Asymmetry of the Interest Rate Pass-through in Zambia

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Abstract

This study undertook to investigate interest rate pass-through in Zambia with a focus on unravelling evidence on the asymmetric response of retail and bond yield rates to monetary policy controlled rates. The study utilise a non-linear ARDL model to investigate the relationship between policy-controlled rates and retail rates as well as bond yield rates. Based on the single-equation error correction model and the associated dynamic multipliers, the study is able to model asymmetries in both the long-run relationship and the pattern of dynamic adjustment simultaneously and in a coherent manner. In addition, the study present results from a symmetrical ARDL model. Results from the study support evidence to the existence of asymmetry in the response of retail and bond yield rates to changes in policy-controlled interest rates (interbank and 3-month rate). Specifically, there is a negative asymmetry in the response of deposit rates to changes in the interbank and 3-month rates while there is a positive asymmetry with regard to lending and bond yield rates.

Keywords: Asymmetry; Symmetry; Interest rate Pass-through; ARDL; Non-linear ARDL; Zambia

JEL Classifications: E00, E43, E51, E52

1.0 Introduction

It is now a well-known fact from a theoretical and empirical perspective that monetary policy affects real sector variables of inflation and output through various channels. Chief among these channels are the interest rate, exchange rate and the credit channels. A number of studies have attempted to study the monetary policy transmission mechanism in Zambia (Chileshe *et al.,* 2014; Zgambo and Chileshe, 2014; Mutoti, 2006; and Simatele, 2004). All these studies focus on investigating the effects of monetary policy on broad money, inflation and economic activity etc. However, the success of monetary policy crucially depends largely on the stickiness of retail interest rates (Aziakpono and Wilson, 2013). In particular, for monetary policy to be effective changes in the policy rate should be quickly transmitted to retail rates and that the magnitude of the change passed on should be large enough to affect aggregate demand and consequently economic activity and inflation (Lim, 2001). Literature has shown that; if the interest rate pass-through (IRPT) is weak, monetary policy tends to be ineffective in affecting real sector variables (Marotta, 2009; Mishra *et al.,* 2013). Therefore, in order to make monetary policy more effective it is cardinal to establish the degree of the IRPT and thereafter enhance it.

Another important aspect for policy makers and financial sector regulators is to understand the nature of the interest rate pass-through, because it is a direct way of assessing the level of competition and financial soundness of the banking sector (Aydin, 2007; Hofmann, 2006). In particular, policy makers need to check if the IRPT is complete in the short-run and long run as well as whether it is symmetric or asymmetric. De Bondt (2005) notes that prices set by banks influence their margins, therefore, profitability, and the soundness of the financial system and financial stability.

Over the years, a lot of empirical studies have been done across the world exploring the degree of stickiness of retail rates and their asymmetry (De Bondt, 2005; Malile, 2013; Aziakpono and Wilson, 2013; Sznajderska, 2012; Roelands, 2012; Greenwood Nimmo, Shin and Van Trek, 2010; and Jamilov and Egert, 2014; Kleimeir and Sander, 2006; Mishra and Montiel, 2012). In general, the results from these studies can be summarised as follows: i) there is sluggish and incomplete pass-through; ii) IRPT varies across countries and overtime and; iii) the pass-through is asymmetrical.

Although Zambia has undergone enormous structural change overtime with implications for the IRPT very little empirical analysis has been done regarding its nature (Chileshe and Zgambo, 2014; Chileshe et al., 2014; Mishra and Montiel, 2012). These studies assume that retail rates responds equally to monetary policy loosening and tightening. In addition, these studies are not comprehensive in scope as they analyse the response of one retail rate (mostly the lending rate) to monetary policy changes. Given the foregoing, the overall objective of this study is to comprehensively explore the IRPT in Zambia. Specific objectives include: i) investigate the response of various retail and yield rates to monetary policy changes; ii) investigate whether the response of retail rates to monetary policy changes is asymmetrical or symmetrical, and; iii) to provide policy implications. In this regard, this paper adds to the literature on Zambia by presenting evidence on the asymmetry of the interest rate pass-through using relatively longer horizon data. Evidence on the asymmetry of interest rate pass-through helps in better understating the transmission process and in better forecasting the response of wholesale and retail interest rates under different monetary policy regimes. In addition, asymmetry of overarching pass-through (from monetary policy rate to lending and deposit rates) might provide some explanations into the pricing behaviour of banks.

This study utilised a non-linear ARDL model developed by Shin, Yu and Greenwood (2009) to investigate the relationship between policy-controlled rates and retail rates as well as bond yield rates. Based on the single-equation error correction model and the associated dynamic multipliers, we are able to model asymmetries in both the long-run relationship and the pattern of dynamic adjustment simultaneously and in a coherent manner. In addition, we present results from a symmetrical ARDL model. Results from our study support evidence to the existence of asymmetry in the response of retail and bond yield rates to changes in policy-controlled interest rates (interbank and 3-month rate). Specifically, there is a negative asymmetry in the response of deposit rates to changes in the interbank and 3-month rates while there is a positive asymmetry with regard to lending and bond yield rates.

The rest of the paper is organised as follows: Section 2 provides the theoretical and empirical literature; Section 3 provides theoretical framework, methodology and data analysis, which is followed by empirical results in section 4 while section 5 concludes and offers some policy prescriptions.

2.0 Review of Literature

2.1 Theoretical Literature Review

Literature on the interest rate pass-through has evolved overtime resulting in numerous concepts. This literature describes retail rate adjustment, or stickiness, as the responsiveness of retail rates to changes in the monetary policy rate. Often analysis of the interest rate pass-through differentiates between the short and long run (Cottarelli and Kourellis, 1994; Aziakpono and Wilson, 2013). In recent years, new theoretical and empirical literature has shifted the focus to analysing whether the pass-through is asymmetrical or symmetrical. Asymmetry of the interest rate pass-through refers to a situation where market rates responds differently to monetary policy tightening or loosening (Cottarelli and Kourellis, 1994; Aziakpono and Wilson, 2013; Malile, 2013).

Theoretical literature offer several explanations for why the IRPT may be sticky, incomplete or complete as well as asymmetrical. Among these, include asymmetric information; menu costs; switching costs; existence of implicit contracts; ownership structure of the financial system; financial frictions; volatile macroeconomic conditions; and bank concentration. Stiglitz and Weiss (1981) relate stickiness of IRPT to presence of information asymmetry. They argue that borrowers with risky projects tend to accept credit at very high interest rates while those with good projects will not (i.e. adverse selection). In addition, increases in lending rates tend to induce borrowers to take on risk projects (Moral hazard). It is therefore expected that in the presence of asymmetric information banks may be hesitant to increase rates even when the cost of funding is increasing but instead engage in credit rationing. In this regard, retail rates may be rigid upwards leading to asymmetry.

Another explanation for asymmetry is high bank concentration, which results in oligopolistic behaviours. The collusive behaviour hypothesis (Hannan and Berger, 1991) shows that deposit rates may be rigid upwards because they represent a cost to a bank. Similarly, retail rates on assets could be rigid downwards because they could imply lower profits. However, according to the adverse customer reaction hypothesis, if customers have bargaining powers then deposit rates may be rigid downwards and interest rates may rigid upwards (Neumark and Sharpe, 1992).

Regarding interest rate stickiness one explanation is the menu cost theory (Rotemborg and Saloner, 1987). This theory predicts that banks will only change retail rates only when the benefits from adjustments exceed the costs of doing so (e.g, printing, advertising new rates, communication, etc.) In this regard, if banks view monetary policy change to be too small and temporary they may decide to delay passing it on to retail rates.

Further, Egert et al. (2007) and Egert and Macdonald (2009) attributes stickiness of retail rates to macroeconomic conditions. They argue that high macroeconomic volatility blurs the information content of policy signals making bank to delay their response. They show that during episodes of high inflation IRPT is high since prices are adjusted more frequently. Further, episodes of high economic growth are associated with high pass-through because it is easier for banks to pass-on changes when economic conditions are favourable.

In addition to the above factors, Grigoli and Mota (2015) relate stickiness to ownership structure of the financial system. For example, they argue that state-owned financial institutions are often created for achieving policy objectives of government making profit maximisation their secondary objective. In this context, state owned banks are less likely to adjust retail rates due to political reasons and inefficiencies making stickiness in the IRPT (Cottarelli and Kourellis, 1994). Furthermore, foreign owned banks could react slowly to monetary policy shocks because their credit policies are not managed locally.

Finally, Bernanke *et al.* (1996) shows that existence of financial frictions and asymmetric information may cause large fluctuations in economic activity and retail rates. When there is information asymmetry, lenders may require borrowers to collateralize their assets. However, tight monetary policy deteriorates the value of assets making it difficult for firms to obtain credit for investment. This may set off a vicious cycle where tight monetary policy leads to a fall in economic activity and hence asset prices, which further tightens financing conditions and reduces economic activity even further. This transmission process may induce overpass-through from monetary policy rate to retail. Another reason, which may cause overpass-through, is the need for banks to cover the losses through a rise in non-performing loans due to tight monetary policy (de Bondt, 2005). De Bondt (2005) argues that in the presence of asymmetry of information banks may increase interest rates beyond the rise in the policy rate, instead of rationing credit.

2.2 Empirical Literature Review

Empirical literature presented in this paper is categorised in three groups: i) Literature on the IRPT on Zambia; ii) Literature on the asymmetry of the IRPT from emerging and developing economies, and; iii) Literature on the asymmetry of the IRPT from developed economies.

Results from Studies on the IRPT in Zambia so far suggest that it is incomplete without assessing whether it is asymmetrical or not. Chileshe et al. (2014) using monthly data found that the short-run pass-through from the money market rate to the lending rate is 0.02 while in the long run it is 0.13. On the other hand, Chileshe and Zgambo (2014) using a similar empirical approach but using quarterly data find that the short-run pass-through is 0.21 while in the long run it is 0.45. However, the shortcoming of these studies is that they assume that interest rate pass-through is asymmetrical which maybe erroneous and likely to produce spurious results. Greenwood-Nimmo , Shin and Van Trek (2010) argues that results from a regression model which assumes that there is symmetry in the response of interest rates to policy shocks could produce misleading results if the true data-generating process is asymmetrical.

