# SOUTH AFRICAN MONEY MARKET VOLATILITY, ASYMMETRY AND RETAIL INTEREST RATES PASS-THROUGH


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## DECLARATION

Excluding the references and sources listed and specified, and other works acknowledged, this thesis is wholly my own work and has not been submitted to any other University, Technikon or College for degree purposes.

**ABSTRACT**

The purpose of this paper is to examine the interest rate transmission mechanism for South Africa as an emerging economy in a pre-repo and repo system. It explains how the money market rate is transmitted to the retail interest rates both in the long-run and short-run and tests the symmetric and asymmetric interest rate pass-through using the Scholnick (1996) ECM and the Wang and Lee (2009) ECM-EGARCH (1, 1)-M methodology. This permitted the examination of the impact of interest rate volatility, along with the leverage effect. An incomplete pass-through is found in the short-run. From the entire sample period, a symmetric adjustment is found in the deposit rate, which had upward rigidity adjustment, while an asymmetric adjustment is found in the lending rate, with a downward rigidity adjustment. All the adjustments supported the collusive pricing arrangements. According to the conditional variance estimation of the ECM-EGARCH (1, 1), negative volatility impact and leverage effect are present and influential only in the deposit interest rate adjustment process in South Africa.

Keywords: Interest rates pass-through, Asymmetric ECM, ECM-EGARCH-M model, Interest volatility, South Africa.

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## TABLE OF CONTENTS

**CHAPTER 3: AN OVERVIEW OF THE MONETARY POLICY AND FINANCIAL STRUCTURE IN SOUTH AFRICA**



**CHAPTER 4: RESEARCH METHODOLOGY**

**LIST OF FIGURES**

**LIST OF TABLES**

**LIST OF ACRONYMS**

| | |
|---|---|
| ADF | Augmented Dickey Fuller unit root test |
| AIC | Akaike Information Criterion |
| ARCH | Autoregressive Conditionally Heteroscedastic |
| ARCH-LM | Autoregressive Conditionally Heteroscedastic Lagrange Multiplier |
| ARMA | Autoregressive (AR) and Moving Average (MA) |
| CMA | Common Monetary Area |
| CNB | Czech National Bank |
| CPIX | Consumer Price Index |
| CRDW | Cointegrating Regression Durbin Watson |
| DW | Durbin Watson |
| EC-EGARCH (1, 1)-M | Error Correction Exponential Generalised Autoregressive Conditionally Heteroscedastic in Mean |
| ECM | Error Correction Model |
| ECM-EGARCH-M | Error Correction Model-EGARCH in Mean |
| ECM (N) | Negative Asymmetric ECM |
| ECM (P) | Positive Asymmetric ECM |
| EG | Engle-Granger |
| EG ADF | Engle-Granger Augmented Dickey Fuller |
| EGARCH-M | Exponential Generalised Autoregressive Conditionally Heteroscedastic in Mean |
| EY | Engle and Yoo |
| GARCH | Generalised Autoregressive Conditionally Heteroscedastic |
| EMU | European Monetary Union |
| IFS | International Financial Statistics |
| IMF | International Monetary Fund |
| IRPT | Interest Rate Pass-Through |
| KPSS | Kwiatkowski, Phillips, Schmidt and Shin |
| LB | Ljung-Box |
| MAL | Mean Adjustment Lags |
| MMV | Money Market Volatility |
| MPTM | Monetary Policy Transmission Mechanism |

| | |
|---|---|
| OECD | Organisation for Economic Co-operation and Development |
| PT | Pass-Through |
| SA | South Africa |
| SACU | Southern African Customs Union |
| SARB | South African Reserve Bank |
| SVAR | Structural Vector Autoregressive |
| VAR | Vector Autoregressive |
| VECM | Vector Error Correction Model |

# CHAPTER 1

# INTRODUCTION

## 1.1 Context of the research

To understand the interest rate pass-through process, the efficiency and transmission of the monetary policy needs to be considered. This is because the effectiveness of monetary policy depends essentially on the transmission of a policy change to output and therefore on to inflation. In essence, the monetary transmission process starts with the central bank announcing a policy action (for example, changes in the official interest rates – repo or discount rate), as well as engaging in open market operations in order to put the money market interest rates in line with the policy rate. From the transmission process, the effects of such changes in policy direction may progress through different channels, such as the interest rate channel, the credit channel, the exchange rate channel and the other asset-prices channel.

Through the pass-through mechanism, the central bank tries to influence and manage the interest rates in order to attain some of its monetary policy goals. The central bank can, for example, manage the retail interest rates by controlling the short-term monetary market rates (Wang and Lee, 2009: 1270). Accordingly, most central banks use the short-term money market rate as their main instrument of monetary policy, and changes to this short-term interest rate are essential in the transmission of monetary policy. This process therefore highlights some of the importance of the central bank and their role in the money market, and the economy as a whole.

Pass-through, in the context of this paper, is the extent to which the retail rates respond to changes in the money market rates in the long and short run (Bredin *et al.*, 2002). Accordingly, the pass-through process is an important element in the monetary transmission process. A strong pass-through process implies an effective monetary policy in an economy when there is a long-run equilibrium relationship among each of the selected interest rate rates (from money market to deposit and lending rates). The interest rate pass-through (IRPT) process is essential to the monetary transmission mechanism, because it determines how strongly changes in the money market rates are transmitted to lending and deposit rates and ultimately to saving and investment (Raunig and Scharler, 2009). Retail deposit and lending rates are assumed to adjust with a delay to changes in the money market interest rates (determined by the central bank)[1]. These retail rates are important because they represent the marginal cost of new credit as well as the opportunity cost of funds in an economy (Wang and Lee, 2009). As a result, the central bank influences commercial banks' actions, as they react to changes in the money market rate, by adjusting their retail rates. Therefore, the size and speed of the adjustment process from the central bank to commercial banks, and its likely influence finally to customers' spending and inflation, is what leads to the study area of pass-through[2].

The pass-through from money market interest rate has sparked a large interest in the field of pass-through of market rate to retail rates. Most of the studies reviewed on monetary policy transmission and IRPT, including market rates[3] to retail interest rates, have arguably all been limited to the Engle and Granger (1987) cointegration test, Johansen, symmetric and asymmetric error correction model (ECM), VAR and SVAR methodology. For example, Cottarelli and Kourelis (1994), Borio and Fritz (1995), Mojon (2000), Weth (2002) and Berstein and Fuentes (2003), using the popular ECM model in their analysis, explained that the market has incomplete pass-through of money market to retail bank interest rates. These authors explained different country-specific pass-through strengths and determinants, and suggested that factors such as a country's financial structure, competition and concentration within the banking sector influence the pass-through mechanism.

Several other studies that examined interest rate pass-through in South Africa, and Southern African Customs Union (SACU) countries, include such as by De Angelis *et al.* (2005), Aziakpono (2006), Sander and Kleimier (2006), Aziakpono *et al.* (2007a), Aziakpono *et al.* (2007b) and Aziakpono and Wilson (2010). In spite of the changing financial environment in South Africa which could have a significant effect on the degree of IRPT, non of the earlier studies have, to the best of knowledge, explicitly examined the impact of money market volatility and leverage effect on the size and speed of adjustment of response of retail interest rates to changes in monetary policy rate.

[1] Note that the wholesale rate is also the cost of funds for the commercial banks.

[2] The interest rate pass-through mechanism occurs when the central bank adjusts the monetary policy: for example, the discount rate/policy rate (repo rate in SA), then the money market rate (for example, the inter-bank call rate) is impacted. These makes the commercial banks transfer the costs resulting from the adjustment of the money market rate to the deposit/lending interest rates (Wang and Lee, 2009: 1271).

[3] Market rates, money market rate or interbank rate are used interchangeably in the chapters.

This study attempts to fill this gap in the literature by adopting and adjusting Wang and Lee's (2009) ECM-EGARCH-M model to explain the IRPT. The aspect of volatility involves answering the question of how interest rates volatility affects the adjustment process of retail interest rates, while leverage explains whether negative shocks of interest adjustment are greater than positive shock. In essence, the study looks at the impact of interest rate volatility on SA interest rates, and how the variances of the retail deposit or lending rates vary with time.

The study focuses on the interest rate channel and on the effectiveness of the monetary transmission mechanism with respect to the size and speed of response of the retail interest rates to changes in the money market interest rates. To create a clearer understanding of the central bank's role and the pass-through mechanism, the study explains the impact of the money market volatility (MMV) on the interest rate pass-through. It essentially argues that South Africa's money market exhibits some features of volatility and it will make excellent research sense to verify the pass-through mechanism in this market. MMV here is related to interest rate fluctuations, which are explained by the asymmetry of market information. According to Manna *et al*. (2001), interest rate fluctuations are an important indicator to the monetary policy during the transmission process. This is because movements in the interest rates are important in an economy as the deposit and the lending rates directly affect the behaviours of fund suppliers and demanders, which in turn, determine economic growth, inflation, and an effective monetary policy.

## 1.2 Goals of the research

The primary goal of the research is to analyse the interest rate pass-through mechanism of monetary policy in the country, and the impacts of interest rate volatility and leverage effect on the pass-through process. To achieve this, the study specifically aims to:

1. examine the long and short-run pass-through mechanisms between the money market rate and the retail interest rate;

2. compare the pass-through of the pre-repo and repo period, and thereby determine the improvement in the monetary transmission through the employment of the repo as a monetary tool;

3. examine the impact of the interest rate volatility on interest rate adjustment, along with the examination of the leverage effect;
4. determine the presence of interest rate effect theory in terms of the presence of collusive pricing arrangement and customer reaction, and compare the results;
5. highlight the policy implications of the findings for monetary policy, investors, consumers and central bank.

## 1.3 Proposed methods, procedures and techniques

The study will follow the error-correction methodology format of Scholnick (1996), Sander and Kleimeier (2000), and the EGARCH-M format of Wang and Lee (2009). This study uses an asymmetric ARCH model, in the form of a combined ECM-EGARCH (1, 1)-M model to examine the IRPT mechanism in South Africa.

The key issue that is addressed is whether, in South Africa, the choice of an operational structure for monetary policy has been systematically related to patterns in money market rates. Empirical tests are conducted using a sample period of monthly data for 20 years, from September 1990 to January 2010. The sample period covers two major periods: the pre-repo and repo period (the repo system was implemented in 1998:3). The data will include the interbank money market rate, lending rate and deposit rate for South Africa. Secondary data will be used, obtained from the International Monetary Fund's (IMF) International Financial Statistics (IFS), and Thomson DataStream.

Since this is, to the best of my knowledge, the first application of the model using South African data, the outcomes of this research will give an indication of whether the interest rates pass-through in the country is complete, and whether the market is influenced by interest rate volatility and leverage presence. It will further assist in identifying appropriate monetary policy design, implementation, implications and importance. In addition to an enhanced understanding of the monetary transmission mechanism in South African, the research may also assist the SARB in influencing short term money market rates and monetary policy.

## 1.4 Organisation of the study

There are six sections in this study, organised as follows: Chapter 2 presents the theoretical and empirical literature on money market volatility, market asymmetry and IRPT. Chapter 3 provides an overview of the South African financial structure, financial structure indicators and changes over time. Chapter 4 describes the theoretical background, empirical methodology and data descriptions. Chapter 5 presents the results and findings of the study. Finally, the conclusion, results and implications are discussed in Chapter 6.

# CHAPTER 2

# THEORETICAL AND EMPIRICAL LITERATURE

## 2.1 Introduction

This chapter reviews the theoretical and empirical literature on money market volatility, market asymmetry and IRPT. The chapter is divided into different subsections. The first part of the chapter provides a brief description of the interest rate transmission channel. This is followed by definitions, description and determinants of the interest rate pass-through. Next, theories relating to the interest rates effects and rigidity adjustment are discussed, and the link between MMV, IRPT and the theories is explained. This is followed by a discussion of the empirical literature, reviewing different econometric methods employed by different authors, and the different results obtained.

## 2.2 Theoretical framework

### 2.2.1 Monetary transmission through the interest rate channel

As described in Chapter 1, the effectiveness of monetary policy depends crucially on the transmission of a policy change to output and eventually to inflation. The monetary transmission process begins with the central bank announcing a policy action and engaging in open market operations to bring money market interest rates in line with the policy rate. From there, monetary transmission may proceed through several channels, such as the interest rate channel, the credit channel, the other asset-prices-effects channel and the exchange rate channel. As a result, the effectiveness of the monetary policy transmission mechanism (MPTM) is explained, in respect of the size and speed by which retail interest rates respond to changes in the policy rate.

#### 2.2.1.1 The traditional interest rate channel theory

The essence of elaborating on the traditional interest rate channel is to determine the importance of interest rates and their use to central banks, commercial banks, IRPT analysis and thereby as a monetary policy tool. The traditional Keynesian view of the MPTM in this context describes the effect of a monetary expansion. This view indicates the important feature of the interest rate transmission mechanism. For instance, the interest-rate transmission channel explains how the central bank makes changes to the short-term nominal interest rate which results in a corresponding change in the real interest rate. The implication of these changes shows that an expansionary monetary policy lowers the short-term nominal interest rate, which also lowers the short-term real interest rate (Mishkin, 2004: 617). It further explains that spending can also be stimulated through the interest rate channel, indicating the effectiveness of monetary policy through the transmission mechanism. With monetary policy being effective, the central bank can make use of this tool (interest rate channel) in attaining monetary goals in the system.

From the above, it can be seen that the implications of the monetary transmission mechanism are important. In the context of the monetary policy transmission process, an important role is assigned to bank interest rates. These interest rate relationships are part of the monetary policy impulses that are transmitted by means of bank interest rates. In addition, the effect of the banks' deposit rates on households' savings and investment decisions is of importance, as changes from the wholesale market rates are passed through to the customers' retail rates. According to the interest rate channel theory, the implication of higher interest rates is that it reduces spending by households and firms, while low interest rates, on the contrary, stimulates spending (Mishkin, 2004).

### 2.2.2 Interest rate pass-through

IRPT is the size and speed of adjustment of the bank lending and deposit rates in response to changes in the official rate (central bank/policy determined rate) in the long and short-run. It is worth noting that there are different types and strengths of pass-through, depending on the size and speed of adjustment of pass-through from the official rate or money market rate to the retail rates. These are complete pass-through, incomplete pass-through and 'over' pass-through (Wang and Lee, 2009).

Complete pass-through is a movement in the money market rate with a one-for-one change in retail rates, which indicates an effective interest rate channel. Incomplete pass-through is when changes in the money market rate to the retail rates are less than one. Incomplete pass-through may occur due to circumstances such as the influence of the financial structure in relation to bank sizes, competition level and market asymmetry, making commercial banks pass-through part of the cost, rather than the whole cost. "Over pass-through" is when the pass-through ratio is greater than one (Wang and Lee, 2009: 1270). This describes a highly competitive and efficient financial market system. A complete and 'over' pass-through is the desires and goals of any economy, while an incomplete pass-through might signal an uncompetitive and inefficient financial system.

There are several means of describing the IRPT, particularly when explaining the incomplete pass-through. For instance, retail rates are described as rigid when there is a slow response of the lending/deposit rates to movements in the money market rate, that is, when the change transferred is incomplete. However, the pass-through process generally differs among countries, such that retail rates rigidity in bank lending/deposit rates in any economy depends on the country's financial market structure, economic policy, the degree of financial market development, the level of competition within the banking system, and the ownership structure of financial intermediaries (Agénor and Montiel, 2008: 177). These factors, and several others such as financial market openness, interest rate volatility and the financial market development, have been suggested and supported by many authors such as Cottarelli and Kourelis (1994), Borio and Fritz (1995), Scholnick (1996), Mojon (2000), Lim (2001), Weth (2002), De Bondt (2002), Sander and Kleimeier (2004), Sander and Kleimier (2006), De Angelis *et al.* (2005), Aziakpono (2006), Aziakpono *et al.* (2007a), Aziakpono *et al.* (2007b), Gambacorta (2008), Liu *et al.* (2008), Wang and Lee (2009), Kwapil and Scharler (2009), Wang and Thi (2010) and Aziakpono and Wilson (2010). Understanding these factors is important, because they may impact on the pass-through mechanism. By taking some of these factors into consideration, this study attempts to explain their impact on the IRPT mechanism.

In addition to rigidity, another determinant used to describe the pass-through mechanism is flexibility. Some findings from the pass-through mechanism are described as flexible, implying the ease, smoothness, and less sluggish movement from the money market changes to the retail rates. Rigidity or inflexibility is the opposite of flexibility. Similarly, because the money market rates are short-term interest rates, changes to these rates can result in a wide gap between the short-run and the long-run adjustments, which can also be viewed as evidence of interest rate rigidity, that is, in the form of structural adjustments in long and short-term interest rates (Aziakpono and Wilson, 2010). This implies that the size and speed of adjustments depend on the presence of adjustment rigidity (Wang and Lee, 2009: 1271). Therefore, the investigation of IRPT can provide reasons behind the presence of rigidity in the interest rate adjustment, as well as providing information on the relationship between the rigidity and the monetary policy tool.

### 2.2.3 Determinants of interest rate pass-through

Some of the determinants of ITRP are explained through the role of the financial system, whereby the financial system explains the changing strength and speed of monetary interest rate transmission through disintermediation, competition level in the banking industry, capitalization and liquidity position of banks and monetary policy and interest rate volatility (Horváth *et al.*, 2004: 7). With regard to the area of competition among banks, the level of competition within the financial system may depend on the terms of regulation in the system: for example, the regulation terms surrounding the entry of new banks, whether local or foreign, and other financial intermediaries in terms of the difficulty or ease of entry; the number and size of intermediaries and the ownership structure, in terms of whether the financial institutions are owned largely by the private sector or by the state, including the openness of the financial system (Aziakpono and Wilson, 2010: 12).

Wang and Lee (2009) elaborated on how competition between commercial banks produces continuous changing financial information, which contributes to more fluctuating interest rates. Other issues that are thought to contribute to interest rate fluctuations include governments and investors having different forecasts of business cycle conditions. If every government has different regulations on inward or outward capital movements, then these regulations are likely to differ with the central banks' interest rate policies. Similarly, the intensity of competition among banks influences the interest rate rigidity of credit demand and deposit supply. Such that a low degree of competition implies a higher interest margin spread, which influences on banks' pricing behaviour. This further indicates the presence of a highly concentrated banking market, which can lead to oligopolistic behaviour of banks. This influences the IRPT process, and is considered to contribute to asymmetric adjustment of the interest rates.

Another influencing factor is the ownership structure of banks, in terms of whether the banks are owned by the state or by the private sector, whereby, a state dominated banking system results in banking concentration or monopoly, which may cause rigidity in the interest rates, because state-owned banks can be subjected to and or influenced by political pressures or inefficiency. Generally, the ownership structure of the banks may influence the presence of competition in the market as banks of different ownership often have different mandates and clients (Cottarelli and Kourelis, 1994, World Bank, 2005: 19 and Aziakpono and Wilson, 2010).

