial banks. However, an increase MG1, IRSR1, IRSR5 and 364DayTbill led to an increase in the interest rate risk exposure for the commercial banks. The interest rate risk as the risk that fluctuations in market interest rates, adversely impact an intermediary's financial condition. Such adverse impacts come from different, often complementary or offsetting sources, giving rise to different approaches for assessing and managing interest rate exposure. Interest rate risks primarily emanate from the asset transformation function of financial institutions which involves intermediating between lenders and borrowers.

## 6. Recommendations

The study recommends that it is essential that banks have interest rate risk measurement systems that capture all material sources of interest rate risk and that assess the effect of interest rate changes in ways that are consistent with the scope of their activities. The assumptions underlying the system should be clearly understood by risk managers and bank management.

Further, banks must establish and enforce operating limits and other practices that maintain exposures within levels consistent with their internal policies. Banks should measure their vulnerability to loss under stressful market conditions including the breakdown of key assumptions and consider those results when establishing and reviewing their policies and limits for interest rate risk.

Banks must have adequate information systems for measuring, monitoring, controlling and reporting interest rate exposures. Reports must be provided on a timely basis to the bank's board of directors, senior management and, where appropriate, individual business line managers. An accurate, informative, and timely management information system is essential for managing interest rate risk exposure, both to inform management and to support compliance with board policy. Reporting of risk measures should be regular and should clearly compare current exposure to policy limits. In addition, past forecasts or risk estimates should be compared with actual results to identify any modelling shortcomings

Supervisory authorities should obtain from banks sufficient and timely information with which to evaluate their level of interest rate risk. This information should take appropriate account of the range of maturities and currencies in each bank's portfolio, including off-balance-sheet items, as well as other relevant factors, such as the distinction between trading and non-trading activities.

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**Annexe 1: Banks Market Stock Returns**

| Bank | Obs. | Mean | Variance | Minimum | Maximum | Skewness | Kurtosis | JB |
|---|---|---|---|---|---|---|---|---|
| KCB Bank | 2772 | 27.20 | 214.20 | 5.67 | 65.00 | 0.794*** | -0.281*** | 589 |
| Equity Bank | 2772 | 23.87 | 145.06 | 3.17 | 59.00 | 0.769*** | -0.212*** | 659 |
| Co-operative Bank | 2772 | 9.57 | 14.06 | 3.57 | 18.96 | 0.592*** | -0.423*** | 539 |
| Barclays Bank Kenya | 2772 | 14.36 | 10.77 | 7.43 | 23.25 | 0.333*** | -0.85*** | 328 |
| Stanchart | 2772 | 187.53 | 3701.69 | 99.91 | 319.50 | 0.508*** | -0.998*** | 450 |
| Diamond Trust Bank | 2772 | 79.51 | 3451.75 | 15.23 | 250.00 | 1.248*** | 0.748*** | 555 |
| Stanbic Bank Kenya | 2772 | 70.72 | 959.55 | 25.00 | 300.08 | 0.982*** | 1.375*** | 285 |
| NIC Bank | 2772 | 27.52 | 219.63 | 7.42 | 72.25 | 0.706*** | -0.369*** | 692 |
| National Bank Kenya | 2772 | 22.44 | 54.56 | 8.56 | 44.27 | 0.312*** | -0.706*** | 335 |
| Housing Finance Kenya | 2772 | 19.37 | 78.78 | 6.40 | 51.31 | 0.618*** | -0.617*** | 314 |

JB is the Jarque-Bera test on normality of stock returns. This statistic is distributed as a chi-squared with two degrees of freedom. ***, **, and * represent significance at the 1%, 5% and 10% respectively implying that the data is normally distributed.

**Annexe 2: Descriptive Statistics for Stock Returns and Interbank Rate**

| | Stock Returns and Interbank Rate | |
|---|---|---|
| **Obs** | 2772 | 2772 |
| **Mean** | 4272.99 | 7.4531 |
| **Median** | 4278.43 | 7.37 |
| **Std. Dev** | 780.265 | 4.47236 |
| **Minimum** | 2360.010 | 1.000 |
| **Maximum** | 6161.46 | 31.36 |

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**Annexe 3: Estimated Sensitivity of Bank Stock Returns to Market and Interest Rate Movements**

| Variables | Sensitivity (D) | Beta(β) | $R^2$ |
|---|---|---|---|
| N | 27720 | 27720 | 27720 |
| Mean | 1.448969 | 0.547805 | 0.213977 |
| Median | 1.45000 | 0.55000 | 0.21000 |
| Std. D | 3.80449 | 0.26293 | 0.08087 |
| Minimum | -35.245 | -0.31 | 0.001 |
| Maximum | 29 | 1.345 | 0.78 |

**Annexe 4: Regression Model for Sensitivity of Bank Stock Returns**

| | Coeff. | Std. Err. | z | P>\|z\| |
|---|---|---|---|---|
| Othorg_Δ_Interbank_Rate | -0.6178931 | 0.224702 | -2.75 | 0.006 |
| Othorg_NSE_20 | 18.74612 | 0.2330329 | 80.44 | 0.000*** |
| _cons | 48.20814 | 18.63039 | 2.59 | 0.010** |
| Wald chi2(2) | 6591.19 | | | |
| Prob > chi2 | 0.0000 | | | |
| Rsquared | 0.1921 | | | |

Note: *** Significance at 1% and ** Significance at 5%.

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**Annexe 5: Regression Model**

| Variables | Coeff. | Std. Err. | z | P>\|z\| |
|---|---|---|---|---|
| MG1 | 0.020 | 0.00450 | 4.546 | 0.039 |
| MG2 | -0.019 | 0.00500 | -3.790 | 0.030 |
| MG3 | -0.013 | 0.00370 | -3.400 | 0.001 |
| MG4 | -0.034 | 0.00870 | -3.960 | 0.000 |
| MG5 | -0.006 | 0.00180 | -3.500 | 0.000 |
| IRSR1 | 0.003 | 0.00160 | 2.000 | 0.0052 |
| IRSR2 | -0.004 | 0.00170 | -2.250 | 0.011 |
| IRSR3 | -0.007 | 0.00210 | -3.250 | 0.000 |
| IRSR4 | -0.006 | 0.00180 | -3.500 | 0.001 |
| IRSR5 | 0.004 | 0.00160 | 2.500 | 0.006 |
| 91DayTbill | -0.123 | 0.01920 | -6.428 | 0.000 |
| 182DayTbill | -0.131 | 0.02510 | -5.213 | 0.000 |
| 364DayTbill | 0.020 | 0.00520 | 3.900 | 0.000 |
| cons | 0.274 | 0.03700 | 7.394 | 0.000 |
| Wald chi2(15) | 1395.357 | | | |
| Prob > chi2 | 0.000 | | | |
| Rsquared | 0.520 | | | |

Note: *** Significance at 1% and ** Significance at 5%.