Elsewhere, there are a number of studies which have attempted to investigate and found evidence of asymmetry of the monetary policy transmission (Greenwood-Nimmo et al., 2010; Malile, 2013; Roelands, 2012; Jamilov and Egert, 2014; Kovanen, 2011; Sznajderska, 2012). Literature from developed economies (Roelands, 2012; Greenwood-Nimmo *et al.,* 2010) finds that there is an asymmetry in the response of interest rates. Specifically, Greenwood-Nimmo, *et al.* (2010) found that in both the short-run and long run pass-through are asymmetrical. A hike has a bigger effect on interest rates in the short and long-run while a cut fails to consistently affect long-run interest rates in both the short and long run. Roelands (2012) using interest rate data on US banks holding companies found evidence in favour of asymmetry. In addition, he finds that the pass-through is sluggish as well. Both these studies attribute the response of interest rates to bank regulations and the lack of competition in the banking system.

However, results of studies on emerging and developing economies show mixed results: some suggest that results are asymmetrical while others do not. A study by Malile (2013) on Albania, using monthly data finds evidence of asymmetry of the interest rate pass-through. Specifically, they find that interest rates respond more to monetary policy loosening than to tightening. Nevertheless, a more comprehensive study by Jamilov and Egert (2014), using an ARDL model, on five Caucasian economies (Armenia, Azerbaijan, Georgia, Kazakhstan, and Russia) found mixed results. Specifically, they find no evidence of asymmetry for Armenia, Azerbaijan and Russia. However, they find evidence of asymmetry in Georgia and Kazakhstan, especially in the long run. Sznajderska (2012) uses the thresh-hold Autoregressive and Momentum-thresh-hold Autoregressive models to examine the asymmetry of retail rates in Poland. They find that Banks adjust interests on credits faster when the ECM term is above the thresh-hold due to strong competition and adverse selection. Another finding is that Polish banks are faster in adjusting rates for credits to sole proprietors and households when the ECM is below the thresh-hold. Finally, they find no conclusive evidence regarding the response of interest rates to negative and positive changes in the money market rate. A study by Grigoli and Mota (2015) on the domi

On Africa, two studies were reviewed with specific purpose of investigating the asymmetry of the interest rate pass-through (Kovanen, 2011; Aziakpono and Wilson, 2013). Specifically, Kovanen (2011) studies the interest rate pass-through in Ghana using VAR approach, with a special attention to asymmetry. They results provide in evidence in support of asymmetry from the policy to wholesale rates, which are argued on the basis of lack of policy credibility and poor liquidity management. A study by Aziakpono and Wilson (2013) on South Africa uses an ARDL model to investigate interest rate pass-through involving six different interest rates. In general, they find that the speed of adjustment varies across the interest rates. Lending rates have the highest speed of adjustment followed by Treasury bill rate and the money market rate while the deposit rate is the most sluggish. More importantly, they find evidence of asymmetry of the interest rate pass-through. They attribute the sluggishness of the deposit rate to collusive behaviour among banks while they argue that the reason for faster adjustment of lending rates is due to high level of competition in the credit market.

3.0 Theoretical Framework, Methodology and Data Analysis

3.1 Theoretical and Empirical Framework

The empirical evidence reviewed in this study clearly showed that monetary policy changes may have an impact on retail interest rates both in the short- and long-run. Hence, it is important that any empirical strategy developed take into account both of these time horizons. Following the empirical literature we assume that the long-run linear relationship between retail rates and monetary policy rate is;

$$r_t = \alpha + \beta i_t + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots 2.1$$

Where r_t is the retail market rate at time t, i_t is the policy rate at time t, μ_t is the stochastic error term while α represents the mark up and β is the size of the pass-through. In this model, if $\beta = 1$ then we have complete interest rate pass-through otherwise maybe deemed incomplete ($\beta < 1$) or overshooting ($\beta > 1$).

Most often when dealing with time series analysis economists are confronted with the issue of non-stationarity which imply that the mean and variance are time dependent. One problem of using non-stationary series in ordinary least squares regression is that it may lead to meaningless or spurious results (Dougherty, 2006, p.367). To avoid getting spurious results economists have to ensure that their models consist of stationary variables. A time series is stationary if its moments are independent of time or it is integrated of order zero I(0), otherwise it is integrated of order d, I(d) where d is the number of differencing required to make it stationary. Empirical literature reviewed shows that interest rates are usually stationary or integrated of order one, I(1) (Onunogbo, 2012; Leroy and Lucotte, 2014; Mojon, 2000; Sander and Kleimeir,2004; Liu and Tao, 2006). Hence to avoid the problem of spurious correlation we can estimate equation 2.1 in first differences;

$$\Delta r_t = \mu + \gamma \Delta i_t + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots 2.2$$

Where γ is the short run effect of the policy rate on lending rates. Although equation 2.2 reduces the possibility of spurious correlation it does not incorporate the dynamism that occurs among the time series variables in the financial markets as well as the long run effects of monetary policy.For example, it does not capture the long-run relationship among the variables but captures the short run effects of the policy rate on the interbank rate and retail rates. Analysis of the long run requires that the variables are cointegrated so that, even if each series is not stationary a combination of them is stationary (Enders, 2010;p.345),($\mu_t = y_t - \alpha - \beta y_t$).Hence incorporating this into equation 2.2 results in an error correction model of the form;

$$\Delta r_t = \mu + \gamma \Delta i_t + \partial (r_{t-1} - \alpha - \delta i_{t-1}) + \varepsilon_t \dots\dots\dots\dots\dots 2.3$$

Where θ is the error correction term, which captures the rate at which variables adjust to their long run equilibrium while ε_t is the error term which is assumed to be independent and identically distributed, $iid(0, \sigma_\varepsilon)$. If $-1 < \partial < 0$ then the variables converges to long-run equilibrium and if $0 < \partial < 1$ it is said to diverge from equilibrium or that long-run equilibrium is unstable. Estimating an error correction model of the form given above requires that variables are intergrated of the same order (Favero,2001; Enders, 2010), implying that if variables are integrated of different orders then we may produce spurrious results. In this regard, we consider an Auto Regressive Distributive Lag (ARDL) model which allows for the existence of differently integrated variables in the same regression (Ononugbo, 2012).

Available literature suggest that there are time dynamics to the pass-through process (Hoffman and Mizen, 2004; Ononugbo, 2012; Sander and Kleimeir,2004; Liu and Tao., 2006). These findings re-inforces the notion that in time series analysis, independent variables may affect the dependent variable with a lag while past values of the dependent variable may have an effect on the current variables. In this case, lag effects may exist between policy rate and interbank rates on one hand and the interbank rate and the retail rate on the other. Given this consideration and after some simple iterations as provided by Shin and Pesaran and Shin (1998) , the Auto Regressive distributed Lag, ARDL (p,q) can be specified as follows;

$$\Delta r_t = \theta + \delta r_{t-1} + \omega i_{t-1} + \sum_{j=1}^{p} \varphi_j \, \Delta r_{t-j} + \sum_{i=0}^{q} \emptyset_i \, \Delta i_{t-i} + \varepsilon_t \dots\dots\dots\dots\dots 2.4$$

Where θ is the intercept while δ provides information about the error correction process. The term ω nests the long run parameter (β), while $\emptyset_i$'s are the parameters for the short run effects of the policy rate on retail rates while φ_j provides the inertial dynamic effects. Hence, $\emptyset_0$ provides the contemporaneous effect of the policy rate changes on lending rates. Given the error correction parameter and the contemporaneuous parameter, the mean average lag time (M.A.L) as derived by Hendry (1995) can be calculated, to provide an indication of the number of months required for complete adjustment to equilibrium. The M.A.L is computed as follows;

$$M.A.L = \frac{1 - \emptyset_0}{-\delta} \dots\dots\dots\dots\dots\dots .2.5$$

If the policy rates and the market rates are cointegrated the long run pass-through can be recovered by; $\beta = \frac{\omega}{-\delta}$. As already stated, if $\beta = 1$ then we have complete pass-through.

Furthermore, literature has showed that the response of market rates differs depending on the type of policy being undertaken by the central bank; tight or loose. This asymmetric response to policy shocks could be caused by the fact that prices are rigid downwards and very flexible upwards. To analyse the asymmetry response of lending rates to policy rates, as suggested in the literature (Greenwood-Nimmo et al., 2010; Ononugbo, 2012) and using an Asymmetry ARDL proposed by Shin et al.(2009), the policy rate is split into positive and negative changes so that the long-run equation is now written as follows;

$$r_t = \alpha + \beta^+ {i_t}^+ + \beta^- {i_t}^- + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots 2.6$$

Wherer_t and i_t maybe integrated of order one, I(1) variables, i_t is partioned as;

$$i_t = i_0 + {i_t}^+ + {i_t}^- \dots\dots\dots\dots..2.7$$

Where${i_t}^+$ and ${i_t}^-$ constitute the partial sum processes of the positive and negative changes in i_t derived as

$${i_t}^+ = \sum_{h=1}^{t} \Delta i_h^+ = \sum_{h=1}^{t} \max(\Delta i_h, 0)\,; {i_t}^- = \sum_{h=1}^{t} \Delta i_h^- = \sum_{h=1}^{t} \min(\Delta i_h, 0) \dots\dots\dots 2.8$$

β^+ and β^- are the assymetric parameters of the long run pass-through. Equation 2.7 can be incorporate into equation 2.4 to obtain the assymetric ARDL model;

$$\Delta r_t = \theta + \delta r_{t-1} + \omega^+ i_{t-1}^+ + \omega^- i_{t-1}^- + \sum_{j=1}^{p} \varphi_j \, \Delta r_{t-j} + \sum_{i=0}^{q} (\varphi_i^+ \, \Delta i_{t-i}^+ + \varphi_i^- \Delta i_{t-i}^-) + \varepsilon_t \dots\dots\dots\dots\dots 2.9$$

There short-run assymetric effects are given by φ_i^+ and φ_i^- while the long run assymetric effects will be recovered from$\beta^+ = \frac{\omega^+}{-\delta}$ and $\beta^- = \frac{\omega^-}{-\delta}$.

3.2 Set up Tests

3.2.1 Unit Root Test

As already mentioned, non-stationarity is a common feature in time series data. Estimating a regression with differently integrated series could result in spurious results. Further, it is a requirement in ARDL models that variables are I(0) or I(1) because in the presence of I(2) computed F tests are invalid (Ouattara, 2004; Pesaran, Shin and Smith, 2001). In this regard, there is need to test for stationarity or non-stationarity in the time series data before proceeding to estimation. Three test are employed to test for non-stationarity for robustness check: the Augmented Dickey Fuller (ADF); the Phillip-Peron (PP); and the Kwiatkowski-Phillips-

Schmidt-Shin (KPSS) test. Literature suggests that the ADF and PP are similar, but slight differences in finite samples (Pelgrin, 2012; Malile, 2013). Both the ADF and PP tests are sensitive to structural breaks and therefore the KPSS is added.