In terms of capitalization and liquidity position of banks, well-capitalized and liquid banks are less vulnerable to adjusting to changes in monetary policy and have the possibility of absorbing the shocks temporarily (Horváth *et al.*, 2004: 8). The influence of monetary policy and interest rate volatility explains that changing interest rates on bank instruments sustain adjustment costs on banks. Due to menu costs or agency costs, the adjustment of bank rates depends on banks' assessment of whether a change in the policy rate is temporary or permanent. If a change is considered to be temporary, a bank might decide to smooth interest rates. Hence, the pricing behaviour of commercial banks is influenced by their observation of the nature of changes in interest rates. Accordingly, higher volatility in interest rates is likely to reduce the speed of adjustment, as each shift in the market rate is probably regarded as temporary (Horváth *et al*., 2004: 12).

Furthermore, the level of local banks' dependency and reliance on the accommodation facilities provided by the central bank for their liquidity needs is also argued to influence the banks' response to changes in the official rate. This depends on whether the financial system is sufficiently open and banks can easily access external sources of finance, which may then reduce banks' dependence on the accommodation facilities from the central bank. Therefore, in an open financial system the response of bank interest rates to changes in the official rate may be slower than when the market is not open (Aziakpono and Wilson, 2010: 13). The level of development of the financial system may also impact the interest rate adjustment process. For instance, a well-developed financial system might provide alternative financial instruments and intermediaries for investors and savers, thereby providing alternative investment or financing sources for bank loans and deposits. Likewise, alternative financing or investment sources can include active and broad markets for Treasury bills, long-term bonds (government and private), and an active stock market, which makes the financial system development level a contributing factor (Aziakpono and Wilson, 2010: 13).

From the argument that several factors contribute to the adjustment of interest rates, causing a rigid adjustment, some major costs and theories relating to the pass-through process are listed. These include agency cost (costs on the banks), adjustment cost, the switching cost, risk sharing and collusive pricing arrangements and adverse customer reaction theories. These theories assist in providing better explanations of reasons contributing to asymmetric pass-through mechanism, and thus to interest rate rigidity adjustment. The Stiglitz and Weiss (1981) theory also supports the ideas underlying interest rate rigidity adjustment.

To provide further explanations of the pass-through mechanism, market imperfections are explained next. These contribute to asymmetric pass-through, which results from market disequilibrium information, and are when interest rates adjust differently to an increase or decrease in money market rate (Acheampong, 2005). Asymmetry of market information contributes to the sluggish and incomplete pass-through mechanism. There may be asymmetries influencing the speed of adjustment whereby the degree of pass-through depends on whether money market rates increase or decrease. Because there are symmetric and asymmetric pass-through mechanisms, this permits the examination of equilibrium relationship among the interest rates variables (Acheampong, 2005). Also, incomplete or asymmetric pass-through is assumed to be caused by financial market imperfections, while a symmetric pass-through mechanism is observed when the interest rate adjustment is indifferent to an increase or decrease in the money market rate. Arguably, asymmetry of market information is considered as a contributing factor towards the pass-through mechanism, and cannot be accounted for by linear models, hence a non-linear model is required to explain this pass-through mechanism (Wang and Lee, 2009).

Generally, all the influencing factors cannot be listed, as the pass-through mechanism, in developing and emerging countries is arguably incomplete and may not occur very quickly due to the influencing factors mentioned earlier.

### 2.2.4 Theories and implications of interest rate rigidity

To provide a further elaboration and better understanding of market imperfections/asymmetry and some of the contributions to IRPT rigidity and incomplete pass-through, theories explaining interest rate effects are explained in detail next. Two major theories behind symmetric and asymmetric rigidities in deposit and lending rates adjustments are the adverse/negative costumer reactions and collusive pricing arrangements or collusive banks behaviour. A collusive pricing arrangement shows that any pricing arrangement different from the collusive pricing arrangement has additional cost associated with it. This implies the presence of rigidity in increasing the deposit interest rate and in reducing the lending rate, that is, deposit rates are rigid upward when the official rate is increased, while the lending rates are rigid downward in the case of a decrease in the official rate (Aziakpono and Wilson, 2010). According to the adverse customer reaction theory, there is rigidity in reducing the deposit interest rate and in increasing the lending rate, that is, the deposit rates will be rigid downward when the official rate is decreased, while the lending rates will be rigid upward in the case of an increase in the official rate (Lowe and Rohling, 1992; Wang and Lee, 2009 and Aziakpono and Wilson, 2010).

Another theory explanation for asymmetric and incomplete pass-through is the Stiglitz-Weiss (1981) model. The model explains how a change in the interest rates causes two types of effects, the adverse selection theory and the adverse incentive theory, while the model also explains how the effects relate to the rigid adjustment of the interest rates. The Stiglitz-Weiss (1981) model provides an illustration for interest rate rigidity adjustment based on asymmetric information. According to Lowe and Rohling (1992: 4), a firm is assumed to know the risks attached to its projects while the banks cannot distinguish between projects. These information gaps between banks, firms and the risks of projects contribute to information asymmetry, which introduces problems of moral hazard and adverse selection. The adverse selection effect results from when the riskiness of a group of applicants increases, which then leads to a reduction in less risky borrowers in the market. The adverse incentive effect, or moral hazard effect, occurs because other borrowers are encouraged to choose projects with a higher default probability, that is, the higher the risk, the higher the returns, making riskier projects associated with higher expected returns (Agénor and Montiel, 2008: 156).

Different studies have obtained different results about some of these theories, including consumer reaction hypothesis and collusive bank pricing arrangement. For example, Sander and Kleimeier (2006) examined the interest rate pass-through in four Common Monetary Area (CMA) countries of the South African Customs Union (SACU) during the period from 1991 to 2005. The authors employed a unifying empirical pass-through model that allows for thresholds, asymmetric adjustment, and structural changes over time. Their results highlight that the bank lending markets of the CMA demonstrate some degree of homogenization as the pass-through is often fast and complete. Deposit markets were more heterogeneous, showing differing degrees of interest rate rigidity and asymmetric adjustment in some countries. A fast pass-through by international standards was found for deposit rates which showed the existence of market imperfection by showing signs of short and long-run rigidity adjustment, including an asymmetric adjustment pattern with a faster downward adjustment of deposit rates (Sander and Kleimeier, 2006: 13). Their paper obtained similar results with Aziakpono's (2006) study, which also supported and confirmed the presence of these theories.

The recent work of Aziakpono and Wilson (2010) examined market interest rate rigidity over time, using a rolling window and symmetric and asymmetric error correction modelling techniques on monthly interest rates data from 1980 to 2007 in South Africa. The study found that the speed of adjustment of market interest rates varies across the rates, with the highest speed occurring for the lending rate, followed by the Treasury bill rate and the money market rate, then the commercial bank deposit rate, with the government bond yield having the slowest speed of adjustment. Their test for asymmetric adjustment of commercial bank interest rates confirmed asymmetric adjustment in South Africa. Aziakpono and Wilson (2010) also found evidence that the commercial banks are becoming increasingly more rigid in adjusting their lending rates upward in response to a positive shock in the official rate, which supported the negative/adverse customer reaction hypothesis[4]; the opposite was found for the deposit rate adjustment, where the evidence supported collusive behaviour of banks.

Other authors that confirmed the presence of adverse customer reaction and collusive pricing arrangement theories are Lim (2001), Sander and Kleimeier (2002), Wang and Lee (2009) and Wang and Thi (2010). For example, Sander and Kleimeier (2002) found that the adjustment process of retail interest rate is related to the monetary market rate in European countries. Their empirical results showed upward adjustment rigidity in the deposit interest rate and downward adjustment rigidity in the lending rate, which supports the collusive pricing arrangement hypothesis.

[4] Negative and adverse customer reaction hypothesis are used interchangeably, meaning the same thing

On the other hand, Iregui *et al*. (2002) did not find adverse customer reaction hypotheses and collusive pricing arrangement in their case study. Irequi *et al*. (2002) found a downward rigidity adjustment in both lending and deposit rates in Colombia and Mexico, with their result not supporting the collusive pricing arrangement and adverse customer reaction hypotheses. Lim (2001), however, found upward rigidity adjustment in the deposit and lending interest rates in Australia, using three bank interest rates to explain that asymmetric interest rate adjustments in the short run but not in the long run.

To elaborate more on market imperfections and their contribution to the pass-through mechanism, the next section explains money market volatility and its relationship to the IRPT mechanism.

### 2.2.5 Money market volatility and IRPT

Money market volatility (MMV) in this context refers to interest rate fluctuation, which is explained by the asymmetry of market information, without much difference between the two terms. Interest rate fluctuation is an essential indicator to monetary policy during the transmission process, as mentioned in Chapter 1. Furthermore, volatility is a measure of risk, and is usually used for explaining the trends of the fluctuation of the stock price or exchange rate (Brooks, 2008). Since volatility is a measure of risk, it shows the fluctuation of interest rates, and is thus likely to contribute to the asymmetry of the adjustment process. This is explained through the fact that bank interest rates are influenced by interest rate volatility, while high volatility of money market rates may increase lending and deposit rates. Patnaik and Shah (2004) showed that increasing volatility of interest rates is not favourable to an economy, and highlighted that the volatility of short-term interest rate can be associated with problems relating to the economy.

Money market volatility can occur due to different factors and uncertainties, which can impact on interest rates over time as monetary policy adjusts. These are then influenced by actions of the central bank, depending on the central bank’s independent power, and monetary authority’s ability to adjust the interest rates and achieve its targets (Wetherilt, 2003). Therefore, actions by the central bank make it possible to stabilise the variability of interest rates, making the central bank have a role to play. To reduce volatility, the central bank chooses a policy rate that minimizes deviations of market rates from the policy rates.

The reason behind this objective function is because excessive money market volatility may mislead or create wrong information on monetary policy.

For example, Wetherilt (2003) explained that the past decade has experienced several changes in the operational framework for monetary policy across developed countries. Changes in the system have been followed by some other emerging and developing markets. The process suggests that central banks are reducing or removing reserve requirements, increasing the use of repo transactions and reducing the use of open market operations for indicators. These transformations influence the levels of volatility of money market rates. These processes and transformations influence the IRPT mechanism, and therefore encourage and motivate the study of time series properties of the money market and their volatility.

Therefore, to understand the central bank's role and the pass-through mechanism better, this paper explains the impact of the money market volatility (MMV) on the interest rate pass-through. In effect, the theoretical literature on IRPT explained some of the major contributing factors to the incomplete pass-through. To illustrate this further, the empirical literature specifically highlights some of the methodologies, data type and period used to explain the pass-through process, as well as the different results obtained. Several influencing factors along with information asymmetries relating to the pass-though mechanism have been discussed and linked to MMV and IRPT. The MMV and IRPT were related to the Stiglitz and Weiss (1981) model, which showed that an increase in the interest rates generates two types of effects: the adverse selection effect and the adverse incentive, or moral hazard, effect.

### 2.2.6 Summary of theoretical review

In summary, the theoretical literature presented some highlights of the money market volatility and the interest rate pass-through mechanism. It provided explanations of types and strengths of pass-through, as well as some of the factors that contribute to incomplete pass-through, and rigidity in the adjustment process. Furthermore, some theories that explain interest rate effects were mentioned, such as the adverse consumer reaction, pricing collusion arrangement and the Stiglitz and Weiss (1981) model theories. The Stiglitz and Weiss (1981) model explained the interest rates effects, and how it relates to the adjustment of interest rates rigidity. This is shown through the two types of interest rate effects generated, in terms of the adverse selection effect and the adverse incentive, or moral hazard, effect. The effects occur with changes in, for instance, the money market rates, and their pass-through to retail rates and finally to customers and consumers. This influences the commercial banks' actions towards being selective and how services are provided to customers.

Overall, theoretically, there are different types of market imperfections, which all contribute to the pass-through mechanism. Understanding some of the influencing factors of the pass-through mechanism is important, as the changes and their adjustment can be used to provide some guidance for the implementation and measure of effectiveness of the monetary policy in South Africa. The next section looks at the empirical review, with more emphasis on methodologies employed.

## 2.3 Empirical review

### 2.3.1 Interest rates pass-through

A majority of the studies on pass-through and retail interest rate adjustments have estimated their data with linear and non-linear models. Various studies on the pass-through from money market rates to bank lending and deposit rates using the Engle and Granger, SVAR, VAR and the Johansen estimation methods have found incomplete pass-through in the process. These works include those by Donnay and Degryse (2001) on the Euro area, Aziakpono (2006) on South Africa and SACU for cross-countries studies, Burgstaller (2005), Disyatat and Vongsinsirikul (2003) and Bredin *et al.* (2002) on single country analysis.

As in most studies, the money market rates are mainly used as a proxy, but differ across studies depending on the specific market rate type used, either as overnight, interbank call rate, 3-month interbank call-rate, etc. Some studies use the central bank administered money market rate, while others use the interbank rate. Most recent studies usually use the banks' cost of funds (central bank administered money market rate) to be represented by the money market rate because of its high correlation with the respective retail interest rate. This study uses the interbank call rate as the money market rate, as an interesting new aspect of the study focuses on the impact of money market volatility on the pass-through. The interbank call rate is chosen because banks prefer to borrow at this rate as is lower than the repo rate. Furthermore, high frequency data is used, as most recent studies now use higher frequency (monthly) data, as it captures events and other factors taking place during the sample coverage. Some of the disadvantages noted in the early studies included the employment of short data periods and low frequency data.

Similarly, earlier studies on monetary policy and pass-through mechanism, such as Cottarelli and Kourelis (1994), Borio and Fritz (1995), Mojon (2000) and Weth (2002), De Bondt (2002) and Sander and Kleimeier (2004), have concluded that retail IRPT is mostly incomplete in the short-run. They explained the size and speed of pass-through from money market rates to retail rates for some selected countries and areas, and found complete pass-through in the long-run, though depending on different factors. They suggested that complete and incomplete interest rates pass-through depended on a country's financial market development, degree of financial market openness, concentration within the banking sector, and the interest rate volatility.

Retail interest rates changes are assumed to be rigid and less volatile than money market rates, while incomplete pass-through is assumed to have implications for business cycle volatility. Some of the studies were across countries, based on Euro area, EMU countries, and OECD countries. The estimation method used was mainly the cointegrating ECM, under the category of linear econometrics methodology. In general, these studies have found that the size and speed of pass-through varies across different retail rates, while having significant differences across countries.

Specifically, Mojon (2000) found that interest rate change increases with lower volatility of the monetary policy interest rate while explaining an incomplete short-term pass-through for deposit rates. Mojon (2000) used panel data, which has some limitations, including information of data details on the structure of the lending or deposit market in each of six Euro countries. The author concluded that money market rate volatility has a negative impact on the response of credit rates, with inflation having a positive impact on the response of bank credit rates. Likewise, the author explained the banks' ability to reduce and delay credit rate changes when the market rate declines and to increase the deposit rate when the market rate rises, due to factors such as competition level within the banking industry. This interest rate effect supported the Stiglitz and Weiss (1981) theory, and similar explanations were also given by Hannan and Berger (1991), while Cottarelli and Kourelis (1994) and Berstein and Fuentes (2003) obtained different results and suggestions.

Other studies that found incomplete pass-through include Bredin *et al.* (2002), Disyatat and Vongsinsirikul (2003), and De Graeve *et al.* (2007). Bredin *et al.* (2002) found an incomplete pass-through from the money market rate to lending rates, a strong varying adjustment speed across alternative lending rates, and a significant structural change in the relationship between the money market rate and lending rates. The authors used monthly data on Ireland from 1980-2001 to examine the extent to which the changes are passed through to a number of retail lending rates, and analyzed the speed of adjustment of lending rates to changes in the money market rate. The estimation methods used included single equation static regressions of Engle and Granger (1987), vector auto-regressions formulated by Johansen (1988), and the single equation ECM. They argued that the rate of interest charged by a financial institution as a function of the marginal cost of funds to the institution influence changes in the rates charged to customers.

Similarly, De Graeve *et al.* (2007) explained the pass-through from Belgium market interest rates to retail bank interest rates. They used a monthly data set of bank-specific interest rates of 31 banks for 13 products for the period January 1993–December 2002. For estimation, they employed the heterogeneous approach to the Belgian banking market, and the popular ECM for measuring the pass-through. The results explained the long-term pass-through as incomplete, but had no solid evidence for asymmetry in the retail rates, with faster reduced large deviations from equilibrium mark-ups than small deviations.

Another study by Hofmann (2002) argued that there is rigidity in the short-term bank lending rates, along with a complete long-term pass-through. The Hofmann (2002) study used the Johansen cointegration method to investigate the pass-through process across four countries for the period 1984 to 1998. The author found a complete pass-through of the money market rate to the retail interest rates in the long-run, while in the short-run the lending rate displayed a lower adjustment speed. However, a further study by Hofmann and Mizen (2004) showed that complete pass-through and the speed of adjustment in retail rates depends on whether the assumed lag between retail and money market rate is widening or narrowing. They used the ECM methodology and assumed it allows for asymmetries and non-linearity in adjustment.

Furthermore, single country studies, with more focus on emerging markets with an inflation targeting regime, such as those by Berstein and Fuentes (2003) on Chile and Ozdemir (2009) on Turkey obtained complete pass-through in the long run, along with incomplete rigidity adjustment in their short run analysis using the symmetric and asymmetric ECM. Another study that used the symmetric and asymmetric ECM estimation method was Hannan and Berger (1991). They found a large rigidity adjustment in a study performed on the USA, with higher rigidity when there was a stimulus to increase deposit rates. Since then, several studies have followed Hannan and Berger (1991), including Scholnick (1996), Aziakpono *et al.* (2007b), Toolsema *et al.* (2002) and Cottarelli *et al.* (1995), which have all obtained similar results.

In addition, looking at the effect of inflation targeting policy on interest rates effects, Bohl and Siklos (2001) analyzed the influence of the Bundesbank’s inflation targeting policy on the behaviour of the spread between long-term and short-term German interest rates. The data covered the period from 1975-1998, and variables used were monthly data of the long-term interest rate, the call money rate and the three months money market rate. The author used linear methods of momentum threshold autoregressive cointegration and error correction for estimation. An asymmetric influence was found in the study period covered.

Furthermore, several studies have examined IRPT in South Africa, including De Angelis *et al.* (2005), Aziakpono (2006), Sander and Kleimeier (2006), Aziakpono *et al.* (2007a), Aziakpono *et al.* (2007b) and Aziakpono and Wilson (2010). Results of these studies have shown that the size and speed of pass-through varies across particular retail rates, along with significant differences in cross-countries and single-country studies. These studies did not explicitly specify whether there was incomplete or complete pass-through in the regions covered, but rather touched on their rigidness and inflexibility. Likewise, some of the econometric methods used included the Engle-Granger, and Johansen symmetric and asymmetric ECM.

### 2.3.2 The error-correction term, asymmetric fluctuation of interest rates and the pass-through mechanism

The ECM has been applied in several analyses of the pass-through mechanism. This section touches on studies that have explained the IRPT, interest rate volatility and some explaining both cases at the same time. For example, a fast and complete pass-through in bank lending rates was found in Sander and Kleimeier’s (2006) article using cointegration and threshold asymmetric adjustment estimation method. The deposit market showed differing degrees of interest rate stickiness and asymmetric adjustment in selected countries. Though the authors employed asymmetric ECM to test for differences in the adjustment of interest rates when above or below their equilibrium level, their explanation is limited as asymmetry can be better explained by non-linear models, and can also be related to volatility.

An article by Wang and Lee (2009) on US and 9 Asian countries, using monthly data like most recent studies, provided a breakthrough advance for the analysis of market rate volatility and its impact on the retail interest pass-through mechanism. They used a non-linear estimation approach, which provides a major advantage over previously used methods in similar fields. The study estimated conditional means using a combined EC-EGARCH (1, 1)-M model to show the effect of interest rate volatility on retail interest rate, specifically called the asymmetric threshold, cointegration test, threshold adjustment and EC-EGARCH (1, 1)-M model. The authors found complete symmetric pass-through for the US only and incomplete asymmetric adjustment in the short run in the other eight countries. From the literature review, it is possible for the response of changes in the money market rate to be asymmetric. This is strongly supported by the Stiglitz and Weiss (1981) theories and rigidity in the pass-through adjustment caused by asymmetry of market information.

Similar to Wang and Lee’s (2009) work and using the same format and estimation methods, Wang and Thi (2010) investigated the pass-through of the money market rate to banking retail rates in Taiwan and Hong Kong. They explained the impact of interest volatility on interest rates using a sample period from February 1988 to December 2004. They found the interest pass-through mechanism of the two markets (Taiwan and Hong Kong) to be incomplete. And according to the asymmetric threshold cointegration test, they discovered the presence of an asymmetric cointegration relationship between retail rates and the market rate in both countries. In addition, while employing the asymmetric EC-EGARCH (1, 1)-M model to test for the influence of money market rate adjustment and volatility on retail rates in the short-run, the authors found strong evidence of upward rigidity in the deposit rate and downward rigidity in the lending rate in the two markets. This finding supports the hypothesis of collusive pricing arrangements.

In order to compare the study's result with a few other inflation countries, some of the countries investigated by Wang and Lee (2009) are selected, especially the inflation targeting countries. Another study by Charoenseang and Manakit (2007) explained the changing financial environment in Thailand after inflation targeting was adopted in order to determine the influence on the size and speed of monetary policy transmission following changes in the policy rate. The authors estimated the long-run relationship and the degree of pass-through between the policy rate and the various financial market interest rates in Thailand using the period from June 2000 to July 2006, which covers the period after the Bank of Thailand adopted the inflation targeting framework. Co-movements between the 14-day repurchase rate and the financial market rates in the long-run were found, excluding the finance company lending rate. They used Engle and Granger's asymmetric ECM to perform estimations on their data.

Raunig and Scharler (2009) analyzed the relationship between money market uncertainty and unexpected deviations in retail interest rates in a sample of ten OECD countries. They found that, with the exception of the United States, money market uncertainty has an impact on the conditional volatility of retail interest rates. Specifically for the United States, they found that the effects of money market uncertainty are spread out over time. The results indicate that money market uncertainty is transmitted to retail rates to a smaller degree in countries where banking relationships play an important role.

A study by Gambacorta and Iannotti (2007) explained the importance of understanding monetary transmission mechanisms by examining the speed and asymmetric response of bank interest rates to monetary policy shock. They used an asymmetric VECM and VAR model to analyse the pass-through of changes in money market rates to retail bank interest rates in Italy for the period 1985–2002. The variables used included the simultaneous interactions between three bank rates (for current accounts, short-term lending and the interbank market) and the monetary policy indicator (the rate on repurchase agreements) in two separate periods. Their methodology explained the importance of asymmetric behaviour of bank interest rates in the case of monetary tightening or easing, and how it can have different effects on output and prices, as well as the knowledge of how much, how quickly and how symmetrically a change in the monetary interest rate is transmitted to bank rates is important for the conduct of monetary policy. The authors further explained that an asymmetric response of banking rates has key consequences for profit margins, interest rate risks and the overall performance of the banking industry.

In Bruna's (2009) study, an analysis of the sources of variability of interest rates in the money market in relation to inflation targeting was explained. The paper covered the period from 1998 to 2007, and used the VAR and GARCH (p, q) model for estimation. For the analysis of interest rate variability the GARCH (p,q) model was used to account for the actual variability of n-day relative changes in interest rates as variability conditioned by past random shocks $\varepsilon_{t-i}$ and by lagged variability of the shocks, since the variability of random shocks is expressed in the framework of the GARCH (p,q) model. The paper answered questions relating to factors of changes in the structural characteristics of economies in transition, changing perception of inflation risks, the inconsistency of the central bank's monetary decisions and the central bank's weakened credibility and uncertainty with regard to the efficient transmission of monetary measures. In essence, Bruna (2009) explained that money market interest rates are based on subjective expectations of means in the financial market towards expected future monetary measures of the central bank. Variability of interest rates is assumed to result from differences between the central bank's official inflation forecast and forecast of the financial market. It is also influenced by views of the financial market regarding the predictability of central bank's behaviour.

The subject on money market usage, monetary policy effectiveness and central banks actions in an economy was explained by Wang and Lee (2009: 1272), who argued that central banks apply different management policies depending on different economic backgrounds, which can result in different adjustment processes of the retail interest rates in the short-run money market fluctuations in some countries. The authors noted that the competition among Asian countries was enhanced after the Asian financial crisis, implying that collusion or competition among commercial banks results in constantly changing financial market information. These conditions could contribute towards increasing the interest rates fluctuation.

From the above discussions, the conditions can be related to South Africa, considering the different changes and challenges that have faced monetary policy and the change in monetary policy tool to the repo system in 1998, followed by the adaptation of the inflation targeting framework in 2000. Some of the challenges encountered included the effects from the September 2001 US terrorist attack, food and oil price increases, tighter bank regulations following the Saambou crisis, weakened SA exchange rates and the 2007 global financial crisis stemming from the US. These conditions may cause higher interest rate fluctuations in South Africa and in the process contribute to the non-linear adjustment processes. The above reasons motivate the need for studying the IRPT mechanism in SA.

### 2.3.3 Summary of empirical review

The empirical literature looked at different methodologies employed by different authors to explain IRPT, which showed different results obtained depending on data type, length and case (country/countries). Though most of the results were similar, the USA was exceptional, because it produced a complete pass-through in the short-run. The review showed that the methodologies employed were mostly the Engle-Granger and Johansen symmetric and asymmetric ECM because it accounts for symmetric and asymmetric adjustments of the IRPT mechanism.

## 2.4 Conclusion

The literature review section explained that lending and deposit rates usually respond sluggishly to money market rate changes, especially in emerging and developing markets. Furthermore, it showed that there should be rigidity in the adjustment processes, because it is assumed that for profit maximization and spread between lending and deposit rate, commercial banks pass on charges partly through the lending rate. In general, these official rate changes or shocks and time lag of adjustment is determined by bank competition, financial structure and development, economic policy, market imperfections, interest rates volatility or fluctuations and several other influencing factors, which contribute towards the incomplete and asymmetric adjustment of the retail rates, causing rigidity in the retail rates adjustment processes.

In summary, the test of asymmetric adjustment of bank interest rates confirms the presence of asymmetric adjustment, collusive pricing arrangement theory and negative customer reaction theory in South Africa, according to previous works, including investigations by Aziakpono and Wilson (2010).

Understanding the monetary transmission mechanisms, specifically through the interest rate channel, is important, particularly when relating the size and speed of adjustment of interest rates response to monetary policy shocks. In addition, the desire and goal of any economy is a quick and complete pass-through, with effective monetary policy. Furthermore, asymmetric behaviour of bank interest rates in a monetary tightening or easing could have different effects on output and prices, and therefore the knowledge of the size and speed of adjustment, in terms of how symmetrically or asymmetrically a change in the monetary interest rate is transmitted to bank rates, is very important for the conduct of monetary policy. The next chapter provides an overview of the South African monetary policy and financial structure.

# CHAPTER 3

# AN OVERVIEW OF THE MONETARY POLICY AND FINANCIAL STRUCTURE IN SOUTH AFRICA

## 3.1 Introduction

This chapter explores the issues relating to South Africa's monetary policy and financial structure, the pre-repo and current repo system, as well as the pre-inflation and the current inflation targeting practice, and is divided into seven sections. Section 3.2 provides information on South Africa's financial structure, and section 3.3 shows SA's monetary policy and monetary transmission system. The monetary policy practice in the country is then explained in section 3.4. The performance of the South African money market and some financial indicators are explained in section 3.5 using charts and tables. This is followed by section 3.6 which explains some of the challenges the South African monetary system has encountered. Lastly, Section 3.7 concludes the chapter and provides a highlight on the expectations from the next chapter.

## 3.2 The South African financial structure

The money market is defined as that part of the financial market that deals in short-term debt instruments with maturities ranging from one day to one year. Within the money market system, there are primary and secondary money markets. The primary market is where new money market instruments are issued, while the secondary market is where previously issued money market instruments are traded. The money market plays an important role in an economy as it affects consumers' daily spending and investment. Similarly, the central bank plays a vital role in this market and are key participants, which according to Botha (2008), makes the money market essential for the transmission of monetary policy.

From the money market, monetary policy goals, tools and variable are influenced to regulate the economy. These variables include the rate of interest, whereby, lowering interest rates improves investment as the cost of borrowing falls, increases households' consumption as disposable incomes rise, etc, with increasing interest rates having opposite effects. Another vital role of the central bank within the money market is by influencing the economy through changes in the money supply (notes, coins, bank deposits).

Furthermore, some monetary policy goals are obtained through the implementation of tools such as the reserve requirements, open-market operations and bank or discount rate policy. By altering the reserve requirement the central bank can influence the money supply and credit extension. For example, if the central bank reduces the cash reserve requirement, the money supply will increase as banks increase credit due to increased lending capacity. Open market operations involve the purchase and sale of government and other securities by the central bank to influence the supply of money in the economy and thereby interest rates and finally credit. The bank or discount rate is the rate at which the central bank lends funds to the commercial banks, and is called the repurchase rate in South Africa. Usually banks borrow from the central bank (or from other banks –interbank rate) primarily to meet reserves rate when in short. With this tool, the central bank can make adjustments to the rates in order to influence the market rates and hence commercial banks' actions. For example, increasing the bank rate raises the cost of borrowing from the central bank and banks will tend to build up reserves. This will decrease the money supply and reduce credit extension. Hence, describing the monetary pass-through mechanism. The South African Reserve Bank (SARB) is the central bank of South Africa, and is currently operating under a monetary policy within an inflation targeting framework.

The pass-through of the money market rate to retail rates can then be analysed to show how efficiently the central bank makes use of the monetary policy and how well commercial banks operate, depending on the financial structure and or level of competition in the country. Inflation targeting is also important as it helps a country to maintain its inflation rate goals and to influence price controls. This is because when inflation is expected to be high, banks charge higher rates for compensation; therefore higher expected inflation may lead to higher interest rates. While inflation targeting is assumed to reduce volatility and uncertainty in price levels, the huge improvement and advancement in technology and the finance market increases uncertainties. To further reduce interest volatility, the repo system is the current monetary policy tool employed in South Africa, while the system follows an inflation targeting framework. Following this system, the interbank market, which is the market for bank loans and deposits among the various banks, plays a key role in the implementation of monetary policy because the interbank and other money market interest rates should respond immediately to any changes in the Reserve Bank's repo rate (Botha, 2008: 17).

## 3.3 Monetary policy, inflation, money supply and the repo system

Like most other developing and emerging economies, banks are the major lending agencies in South Africa, of which bank trading and investment in South Africa is one of the most competitive sector in the industry, especially among the nation's big four banks, namely ABSA Group Limited, Standard Bank Investment Corporation Limited, First National Bank Holdings Limited and Nedcor Limited. These banks maintain the top spot on the retail market, and have widespread branch networks across the nine SA provinces, and have over 70 per cent of the total assets of the banking sector. The rest of the assets in the private banking sector are held by 46 other banks, including the mutual banks. This ratio in the banking sector can impact on the efficiency and level of competition in the market, affecting the monetary transmission process, if the major banks act in an oligopolistic manner, which then influences the IRPT process (Aziakpono and Wilson, 2010).

The money market is important to monetary policy because of the central bank's ability to perform policy goals by taking part in the primary and secondary money markets. These policy actions are done with the aim of influencing liquidity in the banking sector, and thereby impacting interest rates (Faure, 2006: 1). The overall objective of the central bank is observed when quick and efficient monetary policy changes through the interest rate channel are taking place. This explains how the primary instrument is used to target inflation in South Africa through the repo rate. The repo rate is the rate at which the South African Reserve Bank (SARB) charges commercial banks for borrowed cash reserves and is the most important rate in the South African money market (De Angelis *et al.*, 2006: 1). In essence, the SARB uses the repo rate as the primary rate for influencing and impacting other money market rates. Faure (2006: 67) states that in order to make the repo rate effective, the SARB makes sure that the private sector banks are always indebted to it. This creates a money market shortage, which the SARB then refinances at the repo rate. This constant shortage and subsequent borrowing by the commercial banks at the repo rate should result in a close correlation between the commercial bank interest rates and the SARB's repo rate.

### 3.3.1 The role of the Reserve Bank of South Africa

The Reserve Bank implements South Africa's monetary policy and regulates the supply of money by influencing its cost. The monetary policy is conducted and set by the Reserve Bank's monetary policy committee, which comprises the SARB's governors and other senior officials and meets every six weeks. Furthermore, the monetary policy is guided by the SARB's assessment of current and prospective economic developments, with an objective of achieving and maintaining financial stability, stable prices, full employment and economic growth, combined with maintaining a low inflationary level.

The SARB and the National Treasury (Ministry of Finance) both represent the monetary authority in South Africa. The SARB acts as the central bank for the country and its banking institutions, functioning independently, and its primary goal is to protect the value of the currency. For this purpose, the SARB emphasizes that South Africa has a growing economy based on the principles of a market system, private and social initiative, effective competition, and social fairness (SARB, 2010). This is manifested through an economy's financial structure which includes competition and concentration level in the banking system, financial market development and ownership structure of financial intermediaries. These features influence the size and speed of adjustment in the IRPT mechanism in SA. Furthermore, the SARB formulates and implements policies in order for the country to maintain a sound monetary and banking system, meet the requirements of the country and its people, and keep in line with international financial developments. In addition, the SARB's management, powers and functions are governed by the SARB Act of 1989.

To achieve its goals, the Reserve Bank has various instruments at its disposal. It uses various instruments in order to influence the quantity of money and or interest rates in South Africa. A good example of a policy instrument is the repo rate established by the repurchase tender system of the Reserve Bank. The repo system was mentioned in Chapter 2 and at the beginning of this chapter.

The past decade has experienced several changes in the operational framework for monetary policy across developed countries. The SARB is also seen to be taking this route, as there is an increase in the use of repo transactions and a reduction in the use of open market operations. These changes affect the levels of volatility in the money market rates. Since the repo rate is the rate at which the Reserve Bank grants assistance to the banking sector, it therefore represents a cost of credit to the banking sector. When the repo rate is changed, the interest rates on overdrafts, lending, deposit and other loans extended by the banks also tend to change. In this way the Reserve Bank indirectly affects the interest rates in the economy (SARB, 2010).

### 3.4 Monetary policy practice in South Africa

#### 3.4.1 South African monetary transmission mechanism

The transmission mechanism of monetary policy in SA is essentially a forward-looking system, in that a specific target for inflation has to be met within a set time. The forward-looking nature of the framework makes it very important to understand and acknowledge the time lag for monetary policy to impact on the real economy, and eventually inflation (Smal and Jager, 2001).

Since the Reserve Bank makes changes to the quantity of money and interest rates in order to achieve price stability, full employment and economic growth, the SARB's actions are achieved through a series of events between monetary variables, such as the quantity of money and interest rates, and macroeconomic variables, such as the price level, the level of employment and the gross domestic product (GDP). This chain of events is called the monetary transmission mechanism, that is, the way in which monetary changes affect the real economy.

#### 3.4.2 Liquidity management practice: Pre-inflation targeting regime

There were two broad monetary policy regimes in SA before 2000. The first regime was a liquid asset ratio-based system with quantitative controls on interest rates and credit that operated until the early 1980s. The interest rate was initially not important as a corrective tool, because the main form of monetary control was the use of liquid asset requirements. Under this regime, commercial banks held liquid assets as a specified minimum proportion of deposits. The limited supply and low yields of these assets were expected to restrict bank lending and money supply growth (Naraidoo and Gupta, 2009). The dual system era ended in 1983 and was replaced by a floating rate following the Reserve Bank's intervention. This was due to increasing frustration with the financial constraints of the liquid asset ratio system, which led towards a cash reserves-based system. Under the cash reserves system, pre-announced monetary targets were used for the first time from 1986, and were to be achieved indirectly through adjusting interest rates. Therefore the main policy emphasis was on the central bank's official rate in influencing the cost of overnight collateralised lending and hence market interest rates (Naraidoo and Gupta, 2009).

Later on, the SARB accordingly started to move away from formally targeting the money supply and began using a far broader range of economic indicators for the determination of its policy actions, called the eclectic approach to monetary policy decision-making. Before 1998, the SARB used the bank rate system, which used as accommodation rates with limited liquidity to banks through overnight loans (SARB, 2010). In 1998 the SARB implemented a system of repurchase transactions (repos) as the main instrument for managing liquidity in South Africa’s money market. The repo rate, which is the price at which the central bank lends cash to the banking system, has become the most important indicator for short-term interest rates in South Africa (SARB, 2010). It was also needed for financial instruments to be more flexible and for interest rates to react more quickly and sensitively to periodic changes in the underlying financial market conditions. For example, Figure 3.3a shows the relationship between the repo rate, interbank rate, deposit and lending rates. A clear point that can be drawn from the figure is that there is a link between the changes in the rates. The repo rate system was considered far more transparent than the previous method of accommodation in that it continuously signals the Bank’s policy intentions, that is, through the regular disclosure of the amount of liquidity that the Bank is prepared to make available on a daily tendering basis to the banking institutions. The most important signal is the amount of liquidity provided by the Bank (SARB, 2010).

### 3.4.3 Liquidity management practice: The inflation targeting regime

Since 1990, inflation targeting has been adopted by many industrialized countries, such as New Zealand, Canada, the United Kingdom, Sweden, Israel, Australia and Switzerland; by several emerging markets, such as Chile, Brazil, Korea, Thailand and South Africa; and by several transition countries, such as the Czech Republic, Poland and Hungary (Mishkin, 2001). Inflation targeting has been a success in most of the countries that have adopted it. It has been shown that inflation targeting countries have been able to reduce their long-run inflation below the levels that they would have attained in the absence of inflation targeting.

For example, Kahn (2008) compared the inflation-targeting period from 2000 with the period of the 1990s in South Africa. The author found that in the pre-targeting period, the inflation-targeting measure, (CPIX) inflation, averaged 10,8 per cent in the 1990s, but declined to 6,5 per cent in the targeting period. According to Kahn (2008), the period from 1999 to 2008 signaled the longest sustained period of economic growth in South Africa’s economic history, together with a lower rate of inflation and a stable monetary policy, although the inflation outcome exceeded the target range at some points, and since April 2007, because it faced pressure from strong domestic demand, as well as international oil and food price increases.