3.2.2 Cointegration Test

In the presence of non-stationarity in the data set, it has become standard to check for the existence of co-integrating relationship among the variables. To test for the existence of co-integration in the ARDL the PSS bounds testing approach proposed by Pesaran et al. (2001) is adopted. Assuming an unrestricted intercept, in the PSS bounds approach the test is done under the joint null hypothesis of no co-integration as;

$$H_0: \delta = \omega = 0 \ldots\ldots\ldots\ldots\ldots 2.10$$

This test is done using the standard F-test statistic and t-test statistic. However, the assymptotic distribution of these are non-standard under the null hypopothesis that there exists no long-run relation. Pesaran et al. (2001) develops two sets of assymptotic critical values: one set assumes that all the independent variables are I(1); and, the other set assumes that they are I(0). These two sets of critical values are then compared with the computed values to determine existence of co-integration. If the computed statistic falls outside of the bands then we conclude existence of co-integration, otherwise it is not conclusive and requires a re-examination of the stationarity of individual variables.

3.2.3 Parameter restriction Tests

The methodology outlined above, sets out a methods for assessing two aspects: i) Completeness of the pass-through, and; ii) asymmetry of the transmission. To check for interest rate pass-through completeness as well as asymmetry the Wald Parameter Restriction test (Greene,2012, pp 155-161) is employed. As already stated above, the long run interest rate pass-through can be recovered from equation 2.4 by; $\beta = \frac{\omega}{-\delta}$. Further, if $\beta = 1$ then there is complete pass-through. To test the pass through is complete the Wald-test with null hypothesis is utilised;

$$H_0: \beta = 1 \ldots\ldots\ldots\ldots\ldots 2.11$$

In testing for asymmetry of the IRPT the null hypothesis of no asymmetry ($H_0: \beta^+ = \beta^-$) is tested against the alternative of asymmetry ($H_0: \beta^+ \neq \beta^-$) are tested.

3.2.4 Multiple Breakpoint Test

An important aspect of time series regression analysis is that relationships among the variables may change overtime or a sudden shift in the variables (Hansen, 1992). Failure to recognise structural breaks and nonconstancy in parameter estimates is that it may have severe consequences for inferences and forecasting (Glynn, Perera, and Verma, 2007). It is important to note that our data covers a period when significant changes in the economy occurred. During this period, Zambia undertook various economic and financial reforms under the IMF supported structural adjustment program (Whitworth, 2012). In addition, this period covers the 2007-2010 the global financial crisis which had impact on macroeconomic performance. All these events could have lead to structural breaks which could have changed the long run relationships among the variables.

Given the foregoing, this study utilises the Bai-Peron (1998,2003) procedures to test for structural breaks as well as selecting the break dates. Once structural break dates have been identified they are included in the ARDL models as additive and multiplicative dummies to account for the regime shifts in the long-run relationships. However, only significant additive and multiplicative dummies are retained in the estimations unless dropping them lead to parameter instability inspected using the CUSUM test and CUSUM squares test.

3.3 Data Analysis

3.3.1 Nature and Sources of Data

To analyse the interest rate pass-through in Zambia, quarterly data is utilised. Specifically, data is collected from the Bank of Zambia (BoZ) database for the period Q1 1992 to Q2 2016. All the interest rates are available for the entire sample period with an exception of the, the Bank of Zambia (BoZ) policy rate which was first introduced in April 2012. However, before this period, the policy rate is constructed as the TB-rate plus 200 basis points. In addition, the 2-year bond yield rate is available from Q1 2000 while 3-year and 5-year bond yield rates are available from Q3 2003.

3.3.2 The Variables

The analysis consists of 16 different interest rates, mostly of short-term nature. These include two savings rates (saving rates for amounts above K100 and less than K100); the seven deposit rates on amounts exceeding K20,000(24hr Call rate, 7-day rate, 14-day rate, 30-day rate, 60-day rate, 90-day rate, 180-day rate);one lending rate (Weighted lending rate); One Check Rate for amounts above K500,000; Two official rates (91-day TB rate (or the Policy Rate), interbank rate); and three Bond Yield rates (2-Year, 3-Year and the 5-Year bonds).

Given the aim of this study, to deduce the reaction of market rates to changes in the monetary policy stance by the Bank of Zambia, the monetary policy rates forms the basis of the analysis. In this study, two monetary policy rates are utilised; the 3-month TB rate and the interbank rate. The use of the interbank rate as a monetary policy variable is two-fold. First, although currently the central bank signals the direction of monetary policy stance through the revision to BoZ policy rate, it rarely changes on a day to day basis and only forms a basis for monetary policy implementation. In the implementation of monetary policy, the central bank monitors the interbank rate and intervenes in the money market when the rate breaches the upper or lower bound (Mutoti, 2006; Chileshe et al., 2014). Hence, the inter-bank rate is a good indicator of the monetary policy stance. Secondly, the choice of the interbank rate is motivated by empirical evidence which clearly shows that many researcher have tended to use it as a monetary policy variable (Chileshe et al., 2014; Deriantino, 2013). Although the 91-day TB rate, the basis for the first part of the interest pass-through is determined by the demand and supply of securities. The motivation for using it as one of the monetary policy variables is that TBs being short term in nature provides liquidity assets for commercial banks. Hence changes in money market liquidity ocasioned by monetary policy stance will have an impact on TB yield rates.

4.0 Empirical Results

4.1 Set up Test Results

Unit Root Tests

Table 1 presents the results of stationarity tests based on ADF, PP and KPSS tests. The results indicate that according to the KPSS test all the series are integrated of order one, I(1). On the other hand, the ADF test indicate that all the series are integrated of order one with an exception of interbank rate, savings rate, 30-day rate, and the 90-day rate while the PP test also indicate that all the series are I(1), except interbank rate and the saving rate for deposits greater than K100, 3-month rate and Interbank rate. However, existence of differently integrated series does not pose any danger to uncovering the long run pass-through relationship using the ARDL. The Pesaran-Schmidt-Shin cointegration test does depend on whether the series involved are I(0) or I(1).

Table 1: Stationarity Tests

	ADF			PP			KPSS		
	Levels	1st Difference	I(d)	Levels	1st Difference	I(d)	Levels	1st Difference	I(d)
Interbank Rate	-3.16**	-26.94***	I(0)	-4.78***	-39.72***	I(0)	1.37***	0.27	I(1)
3-month Rate	-4.69***	-12.77***	I(0)	-3.85**	-12.76***	I(0)	0.14*	0.02	I(1)
Average Lending Rate	-1.48	-6.47***	I(1)	-1.53	-6.38***	I(1)	0.84***	0.20	I(1)
Check Rate	-1.93	-7.04***	I(1)	-1.83	-7.04***	I(1)	0.21**	0.09	I(1)
Call Rate	-5.94***	-7.61***	I(0)	-5.50***	-7.58***	I(0)	0.25***	0.06	I(1)
7-Day Deposit Rate	-1.74	-14.03****	I(1)	-1.88	-14.09***	I(1)	0.24***	0.04	I(1)
14-Day Deposit Rate	-1.61	-13.79***	I(1)	-2.10	-14.14***	I(1)	0.18**	0.04	I(1)
30-Day Deposit Rate	-1.79	-11.98***	I(1)	-2.14	-12.99***	I(1)	0.23***	0.03	I(1)
60-Day Deposit Rate	-3.25**	-12.21***	I(0)	-2.25	-12.75***	I(1)	0.16**	0.04	I(1)
90-Day Deposit Rate	-3.66**	-4.47***	I(0)	-2.37	-13.17***	I(1)	0.17**	0.03	I(1)
Saving Rate<K100	-3.16***	-5.33***	I(0)	-2.89**	-14.46***	I(0)	0.99***	0.33	I(1)
Saving Rate>K100	-3.62**	-5.01***	I(0)	-2.50	-13.99***	I(1)	1.20***	0.20	I(1)
180-Day Deposit Rate	-2.36	-11.56***	I(1)	-2.28	-11.57***	I(1)	0.14*	0.04	I(1)
2-Year Bond Rate	-2.28	-7.25***	I(1)	-1.93	-7.43***	I(1)	0.34***	0.06	I(1)
3-Year Bond Rate	-0.84	-5.57***	I(1)	-1.07	-7.68***	I(1)	0.13*	0.05	I(1)
5-Year Bond Rate	-0.38	-8.20***	I(1)	-0.97	-8.32***	I(1)	0.16**	0.07	I(1)

Source: Computations by the Author. In the table *,**,*** means statistically significant at 10%, 5% and 1% respectively.

Structural break Test Results

Table 2 present results of the Bai-Peron tests for structural breaks in the relationship between the 3-month TB rate (Policy rate) and other interest rates. Results clearly indicate presence of structural breaks. In all cases, both double maximum statistics are significant at 1%, indicating strong evidence in favour of structural change in the link between 3-month TB rate (policy rate) and other interest rates. In addition, in all cases the SupF (1/0) is rejected indicating the presence of at-least one structural break (see table 3.2 below). Using the sequential methods, a structural break is identified in 1998 for 10/15 cases which coincides with Asian financial crisis. Further, in all cases a structural break is identified in 2007 coinciding with the start of the global financial crisis. Furthermore, in 7/15 cases a structural break is identified for 2004, which coincides with Zambia reaching the Heavily Indebted Poor Country (HIPC) initiative completion point. Other breaks are identified to have occurred in 2002, 2010 and 2013.