Furthermore, Naraidoo and Gupta (2009), who used a simple empirical nonlinear framework to analyse monetary policy between 1983 and 2007 in South Africa and focused on the policy of inflation targeting, found that the adoption of inflation targeting causes significant changes in monetary policy, and that the post-2000 monetary policy is asymmetric because policy-makers respond more to downward deviation of inflation away from the target. The authors found that the post-2000 policy-makers had inflation within the 4.5%-6.9% range rather than the set target zone of 3-6% that was pre-announced. The current monetary policy in South Africa is the use of inflation targets.

On 6$^{th}$ April 2000, the South African government and the SARB officially implemented an inflation target as part of monetary policy in South Africa. The chosen CPIX (consumer price index) inflation targeting zone was 3-6%, which was a major target for 2002 (Mboweni, 2009). In addition, Naraidoo and Gupta (2009) argued that the response of monetary policy to inflation is nonlinear as interest rates respond more when inflation is further from the target. Since the implementation of the inflation targeting framework, monetary policy has generally been effective in maintaining a controlled level of inflation within its targeted bracket of three to six percent in certain periods, except during certain conditions, explained earlier, and further illustrated in Figure 3.1a. For adjustment purposes, when inflation rate surpasses the 6 percent band, the SARB usually increases the official interest rate (the repo rate) in order to bring inflation back to the target.

### 3.5 Performance of the South African money market

This section describes and illustrates the South African money market indicators using charts. These are the inflation rate trends, the money supply (M1, M2 and M3) trends and the different interest rates trend. Their trends, volatility (changes over time) and comparison are then illustrated. A more explicit analysis of the interest rates will be performed in Chapter 4, providing clearer explanations.

Figure 3.1a: Inflationary trends

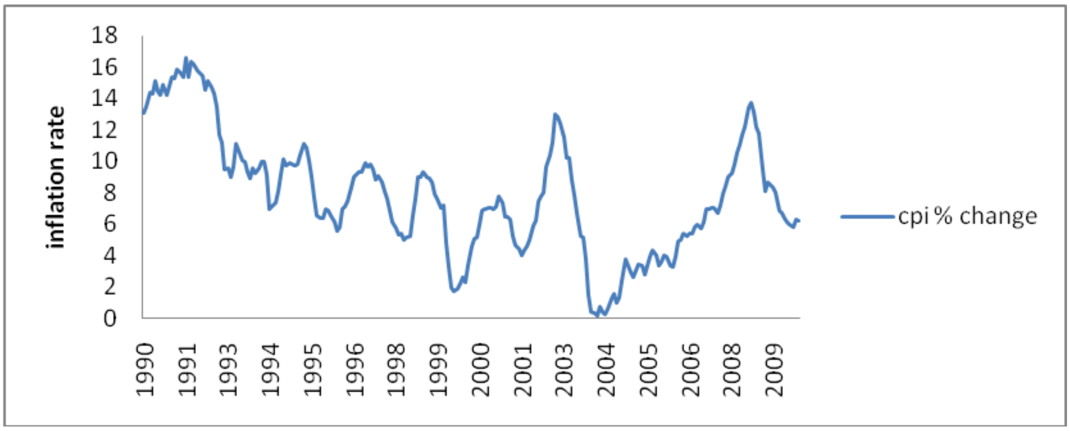
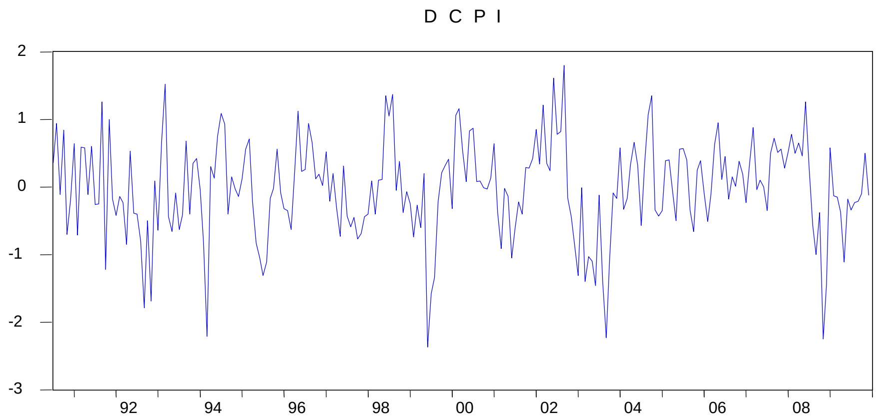



Figure 3.1b: Change over time




Note: DCPI represents change in inflation rate overtime

Figure 3.1a shows the inflationary trend over time, from 1990 to 2010. In Figure 3.1a it can be seen that after 2000, when inflation targeting was implemented, the inflation rate first reached the target range of below 6% around mid-2001. However, due to the terrorist attack in the US on 11th September 2001, along with the weakened exchange rate of the South African rand, high inflationary pressure was experienced, increasing to a peak of over 13% after mid-2002, and then falling by September 2002. This increase was also spiked by the increasing oil prices. This is also seen in the changes over time trend of the inflation rate, in Figure 3.1b, where the maximum change after 2000 is reflected after the 2001 terrorist attack in US and also after the global financial crisis of 2007. The SARB reacted by increasing the repo rate (see Figure 3.3a) from end of 2001 to the end of 2002 when the repo rate was increased for adjustment purposes from around 9.5% to 13.5%. The period before 2002 looks more volatile than the period after 2002, which is when the inflation target goal was set for.

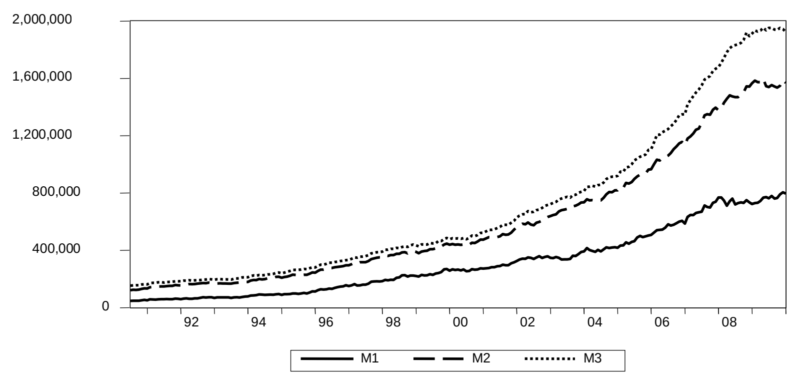
This is likely to result from higher usage of the current repurchase (repo/discount rate) system. By the end of 2008, the inflation rate started declining back to the target region, as more restrictive methods were taken. The repo rate was increased in 2007, but later reduced to stimulate spending and increase money supply.

Another important factor for consideration is the profit and loss of commercial banks in South Africa since the adoption of an inflation targeting system. This is not discussed in detail in this study.

### 3.5.1 Money supply (M1, M2 and M3) trends

The supply of money in an economy can be influenced by various factors, but since the central bank (SARB) governs the money supply, it is sufficient to assume that the supply of money is controlled by the central bank, given the objectives of monetary policy (SARB, 2010).

Figure 3.2: M1, M2 and M3 money supply

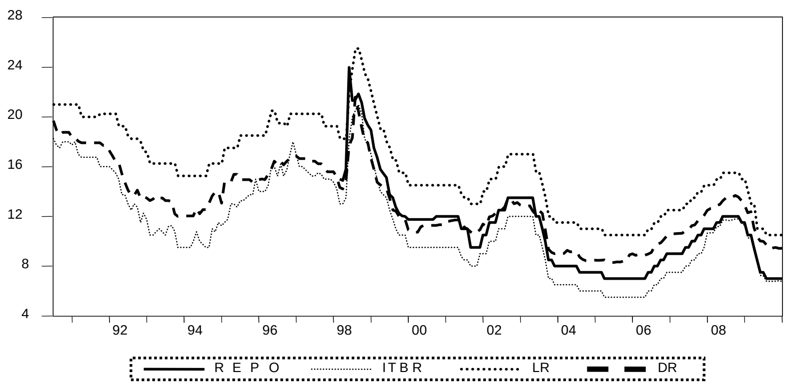



In Figure 3.2, M1 represents the narrow definition of money, M2 includes time deposits, small certificates of deposit, and M3 represents the broad definition of money, which includes M2 plus large time deposits, large denomination repurchase agreements, and shares in money market mutual funds held by institutional investors. Monetary aggregates are monitored by analysts because they measure the amount of money an economy currently needs. This means they reflect the state of that economy in terms of current activity and price levels. Relationships between monetary measures and other macroeconomic variables are studied in order to describe and to forecast changes in economic activity, interest rates and inflation (OECD, 2010). From Figure 3.2, a significant increase in the values of M1, M2 and

M3 can be seen. Policy makers can manage the rate of increase in the money supply, by looking at the IRPT process and its effects on the money supply.

From SARB (2010)'s suggestions, there are various economic views about the monetary transmission mechanism. Some of the views include that there is a direct link between changes in the quantity of money (M) and changes in the interest rates (i) levels; and that a link between interest rates (i) and investment spending (I) in the economy. From the idea that an increase in money supply implies a fall in interest rates, it means that at lower interest rates more investment projects will become profitable, thereby leading to an increase in investment (I). This invariably implies that changes in interest rates is an outcome of the interaction between the money demand and the money supply. In Figure 3.2, M2 and M3 have a steeper slope after year 2000, implying an increased money supply associated with lower interest rates in Figure 3.3a[5].

Figure 3.3a: Comparison of interest rates and changes over time




Note: REPO, ITBR, LR and DR denotes repo, interbank, lending and deposit rates respectively

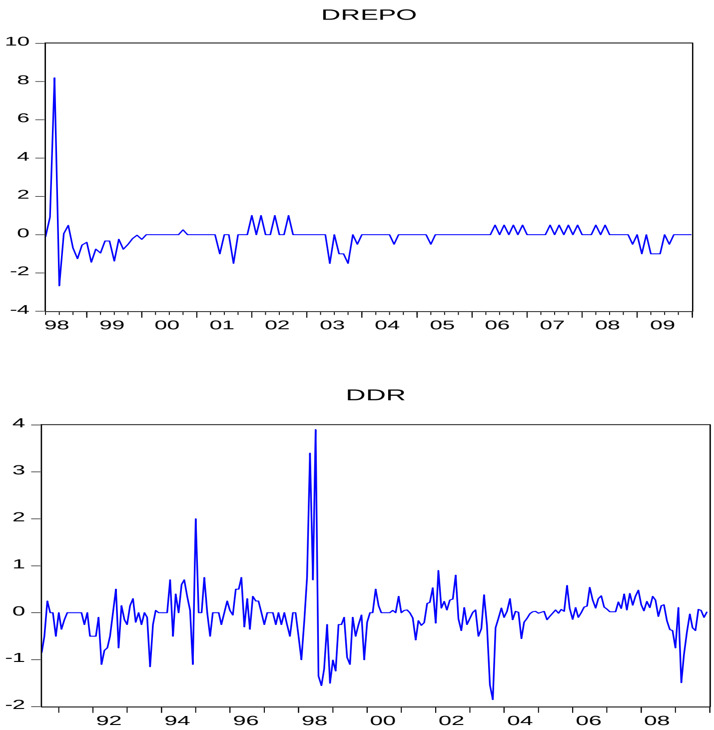
Though these have a negative impact on the increasing inflation rate, a well implemented inflation targeting framework can accommodate the consequences. This, in turn, will result in an increase in GDP. This indicates the risk that lower interest rates and an associated increase of money supply leads to a rise of the inflation rate (SARB, 2010). The actions by the central bank are therefore important. This view also relates to the traditional interest rate channel theory discussed in Chapter 2, which describes interest rate effects.

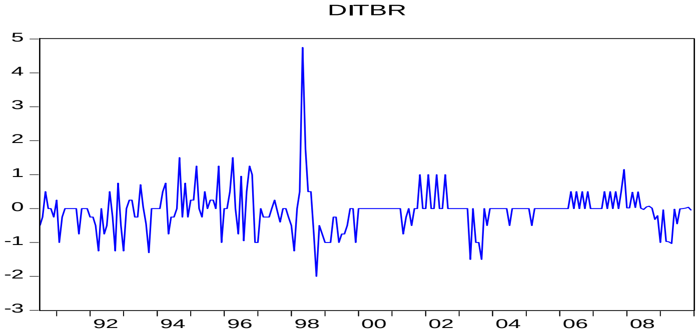
[5] When comparing the period before 2000 in Figure 3.3a, there is higher interest rates than periods after 2000. Likewise, the period after 2000 is associated with increasing money supply and lower interest rates. These can also be associated with bank concentration and competition level in the country.

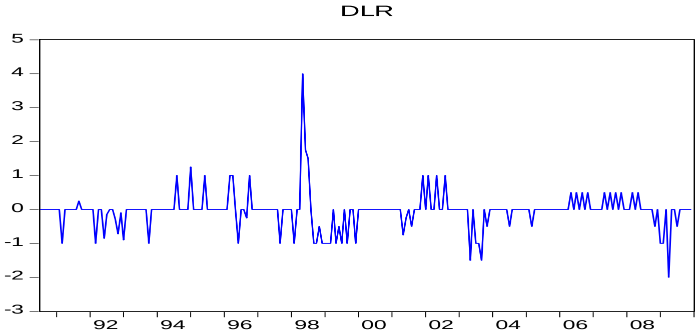
Figure 3.3a shows the trend in interest rates, and how the four rates – repo, interbank, deposit and lending – are linked and follow each other whenever there is a change in the official rate. This implies that changes in the official rate are effective in influencing the interbank rate and thus the retail rates. Similarly, the SARB's use of the interest rate channel for monetary transmission purposes is also effective. Soon after the official rate is changed, domestic banks are usually, but not necessarily, inclined to adjust their lending rates.

From Figure 3.3b, it is clear that the some of the rates move in cycles, and a clearer distinction from the figure is that the rates have not passed a peak adjustment range of 250 basis points since the 1998 implementation of the repo system, as well as since the implementation of the inflation targeting framework in 2000. Figure 3.3b also displays more volatility in terms of interest rate fluctuations from 1990 to 2000, and fewer fluctuations after 2000, especially the interbank rate. The repo and lending rates display fewer frequency changes, as well as fewer changes in the basis points. Another major point to be noted is the drastic change in the repo system after the start of inflation targeting: the repo rate became less volatile, and had reduced size changes.

<u>Figure 3.3b: Changes in interest rates overtime</u>






Note: DREPO, DDR, DITBR and DLR represent changes in the repo, deposit, interbank and lending rates overtime

Firms and individuals respond to the change in interest rates by altering their investment and spending patterns. As a result, responses to changes are transferred onto consumer spending (C), fixed capital formation (I) and real output (y). In essence, the interest rate channel illustrates that demand pressures pass changes in the output gap through to inflation (Smal and Jager, 2001: 6). These changes, likewise, relate to the interest rate channel, the IRPT and the interest rates effect and rigidity adjustment explained by the Stiglitz-Weiss (1981) model.

### 3.5.2 Financial structure indicators over time

Tables 3.1 and 3.2 compare South Africa's financial development and structural indicators over time to other inflation targeting countries, emerging markets, and three developed countries, with the exception of the USA as the only non-inflation targeting country. These tables show the annual bank concentration and net interest margin respectively, from 1990 to 2008. The indicators indirectly explain the terms of the size, activity, and efficiency of financial intermediaries and markets in a country.

The values of bank concentration and net interest margin follow Fitch's BankScope database. These indicators can then be used to investigate the empirical link between the legal, regulatory and policy environment and indicators of the financial structure within a system.

They can also be used to analyse the implications of financial structure for economic growth (World Bank, 20109).

Table 3.1: Bank concentration

| Bank Concentration | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **South Africa** | **Thailand** | **Turkey** | **Korea** | **Chile** | **UK** | **USA** | **Canada** |
| 1990 | – | 0.853 | 0.856 | – | 0.842 | 0.736 | – | 0.446 |
| 1991 | 1.000 | 0.849 | 0.825 | 1.000 | 0.851 | 0.747 | – | 0.397 |
| 1992 | 0.947 | 0.540 | 0.774 | 0.324 | 0.510 | 0.894 | 1.000 | 0.652 |
| 1993 | 0.952 | 0.525 | 0.738 | 0.269 | 0.486 | 0.858 | 0.205 | 0.567 |
| 1994 | 0.908 | 0.517 | 0.711 | 0.260 | 0.431 | 0.848 | 0.215 | 0.573 |
| 1995 | 0.801 | 0.496 | 0.635 | 0.258 | 0.419 | 0.674 | 0.207 | 0.573 |
| 1996 | 0.837 | 0.468 | 0.623 | 0.256 | 0.415 | 0.729 | 0.227 | 0.578 |
| 1997 | 0.801 | 0.469 | 0.498 | 0.243 | 0.439 | 0.731 | 0.201 | 0.566 |
| 1998 | 0.721 | 0.508 | 0.528 | 0.383 | 0.436 | 0.702 | 0.220 | 0.546 |
| 1999 | 0.851 | 0.495 | 0.487 | 0.358 | 0.435 | 0.500 | 0.214 | 0.527 |
| 2000 | 0.849 | 0.502 | 0.741 | 0.379 | 0.409 | 0.510 | 0.212 | 0.520 |
| 2001 | 0.873 | 0.490 | 0.660 | 0.466 | 0.421 | 0.558 | 0.228 | 0.539 |
| 2002 | 0.957 | 0.492 | 0.742 | 0.467 | 0.586 | 0.559 | 0.231 | 0.541 |
| 2003 | 1.000 | 0.499 | 0.711 | 0.469 | 0.582 | 0.753 | 0.230 | 0.535 |
| 2004 | 0.943 | 0.478 | 0.701 | 0.477 | 0.575 | 0.505 | 0.277 | 0.534 |
| 2005 | 0.922 | 0.445 | 0.962 | 0.453 | 0.588 | 0.493 | 0.296 | 0.542 |
| 2006 | 0.752 | 0.449 | 0.505 | 0.513 | 0.581 | 0.503 | 0.325 | 0.555 |
| 2007 | 0.770 | 0.472 | 0.462 | 0.527 | 0.560 | 0.599 | 0.339 | 0.564 |
| 2008 | 0.789 | 0.497 | 0.424 | 0.541 | 0.541 | 0.722 | 0.352 | 0.574 |

Sources: Adapted from the World Bank Financial Structure Database 2010 (World Bank, 2010). UK and USA denote United Kingdom and United States of America respectively.

The bank concentration ratio is calculated using the assets of the country's three largest banks as a share of the assets of all commercial banks. Measures of concentration have often been used as indicators of competition, while higher values of the index indicate greater market concentration. Concentration is defined as the degree to which the financial sector is controlled by the biggest institutions in the market (World Bank, 2005: 19). In essence, a lower value of the concentration obtained in Table 3.1 is preferred in a system, because the competition and efficiency of the banking industry are related, and thus more beneficial, with the efficiency implying that current security prices are fully reflecting all available information (World Bank, 2005: 19). According to the concentration values in Table 3.1, South Africa has the highest value, indicating low competition and efficiency of the bank industry when compared to other inflation-targeting countries and the USA, although following a declining pattern from 2004, a rise is seen in 2008. Likewise, there is not much difference between the pre-repo and repo period, or between the pre-inflation targeting and inflation targeting period.

Table 3.2: Net interest margin

| Net Interest Margin | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | South Africa | Thailand | Turkey | Korea | Chile | UK | USA | Canada |
| 1990 | – | 0.023 | 0.054 | – | 0.091 | 0.019 | – | 0.019 |
| 1991 | 0.044 | 0.019 | 0.064 | 0.023 | 0.045 | 0.022 | – | 0.022 |
| 1992 | 0.043 | 0.033 | 0.078 | 0.035 | 0.058 | 0.029 | 0.037 | 0.016 |
| 1993 | 0.055 | 0.032 | 0.142 | 0.033 | 0.051 | 0.021 | 0.044 | 0.017 |
| 1994 | 0.057 | 0.036 | 0.171 | 0.028 | 0.056 | 0.020 | 0.044 | 0.019 |
| 1995 | 0.052 | 0.031 | 0.085 | 0.026 | 0.059 | 0.022 | 0.044 | 0.024 |
| 1996 | 0.063 | 0.033 | 0.100 | 0.026 | 0.054 | 0.023 | 0.044 | 0.022 |
| 1997 | 0.043 | 0.028 | 0.124 | 0.024 | 0.053 | 0.028 | 0.045 | 0.019 |
| 1998 | 0.054 | 0.012 | 0.169 | 0.024 | 0.058 | 0.029 | 0.044 | 0.022 |
| 1999 | 0.050 | 0.013 | 0.148 | 0.022 | 0.062 | 0.028 | 0.042 | 0.022 |
| 2000 | 0.048 | 0.020 | 0.083 | 0.023 | 0.057 | 0.032 | 0.043 | 0.026 |
| 2001 | 0.038 | 0.021 | 0.157 | 0.022 | 0.061 | 0.023 | 0.041 | 0.031 |
| 2002 | 0.054 | 0.027 | 0.117 | 0.025 | 0.059 | 0.020 | 0.041 | 0.028 |
| 2003 | 0.058 | 0.031 | 0.090 | 0.026 | 0.051 | 0.024 | 0.040 | 0.035 |
| 2004 | 0.039 | 0.031 | 0.098 | 0.029 | 0.051 | 0.027 | 0.040 | 0.024 |
| 2005 | 0.068 | 0.026 | 0.080 | 0.028 | 0.047 | 0.029 | 0.040 | 0.022 |
| 2006 | 0.071 | 0.033 | 0.067 | 0.027 | 0.054 | 0.029 | 0.040 | 0.022 |
| 2007 | 0.072 | 0.033 | 0.057 | 0.027 | 0.050 | 0.020 | 0.039 | 0.020 |
| 2008 | 0.073 | 0.032 | 0.050 | 0.027 | 0.047 | 0.014 | 0.038 | 0.019 |

Sources: Adapted from the World Bank Financial Structure Database 2010 (World Bank, 2010). UK and USA denote United Kingdom and United States of America respectively.

The analysis of interest margins can assist policy makers in assessing a country's banking system and in identifying and quantifying major deficiencies and barriers relating to the efficiency of financial intermediaries. In Table 3.2, net interest margin is computed as the accounting value of a bank's net interest revenue as a share of its interest-bearing (total earning) assets.

In addition, the net interest margin explains the net interest received and expressed as a percentage of interest-bearing assets (World Bank, 2005: 409). Although this margin can be influenced by costs value, tax, fraud, security costs, the inefficient payment system, a heavy regulatory burden and other factors, South Africa once again has the highest interest margin in Table 3.2 compared to the other countries. This implies that South African banks are reaping and enjoying more profit margins from the interest margins, and thus indicates signs of oligopolistic behaviour in the banking industry. From the repo implementation period, 1998 and after 2000 following the inflation targeting framework, a significant increase is seen in the calculated values.

### 3.6 Challenges of monetary policy practice in South Africa

Some of the challenges that faced the SA monetary policy performance were discussed in Section 3.2 of this chapter. These challenges resulted in the monetary policy environment in SA undergoing several reforms over time. Such reforms, as mentioned earlier, include the liberalisation of the financial markets since the early 1980s which resulted in the abolition of the credit and interest rate ceilings that were applicable to banks. Also, high cash reserve and liquid asset requirements were reduced, while the use of repo transactions was encouraged.

Furthermore, prior to the end of 2009, monetary policy actions were affected by a number of unexpected events that had important effects on inflation, making it exceed the target range. These include the sharp increase in petroleum prices, large fluctuations of the rand against other major currencies, food prices increases, the 2001 terrorist attack and the 2007 global financial crisis, all causing inflationary pressure. The recession and sub-prime crisis stemming from the United States to the world markets posed an important challenge to global financial stability and economic growth. During these periods, SARB and SA monetary authorities had to maintain their inflation target goals, which became a bigger task. All this incidents contributed towards increased fluctuations of the money market rates and asymmetry as adjustments were made. These issues and changes in the world markets can contribute further to interest rates volatility, as the central bank adjusts its repo rate in order to accommodate inflationary pressures. The changes made to the repo rate are then reflected on the money market rate (interbank), and further onto retail rates.

Another important challenge that the South African economy encountered was the differing banking concentration levels. There was an increase in the number of banks in the industry from 1995-1997 due to the 1995 Bank Act [?], which permitted the opening up of entry for more foreign banks to open and operate branch offices in South Africa. This also led to an increase of foreign banks with branch offices from four in 1995 to fifteen in 2000. Their entrance was expected to increase competition in the domestic banking market, but because of their inability to compete with the top four banks, by implication, their entrance did not influence the market power of the top four major banks, who continue to behave in an oligopolistic manner (Aziakpono and Wilson, 2010: 8). This concentration effect is also likely to have an effect on the adjustment of interest rates, as well as the asymmetric effect.

The South African monetary policy faced more challenges following the 2007 global financial crisis that started in the US sub-prime mortgage market, together with increasing food and oil prices. The South African banking sector survived challenges during this period due to careful supervision and a quick implementation of the Basel II capital-adequacy framework in January 2008. SA is also said to have a strict bank regulatory system. During this period, high inflation rates were experienced, but actions by the SARB such as changes in the official rate and an inflation targeting framework assisted in limiting higher inflationary rates pressure and other economic effects.

### 3.7 Conclusion

This chapter showed how the SARB plans and controls its policies in order to stabilize or control inflation pressures. It gave a brief history and the changes made by the SARB in order to have more effective and efficient monetary policies.

From 1998, the main form of instrument in SA for liquidity management implemented by the SARB has been the repurchase transactions (repos). Since then, it has been the most important indicator for short-term interest rates, and in the money market. Similarly, according to SARB (2010), the interest rate policy following the inflation targeting system has been useful to the SA economy since its implementation by the SARB. In essence, this chapter provided a brief insight as to why the SA money market might be volatile, and hence have an influence on the pass-through mechanism. It also explained how the actions by the SARB may influence the pass-through mechanism and SA liquidity management practises involving the use of official rate (repo transactions). From the literature and overview, it can be seen that the money market, lending and deposit rates are generally linked. This is seen from the central bank’s policy in setting the repo rates to control commercial banks actions and finally consumer’s behaviours and prices, via the interest rate channel. The figures in Section 3.3 of this chapter also explained the links between the rates whenever there is a change or movement in the interbank rate. Therefore, the SA monetary policy and inflation targeting framework, as well as their effectiveness, can be related to the setting of lending and deposit rates and consequently the interest rates pass-through.

For clarification, attention has been given to inflation targeting, as its adoption in the SA system complements the use of the repo monetary policy tool. This is because the repo rate serves as a benchmark for the level of short-term interest rates, and has gained importance to the economy both as a form of influencing commercial bank actions, and for use by the central bank. A further means of influence from the repo rate on the interbank rate was made possible after a major adjustment was made to the repo system in September 2001. This was a change from a floating repo rate to a fixed repo rate by the SARB (De Angelis *et al.*, 2005). This major change can be seen in Figure 3.3b, as fewer changes are seen from 2000 in all the variables/rates. Hence, references may be made about inflation targeting and the repo period, when interpreting the results obtained.

The overview provided some insight into what may be obtained from the empirical analysis through the financial indicators of bank concentration and net interest margin in South Africa, as explained in this chapter. The estimation results from the IRPT in the sample periods are of interest, as it is likely that bank concentration, competition and interest rate volatility will have an impact on the pass-through mechanism in South Africa. Hence, a more thorough analysis is necessary before conclusions can be drawn as to whether money market volatility in terms of asymmetry of market information (see Chapter 2) and interest rates fluctuations impact on the IRPT. A better explanation for SA's IRPT mechanism (in terms of size and speed of adjustment) is also expected to be observed. To answer these questions, the next chapter presents the methodology for testing the asymmetry of interest rate fluctuations and the IRPT adjustments in SA.

# CHAPTER 4

# RESEARCH METHODOLOGY

## 4.1 Introduction

In order to provide a better investigation of the transmission process from the South African interbank rate to retail rates, the size and speed of the pass-through mechanism of the selected sample period is analysed along with the impacts of the interest rate fluctuation on the pass-through mechanism. This should provide information on how the pass-through has been affected by the changes in the transmission system during the pre-repo and repo period, which covers a time of global recession following the 2007 global financial crisis. Thus, Chapter 4 is organised into two broad sections. The first section, section 4.2, covers the theoretical background, which explains the types of stationarity tests, discusses the procedures for testing for stationarity, defines cointegration, cointegration estimation steps, and gives explanations on the cointegration, the ECM, ARCH and GARCH tests for asymmetries in volatility. This is followed by section 4.3, which provides the data description and empirical methodology. It describes the data used in this study, illustrates the descriptive statistics of the data, illustrates the method estimation for symmetric and asymmetric ECM and mean adjustment lag suggested by Schonick (1996) and Sander and Kleimeier (2000). Section 4.3, more importantly, describes the asymmetric GARCH model, and the specification test of the combined ECM-EGARCH (1, 1)-M model. This explains the symmetric and asymmetric ECM-EGARCH (1, 1)-M models. Lastly, the conclusion is drawn in Section 4.4.

## 4.2 The theoretical background

### 4.2.1 Type of stationarity test and definition of cointegration

As a prerequisite and a common process followed by most researchers in this field, the first step in the estimation procedure is to determine the stationarity properties of all the selected variables before performing the estimations. A stationary series can be defined as one with a constant mean, constant variance and constant autocovariances for each given lag. The time series are tested for stationarity or non-stationarity in levels. If they are non-stationary at level but stationary at first difference, their cointegration can then be ascertained, that is, whether or not they are cointegrated. When each of the variables is I(1), then their cointegration relation within the selected variables is determined (Brooks, 2008).

Many time series are non-stationary but move together over time. In practice, many financial variables contain unit root, and are thus I(1). In this context, a set of variables is defined as cointegrated if their linear combination is stationary. A cointegrating relationship may also be seen as long-term or in equilibrium because cointegrating variables may deviate from their relationship in the short run, but their association would return in the long run. No cointegration implies that series could wander apart without bound in the long run (Brooks, 2008).

### 4.2.2 The ADF and KPSS tests and why a test for stationarity is necessary

The stationarity of a series can strongly influence its behaviour and properties (Brooks, 2008: 318). Stationarity of series is important because it minimises the possibility of spurious Ordinary Least Square (OLS) regressions, as the employment of non-stationary data can lead to spurious regressions (Brooks, 2008: 319). There are several methods of testing for stationarity, but this study uses two test formats: the Augmented Dickey Fuller (ADF) unit root test and the Kwiatkowski, Phillips, Schmidt, Shin (KPSS) stationarity tests. Stationarity tests are essential because they explain a change or an unexpected change in a variable or the value of the error term during a particular time period. For a stationary series, shocks to the system will gradually die away (Brooks, 2008: 319).

The KPSS test is an alternative test proposed by Kwiatkowski *et al.* (1992) which has a null hypothesis of stationarity, and is often used in conjunction with other tests to determine stationarity in series. The implication from this test is opposite to that derived from those based on the Augmented Dickey Fuller test. The results of the KPSS tests can be compared with the ADF procedure to see if the same conclusion is obtained (Brooks, 2008: 331). The joint use of stationarity and unit root tests is known as a confirmatory data analysis. For decision purposes, the test statistic is observed, such that if it exceeds the critical value, the null hypothesis of a stationary series is rejected, which confirms the result of the unit root test previously conducted on the same series (Brooks, 2008: 335).

### 4.2.3 Cointegration estimation methods

When testing for cointegration, different modelling techniques are applied. The three popularly used methods include Engle-Granger (2 step), Engle-Yoo and Johansen. Under the Engle-Granger first step, it is necessary to make sure that all the individual variables are I(1).

Then the cointegrating regression is estimated using OLS. The residuals are then tested to ensure that they are I(0). If they are I(0), one proceeds to Step 2; if they are I(1), a model containing only first differences is estimated. The second step involves the step 1 residuals as one variable in the error correction model (Brooks, 2008: 341).

The Engle-Granger 2-step method has some shortcomings. These includes a finite sample problem of a lack of power in unit root and cointegration tests, possibility of a simultaneous equations bias if the causality between y and x runs in both directions, and the requirement of the researcher to normalise on one variable, by specifying one variable as the dependent variable and the others as independent variables. The researcher is forced to treat y and x asymmetrically, even though there may be no theoretical reason for doing so. Also, if there is an error in the model specification at stage 1, this will be carried through to the cointegration test at stage 2. Thirdly, it is not possible to perform any hypothesis tests about the actual cointegrating relationship estimated at stage 1 (Brooks, 2008).

The first and second problems are small sample problems that should disappear asymptotically. The third disadvantage can be resolved by the Engle and Yoo (EY) method. Problems 2 and 3 can also be fixed, by adopting a different approach based on the estimation of a VAR system. However, this will not be of issue in this study, as longer data and fewer variables are employed. Under the EY 3-step method, the Engle and Yoo (1987) 3-step procedure takes its first two steps from Engle-Granger (EG). Engle and Yoo then added a third step, which provides updated estimates of the cointegrating vector and its standard errors. The EY third step is algebraically technical and likewise suffers from the other EG method problems (Brooks, 2008). Arguably, the EY procedure is rarely employed in empirical applications, because it has a likelihood of not being able to find cointegration due to structural instability in the long-run relationship. As argued in the earlier chapters, several studies on this field have used the symmetric and asymmetric cointegration test, such as the Engle and Granger (1987) cointegration test, to examine the presence of the pass-through mechanism, when dealing with few variables, while using the Johansen method when dealing with more variables. Basically, the choice lies with the author.

### 4.2.4 Equilibrium correction or error correction models

If the series are cointegrated, then the relationship between the variables can be estimated as an error correction model (ECM), since a linear combination of the rates can be stationary. This represents the Granger theorem, whereby the error term from the OLS regression, lagged once, represents the error correction term. This cointegration enables the capturing of a long-run relationship between the variables, whilst the ECM provides evidence of the short-run relationship (Brooks, 2008: 367). With the error-correction model, a test for differences in the interest rate adjustments when they are above or below their equilibrium level can be performed. The error-correction model can also be used to explain and determine how long it takes for the retail rates to adjust in a month to equilibrium, following changes in the interbank rate.

The ECM model is used and preferred because it can overcome problems of models with no long-run solution and determinations between equilibrium relationships (Brooks, 2008).

### 4.2.5 Testing for autocorrelation and heteroskedaskicity (ARCH)

A test for determining whether ARCH-effects are present in the residuals of an estimated model may be conducted. This is done by testing a joint null hypothesis that all $q$ lags of the squared residuals have coefficient values that are not significantly different from zero. If the value of the test statistic is greater than the critical value from the $x^2$ distribution, then the null hypothesis is rejected. This test can also be used to check for autocorrelation in the squared residuals (Brooks, 2008: 389). This is performed after estimating the ECM on the short run. If both the $F$-statistic and the $LM$-statistic are very significant, it suggests that there is evidence of ARCH effect in the short-run ECM results.

In addition, the Ljung-Box $Q$-statistics (LB) for the corresponding lags computed from the correlograms of the squared residuals test can be added to the verification tests for presence of autocorrelations**.** The correlograms of the squared residuals can be used to check autoregressive conditional heteroskedasticity (ARCH) in the residuals. If there is no ARCH in the residuals, the autocorrelations should be zero at all lags and the $Q$-statistics should not be significant. This view is available for equations estimated by least squares, two-stage least squares, and nonlinear least squares estimation. In calculating the probability for $Q$-statistics, the degrees of freedom are adjusted for the inclusion of ARMA terms (Eviews, 2007: 154).

Furthermore, the heteroskedasticity test allows testing for a range of specifications of heteroskedasticity in the residuals of the equation.

A normality test is also performed which shows the descriptive statistics of the residuals, including the Jarque-Bera statistic for testing normality. If the residuals are normally distributed, the Jarque-Bera statistic should not be significant. This view is available for residuals from least squares, two-stage least squares, nonlinear least squares, and several other types of models. The Jarque-Bera statistic has a distribution with two degrees of freedom under the null hypothesis of normally distributed errors (Eviews, 2007: 154). If there is evidence of heteroskedasticity, the combined ECM-EGARCH-M model is then followed.

### 4.2.6 Asymmetric GARCH models and tests for asymmetries in volatility

Arguably, the properties of linear estimators are largely researched and understood, such that a major disadvantage of linear models that have been commonly identified is their inability to explain a number of important features common to several financial data (Brooks, 2008: 380). Similarly, there are an infinite number of different types of non-linear model, but just a few non-linear models have been found to be useful for modelling financial data. A non-linear model should be used where financial theory suggests that the relationship between variables should be such as to require a non-linear model (Brooks, 2008: 341). These include explaining leverage effects (the tendency for volatility to rise more following a large rate fall than following a rate rise of the same magnitude). However, it has been argued that a negative shock to financial time series is likely to cause volatility to rise by more than a positive shock of the same magnitude.

Although asymmetries in returns series other than equities cannot be attributed to changing leverage, there is equally no reason to suppose that such asymmetries only exist in equity returns (Brooks, 2008). Hence, the popular asymmetric EGARCH formulation proposed by Nelson (1991) is later explained and employed in this study. Although different types of non-linear model exist, only a few, such as the ARCH, GARCH, and EGARCH models, are found to be useful for modelling financial data.

The GARCH models can be useful in this study because of their suitability in modeling the volatility of a series over time. More than one of the time series models can be combined in order to have a more complex hybrid. For example, the time series models can be combined together to create more formations, which have been considered to obtain more complex hybrid models (Brooks, 2008). These kinds of models can account for a number of important features of financial series at the same time, such as an ARMA-EGARCH-M model, and the approach combined for this study, an ECM-EGARCH-M model. These kind of models can account for various and different important features of financial series at the same time. The popular asymmetric exponential GARCH (EGARCH) model proposed by Nelson (1991) is considered. There are various ways to express the conditional variance equation, and the model further has several advantages over the pure GARCH specification.

Furthermore, based on arguments by Nelson (1991), it is assumed that different market information has different effects on the conditional variance (Wang and Lee, 2009: 1272). Nelson (1991) employed an EGARCH model to explain trends of asymmetric adjustment margins. In short, the volatility aspect looks at whether the effect of interest rate volatility on the retail interest rates differs for the selected sample period.