Table 2: Bai-Perron (1998, 2003) tests for Multiple Structural Breaks for the Effect of 3-month rate on other rates

Dependent	UD_{max}	WD_{max}	$SupF(1/0)$	$SupF(2/1)$	$SupF(3/2)$	$SupF(4/3)$	$SupF(4/5)$	Break Dates
Interbank	21.16***	27.43***	6.58**	18.92**	6.24	-	-	1998Q1; 2010Q1
Check Rate	36.53***	57.88***	65.01***	18.00**	59.84***	2.16	-	1998Q4; 2007Q4; 2013Q2
Call	43.98***	70.19***	16.24**	34.61***	74.45***	17.41**	-	1998Q4; 2004Q2;2007Q4;2013Q2
7-Day	46.20***	86.59***	70.78***	45.21***	4.93	-	-	1998Q4;2004Q2
14-Day	34.62***	63.35***	16.50**	11.49**	-	-	-	1998Q4;2007Q2
30-Day	56.60***	110.92***	65.70***	9.11**	34.30***	32.34***	-	1998Q4;2004Q2;2007Q4;2013Q1
60-Day	82.00***	149.57***	26.53***	9.49**	23.85***	9.18**	-	1998Q4; 2004Q1;2007Q2;2013Q2
90-Day	38.09***	74.68***	40.28***	46.73***	17.82**	6.23	-	1998Q4;2004Q2;2007Q2
180-Day	47.98***	94.07***	27.69***	13.68**	1.84	-	-	2004Q2;2007Q2
Saving1	38.14***	71.14***	34.82***	27.57***	18.53**	3.76	-	1998Q4;2002Q2;2007Q4
Saving2	44.21***	56.24***	34.44***	16.23**	3.29	-	-	1998Q4;2004Q4
2-Year Bond	30.12***	31.21***	26.66***	13.90**	3.90	-	-	2004Q4; 2007Q4
3-Year Bond	111.32***	218.26***	32.99***	7.36	-	-	-	2007Q4
5-Year Bond	51.28***	100.55***	27.42***	6.37	-	-	-	2007Q4

Source: Computations by the Author using BoZ database

Table 3 below presents tests results for the presence of structural breaks in the relationship money market rate and other rates. Again, results indicate that there are structural breaks in the long-run relationship between the money market rate and other rates. In all cases, the double maximum statistics are significant at 1% thereby rejecting the null hypothesis of no structural breaks. In all cases, the SupF(1/0) is rejected indicating the presence of at-least one structural break in the data. Furthermore, in 9/14 cases the SupF(2/1) is rejected indicating the presence of two structural breaks while in 4/14 cases the SupF(3/2) is rejected suggesting three structural breaks. Finally, in 3/14 cases the SupF(4/3) is rejected indicating that there are four structural breaks. Using sequential methods, we identify a structural break in 1998 Q4 coinciding with the Asian Financial Crisis; in 2004 Q4 coinciding with Zambia's agreement for debt relief with donors under the HIPC initiative; and in 2007 Q4 coinciding with global financial crisis. The identified break dates are included in the ARDL models estimated as additive and multiplicative dummies.

Table 3: Bai-Perron (1998, 2003) tests for Multiple Structural Breaks for the pass-through of Money Market rate to other rates

Dependent	UD_{max}	WD_{max}	$SupF(1/0)$	$SupF(2/1)$	$SupF(3/2)$	$SupF(4/3)$	$SupF(4/5)$	Breaks
Check Rate	69.19***	121.37***	13.40**	5.20	-	-	-	2007Q4
Call	37.05***	57.68***	17.61**	82.84***	44.79***	44.73***	-	1998Q4;2004Q4; 2007Q4; 2013Q2
7-Day	64.29***	126.06***	11.42**	16.39**	4.69	-	-	1999Q1; 2004Q4
14-Day	23.67**	38.93***	11.93**	16.12**	5.69	-	-	1998Q4; 2004Q4

30-Day	27.49***	43.47***	17.11**	17.01**	10.99**	20.54***	-	1998q4;2004Q4;2007Q4;2013Q3
60-Day	20.53***	32.63***	10.22**	6.29	-	-	-	2004Q4
90-Day	30.82***	48.75***	19.11***	9.42**	7.79	27.05***	-	1999Q1;2004Q3;2007Q4
180-Day	50.14***	96.48***	9.48**	3.01	-	-	-	2004Q4
Saving1	39.64**	68.50***	30.88***	6.24	-	-	-	1998Q4
Saving2	26.52***	59.96***	11.31**	8.78**	20.66***	4.86	-	1998Q4;2004Q2;2007Q4
2-Year Bond	25.11***	44.17***	8.85**	11.27**	4.59	-	-	2004Q2; 2007Q4
3-Year Bond	32.56***	63.84***	8.72**	3.30	-	-	-	2007Q4
5-Year Bond	52.37***	102.68***	17.11**	27.50***	5.95	-	-	2007Q1; 2014Q4
ALR	88.00***	143.94***	19.89***	23.16***	11.932**	0.932	-	1999Q1; 2004Q3; 2007Q3

Source: Computations by the Author using BoZ database

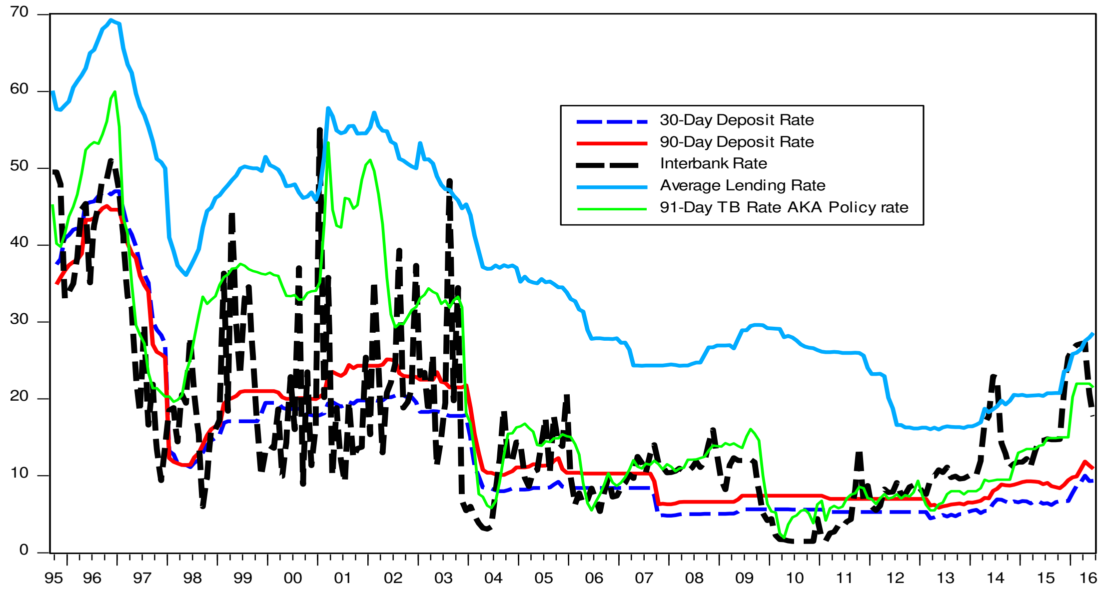
4.2 The Pass-Through Analysis

4.2.1 Stylised Facts Analysis

Figure 3.1 below shows trends in retail rates (Deposit Rates, Lending rates) as well as the interbank rates and the 3-month TB yield rate. It can be seen from the chart that there is a positive relationship between the policy-controlled rates such as interbank and 3-month TB rate on one hand and the retail rates on the other, though with a lag. Another observation from the chart is that the interbank rate is more volatile from the introduction of the interbank market in 1995 to late 2005 compared to the period after 2005. This is expected in that during the period of monetary aggregate targeting interest rates are expected to be more volatile as the primary aim of the Central Bank is to stabilise money supply in line with its inflation objective.

Furthermore, the chart reveals that there were wider margins between the average lending and deposit rates, which have been narrowing in recent years. This point to the fact that financial markets have become more competitive over the years following the reforms of the 1990s, causing lending rates to fall quickly. In addition, this reduction in the margins could be attributed to the reduction of governments' borrowing on the domestic money market, which has forced the commercial banks to reduce their lending rates to attract private borrowers while keeping deposit rates high to attract funds from surplus economic agents.

Figure 1: Trends in Interest Rates from January 1995-June 2016



Source: Compilations by Author Using

Finally, in their intermediation role, commercial banks obtain liquidity from three sources for onward lending to deficit economic agents at a margin. These sources of liquidity include interbank money market, the deposits from clients, and loans from the Central Bank. Hence, from a theoretical perspective, it is expected that if financial markets are working well, then the policy-controlled rates should lie between the average lending rate and the deposit rates. An inspection of the chart shows that for most of the period, the interbank rate and the 3-month TB rate were between the lending rate and deposit rates, with an exception of a few periods when policy controlled rates were below deposit rates.

4.2.2 Symmetry Pass-through from the ARDL model

Tables 4 below reports the estimation results involving the pass-through from the policy rate (3-month rate) to fifteen retail rates whereas table 5 provide the results for that from money market rate to other retail rates. The results in tables 4 and 5 incorporate additive and multiplicative dummies to account for structural breaks. Parameter stability tests are later performed using the CUSUM and CUSUM squares test. Results for the CUSUM and CUSUM squares tests reported in figures 1A and 2A in the appendix indicate that after incorporating dummies the parameter estimates are stable.

The results in table 4 indicate that the correlation between the 3-month TB rate with the money market rate, the retail rates, and the long-term yield rates look relatively weak with the adjusted R^2 typically between 0.1 and 0.49, with an exception of the 180-day deposit rate which was 0.59. However, on the other hand the correlation between policy rates and the lending rate as well as yield rates was relatively stronger with the adjusted R^2 between 0.60-0.9. Although the adjusted R^2 is low in some cases, all the coefficients are correctly signed for both the short and long run effects. Specifically, the short and long run coefficients are positive while the error correction term is negative. More importantly, the coefficients $(\omega, \delta, \emptyset_0)$ are correctly signed and lie in the range from 0 to 1. The results in Table 4 below indicate that all the coefficients are statistically significant with an exception of the intercept. In the short-run, a one per cent change in the 3-month TB rate will cause the interbank rate to adjust by close to 66 basis points while in the long run the table indicate that there is complete pass-through with mean adjustment lag time of just 0.6 quarters or 1.8 months.

The results for the retail deposit and savings rates which are on the liability side of commercial banks show mixed results, with only the 180-day deposit rate having a long-run complete pass-through effect. For the Check, Call, the saving for amounts less than or above K100, the results show an insignificant effect in the immediate short-run. Furthermore, speeds of adjustment parameter, though significant in all cases, are very low resulting in high mean adjustment lag of between approximately 9.1 to 9.9 quarters or more than 2-years. However, for the retail deposit rates with maturity greater than a week have a significant and higher pass-through of 0.10-0.23 with lower mean adjustment of 2.0 to 8.0 quarters (6 months to 24 months). An important observation to note on the deposit rates is that for very short time deposits (less than a week) as well as the saving rates the pass-through rates for both the short and long-run are lower compared to the long-term deposit rates. This result is expected because very short-term deposits are not held purely for saving but transaction purposes while long-term maturity deposits are held for saving purposes. Hence, it is expected that long-term deposit rates respond more to policy changes than short-term rates. Finally, the Wald test for interest rate pass-through completeness is significant for the 180-day rate, which is the deposit category with the longest maturity.

Table 4: The Pass-Through of 3-month Rate to Other Interest rates

	Money market Rate	Deposit Rates on Amounts Exceeding K20,000								Saving rate for Savings less or More K100		Average Lending Rate
	Interbank Rate	Check	Call	7-Day	14-Day	30-Day	60-Day	90-Day	180-Day	Saving1	Saving2	Lending Rate
θ	0.039***	-0.058	-0.017	0.002	0.000	0.000	0.007*	0.001	0.038**	0.002	0.007	-0.036
ω	0.407***	0.022*	0.023**	0.044	0.104***	0.061**	0.136***	0.136***	0.359***	0.013**	0.008	0.270***
δ	-0.603***	-0.096***	-0.106*	-0.130***	-0.255***	-0.114***	-0.267***	-0.220***	-0.420***	-0.104***	-0.104*	-0.244***
$\emptyset_0$	0.659***	0.042	0.034	0.152***	0.100**	0.176***	0.130**	0.230***	0.140*	0.006	0.007	0.414***
β	0.676***	0.229**	0.214**	0.338**	0.378**	0.53***	0.51**	0.615***	0.856***	0.123**	0.100**	1.108***
R^2	0.51	0.34	0.26	0.39	0.34	0.38	0.40	0.49	0.59	0.41	0.40	0.71
$\beta = 1$	YES	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	YES
PSS Test	9.58***	5.34**	10.128***	4.081*	18.34	4.301**	16.36***	8.763***	13.18***	7.33***	6.649***	10.57***
MAL	0.60	9.9	9.1	8.0	3.55	7.2	3.3	3.4	2.0	9.6	9.6	2.4

Pass-Through from the 3-Month rate to Long-term Yield Rates			
	2-Year Bond Yield rate	3-Year Bond Yield Rate	5-Year Bond Yield Rate
θ	0.034	0.023*	0.016
ω	0.481***	0.401*	0.225*
δ	-0.474***	-0.483***	-0.277***
$\emptyset_0$	0.695***	0.598***	0.588***
β	1.015***	0.831***	0.812***
R^2	0.81	0.63	0.60
$\beta = 1$	YES	YES	YES
PSS Test	8.74***	4.18**	4.83**
MAL	0.6	0.8	1.5

*Source: Computations by the Author. In the table *,**,*** means statistically significant at 10%, 5% and 1% respectively.*

On the asset side of the bank's balance sheet, lending rates, and bond rates, results in Table 4 above show that there is a complete pass-through between the 3-month TB rate to the average lending rates and yield rates. Specifically, the coefficients are rightly signed and significant. The contemporaneous effect of the policy changes on the average lending and yield rates ranges from 0.40 to 0.70, far above those for deposit rates. Furthermore, the Wald test for the pass-through completeness shows that there is complete pass-through (0.7-1.02). Finally, the speed of adjustment parameter though very low and significant in all the cases the speed of mean adjustment lag is low and lie between 0.6 to 2.4 quarters (1.8 to 7.2 months).

Table 1A in the appendix shows the full results which incorporates dummies for structural break dates for the pass-through from the policy rate (3-month TB rate) to other rates. The results indicate that only the additive and multiplicative dummies for the 1998, 2004, 2007 and 2013 are significant in the results. Specifically, in 9/15 cases the additive dummy for 2007Q4 is positively significant while in 5/15 regressions the multiplicative for 2007Q4 are negatively significant. In addition, 4/15 cases the additive dummy for 1998Q4 is positive and significant while in 2/15 cases it is negatively significant. However, only in one case is the dummy for 2004 and 2013 significant. These results clearly indicate that the global financial and Asian financial crises had significant impact on the IRPT. Specifically, the crises led to a rise in interest rates charged by commercial bank on assets and deposits while the transmission of policy changes to yield and retail rates declined. These results are expected in that during a financial crisis the probability of default increase making commercial banks charge a higher premium on assets. On the liability side depositors tend to ask for funds deposited with financial as the see a higher risk of bank failure for which they need to be compensated. Finally, the higher level of macroeconomic volatility during a financial crisis reduces the information content of policy signals making banks to delay their response and hence making interest rates sticky.

Table 5: The Pass-Through of the Money Market Rate to other interest rates

	Deposit Rates on Amounts Exceeding K20,000								*Saving rates for Amounts less or more than K100*		*Average lending Rate*
	Check	*Call*	*7-Day*	*14-Day*	*30-Day*	*60-Day*	*90-Day*	*180-Day*	*Saving1*	*Saving2*	*Lending Rate*
θ	-0.006	-0.023	0.014	0.004***	0.013	0.013	0.006	0.001	-0.005	0.071**	0.123
ω	0.082**	0.082***	0.090***	0.046***	0.133***	0.163***	0.290***	0.232***	0.053***	0.061**	0.049
δ	-0.155***	-0.179***	-0.185***	-0.136***	-0.252***	-0.239***	-0.303	-0.285***	-0.130**	-0.178***	-0.053**
$\emptyset_0$	0.057**	0.041**	0.025***	0.027***	0.116***	0.060	0.129****	0.176**	0.012	0.009	0.152***
β	0.527***	0.458***	0.486***	0.336**	0.531***	0.682***	0.956***	0.814***	0.405***	0.345**	0.920*
R^2	0.52	0.33	0.39	0.47	0.38	0.43	0.36	0.46	0.34	0.43	0.32
$\beta = 1$	NO	NO	NO	NO	NO	YES	YES	YES	NO	NO	YES
PSS Test	7.073***	20.04***	16.07***	22.68	5.691***	14.045***	16.645***	13.824***	9.865***	12.884***	2.150
MAL	6.1	5.4	5.3	7.2	3.5	3.9	2.9	2.9	7.6	5.6	15.9

Pass-Through to Long-Term Bond rates			
	2-Year Bond Yield	*3-Year Bond Yield*	*5-Year Bond Yield*
θ	0.020**	0.065**	0.045
ω	0.262*	0.285***	0.232***
δ	-0.286***	-0.334***	-0.280***
$\emptyset_0$	0.272***	0.267***	0.232***
β	0.915***	0.854***	0.829***
R^2	0.52	0.29	0.32
$\beta = 1$	YES	YES	YES
PSS Test	5.48**	5.049**	4.540**
MAL	2.5	2.2	2.7

*Source: Computations by the Author. In the table *,**,*** means statistically significant at 10%, 5% and 1% respectively.*

Regarding the pass-through from the money market to other rates, the results indicate that most of the parameter estimates are statistically significant and have correct signs with a few exceptions. The long-run pass-through for the deposit retail rates lies between 30-90 basis points. An important observation is that very short-term deposit interest rates such as the check, call, saving and 7-day have lower short- and long-run pass-through compared to longer maturity rates. Specifically, the results show that the contemporaneous effect of the changes in the interbank rate on short-term maturity deposit is lie in the range 0.01-0.06 and is significant for check rate, call rate, 7-day, and 14-day deposit rates while it is insignificant for the savings rate. On the other hand, for deposit interest rates with a maturity 30-days and above, the contemporaneous effect is significant for all (0.1-0.2) except for the 60-day rate which is insignificant. The long-run pass-through for the shorter deposit rates is incomplete and lies between 0.30-0.55 while that of longer deposit rates is between 0.68-0.9. Furthermore, the Wald-test for completeness shows that there is evidence for complete pass-through ($\beta = 1$) for deposit rates with maturity above 60-days. Results from the bounds test show that there is a significant co-integrating relationship between the interbank rate and all the deposit rates while the mean adjustment lag is between 2.9 to 7.6 quarters or 8.7 to 22.8 months.

On the asset side of the balance sheet, the results show that there is complete pass-through for all interest and yield rates. Furthermore, the bounds test also shows that there is a significant long-run relationship between the interbank rate and other rates with an exception of the average lending rate. Specifically, the contemporaneous effects are significant in all cases ranging from 0.15 to 0.28 while the long-run effect lies between 0.82-0.92. In addition, the mean adjustment lag ranges between 2.2- 15.9 quarters or 6.6-47.7 months.

Finally, results incorporating dummies for structural breaks or regime shifts that may have occurred overtime are reported in table 2A of the appendix. Results indicate that 10/15 cases the additive dummy for 1998Q4 is positive and significant while in 7/15 cases the additive dummy for 2007Q4 is positive and significant. Further in 2/15 and 1/15 cases the additive dummies for 2004Q4 and 2013Q2 is negative and significant, respectively. Further, the results reveal that in 5/15 cases the multiplicative dummy for 1998Q4 is negative while in 1/15 cases the multiplicative dummy for 2007Q4 it is negative. These results indicate that the Asian and global financial crises had significant impact on the pricing of financial assets in Zambia as well as the transmission of money market changes to retail and yield rates.

4.2.3 Asymmetry Pass-Through from the Non-Linear ARDL Models

In the previous sub-section, results from the symmetrical ARDL models which assume that interest rates respond symmetrically to monetary policy loosening or tightening were presented. However, a lot of empirical literature has revealed that economic agents respond differently to either loosening or tightening (Ononugbo, 2012; Greenwood-Nimmo *et al.,* 2010). These papers have gone on to argue that results obtained from symmetrical ARDL models could actually present spurious outcomes. In this section, results from the Non-Linear ARDL (NARDL) models presented. In particular, we present results for both the asymmetrical IRPT from the Policy rate to the money market rate and other rates as well as from the money market rate to the retail rates and yield rates.