This section thus explains the pass-through mechanism in SA due to the limitations of the asymmetric ECM, in that it cannot account for volatility impact and leverage effect. In order to provide better analysis and explanation of pass-through mechanism and market volatility, the Wang and Lee (2009: 1271) Error-Correction EGARCH in Mean (ECM-EGARCH-M) model is used to estimate the interest rate pass-through mechanism. This study attempts to fill this gap in the literature by adopting the ECM-EGARCH-M model to explain the IRPT. The aspect on volatility involves answering the question of how interest rates volatility affects the adjustment process of retail interest rates, while the leverage explains whether negative shocks of interest adjustment are greater than positive shocks. In essence, the study looks at the impact of interest rate volatility on SA interest rates, and how the variances of the retail deposit or lending rates vary with time.

Furthermore, understanding whether the methodology employed for explaining IRPT and money market volatility in SA to provide different results is important because it might provide a better analysis of the IRPT in SA and the results obtained may contribute to a better explanation of SA monetary policy and its effectiveness.

## 4.3 The data description and empirical methodology

### 4.3.1 The data

In order to clearly demonstrate the pass-through mechanism, monthly data for South Africa are used. Emphasis is laid on investigating the long and short-run pass-through mechanisms between the interbank rate and the retail interest rates. The three types of interest rates that formed the focus of the estimations are the interbank money market rate, which is closely correlated with policy-controlled interest rates (specifically, the SA interbank call rate), the deposit rate and the lending rate. These are chosen because they provide a major representation of South Africa's monetary market rates. The interbank call rate is utilized because banks prefer to borrow at this rate, and should thus capture more asymmetry. Secondary data are employed and are generated from the International Monetary Fund's (IMF) International Financial Statistics (IFS) under the Thompson DataStream. The empirical tests are conducted using a period of 20 years, from 1990:7 to 2010:1. The selected period covers a time of pre-repo and the current repo system.

### 4.3.2 Descriptive statistics of the interest rates

Summary statistics of the first difference of the interest rates are discussed under this category, which focuses on the means, standard deviation, skewness, kurtosis and Jarque-Bera statistics. The standard deviation indicates the riskiness of the variable, while the skewness, kurtosis and Jarque-Bera statistics indicate whether the variable is normally distributed. If normally distributed at difference, the p-value of the Jarque-Bera statistics should be rejected when above 0.05%. The *Q*-statistic, shown as the Ljung-Box (LB) statistics of the interest rate fluctuations, is then used as a test for determining whether the series is white noise (Wang and Lee, 2009). This check is also performed to determine auto-correlation in the level values.

### 4.3.3 Methodology of estimation: The asymmetric cointegration test suggested by Scholnick (1996) and Sander and Kleimeier (2000)

**The empirical model: The Engle-Granger two-step method**

The Engle and Granger (1987) cointegration test involves estimating the cointegration regression by OLS, obtaining the residual $u_t$ and applying unit root test on $u_t$. If the residuals are I(0) then the retail rates and interbank rate series are cointegrated. For cointegration, the model tests the null that $u_t$ has a unit root, and if the null hypothesis of a unit root is rejected, then there is cointegration.

$$r_t = \alpha_0 + \beta_1 itbr_t + u_t \tag{1}$$

The model given in equation (1) explains the retail interest rate and the interbank rate long-run relationship. This represents the relationship between the bank lending/deposit rates and the interbank rate in the IRPT analysis, where $r_t$ represents the endogenously determined bank deposit/lending interest rate; $itbr_t$ denotes the interbank rate (which is assumed to be exogenous); $u_t$ is the long-run error term; $\alpha_0$ and $\beta_1$ are the model parameters, where $\alpha_0$ is the intercept and measures the constant mark-up or mark-down on the retail rates, and $\beta_1$ measures the status of the pass-through in the long run. Likewise, $\beta_1 < 1$ signifies an incomplete pass-through, $\beta_1 = 1$ a complete pass-through, and $\beta_1 > 1$ an over pass-through. It is unlikely to obtain $\beta_1 = 1$, because South Africa is an emerging market, together with the influencing factors mentioned in Chapter 2, including interest rate volatility, asymmetric influence, market imperfections and the banking system in the economy determined through bank concentration and net interest margin indicators mentioned in Chapter 3.

In order to validate the presence of cointegration, the Engle-Granger residual ADF test, the Durbin Watson (DW) test, Cointegrating Regression Durbin Watson (CRDW) of the Durbin Watson (DW) test and the Kremers *et al*. (1992) version of MacKinnon critical values of ECM coefficient *t* test (Kremers *et al*., 1992) are used in the residual test, in order to provide solid conclusions for the existence of cointegration. If the different methods provide conflicting results, the conclusion will be based on the error-correction *t* test, even if the other methods do not find evidence of cointegration.

### 4.3.4 The error correction model

If the series are cointegrated, then the relationship between the variables ‘itbr’ and ‘r’ can be estimated as an error correction model (ECM). Using a combination of first difference and lagged levels of cointegrated variables, equation (2) illustrates the ECM model as follows:

$$\Delta r_t = \alpha_0 + \beta_1 \Delta itbr_t + \beta_2 (r_{t-1} - \gamma itbr_{t-1}) + \varepsilon_t \tag{2}$$

This model is known as an error correction model or an equilibrium correction model. In the above model, Δ denotes first difference; the component $(r_{t-1} - \gamma itbr_{t-1})$ is known as the error correction term, and is a residual series obtained from the cointegration; $\gamma$ represents the long-run relationship between $itbr_t$ and $r_t$; $\beta_1$ captures the short-run relationship between changes in $itbr_t$ and changes in $r_t$; and $\beta_2$ is the coefficient of the error correction term, which describes the speed of adjustment back to equilibrium level. Lastly, $\varepsilon_t$ is a white noise error term. For $r_t$ and $itbr_t$ to be cointegrated with cointegrating coefficient γ, then $(r_{t-1} - \gamma itbr_{t-1})$ should be I(0), while its components are I(1). This makes the application of OLS and standard procedures for statistical inference on the equation reliable (Brooks, 2008: 338).

The model shows the error correction that occurs in the presence of cointegration, as well as representing the model for estimating long-run impact of changes in the interbank rate on retail rates. After estimating the error correction, the speed of adjustment for the retail rates back to equilibrium following a change in the interbank rate can then be performed.

### 4.3.5 Short-run symmetric and asymmetric adjustment

The short run impact can be computed from running equation (1) in its first differences, and is described as follows:

$$\Delta r_t = \alpha_0 + \beta_1 \Delta itbr_t + u_t \qquad (3)$$

Short-run adjustment can be estimated with or without the presence of cointegration, as long as the series are I(1), because differencing the series makes them stationary, resulting in OLS estimation with non-spurious results. Furthermore, the differencing system removes the long-run information in the data, leading to a more reliable estimation of the short-run parameters.

#### 4.3.5.1 Symmetric Mean Adjustment Lags (MAL)

Since the error correction process illustrated the adjustment within a month towards equilibrium, the symmetric MALs describes how long it takes the adjustment lag to return to equilibrium, when above or below their equilibrium level. When using monthly data, this is done by showing how many months it takes for the change in interbank rate to be fully reflected in the bank lending and deposit rates. Relying on an earlier work by Doornik and

Hendry (1994), Scholnick (1996:5) demonstrated that the MAL can be calculated from Equation (2) as follows:

$$MAL = (1 - \beta_1) / \beta_2 \qquad (4)$$

For interpretation, if the mean adjustment lag is high, it signifies a high rigidity/slow adjustment in the response of retail rates to interbank rate changes. The opposite is also true, with a low mean adjustment lag suggesting low rigidity/fast adjustment of bank rates to policy rate changes.

In order to deal with the disadvantage of the symmetric MAL which assumes that adjustment is symmetric when the retail rate is above or below its equilibrium level, the asymmetric adjustment is then considered. The asymmetric MAL would show how long it takes the retail rates to adjust up to equilibrium and down to equilibrium.

**4.3.5.2 Asymmetric Mean Adjustment Lags (MAL)**

The asymmetric MALs would effectively show how fast bank rates adjust upwards and downwards. To determine the asymmetric effects, Scholnick (1996) suggested separation of the residuals '$u_t$'. Below the residuals are shown as ECM from the cointegrating equation, and are separated into two series, $ECM^+$ and $ECM^-$ (in the form of dummy variables), where:

$ECM^+ = ECM$, if $ECM > \mu$

$ECM^+ = 0$, if $ECM < \mu$

and

$ECM^- = ECM$, if $ECM < \mu$

$ECM^- = 0$, if $ECM > \mu$

where $\mu$ is the mean and is equal to zero since it is the residual series of the cointegrating equation (Scholnick, 1996:6). When a residual is above its mean, this can be interpreted as the bank lending/deposit rates being above their equilibrium level with the interbank rate and expected to return back down to equilibrium. On the other hand, when the residual is below its mean, this can be interpreted as the bank lending/deposit rates being below their equilibrium level with the money market rate and expected to return back up to equilibrium.

After the residuals have been separated into two series, an asymmetric error correction system is calculated, where the asymmetric MALs can then be computed. The asymmetric error correction equation is as follows:

$$\Delta r_t = \alpha_0 + \beta_1 \Delta itbr_t + \beta_2 ECM^{+}_{t-1} + \beta_3 ECM^{-}_{t-1} + u_t \quad (5)$$

The asymmetric MAL is then described as:

$$MAL^{+} = (1 - \beta_1) / \beta_2 \quad (6)$$

or as:

$$MAL^{-} = (1 - \beta_1) / \beta_3 \quad (7)$$

These asymmetric MAL equations allow the estimation of mean adjustment lags when the series is below and above its mean. The mean adjustment lags in equations (6) and (7) show the asymmetric adjustment in bank lending and deposit rates when they are above and below their equilibrium means respectively. If the mean lags are different then the adjustments of the bank rates can be seen to be different. In the above equations, $MAL^{+}$ represents the mean adjustment lag when the rates are above their equilibrium level and $MAL^{-}$ represents the mean adjustment lag when the rates are below their equilibrium level.

For confirmation of a presence of asymmetry, a Wald test with $x^2$ (1) distribution on the restriction that $\beta_2 = \beta_3$ in equation (5) is used to test for equality, which determines whether they are statistically different from zero. If the equality test is accepted, it implies that there is no asymmetry, otherwise there is asymmetry. If there is then an asymmetric response, the retail rates are said to adjust differently.

Following the result obtained from the above, whether symmetric or asymmetric MAL is obtained, the short run ECM is checked for heteroskedastic variance problems. If a heteroskedastic variance problem is found, the error-correction model may be combined with the EGARCH model. In order to deal with this issue, the ECM-EGARCH-M model is employed next.

### 4.3.6 The ECM-EGARCH (1, 1)-M model

According to equation (1), when there is cointegration and the asymmetric ECM adjustment does not have a white noise residual of the error-correction model, the combined asymmetric ECM-EGARCH (1, 1)-M model is then followed:

$$\Delta r_t = \alpha_0 + \sum_{i=1}^{p} a_i\, \Delta r_{t-i} + \sum_{i=1}^{p} b_j \Delta v_{t-j} + m\Delta itbr_t + \sqrt[s]{\sigma_t^2} + \eta_1\, ECM^{+}_{t-1} + \eta_2\, ECM^{-}_{t-1}$$

$$+ v_t v_t|\Omega_{t-1} \sim N(0, \sigma_t^2) \qquad (8)$$

$$\text{Log}\,(\sigma_t^2) = \omega + \alpha \left| \frac{v_{t-1}}{\sigma_{t-1}} \right| + \gamma \frac{v_{t-1}}{\sigma_{t-1}} + \beta \log(\sigma_{t-1}^2) \qquad (9)$$

Equation (8) shows the conditional mean equation, where a delay autoregressive term, AR (p), and a moving average term MA (q) is inserted to adjust for autocorrelation. In addition, the effect of the interest rate volatility (or risk) is included on the interest rate in the mean equation and specified as a function of the time-varying standard deviation ($\sqrt{\sigma_t^2}$ ), where $\sigma_t^2$ is the conditional variance of $v_t$ (Wang and Lee, 2009). In equation (8), 'm' represents the impact of the changes of the interbank rates on the retail interest rates, while 's' indicates the impact of the volatility of the interest rates on the retail interest rates. Therefore, when the parameter 's' is significantly positive, it means that the interest rates volatility should increase the fluctuation margin of the interest rates, and vice versa. The parameters $\eta_1$ and $\eta_2$ in equation (8) are the adjustment speeds of the positive and negative error-correction terms respectively. $ECM_{t-1}$ is the error-correction term and is also the long-run equilibrium error value of the previous period. The error correction terms $ECM^{+}_{t-1}$ and $ECM^{-}_{t-1}$, represent the positive and negative error correction terms, where the margins of the retail interest rates can adjust to different sizes. From the signs, if $\eta_1 \neq \eta_2$, then there is adjustment rigidity in the retail interest rate. If $|\eta_1|>|\eta_2|$, then there is upward adjustment rigidity in the retail interest rate, otherwise, there is downward adjustment rigidity in the retail interest rate.

Furthermore, if the speed of adjustment parameter is positive, then the retail interest rate fluctuates to a bigger value with the long-run equilibrium error. On the other hand, if the speed of adjustment parameter is negative, then the retail interest rate fluctuates to a smaller value with the long-run equilibrium error. Equation (9) shows the conditional variance equation. Here, if $\gamma$ is significant and different from zero, then there is an asymmetric effect in the conditional variance, while if $\gamma$ is significant and smaller than zero, then there is leverage effect in the conditional variance (Wang and Lee, 2009). Leverage effect is looked into, because when there is a production of excessive volatility in markets and economies, consideration of this analysis is important, as it explains whether the market has the presence of negative shocks of interest adjustment larger than positive shocks.

The asymmetric ECM-EGARCH (1, 1)-M model is then estimated using the maximum likelihood method. The log likelihood function is as in equation (10) and is reported in Eviews.

$$\text{LogL} = -(T/2)\log(2\pi) - (1/2)\sum_{t=1}^{T}\log(\sigma_t^2) - (1/2)\sum_{t=1}^{T}(v_t^2/\sigma_t^2) \qquad (10)$$

If the cointegration relation is symmetric, then the error correction term in equation (8) is adjusted into a symmetric form:

$$\Delta r_t = a_0 + \sum_{i=1}^{p} a_i\, \Delta r_{t-i} + \sum_{j=1}^{q} b_j\, \Delta v_{t-j} + m\Delta itbr_t + \sqrt[s]{\sigma_t^2} + \eta_1 ECM_{t-1} + v_t \qquad (11)$$

If there is no cointegration relation, then the error-correction term in equation (8) is excluded:

$$\Delta r_t = a_0 + \sum_{i=1}^{p} a_i\, \Delta r_{t-i} + \sum_{j=1}^{q} b_j\, \Delta v_{t-j} + m\Delta itbr_t + \sqrt[s]{\sigma_t^2} + v_t \qquad (12)$$

In summary, the ECM-EGARCH (1, 1)-M model approach is useful because it examines the asymmetric and symmetric adjustment of interest rates in the short run. In essence, it accounts for the heteroskedastic variance problem of the short-run adjustment of the interest rates, analyzes the effect of the interest rate volatility on the interest rate adjustment and explains the presence of the leverage effect on the interest rate adjustments.

For confirmation, the diagnostic tests are carried out to verify the appropriateness of the ECM-EGARCH-M model, and in testing for the capturing of ARCH effects in relation to heteroskedasticity. These are the ARCH-LM test, and the LB Q-statistics tests. The test of $H_0$: $\eta_1 = \eta_2$ is also performed.

### 4.4 Conclusion

This chapter sets out the methodology used in explaining the IRPT in the long-run and short-run analysis, as well as investigating the impact of interest rate volatility and presence of leverage effect on the pass-through mechanism. It provides the types and length of data employed. The chapter also touches on the importance of testing for stationarity, the ECM, cointegration and the uses and types of non-linear models, as well as some of their advantages. The chapter then identifies how the symmetric and asymmetric speeds of adjustments are calculated from the symmetric and asymmetric ECM, in order to determine the computation of the symmetric and asymmetric mean adjustment lag of the different samples.

Furthermore, justification is provided for the use of the selected EGARCH-M model along with its combination with the ECM to form the ECM-EGARCH (1, 1)-M model for explaining the presence of volatility, leverage and asymmetry in the short run adjustment. The next chapter presents the empirical results of these tests.

# CHAPTER 5

# EMPIRICAL RESULTS

## 5.1 Introduction

This chapter presents and discusses the empirical results obtained from the detailed tests processes in chapter 4. The chapter is organized as follows: Section 5.1 presents the summary statistics of the interest variables. Section 5.2 shows the stationarity and unit root test results, while Section 5.3 deals with the cointegration and error correction results. Section 5.4 presents the long-run and short-run pass-through estimation output, and the symmetric error correction and asymmetric error correction results. Section 5.5 covers symmetric and asymmetric mean adjustment lag results, Section 5.6 presents the combined ECM-EGARCH (1, 1)-M results, and lastly Section 5.7 concludes the empirical results.

## 5.2 Descriptive statistics of the interest variables

The sample covers the period from July 1990 to January 2010. Three sets of analyses are carried out as mentioned in the methodology. These include the entire sample period (1990-2010), the pre-repo period (1990-1998) and the repo period (1998-2010). Firstly, the descriptive statistics of the first differential interest rate variables performed are presented in Table 5.1, which shows that the means of deposit and lending rates are negative for all three sample periods. These negative results could suggest a presence of a decline in the rates. From the standard deviation, the 1998-2010 repo period's interest risk is greater than the other two periods, with the pre-repo period 1990-1998 having the lowest. For all three sample periods, the deposit rates have more risk than the lending rate. From the skewness, the repo period of 1998-2010 shows the highest deposit and lending rate value, followed by the whole sample period of 1990-2010. The kurtosis and Jarque-Bera statistics are significant for all, rejecting the normality hypothesis.

For more validation, the Ljung-Box (LB) statistic of the interest rate fluctuations is significant for the 1990-2010 deposit and lending rate, as well as for the lending rate of the repo period of 1998-2010. This shows that there might be evidence of autocorrelation in the differenced level, and further hints for some features of heteroskedastic variance problem in interest rate volatility (Wang and Lee, 2009). This therefore suggests that the combined

ECM-EGARCH (1, 1)-M analysis should be performed on the 1990-2010 period, though further analyses are still to be considered.