The summary of the results for the NARDL model of the 3-month interest rate to other interest rates are presented in Table 6 below. Results on the IRPT from the 3-month TB rate to other rates show that all the important parameters are significant and correctly signed with an exception of the intercept terms and some contemporaneous effects. In the case of the effect of the 3-month TB rate on the interbank rate, the results show that there is complete pass-through though it is asymmetrical for both short and long run. Further, the results show that there is a quicker response of the interbank rate to the 3-month changes with the mean adjustment lag of 0.6 quarters (1.8 months) for positive changes and 1.1 quarter or 3.3 months for negative changes. In the case of deposit rates, all with the exception of the 90-day (for both short and long run) and the saving rate for amounts less than K100 (for long run) show asymmetrical behaviour, a negative asymmetry. Specifically, the results show that both the contemporaneous and long run response deposit interest rates respond less to a fall in the 3-month rate compared to a rise. Finally, the PSS tests confirm the existence of long-run relationship for all except for the 60-day rate.

Table 6: The asymmetric Pass-through of the 3-month rate to other rates

	Money market Rate	Deposit Rates on Amounts Exceeding K20,000								Saving rates for Amounts less or more K100		Average Lending Rate
	Interbank Rate	Check	Call	7-Day	14-Day	30-Day	60-Day	90-Day	180-Day	Saving1	Saving2	Lending Rate
θ	0.022	0.016**	0.050***	0.043	0.041	0.036	0.002	0.048	0.064*	0.083	0.069***	0.034***
ω_-	0.309**	0.057*	0.016	0.059*	0.058**	0.103*	0.101**	0.080**	0.370***	0.013*	0.017	0.104**
ω_+	0.348**	0.040	0.025	0.041	0.042	0.097*	0.093**	0.079*	0.410***	0.013	0.028*	0.161***
δ	-0.402***	-0.134***	-0.144***	-0.111**	(0.113)**	(0.136)**	(0.117)***	(0.130)***	(0.454)***	(0.084)***	(0.213)***	(0.151)***
$\emptyset_0^-$	0.565***	0.026*	0.062**	0.251***	0.231*	0.146*	0.185**	0.095*	0.140**	0.077	0.022**	0.157***
$\emptyset_0^+$	0.772**	-0.025	0.051	0.110*	0.120	0.098**	0.044***	0.255***	0.178*	0.012	0.012	0.489***
β^-	0.767***	0.423**	0.174*	0.535***	0.514**	0.760***	0.793*	0.619**	0.815***	0.151**	0.339*	0.691**
β^+	0.865**	0.299	0.111	0.372***	0.370	0.718**	0.866**	0.606**	0.903***	0.151*	0.213*	1.109***
R^2	0.44	0.39	0.62	0.44	0.57	0.58	0.45	0.64	0.53	0.34	0.31	0.74
$\beta^- = 1$	YES	NO	NO	NO	NO	YES	YES	NO	YES	NO	NO	YES
$\beta^+ = 1$	YES	NO	NO	NO	NO	YES	YES	NO	YES	NO	NO	YES
$\beta^+ = \beta^-$	NO	NO	NO	NO	NO	NO	NO	YES	NO	YES	NO	NO
$\emptyset_0^+ = \emptyset_0^-$	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO
PSS Test	6.230***	7.324***	10.797***	4.386**	6.909***	3.398*	2.556	3.430*	10.770***	3.371*	10.471***	7.350***
MAL-	0.6	7.3	6.5	6.7	6.6	6.3	7.0	5.7	1.9	11.0	12.0	5.6
MAL+	1.1	7.7	6.6	8.0	7.8	6.6	8.2	6.9	1.8	12.1	12.1	3.4

Pass-through from the 3-month rate to long term Yield rates

	2-Year Bond Yield rate		3-Year Bond Yield Rate		5-Year Bond Yield Rate
θ	0.019*		0.028**		0.038
ω_-	0.434***		0.596***		0.303**
ω_+	0.459***		0.750***		0.460***
δ	(0.432)***		(0.743)***		-0.399***
$\emptyset_0^-$	0.482**		0.425**		0.548***
$\emptyset_0^+$	0.757***		0.725*		0.564***
β^-	1.006***		0.802***		0.759**
β^+	1.064**		1.009***		1.153**
R^2	0.77		0.67		0.73
$\beta^- = 1$	YES		YES		YES
$\beta^+ = 1$	YES		YES		YES
$\beta^+ = \beta^-$	NO		NO		NO
$\emptyset_0^+ = \emptyset_0^-$	NO		NO		NO
PSS Test	3.791*		5.959***		3.901**
MAL-	1.2		0.8		1.2
MAL+	0.6		0.4		1.1

*Source: Computations by the Author. In the table *,**,*** means statistically significant at 10%, 5% and 1% respectively.*

In the case of the retail lending rate and yield rates, the results show that there is positive asymmetry as well as a complete pass-through for both upward and downward adjustments in the policy rate. Specifically, a 1% rise in the 3-month rate will contemporaneously (or in the short-run) cause a significant of 0.489% rise in the lending rate and a significant 0.157% for a drop while in the long-run it will rise by 1.11% and drop of 0.69%, respectively. In the case of the yield rates on securities, the contemporaneous effect is between 0.56-0.76% for positive changes and 0.42-0.54% for negative changes while in the long run it is 1.0-1.2% for positive changes and 0.76-1.01% for negative changes. The Wald test for symmetry shows that there is asymmetry in the response of the deposit rates while the PSS-test shows the existence of the long-run relationship.

Table 7: The asymmetric Pass-through of the money market rate to other rates

	Deposit Rates on Amounts Exceeding K20,000								Saving rates		Average lending Rate
	Check	*Call*	*7-Day*	*14-Day*	*30-Day*	*60-Day*	*90-Day*	*180-Day*	*Saving1*	*Saving2*	*Lending Rate*
θ	0.029***	-0.005	0.098*	0.160**	0.061***	0.064***	0.063***	0.171***	0.021**	0.100***	0.075***
ω_-	0.037	0.030	0.069***	0.091***	0.042***	0.163***	0.172***	0.163***	0.056**	0.041	0.071***
ω_+	0.029	0.019	0.048***	0.081***	0.041***	0.150***	0.156***	0.162***	0.055**	0.026	0.065*
δ	(0.168)***	(0.124)*	(0.194)***	(0.210)***	(0.065)***	(0.248)***	(0.213)***	(0.215)***	(0.136)***	(0.132)***	(0.144)***
$\emptyset_0^-$	0.018	0.089***	0.112**	0.080	0.103*	0.103**	0.125**	0.160*	0.076**	-0.018	0.140**
$\emptyset_0^+$	0.005	0.013	0.058*	-0.014	0.089*	0.008	0.062	0.114***	-0.068	0.000	0.161*
β^-	0.222	0.245*	0.357***	0.436**	0.647***	0.658***	0.805***	0.759***	0.414***	0.312*	0.449***
β^+	0.174	0.115**	0.249**	0.384**	0.545***	0.603**	0.731***	0.757***	0.407***	0.200**	0.492***
R^2	0.48	0.32	0.35	0.44	0.49	0.42	0.41	0.48	0.40	0.4	0.45
$\boldsymbol{\beta^- = 1}$	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**	**NO**
$\boldsymbol{\beta^+ = 1}$	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**	**NO**
$\boldsymbol{\beta^+ = \beta^-}$	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**
$\boldsymbol{\emptyset_0^+ = \emptyset_0^-}$	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**
PSS Test	13.649***	9.287***	10.095***	9.842***	4.217**	9.878***	9.586***	8.880***	4.966**	4.321**	4.983**
MAL-	5.8	7.4	4.5	4.4	4.9	3.6	4.1	3.9	6.8	7.6	6.0
MAL+	5.9	8.0	4.9	4.8	4.0	4.0	4.4	4.4	7.8	7.7	5.8
Pass-through from the money market rate to long term Yield rates											
	2-Year Bond Yield				*3-Year Bond Yield*				*5-Year Bond Yield*		
θ	0.193***				0.052				0.008		
ω_-	0.107***				0.246***				0.188**		
ω_+	0.139***				0.271***				0.225***		
δ	(0.187)***				(0.421)***				(0.292)***		
$\emptyset_0^-$	0.137*				0.136***				0.183**		
$\emptyset_0^+$	0.171**				0.214***				0.245*		
β^-	0.570***				0.585***				0.610***		
β^+	0.744***				0.642***				0.773***		
R^2	0.56				0.30				0.32		
$\boldsymbol{\beta^- = 1}$	**NO**				**NO**				**NO**		
$\boldsymbol{\beta^+ = 1}$	**YES**				**NO**				**YES**		
$\boldsymbol{\beta^+ = \beta^-}$	**NO**				**NO**				**NO**		
$\boldsymbol{\emptyset_0^+ = \emptyset_0^-}$	**NO**				**NO**				**NO**		
PSS Test	**6.347*** **				**3.883** **				**4.048** **		
MAL-	4.4				2.1				2.6		
MAL+	4.6				1.8				2.8		

*Source: Computations by the Author. In the table *,**,*** means statistically significant at 10%, 5% and 1% respectively.*

The results of NARDL model for the pass-through from money market to retail and securities yield rates are presented in Table 7 above. Results in table 7 include additive and multiplicative dummies for the identified structural breaks in the data. Generally, the results from the models show low levels of explanatory power with adjusted R^2 of between 0.30-0.49. The results show that positive changes in the interbank rate have limited contemporaneous effect on deposit rates while negative changes have significant immediate impact. In-fact, negative changes have a significant effect on all deposit rates with an exception of the check rate, 14-day and the saving rate for amounts above K100. On the other hand, positive changes have mostly insignificant effects with an exception of 7-day, 30-day and 180-day rate. However, in the long run both positive and negative changes in the interbank have significant effect on the deposit rates with an exception of the check rate. Specifically, the results show that a 1% positive change in the interbank rate will cause deposit rates to rise by between 0.17-0.76% while a negative change would cause interest rates to fall by between 0.12-0.81% in the long-run. In addition, the Wald-test for symmetry shows that with a few exceptions there is asymmetry of the pass-through between positive and negative changes in the long run. The long-run exceptions include 90-day and 180-day while for the contemporaneous effects it is the saving rate for amounts less than K100 and the 14-day deposit rate. Finally, the Bounds test results show that there is a significant long-run relationship in all cases.

On the asset side, the results from Table 7 above show that there is relatively better explanatory power is relatively low with an exception of the 2-year bond yield rate with the adjusted r-squared of 0.56. The results show that there is asymmetry of the pass-through both in the short- and long-run. Specifically, the effects of positive changes in the interbank rate on lending and yield rates lie between 0.16-0.25% while for negative changes it is between 0.13-0.19 in the short-run while in the long run it is between 0.49-0.800 for positive changes and 0.45-0.61% for negative changes. Furthermore, the Wald-test for long-run asymmetry completeness shows that there is only complete pass-through for positive change in the 2-year yield rate and 5-year bond yield rate while for negative changes there is none, which shows complete pass-through.

5.0 Conclusions and Discussions

This paper investigates interest rate pass-through of monetary policy changes to retail and yield rates in Zambia. Specifically, the study focuses on unravelling evidence on the asymmetric response of retail and bond yield rates to monetary policy. The empirical analysis is undertaken in two phases, namely; the first parts looks at the symmetrical response of retail and bond yield rates to changes in policy controlled rates while the second part looks at the asymmetrical response of retail and bond yield rates.

Using quarterly data and results of the linear ARDL model: *i) there is low pass-through from the 3-month rate or Policy rate to the deposit rates while there is a high and complete pass-through to the lending and yield rates*. This result is consistent with findings by others (Ononugbo, 2012; Hoffman and Mizen, 2004; de Bondt, 2005). This result has many implications regarding the behaviour of commercial banks. Specifically, they imply that commercial banks do not raise or reduce deposit rates quickly in response to monetary policy loosening or tightening in order to increase their profit margins or cut costs. On the other hand, commercial banks raise or cut their interest rates on the assets to protect their margins. This also gives an impetus for us to look at the asymmetry of interest rates response; *ii) There is a strong pass-through from the policy rate (3-month rate) to the money market rate in the short- and long-run*. This result clearly shows that monetary policy has a strong effect on the money market which is the first stage in monetary policy transmission; *iii) There is generally short-*

term stickiness of the interest rates relative to long-run. This result is consistent with others (Ononugbo, 2012; Mojon, 2000; De Bondt, 2005; Chileshe and Zgambo, 2014). It is important to note that monetary policy would be effective if the contemporaneous effect were larger. Although, the immediate pass-through is higher in some instances such as policy to interbank rate, it is generally lower than unit. This clearly indicates that interest rates are sluggish in the short run. *iv); and Finally, the pass-through from the money market rate are generally higher and complete for longer maturity deposit rates and asset side rates.* The results show that the pass-through from the money market rate to retail rates is higher for deposits with maturity of 30-days and above as well as for the lending and yield rates. However, the pass-through is generally lower for the deposit rates with maturities less than a month.

On the other conclusions drawn from results using the NARDL model include: i) *the pass-through is generally higher from the 3-month rate (policy rate) than from the interbank rate*. In general, the pass-through from the interbank rate is slower and lower compared to that from policy rate for both positive and negative changes. This result is similar to those obtained by Ononugbo (2012) on Nigeria. This could be explained in the sense that economic agents consider changes in the policy rate more cardinal in interpreting future changes in economic fundamentals than changes in money market rate, which could be responding to changes in financial market liquidity, which could be attributed to other factors other than policy changes.

i) *There is negative asymmetry in the pass-through from policy to deposit rates.* The results show that commercial bank tend to cut interest rates on deposit more during loosening compared to periods of tightening. Specifically, commercial banks reduce interest rates less in response to loosening compared to the increase in response to tightening in both the short- and long-run. This may arise when commercial banks are biased towards maintaining or increasing their margins. This is highly likely in markets where there are high levels of concentration or less competition in the banking sector where the source of funds is not primarily deposits.

ii) *There is a positive asymmetry in the pass-through from both interbank rate and policy rates to lending and yield rates.* The yield rates and lending rate showed a positive asymmetry both in the short and long run, which shows that commercial banks tend to increase interest rates when there is tightening while they are not willing to lower these rates when there is policy loosening.

In general, results from the analysis point to evidence of asymmetry in the response of interest rates to changes in policy-controlled rates to retail and yield rates. This phenomenon may arise for a number of reasons such as: 1) the bank-borrower relationship maybe characterised by higher switching costs or incomplete information on the part of bank client (Greenwood-Nimmo et al., 2010). For example, when the cost of funds increases due to tight policy commercial banks increases interest rates to maintain their margins while when the interest rate fall banks cut the rates less. Further, switching costs and information costs maybe more relevant in case of consumer loans such as business and household loans (Borio and Fritz, 1995; Mojon, 2000); 2) Retail rates maybe rigid due to market structure in the banking system (Greenwood-Nimmo et al., 2010). If the markets are oligopolistic the lending maybe rigid downwards as banks may be scared of cutting prices for fear of starting a price war; 3) Positive asymmetry may arise due to demand-side phenomenon, linked to business cycles. During a recession the demand for loans may become more inelastic as more firms become bank dependent making them vulnerable to the banks.

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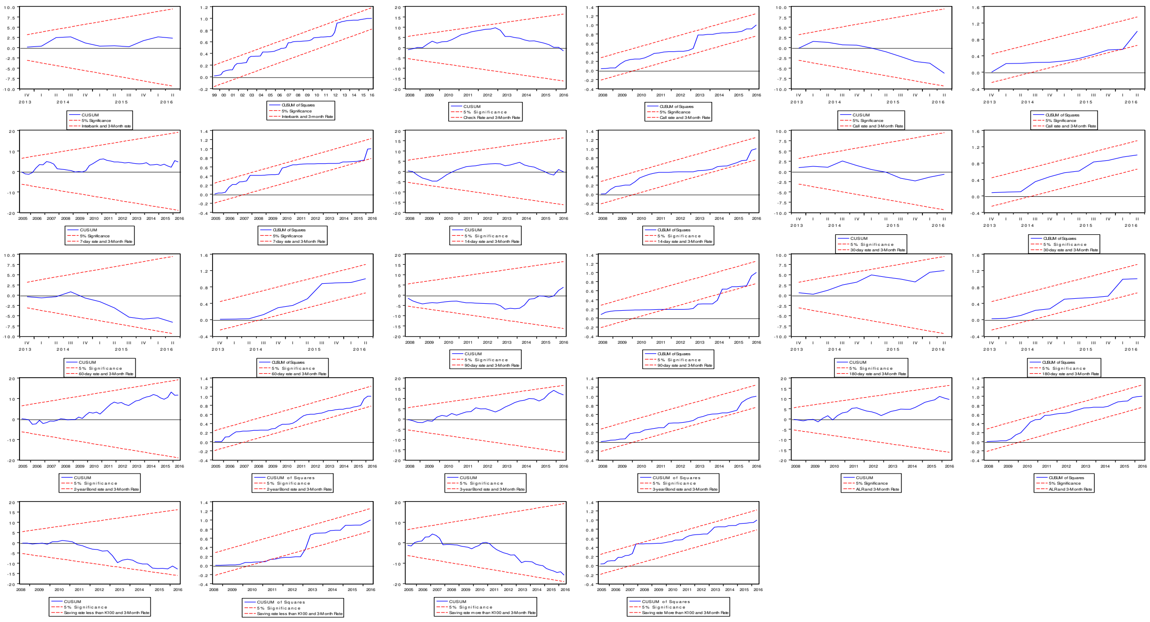
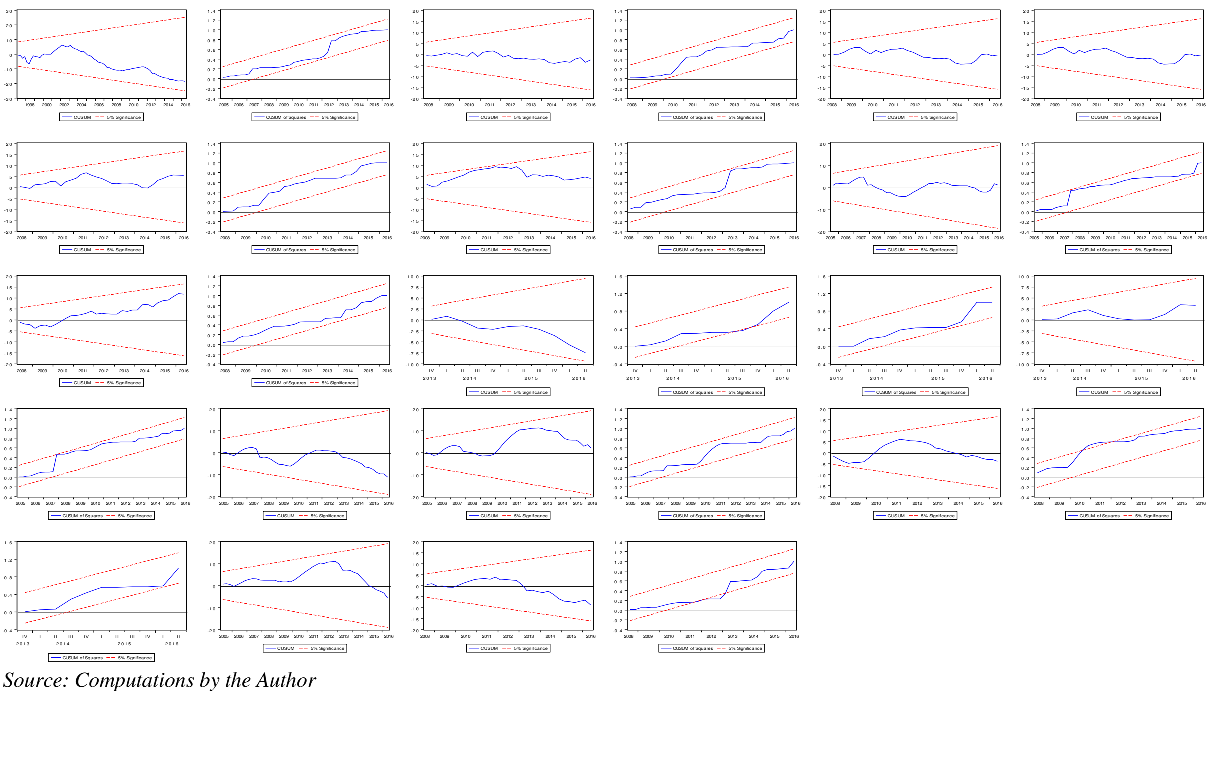
Appendix A

Figure 1A: CUSUM plots for the pass-through of the changes in 3-month rate to other rates incorporating structural breaks



Source: Computations by the Author

Figure 2A: CUSUM Plots of the Pass-through of changes in the Money Market Rate to others Rates after taking account Structural Breaks



Source: Computations by the Author

Table 1A: ARDL results of the pass-through of changes in the 3-month Rate to other Interest Rates incorporating Break Dates