Table 5.1: Descriptive statistics of the first differenced retail interest rates

| | 1990-2010 | | 1990-1998 | | 1998-2010 | |
|---|---|---|---|---|---|---|
| | **dr** | **lr** | **dr** | **lr** | **dr** | **lr** |
| Mean | -0.05 | -0.04 | -0.06 | -0.02 | -0.06 | -0.04 |
| Median | 0 | 0 | 0 | 0 | 0 | 0 |
| Maximum | 3.9 | 4 | 2 | 1.25 | 3.9 | 4 |
| Minimum | -1.85 | -2 | -1.15 | -1 | -1.55 | -1 |
| Std. Dev. | 0.57 | 0.54 | 0.44 | 0.39 | 0.67 | 0.59 |
| Skewness | 1.87 | 1.55 | 0.76 | 0.19 | 2.32 | 2.39 |
| Kurtosis | 17.98 | 17.57 | 7.55 | 6.65 | 15.91 | 18.07 |
| Jarque-Bera | 2325.76 | 2162.82 | 87.14 | 51.06 | 1112.96 | 1478.61 |
| P-value | 0 | 0 | 0 | 0 | 0 | 0 |
| Sum | -12.13 | -10.5 | -5.35 | -1.75 | -8.81 | -6 |
| Sum Sq. Dev. | 76.96 | 67.32 | 17.52 | 13.82 | 62.48 | 49.28 |
| LB(12) | 36.298 | 49.596 | 11.516 | 11.798 | 21.07 | 30.792 |
| P-value | 0 | 0 | 0.485 | 0.462 | 0.049 | 0.002 |
| Observations | 234 | 234 | 91 | 91 | 142 | 142 |

Note: dr indicates the deposit interest rate of South Africa, while lr denotes the lending rate variable. The Jarque-Bera statistic value shows the Jarque-Bera normality test. LB (12) is the Ljung–Box statistic because monthly data is used. Std. Dev. represents standard deviation and Sum Sq. Dev. is the sum of square deviation.

## 5.3 Stationarity and unit root tests

As noted in the previous chapter, the Augmented Dickey Fuller (ADF) unit root test and the KPSS stationarity test are selected to determine the stationarity and the level of integration of the interest rates series. The test results obtained are shown in Table 5.2, listing the level and the first difference values of the variables. The results from the ADF and KPSS tests show that the entire sample data and the repo period are all stationary at first difference. For the pre-repo period, the ADF showed that the series are stationary at first difference, while the KPSS showed that they are stationary at level. The test for cointegration is also performed on all the series, as the series are stationary at first difference. This is not a major concern for the analysis, since the most important stage is stationarity of the cointegration residuals.

The unit root and the KPSS stationarity tests results generally suggest that the interest rates are I(1) series for all three sample periods, so the cointegration analysis is conducted next.

Table 5.2a: ADF unit root

| ADF | | 1990-2010 | | | | | | 1990-1998 | | | | | | 1998-2010 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| unit root | | level | lags | pv | diff | lags | pv | level | lags | pv | diff | lags | pv | level | lags | pv | diff | lags | pv |
| | itbr | -1.91 | 1 | 0.33 | -11.47 | 0 | 0 | -1.70 | 0 | 0.43 | -9.43 | 0 | 0 | -1.91 | 1 | 0.33 | -8.98 | 0 | 0 |
| | lr | -2.00 | 2 | 0.29 | -7.12 | 1 | 0 | -1.39 | 0 | 0.59 | -8.59 | 0 | 0 | -1.86 | 1 | 0.35 | -8.27 | 0 | 0 |
| | dr | -2.22 | 2 | 0.20 | -7.51 | 1 | 0 | -2.24 | 0 | 0.19 | -9.12 | 0 | 0 | -2.25 | 2 | 0.19 | -5.85 | 1 | 0 |

Note: ADF equation includes constant, lags indicates the lag length determined by the minimum AIC, pv denotes the p-value and diff represents first difference. They are all significant at 1%, 5% and 10%. The critical value of MacKinnon (1996) was employed. The critical values are: 1990-2010 – 1% = -3.46, 5% = -2.87, 10% = -2.57, 1990-1998 – 1% = -3.50, 5% = -2.89, 10% = -2.58 and 1998-2010 – 1% = -3.48, 5% = -2.88, 10% = -2.58.

Table 5.2b: KPSS Stationarity

| KPSS | | 1990-2010 | | 1990-1998 | | 1998-2010 | |
|---|---|---|---|---|---|---|---|
| stationarity | | level | diff | level | diff | level | diff |
| | itbr | 1.13 | 0.06 | 0.29 | 0.43 | 0.34 | 0.10 |
| | lr | 1.29 | 0.04 | 0.29 | 0.42 | 0.35 | 0.08 |
| | dr | 1.23 | 0.08 | 0.32 | 0.45 | 0.49 | 0.10 |

Note: The corresponding critical values for significance level are 1% = 0.739, 5% = 0.463 and 10% = 0.347 following Kwiatkowski *et al.* (1992). itbr, lr and dr denote interbank, lending and deposit rate respectively.

## 5.4 Cointegration and the error correction model results

Following the Engle-Granger method, the CRDW test and the error correction *t* test, the cointegration estimations obtained show that there is cointegration between the deposit/lending rate and the interbank rate. The summary results of the cointegration tests are displayed in Table 5.3.

As mentioned in the methodology section, three methods are used to test for cointegration in the pair of interest rates. All the tests for the three sample periods are cointegrated using the Engle-Granger ADF, leading to a rejection of the null hypothesis of no cointegration. The tests are all confirmed at 1%, 5% and 10% significance levels, presenting strong evidence of cointegration between the deposit/lending rates and the interbank rates. For the CRDW, they were all significant at all levels, except the lending rate of period 1990-2010, which is only significant at the 10% level.

Table 5.3: Cointegration result

| | | | | | ECM(A) | |
|---|---|---|---|---|---|---|
| | **Period** | **EG ADF** | **pv** | **CRDW** | **coef** | **t-stat** |
| **dr** | 1990-2010 | -3.728 | 0 | 0.571 | -0.232 | -5.269 |
| | 1990-1998 | -4.186 | 0 | 0.561 | -0.200 | -3.237 |
| | 1998-2010 | -2.872 | 0 | 0.613 | -0.257 | -4.431 |
| **lr** | 1990-2010 | -3.326 | 0.001 | 0.348 | -0.149 | -4.361 |
| | 1990-1998 | -5.042 | 0 | 0.867 | -0.348 | -4.622 |
| | 1998-2010 | -4.986 | 0 | 0.547 | -0.272 | -5.129 |

For significance, the CRDW critical values are: 1% (0.511), 5% (0.386) and 10% (0.322) (Gujarati, 2004: 824). lr and dr denote lending and deposit rate respectively. EG ADF is the Engle-Granger Augmented Dickey Fuller test and CRDW is the Cointegrating Regression Durbin Watson. pv denotes the probability value and diff represents first difference.

The error correction based cointegration test also rejected the null hypothesis that retail rates and the interbank rate are not cointegrated. Based on the t-ratio, the retail rates are cointegrated at all levels for the three samples. Overall, the three tests are in agreement of cointegration. This cointegration is a measure of long run relationship; hence the next section provides results on the long-run and short-run pass-through.

## 5.5 Long-run and short-run pass-through

Table 5.4 shows the summary of the results obtained for the long-run pass-through analysis, the short-run pass-through, and the symmetric and asymmetric error correction coefficients. The symmetric ECM is denoted as '$ECM_{t-1}$', while the asymmetric ECM is presented in the form of positive and negative, which are '$ECM_{t-1}$ and $ECM^{-}_{t-1}$'.

For the long-run pass-through explanations in Table 5.4, a significant constant mark-up (intercept coefficient) is seen for all the sample periods, with the lending rate having a higher mark-up value on fixed rates. In addition, the entire sample period has a lower mark-up compared to the pre-repo and repo periods. To show the impact of the type of monetary policy tool implemented, the repo period has a lower mark-up value compared to the pre-repo period, for both the lending and deposit rate. When looking at the slope coefficient of the long-run pass-through of the deposit and lending rates, a significant result is obtained for all three sample periods. A high pass-through rate, close to a one-for-one PT, is observed for the deposit and lending rate of the entire sample period 0.922, while for the deposit rate, the pre-repo period (1990-1998) produced a lower PT compared to the repo period 1998-2010. For the lending rate, the pre-repo period has a lower pass-through compared to the repo period. Overall, a higher long-run pass-through is observed in the deposit rate than in the lending rate.

Table 5.4: Long-run and short run pass-through

| | | Long-run Intercept | | Slope | | Short-run | | Error Correction Terms $ECM_{t-1}$ | | $ECM^{+}_{t-1}$ | | $ECM^{-}_{t-1}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Period | Coeff | t-stat | Coeff | t-stat | Coeff | t-stat | Coeff | t-stat | Coeff | t-stat | Coeff | t-stat |
| dr | 1990-2010 | 1.107 | 8.607 | 0.922 | 84.834 | 0.643 | 13.542 | -0.238 | -5.245 | -0.173 | -2.116 | -0.304 | -3.633 |
| | 1990-1998 | 2.226 | 6.035 | 0.863 | 33.129 | 0.395 | 5.637 | -0.189 | -2.924 | -0.074 | -0.542 | -0.291 | -2.356 |
| | 1998-2010 | 1.284 | 5.043 | 0.912 | 48.488 | 0.633 | 10.186 | -0.258 | -4.287 | -0.165 | -1.461 | -0.351 | -3.082 |
| lr | 1990-2010 | 5.571 | 40.939 | 0.922 | 80.193 | 0.655 | 16.972 | -0.148 | -4.283 | -0.294 | -4.306 | -0.042 | -0.768 |
| | 1990-1998 | 8.947 | 34.413 | 0.689 | 37.527 | 0.321 | 5.258 | -0.354 | -4.580 | -0.417 | -2.702 | -0.281 | -1.645 |
| | 1998-2010 | 6.870 | 32.916 | 0.837 | 54.291 | 0.582 | 12.493 | -0.272 | -5.075 | -0.389 | -3.868 | -0.146 | -1.380 |

Note: Coeff denotes coefficient, $ECM_{t-1}$ is the coefficient of the symmetric error correction; $ECM_{t-1}$ is the coefficient of the asymmetric error correction for adjustments up to equilibrium; $ECM^{-}_{t-1}$ is the coefficient of the asymmetric error correction for adjustments down to equilibrium. lr and dr denote lending and deposit rate respectively.

Looking at the short-run pass-through, all its coefficients were significant to changes in the money market rate. For the entire sample period, the lending rate had a higher pass-through compared to the deposit rate when responding to the interbank changes, though the difference is minimal. More importantly, the pass-through is incomplete, with the lending rate having a lower pass-through (0.321 and 0.582) than the deposit rate (0.395 and 0.633), for both the pre-repo and repo period respectively. More importantly, the repo period produced a higher pass-through in the deposit and lending rate.

When considering the difference between the long-run and short-run pass-though, a huge gap is evident, as the short-run PT is lower than the long-run PT for all the sample periods, as expected. This indicates that the interest rates adjustments are rigid in the SR. The pre-repo period is also noted to be more rigid than the repo period.

A conclusion that can be drawn when comparing the pre-repo system to the repo-system period is that, in the long run, for the deposit rate, the repo system produced a higher pass-through (0.922), and likewise for the lending rate, the repo system produced a higher PT

(0.837). This is also evident in the short-run PT results. In both the deposit (0.633) and lending (0.582) rate response to changes in the interbank rate, a higher pass-through is witnessed in the repo period, compared to the pre-repo period. This indicates or suggests that the adoption of the repo system improved the monetary policy through the increase in the speed of transmission of monetary policy. The improvement can also be related to the implementation of inflation targeting framework.

### 5.6 Symmetric and asymmetric ECM

In this section, the ECM coefficients show the amount of change made to the retail rates when adjusting to equilibrium every month. The test results in Table 5.4 exhibit the symmetric and asymmetric ECM, represented by '$ECM_{t-1}$' and '$ECM^{+}_{t-1}$, and $ECM^{-}_{t-1}$' respectively, which show the asymmetric cointegration of interest variables in South Africa.

The symmetric ECM appears significant for both the deposit and the lending rate in all three sample periods. Furthermore, the deposit rate adjusts faster than the lending rate in the entire sample period, while in the split period, both in the pre-repo and repo period the lending rate adjusted faster than the deposit rate. More importantly, for the deposit rate, the repo-period has a higher and faster adjustment than in the pre-repo period, while for the lending rate, the pre-repo period had faster adjustments.

In summary, for the deposit rate, the repo system produced a faster adjustment, while for the lending rate, the pre-repo showed faster adjustment. When comparing the lending and deposit rate adjustments in the entire period, the deposit rate produced a faster adjustment. Likewise, in the pre-repo and repo-period, the lending rate had a faster adjustment than the deposit rate. The results obtained show that the type of monetary system in an economy or market monitored by the central bank influences the speed and monetary transmission process.

The asymmetric error correction shows the positive and negative error correction mechanism indicating periods when retail rates are above and below equilibrium. For the deposit rate, the asymmetric results are significant for the negative ECM, which showed that adjustments downwards (-0.304) are faster than the adjustments upwards (-0.173). In addition, the repo period also showed faster adjustments down (-0.351), compared to the pre-repo period (-0.291). This outcome indicates and supports evidence of collusive pricing arrangements.

On the other hand, for the lending rate, the asymmetric results are significant for the positive ECM, which showed that adjustments upwards (-0.294) were faster than adjustments downwards (-0.042). Interestingly, the pre-repo period has a faster adjustment compared to the repo-period. The overall outcome once again supports the evidence of collusive pricing arrangement theory.

When comparing the deposit and lending rate of the entire period, the deposit rate showed faster adjustment downwards than the upward adjustments for the lending rate, which are all rigid, as their sizes are low. This provides evidence that commercial banks are not encouraging savings by customers and consumers. Likewise, it could show a sign of lack of competition within the banking system in the economy or market, as well as evidence of oligopolistic behaviour.

## 5.7 Symmetric mean adjustment lags and asymmetric adjustment

This section presents the symmetric mean adjustment and asymmetric mean adjustment outcomes. In order to measure the efficiency level, speed and effectiveness of the monetary transmission mechanism, and thereby improve policy implementations for policy makers and economists, the adjustment in retail rates is checked for the presence of asymmetry. The results of the symmetric and asymmetric mean adjustment lags are reported in Tables 5.5, which also explains the margin between the long-run and short-run PT.

### 5.7.1 Symmetric MAL

In Table 5.5, the lending rate of the entire sample period shows a larger symmetric MAL, meaning that it takes longer, or a slower adjustment time, compared to the deposit rate. That is, it takes an average of 2.334 months or 69 days for adjustment to equilibrium after a shock in the interbank rate, compared to the average 1.502 months or 45 days of adjustment time for the deposit rate. This makes sense, as banks maximize their profit from the retail rate margins by taking longer time to adjust their lending rates.

Furthermore, when comparing the pre-repo and repo period, in both the lending and deposit rate, the repo period has a smaller symmetric MAL, implying a shorter time for adjustment. This also shows that the repo period produced a better monetary transmission mechanism, which once again proves that the repo system is more efficient as it encourages faster pass-throughs.

Table 5.5: Mean adjustment lag

| | | Symmetric | Asymmetric | Adjustment | Wald Test | |
|---|---|---|---|---|---|---|
| | **Period** | **MAL** | **MAL(P)** | **MAL(N)** | **Coeff** | **P-value** |
| **dr** | 1990-2010 | 1.502 | 2.034 | 1.159 | 0.891 | 0.345 |
| | 1990-1998 | 3.199 | 8.218 | 2.080 | 0.935 | 0.334 |
| | 1998-2010 | 1.423 | 2.178 | 1.026 | 0.931 | 0.335 |
| **lr** | 1990-2010 | 2.334 | 1.187 | 8.291 | 6.102 | 0.014 |
| | 1990-1998 | 1.919 | 1.638 | 2.435 | 0.228 | 0.633 |
| | 1998-2010 | 1.536 | 1.089 | 2.904 | 1.896 | 0.169 |

Note: MAL: Mean Adjustment Lag, MAL(P): Mean Adjustment Lag when the bank rate is above its equilibrium with the official rate and the impulse is for bank rates to fall MAL(N): Mean Adjustment Lag when the bank rate is below its equilibrium with the official rate and the impulse is for bank rates to rise.

### 5.7.2 Asymmetric MAL

The presence of asymmetry in the adjustment of the bank retail rates is answered by using the Wald test, which tests for equality between the coefficients of the positive and negative residuals in the asymmetric error correction model. These results are reported in Table 5.5, which indicates the different outputs obtained.

For the entire sample period, Table 5.5 shows that there is asymmetry in the lending rate, along with a very large downward rigidity adjustment (8.291). This result supports the collusive pricing arrangement, and also assists the policy makers in determining the speed of monetary transmission. It can be seen that with an asymmetric effect on the pass-through, it takes 8.291 months or 249 days of adjustment time back to equilibrium in the lending rate after a shock. This implies that commercial banks are enjoying maximum profits in the delay time lag, supporting the net interest margin indicator explained in Chapter 3. The deposit rate has no asymmetric effect on its adjustment.

Unfortunately, for both the pre-repo and repo period samples, the Wald test rejected the presence of asymmetry in the deposit and lending rate, with the repo period lending rate close to having a significant asymmetry (0.169). A reason for non-asymmetry in the data could be due to the length of the selected period, as longer data series could produce better results, but a longer time span could not be estimated as the repo system started in 1998. This indicates that the data period or length also influences the results obtained.

Table 5.6: Symmetric and asymmetric ECM summary results

| Symmetric and Asymmetric ECM Summary Results | | | | | | |
|---|---|---|---|---|---|---|
| Period | | ECM mark-up/ mark-down (α) | Rigidity adjustment | Degree of IRPT | IRPT mechanism | Theory support |
| **1990-2010** | dr | mark-up | upward | incomplete | symmetric | collusive pricing arrangement |
| | lr | mark-up | downward | incomplete | asymmetric | collusive pricing arrangement |
| **1990-1998** | dr | mark-up | upward | incomplete | symmetric | collusive pricing arrangement |
| | lr | mark-up | downward | incomplete | symmetric | collusive pricing arrangement |
| **1998-2010** | dr | mark-up | upward | incomplete | symmetric | collusive pricing arrangement |
| | lr | mark-up | downward | incomplete | symmetric | collusive pricing arrangement |

Note: dr and lr denotes deposit and lending rate respectively, IRPT is the interest rate pass-through

In summary, the symmetric and asymmetric ECM results provided in Table 5.6 show that there is statistically, a significant asymmetric adjustment in the lending rate for the entire period. It also suggests that there is evidence of upward rigidity in the deposit rate and downward rigidity in the lending rate when there is a change in the official rate. In addition, the upward rigidity in the deposit rate and the downward rigidity in the lending rate both support the collusive pricing arrangement theory. This shows the presence of oligopolistic behaviour in the finance market, as well as bank concentration and large net interest margins by banks in the market through maximization of profits, which is evidenced through the small pass-through and a longer delay in adjustment time after a shock in the money market rate.

The next section applies the ECM-EGARCH (1, 1)-M methodology to the entire sample period of 1990-2010 only, as the results from the descriptive statistics of Table 5.1 suggest the presence of autocorrelation. In addition, the results of the conditional heteroskedasticity test on the short-run ECM shown in Table 5.7 are significant for the sample period, implying the presence of heteroskedasticity. This calls for the utilization of the combined methodology to test for volatility impact on interest rates adjustment, if any, and leverage effects. The symmetric deposit rate and asymmetric lending rate only will be estimated, as the Wald test earlier rejected the presence of asymmetry in the deposit rate.

Table 5.7: Heteroskedasticity Test: Short-run

| Heteroskedasticity Test: Short run | | | | | |
|---|---|---|---|---|---|
| | | F-stats | P-value | R-squared | P-value |
| 1990-2010 | dr-asymmetric | 4.375 | 0.001 | 20.451 | 0.001 |
| | dr-symmetric | 3.717 | 0.003 | 17.612 | 0.004 |
| | lr-asymmetric | 3.294 | 0.007 | 15.748 | 0.008 |

Note: dr and lr denotes deposit and lending rate respectively.