$\Delta int_t = 0.659\Delta Bozr_t - 0.146\Delta Bozr_{t-1} + 0.054SD98_{Q4} + 0.039 - 0.407int_{t-1} + 0.603Bozr_{t-1}$ (0.000) (0.356) (0.016) (0.299) (0.000) (0.000)	R^2=0.51
$\Delta Check_t = 0.250\Delta Check_{t-1} + 0.151\Delta Bozr_t + 0.063SD98_{Q4} - 0.203BoZR * SD98_{Q4} - 0.058 - 0.096Check_{t-1} + 0.022Bozr_{t-1}$ (0.049) (0.019) (0.023) (0.000) (0.156) (0.000) (0.049)	R^2=0.34
$\Delta Call_t = 0.285\Delta Call_{t-3} + 0.034\Delta Bozr_t + 0.018SD98_{Q4} - 0.017 - 0.106Call_{t-1} + 0.023Bozr_{t-1}$ (0.000) (0.257) (0.187) (0.251) (0.049) (0.052)	R^2=0.26
$\Delta 7day_t = 0.152\Delta Bozr_t - 0.016BoZr * SD07_{Q4} + 0.002 - 0.130 * 7day_{t-1} + 0.044Bozr_{t-1}$ (0.001) (0.067) (0.183) (0.002) (0.103)	R^2=0.39
$\Delta 14day_t = 0.137\Delta 14day_{t-1} + 0.152\Delta 14day_{t-2} + 0.187\Delta 14day_{t-3} + 0.100\Delta Bozr_t + 0.001SD07_{04} - 0.0004 - 0.255 * 14day_{t-1} + 0.104Bozr_{t-1}$ (0.155) (0.055) (0.000) (0.029) (0.075) (0.313) (0.000) (0.000)	R^2=0.34
$\Delta 30day_t = 0.214\Delta 30day_{t-1} + 0.176\Delta Bozr_t + 0.079SD98_{04} - 0.052BOZr * SD98_{Q4} + 0.0004 - 0.114 * 30day_{t-1} + 0.061Bozr_{t-1}$ (0.025) (0.000) (0.000) (0.000) (0.886) (0.0017) (0.026)	R^2=0.38
$\Delta 60day_t = 0.180\Delta 60day_{t-1} + 0.130\Delta Bozr_t + 0.011SD07_{04} + 0.002SD13_{Q2} + 0.007 - 0.267 * 60day_{t-1} + 0.136Bozr_{t-1}$ (0.067) (0.014) (0.024) (0.084) (0.089) (0.000) (0.000)	R^2=0.40
$\Delta 90day_t = 0.396\Delta 90day_{t-1} + 0.230\Delta Bozr_t + 0.008SD07_{04} - 0.045BoZr * SD07_{Q4} + 0.001 - 0.220 * 90day_{t-1} + 0.136Bozr_{t-1}$ (0.000) (0.003) (0.057) (0.001) (0.101) (0.008) (0.000)	R^2=0.49
$\Delta 180day_t = 0.183\Delta 180day_{t-1} + 0.140\Delta Bozr_t - 0.052D04_{Q4} + 0.038 - 0.359 * 180day_{t-1} + 0.420Bozr_{t-1}$ (0.050) (0.043) (0.001) (0.014) (0.000) (0.000)	R^2=0.59
$\Delta Saving1_t = 0.228\Delta Saving1_{t-1} + 0.006\Delta Bozr_t + 0.004SD07_{Q4} - 0.037BoZR_t * SD07_{Q4} + 0.001 - 0.104 * Saving1_{t-1} + 0.013Bozr_{t-1}$ (0.026) (0.185) (0.058) (0.078) (0.000) (0.047)	R^2=0.41
$\Delta Saving2_t = 0.215\Delta Saving1_{t-1} + 0.007\Delta Bozr_t - 0.038BoZr * SD07_{04} + 0.007 - 0.104 * Saving1_{t-1} + 0.008Bozr_{t-1}$ (0.024) (0.301) (0.041) (0.135) (0.068) (0.001)	R^2=0.40
$\Delta ALR_t = 0.310\Delta ALR_{t-1} + 0.414\Delta Bozr_t + 0.048SD07_{Q4} - 0.114BoZR * SD07_{Q4} - 0.036 + 0.270 * 90day_{t-1} + 0.244Bozr_{t-1}$ (0.021) (0.000) (0.004) (0.005) (0.096) (0.000) (0.000)	R^2=0.71
$\Delta Bond2\_year_t = 0.173\Delta Bond2\_year_{t-1} + 0.695\Delta Bozr_t + 0.034 + 0.015SD07_{04} - 0.474 * Bond2\_year_{t-1} + 0.481Bozr_{t-1}$ (0.029) (0.000) (0.109) (0.015) (0.000) (0.000)	R^2=0.81
$\Delta Bond3\_year_t = 0.588\Delta Bozr_t + 0.016 + 0.011SD07_{Q4} - 0.277 * Bond3\_year_{t-1} + 0.277Bozr_{t-1}$ (0.000) (0.141) (0.057) (0.090) (0.009)	R^2=0.60
$\Delta Bond5\_year_t = 0.598\Delta Bozr_t + 0.023 + 0.014SD07_{Q4} - 0.483 * Bond5\_year_{t-1} + 0.401Bozr_{t-1}$ (0.000) (0.121) (0.053) (0.018) (0.007)	R^2=0.63

Source: Computations by the Author

Table 2A: ARDL results of the Money Market Rate Pass-through to other Interest Rates incorporating Break Dates

$\Delta Check_t = 0.462\Delta Check_{t-1} + 0.057\Delta INT_t + 0.011SD07_{Q4} - 0.114INT * SD07_{Q4} - 0.006 - 0.155Check_{t-1} + 0.082INT_{t-1}$ (0.000) (0.048) (0.013) (0.031) (0.311) (0.000) (0.021)	R^2=0.52
$\Delta Call_t = -0.091\Delta Call_{t-1} + 0.041\Delta INT_t + 0.021SD98_{Q4} + 0.001SD07_{Q4} - 0.007SD13_{Q4} - 0.023 - 0.179Call_{t-1} + 0.082Bozr_{t-1}$ (0.148) (0.024) (0.087) (0.063) (0.073) (0.202) (0.002) (0.000)	R^2=0.33
$\Delta 7day_t = 0.025\Delta INT_t + 0.048SD98_{Q4} - 0.017INT * SD98_{Q4} + 0.009SD07_{Q4} + 0.014 - 0.185 * 7day_{t-1} + 0.090INT_{t-1}$ (0.000) (0.001) (0.003) (0.069) (0.169) (0.000) (0.000)	R^2=0.39
$\Delta 14day_t = 0.027\Delta INT_t + 0.085SD98_{Q4} - 0.026INT * SD98_{Q4} + 0.004 - 0.136 * 14day_{t-1} + 0.046Bozr_{t-1}$ (0.000) (0.000) (0.000) (0.000) (0.000) (0.000)	R^2=0.47
$\Delta 30day_t = 0.351\Delta 30day_{t-1} + 0.116\Delta INT_t + 0.036SD98_{Q4} - 0.170INT * SD98_{Q4} + 0.013 - 0.252 * 14day_{t-1} + 0.133INT_{t-1}$ (0.002) (0.000) (0.032) (0.000) (0.157) (0.000) (0.000)	R^2=0.38
$\Delta 60day_t = 0.293\Delta 30day_{t-1} + 0.060\Delta INT_t - 0.036SD04_{Q4} + 0.013 - 0.239 * 14day_{t-1} + 0.163INT_{t-1}$ (0.003) (0.116) (0.013) (0.256) (0.000) (0.000)	R^2=0.43
$\Delta 90day_t = 0.418\Delta 90day_{t-1} + 0.126\Delta INT_t + 0.043SD98_{Q4} - 0.190INT * SD98_{Q4} + 0.006 - 0.303 * 90day_{t-1} + 0.290INT_{t-1}$ (0.001) (0.000) (0.006) (0.000) (0.743) (0.000) (0.000)	R^2=0.36
$\Delta 180day_t = 0.313\Delta 180day_{t-1} + 0.176\Delta INT_t + 0.015SD98_{Q4} - 0.110INT * SD98_{Q4} + 0.001 - 0.285 * 90day_{t-1} + 0.232INT_{t-1}$ (0.004) (0.079) (0.016) (0.053) (0.693) (0.000) (0.000)	R^2=0.36
$\Delta SVR1_t = 0.287\Delta SVR1_{t-1} + 0.012\Delta INT_t + 0.003SD98_{Q4} - 0.005 - 0.130 * SVR1_{t-1} + 0.053INT_{t-1}$ (0.027) (0.563) (0.070) (0.670) (0.015) (0.007)	R^2=0.35
$\Delta SVR2_t = 0.520\Delta SVR2_{t-1} + 0.008\Delta INT_t + 0.009SD98_{Q4} + 0.071 - 0.178 * SVR2_{t-1} + 0.061INT_{t-1}$ (0.002) (0.715) (0.032) (0.032) (0.000) (0.013)	R^2=0.43
$\Delta Alr_t = 0.523\Delta Alr_{t-1} + 0.154\Delta INT_t + 0.049SD98_{Q4} - 0.014SD04_{Q4} + 0.123 - 0.053 * 7day_{t-1} + 0.049INT_{t-1}$ (0.000) (0.000) (0.011) (0.043) (0.169) (0.042) (0.096)	R^2=0.32
$\Delta Bond2\_year_t = 0.490\Delta Bond2\_year_{t-1} + 0.272\Delta Bozr_t + 0.020 + 0.010SD07_{04} - 0.016SD04_{04} - 0.286 * Bond2_{year_{t-1}} + 0.262Bozr_{t-1}$ (0.000) (0.000) (0.049) (0.058) (0.045) (0.013) (0.068)	R^2=0.81
$\Delta Bond3\_year_t = 0.267\Delta Bozr_t + 0.065 + 0.010SD07_{Q4} - 0.334 * Bond3\_year_{t-1} + 0.285Bozr_{t-1}$ (0.000) (0.039) (0.017) (0.002) (0.001)	R^2=0.29
$\Delta Bond5\_year_t = 0.232\Delta Bozr_t + 0.045 + 0.044SD07_{Q4} - 0.280 * Bond3\_year_{t-1} + 0.232Bozr_{t-1}$ (0.004) (0.164) (0.082) (0.006) (0.005)	R^2=0.32

Source: Computations by the Author