### 5.8 The ECM-EGARCH (1, 1)-M model results

This section provides the results obtained from the combined ECM-EGARCH-M model estimation of interest rate adjustment in the short run. Table 5.8 shows the results, which includes the use of diagnostic models for verification. The implications of parameters ω, α, and β (representing the mean, intercepts for constant mark up or down, and long-run response to changes respectively) in the equation are not elaborated or interpreted in the combined model. Their implications have been explained in the earlier ECM model. The results in Table 5.8 include the heteroskedasticity test of ARCH effect following F-stat and R-squared, as well as the serial correlation test with statistics $Q_{12}$ ($uh^{-½}$) and $Q_{12}$ ($u^2h^{-1}$). The diagnostic results show that the model is appropriate, as they produce insignificant results rejecting the null hypotheses, implying that there is no asymmetric effect in the standardized residuals (Wang and Lee, 2009). The symmetric ECM-EGARCH (1, 1)-M model is adopted to examine the deposit interest rate, while the asymmetric ECM-EGARCH (1, 1)-M model is adopted for the lending rate.

In Table 5.8a, parameter ‘s’, which explains the impact of the volatility of the interest rates on the retail interest rates, is only significantly negative for the deposit rate (-0.262). This implies that the PT is influenced by volatility, but the impact does not increase the fluctuation margin of the interest rates. Next, parameter ‘m’ shows the impact of the changes of the interbank rates on the retail interest rates as positive and significant. Specifically, the impact on lending rate (0.709) is largely greater than on the deposit rate (0.497). This shows that the deposit and lending rates adjustment margins are positively related to the interbank adjustment margins and the adjustment ratio is less than one.

Parameters $\eta_1$ and $\eta_2$ are the adjustment speeds of the positive and negative error-correction terms respectively. For the deposit rate, parameter $\eta_1$ showed the effect of the symmetric error-correction term on the retail interest rate, which is significant and negative. It indicates that the deposit rate fluctuates to a smaller value with the long-run equilibrium error, which further implies that the short-run disequilibrium should return back to the long-run equilibrium by bias adjustments, with a slow adjustment.

For the lending rate, from parameters $\eta_1$ and $\eta_2$, in terms of the absolute values, the result showed that $|\eta_1| \neq |\eta_2|$, implying that there is rigidity in adjustment in the lending rate. In addition, $|\eta_1| < |\eta_2|$ in the lending rate, meaning there is downward adjustment supporting the theory of collusive pricing arrangements. Furthermore, the test results on the parameters for $H_0$: $\eta_1 = \eta_2$ are significant for the lending rate, rejecting the null hypothesis, meaning that the adjustment of interest in the short-run disequilibrium is asymmetric. Parameter $\gamma$, which tests for the presence of leverage effect on the adjustment of the conditional variance of the interest rates, is not significant for either the deposit or lending rates.

Table 5.8a: ECM-EGARCH (1,1)-M results

| | | dr-symmetric | | lr-asymmetric | |
|---|---|---|---|---|---|
| | **1990-2010** | estimate | p-value | estimate | p-value |
| Mean | s | -0.262 | 0.062 | 0.165 | 0.212 |
| equation | $\alpha 0$ | 0.095 | 0.014 | -0.036 | 0.152 |
| | $\alpha 1$ | 0.423 | 0 | 0.171 | 0 |
| | m | 0.497 | 0 | 0.709 | 0 |
| | $\eta_1$ | -0.067 | 0.007 | -0.055 | 0.081 |
| | $\eta 2$ | | | -0.111 | 0.045 |
| Variance | $\omega$ | -0.827 | 0 | -0.614 | 0 |
| equation | $\alpha$ | 0.613 | 0 | 0.545 | 0 |
| | $\gamma$ | -0.075 | 0.336 | 0.053 | 0.359 |
| | $\beta$ | 0.849 | 0 | 0.903 | 0 |
| | Diagnostic tests | | | | |
| ARCH | F-stat | 0.516 | 0.903 | 0.177 | 0.999 |
| effect | R-squared | 6.395 | 0.895 | 2.238 | 0.999 |
| Q-Stats | $Q_{12}(uh^{-1/2})$ | 10.283 | 0.416 | 11.501 | 0.32 |
| | $Q_{12}(u^2h^{-1})$ | 6.434 | 0.778 | 2.077 | 0.996 |
| | $H_0 : \eta_1 = \eta_2$ | | | 12.456 | 0.002 |
| Log L | | | -46.14993 | | -20.65604 |

Note: $Q_{12}$ $(uh^{-½})$ and $Q_{12}$ $(u^2h^{-1})$ represent the standardized residual and squared Ljung-Box statistic with 12 month lags. Log *L* is the value maximum likelihood function of which p-value of *t*-test is presented. dr and lr denotes deposit and lending rate respectively. Significance level is at 1%, 5% and 10%.

In Table 5.8b, a dummy variable is included to analyse the impact of the monetary policy tool in place in South Africa on the PT mechanism, from pre-repo to repo usage. A dummy variable of ‘0’ is inserted before 1998:03 and 1 from 1998:03 in the estimation. The results from Table 5.8b similarly show the impact of the volatility on the interest rates ‘s’, which is also negatively significant for the deposit rate (-0.444), and insignificant for the lending rate (0.060). Although a larger value is obtained after capturing the change in the monetary tool, the same implication is clear: that is, that the volatility impact of the interest rates does not increase the fluctuation margin of the interest rates.

Table 5.8b: ECM-EGARCH (1,1)-M results with dummy variables

| | | dr-symmetric | | lr-asymmetric | |
|---|---|---|---|---|---|
| | **1990-2010** | estimate | p-value | estimate | p-value |
| Mean equation | s | -0.444 | 0.006 | 0.060 | 0.675 |
| | $\alpha 0$ | 0.187 | 0.001 | 0.049 | 0.291 |
| | $\alpha 1$ | 0.416 | 0 | 0.177 | 0 |
| | m | 0.503 | 0 | 0.703 | 0 |
| | $\eta_1$ | -0.068 | 0.016 | -0.009 | 0.791 |
| | $\eta 2$ | | | -0.123 | 0.011 |
| | dummy | -0.044 | 0.0626 | -0.061 | 0.012 |
| Variance equation | $\omega$ | -0.876 | 0 | -0.696 | 0 |
| | $\alpha$ | 0.627 | 0 | 0.585 | 0 |
| | $\gamma$ | -0.134 | 0.092 | 0.022 | 0.7434 |
| | $\beta$ | 0.834 | 0 | 0.880 | 0 |
| | Diagnostic tests | | | | |
| ARCH effect | F-stat | 0.700 | 0.750 | 0.184 | 0.999 |
| | R-squared | 8.584 | 0.738 | 2.317 | 0.999 |
| Q-Stats | $Q_{12}(uh^{-1/2})$ | 14.201 | 0.164 | 6.4481 | 0.776 |
| | $Q_{12}(u^2h^{-1})$ | 10.336 | 0.412 | 2.196 | 0.995 |
| | $H_0 : \eta_1 = \eta_2$ | | | 8.911 | 0.012 |
| Log L | | | -45.77107 | | -20.0091 |

Note: $Q_{12}$ $(uh^{-½})$ and $Q_{12}$ $(u^2h^{-1})$ represent the standardized residual and squared Ljung-Box statistic with 12 month lags. Log *L* is the value maximum likelihood function of which p-value of *t*-test is presented. dr and lr denotes deposit and lending rates respectively. Significance level is at 1%, 5% and 10%.

Looking at the impact of the changes of the interbank rates on the retail interest rates ‘m’, a positive and significant result is obtained for the deposit (0.503) and lending rate (0.703) respectively in Table 5.8b. This is lower than when the dummy variable was excluded, and further shows that the deposit and lending rates adjustment margins are positively related to the interbank adjustment margins and that the adjustment ratio is less than one. For the deposit rate, parameter $\eta_1$ of Table 5.8b shows the effect of the symmetric error-correction term on the retail interest rate as significant and negative, indicating that the deposit rate fluctuates to a smaller value with the long-run equilibrium error, which further implies that the short-run disequilibrium should return to the long-run equilibrium by bias adjustments, with a slow adjustment.

Interestingly, the adjustment speed of the positive error-correction term in Table 5.8b $\eta_1$ produced an insignificant result, while the negative ECM adjustment $\eta_2$ was significant. In terms of interpreting the absolute values of $\eta_1$ and $\eta_2$ for the lending rate, the same conclusion from table 5.8a, as in when the dummy variables were excluded, is observed. That is, $|\eta_1| \neq |\eta_2|$, implying that there is rigidity in adjustment in the lending rate. Likewise, $|\eta_1| < |\eta_2|$ in the lending rate, meaning there is downward adjustment supporting the theory of collusive pricing arrangements. The test results on the parameters for $H_0$: $\eta_1 = \eta_2$ are significant for the lending rate, rejecting the null hypothesis, meaning that the adjustment of interest in the short-run disequilibrium is asymmetric. And, asymmetry is found in the lending rate, with an adjustment that supports collusive pricing arrangement.

The major and important difference in the result obtained showed the presence of leverage effect '$\gamma$' on the adjustment of the deposit rates is significant, as the value is less than zero. It further implies that the interest adjustment margins would lead to a larger interest rate fluctuation. That is, negative shocks of adjustment are greater than positive shocks, as they explain that the margin of deposit rate change decreases when interest risk increases. A leverage effect within the deposit rate adjustment to the interbank rate is hence found. More importantly, it shows the influence of the type of monetary policy tool utilized by the central bank to influence commercial banks' actions. Lastly, the diagnostics tests of ARCH effect and Q-Stats show that the model successfully captured the asymmetric effect as they are all significant in Tables 5.8a and 5.8b.

The sign and significance of the dummy variable, which is significantly negative, implies that policy change from non repo to repo period has had a downward effect on both deposit and lending rates, suggesting that the change to a repo monetary policy tool is effective and from the results, improved the speed of pass-through in the South African commercial banking system.

Table 5.9: Summary of ECM-EGARCH (1, 1)-M model results

| | Volatility impact on rate (s) | Symmetry/Asymmetry of conditional variance (γ) | Rigidity adjustment (η1, η2) | Theory support |
|---|---|---|---|---|
| dr | negative | negative leverage | - | - |
| lr | - | - | downward | collusive pricing arrangement |

Note: dr and lr denotes deposit and lending rate respectively.

The summary in Table 5.9 shows that there is a leverage effect only in the deposit retail rate when responding to changes in the interbank market. In terms of confirming the presence of theories, the same outcome as the ECM, supporting the presence of a collusive pricing arrangement is obtained.

## 5.9 Discussion of results

From the summary results, when comparing the results with other works, this study differs from most previous studies performed on South Africa, including Sander and Kleimeier (2006), De Angelis *et al.* (2005), Aziakpono (2006), Aziakpono *et al.* (2007b), and Aziakpono and Wilson (2010: 4), who all found both negative customer reaction and collusive pricing arrangement in the PT mechanism, while this study only found collusive pricing arrangement in the retail adjustment rigidity in South Africa.

When compared with other studies, it agrees with the Sander and Kleimeier (2002) study. The study did not correspond to those such as Lim (2001) who found upward rigidity adjustment in both the lending and deposit rates in Australia, and Irequi *et al.* (2002) who found downward rigidity adjustment in both lending and deposit rates in Colombia and Mexico. Finally, when compared to Wang and Lee's (2009) work, the study results matched some of the countries with upward rigidity adjustments in the deposit rate. Specifically, the results for the inflation-targeting countries that fall in the selected period before 2004 (Korea, the Philippines and Thailand), indicated a mark-up, incomplete pass-through and asymmetric presence.

In general, an incomplete PT was found in the short run, as is in most countries and most studies (Cottarelli and Kourelis (1994), Borio and Fritz (1995), Mojon (2000), Weth (2002), De Bondt (2002) and Sander and Kleimeier (2004)). The differences were found in the long-run pass-through, where some obtained complete and others incomplete or over pass-through. In the long-run, South Africa obtained an incomplete pass-through in all the three sample periods, although they are close to one.

### 5.10 Conclusion

This study utilizes the asymmetric cointegration test of the ECM-EGARCH (1, 1)-M model to study the IRPT and the relationship between interest volatility and leverage presence in the South African money market. An incomplete pass-through was found, along with symmetric upward rigidity adjustment in deposit rate and an asymmetric downward adjustment in the lending rate in all periods. In addition, the presence of volatility impact as well as leverage effect was significant in the deposit rates, implying its existence in the pass-through system of South Africa. The results estimated by ECM-EGARCH (1, 1)-M confirmed the presence of collusive pricing arrangements in the lending rate, signalling the presence of bank concentration, high net interest margin and oligopolistic bank behaviour.

The study is important as it provides a guide to policy makers on how effective the current monetary tool is, and how efficient the commercial banks are, thereby determining the size and speed of monetary policy transmission. It also provides a form of assistance to both local and foreign investors, banks, governments, and daily customers and consumers on spending and savings ability.

# CHAPTER 6

# SUMMARY, CONCLUSIONS, IMPLICATIONS OF RESULTS AND AREAS FOR FURTHER STUDY

## 6.1 Summary and conclusions

The importance of the size and speed of the monetary policy transmission have been looked at, along with the effect of interest rate volatility on the pass-through. A conclusion drawn is that the pass-through in the South African money market is incomplete in the long run and largely incomplete in the short run with the presence of asymmetry in the lending rate rigidity adjustment downward, along with a symmetric upward rigidity adjustment in the deposit rate. Furthermore, from the comparison of the pre-repo and repo period, the repo-period produced better results with faster pass-though. This implies that the change to the repo system by policy makers is a success in the SA money market, and thus the type of monetary policy tool in place influences the IRPT. Results from this research have shown that understanding the monetary policy transmission mechanism is important, especially for decision making by the central bank and commercial banks during expansionary and contractionary cycles. Moreover, IRPT is also essential for financial system soundness as it entails serious implications for the central bank and financial analysts.

The improved results obtained during the repo period can also be assisted by the use of an inflation-targeting framework. Unfortunately, the estimation results suggest that the banking system and regulations in South Africa should be re-evaluated or improved as it can be seen that banks are enjoying high net interest margins through a longer delay time in adjustments and a low pass-through, as well as through profit margins earned from the gap between the retail rates. In addition, upward rigidity in the deposit rate supports the collusive pricing theory, while the presence of downward rigidity in lending rates supports the presence of collusive pricing arrangements. Some of the reasons behind the presence of a symmetric deposit rate adjustment and an asymmetric lending rate adjustment, according to collusive pricing arrangements, can be due to asymmetric information, menu costs and agency costs, and other causes on the banks' side, which then lead to the rigid adjustment of deposit and lending rates.

The downward asymmetric adjustment in the lending rate can also be a result of the adverse consumer reaction (De Bondt, 2005). This can be so, following that the higher the interest rate is, the more the bank's losses. Therefore, no matter how the money market rate adjusts, the commercial banks could not reduce their lending rates. Similarly, when the banks could not completely pass-through the cost to the borrowers, the banks would mark up the retail interest rates with a fixed proportion to cover the cost or the loss.

Furthermore, the repo-period also shows evidence of these theories, though the period covers times of global financial crisis and impacts on the market. It still suggests that commercial banks are reaping high net interest margin benefits. Accordingly, this is to be avoided, as the ultimate goal of an economy is to achieve a complete pass-through with little or no asymmetric influence. A solution to this could be that more banks should be encouraged to open and operate in South Africa, that is, the terms and conditions should be made easier, in order to ameliorate the concentration level, and hence raise the level of competition locally.

The combined methodological approach used in this study further assisted in determining the presence of leverage effects and interest rate fluctuation influence on the IRPT. The empirical evidence showed that the effect of interest risk on interest rate is only significant on the deposit rate in South African. The presence of leverage effect in the deposit rate implies that the effects of negative shocks in the deposit rate adjustment are greater than positive shocks in South Africa. Furthermore, the deposit IRPT adjustment process is influenced negatively by volatility in terms of interest rate fluctuation. Furthermore, the deposit IRPT adjustment process is influenced negatively by volatility in terms of interest rate fluctuation.

## 6.2 Policy implications of results

Under the influence of factors such as asymmetry and collusive price behaviour, volatility impact and leverage effects, commercial banks' rates in South Africa might or might not respond to changes in the interbank rate following changes in the official rate. The actions of commercial banks are essential, as banks sometimes anticipate a rise in funding costs and hence increase lending rates in advance. Following such factors, banks in uncompetitive or concentrated markets, or large banks with major capital values, will not be responsive to changes in the official rate, which indirectly makes central banks' actions less influential, impacting the monetary transmission mechanism weakly or even negatively.

From the literature, some of the reasons influencing the IRPT can be related to South Africa, based on the results obtained. The competition level in an economy seriously influences the speed of adjustment of rates. Furthermore, in the case of South Africa, banks that have relatively large capital, for example the top four banks, can be unresponsive to changes in the official rates, as they might have excess liquidity, making them have longer adjustment lag with little and slow pass-through. Therefore, irrespective of the changes made to the official, policy or repo rate, and thereby the interbank rate, commercial banks tend not to reduce their lending rates. Furthermore, from the mark-up pass-through, when banks tend not to completely pass-through the cost to the borrower, the banks would mark up the retail interest rate with a fixed proportion to cover costs or losses, as seen in the high fixed mark-up values on the lending rate and lower value on the deposit rate. Likewise, from the volatility and leverage effect in the deposit rate, banks in South Africa react more to negative shocks than positive shocks, discouraging savings while having higher margins.

The essential role of the interest rate channel as a monetary policy tool is established, as changes to selected rates are more influential on the actions of both the central bank and commercial banks during the repo period. This makes the repo a useful tool and indicator for the central bank, policy makers, government, investors, banks and consumers. Likewise, the study further showed that a combination of the repo system, along with an inflation-targeting system is effective, but can be improved. In summary, policy makers and the central bank should follow the pass-through speed and adjustment process in South Africa, as well as the link between the results, factors and theories confirmed in the study, in order to influence and impact the monetary policy and financial market system effectively.

## 6.3 Areas for further study and limitation of the study

An area for further study could be the need to verify the link between one of the mentioned influencing factors, financial market openness and pass-through, as this aspect may draw ripple effects of developments in financial markets in one part of the world and there onto the other parts, which ultimately, serves to complicate the task of the monetary authorities. The findings from the combined methodology and use of dummy variable could also serve as a base for future studies, as the results, explanation and elaborations on volatility and leverage was limited, because it is still a fresh and new area explored.

The study explained the IRPT, volatility impact and leverage effect in the South Africa money market rates using the symmetric and asymmetric ECM and the ECM-EGARCH-M method. It covered the period from 1990 to 2010 and compared the pre-repo and repo period pass-through. Due to the length of data period, it would be interesting to compare the pass-though from the interbank rate to retail rates from 1990 with the pass-through from the repo rate to retail rates using the combined ECM-EGARCH-M methodology. Unfortunately, the repo system started in 1998, making the time length slightly short.

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