

**AN ANALYSIS OF THE MONEY MARKET LINKAGES BETWEEN SOUTH AFRICA AND
SELECTED MAJOR WORLD ECONOMIES**

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ABSTRACT

Globalisation and financial liberalisation has increased the linkages across countries in recent times. The existence of money market links has important implications for both domestic monetary policy and for investment decisions. This study examines the linkages between South Africa's money market and selected major international money markets. The objectives of the study are firstly to examine the links between the repo rate of South Africa and the central bank rates of the EU, Japan, UK and US. Secondly, is to compare the influence of domestic and foreign monetary policy decisions on South Africa's money market. The third objective is to examine the long run relationship between the South African money market and the money markets of its major trading partners.

Three estimation techniques are used to examine the different links. Principal components analysis, four tests of cointegration, and stationarity tests of the spreads/risk premium between South Africa's interest rates and the interest rates of the other countries. All three techniques show that there is no long-run link between South Africa's central bank rates and the central bank rates of the other countries. This shows that the repo rate does not depend on movements in other central bank rates. Domestic money market interest rates respond strongly to changes in the repo rate whilst showing no dependence on central bank rates of the other countries. This confirms the autonomy of the South African Reserve Bank in carrying out policy objectives. When the risk premium is accounted for under the third technique, evidence of integration is found. This indicates that the risk premium plays a crucial part in the level of integration between South Africa and the countries included in the study.

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CHAPTER ONE:

INTRODUCTION

1.1 CONTEXT OF RESEARCH

Globalisation and the increase in international capital flows have increased the financial links between countries, within a sub-region and also across continents. This has enhanced a country's access to capital and financial products, and has increased financial innovation in terms of the creation of more complex financial transactions to meet international demands. The consequences of this are that many countries no longer function independently in terms of both monetary policy and financial market transactions. Increased financial liberalisation could also have certain adverse effects on some countries. According to Demetriades (1999:1), the risks from financial liberalisation certainly had a role to play in the exacerbation of the Asian financial crisis. In much more recent times, the credit crunch was launched into a full-scale financial crisis mainly because of the contagion effect the housing crises in the US had on not only the US financial market, but also on banks and markets in Europe. It is therefore crucial to examine the extent of the linkages of the major world economics on a growing emerging market economy like South Africa.

Most research in this area has been focused on the stock market. Considering the fact that the money market has not been immune to the trend of globalisation, it is necessary to examine this market also. Accordingly, as noted by Hsieh *et al.* (1999:1) the recent liberalisation of capital flow restrictions in most countries has generated an increased interest in money market interrelationships as market segmentation is being reduced. The money market plays an important role in the execution of monetary policy in South Africa. Also, the South Africa reserve bank (SARB) plays quite a dominant role in the money market's transactions. Apart from the regulatory role that the SARB plays, a further function of the SARB is to supply the commercial banks with funds to meet shortages of cash, and in the process the SARB materially affects conditions in the domestic money market (Botha, 2007: 8).

There are a variety of important reasons to understand the international links between money markets. Van der Merwe (1997) states that the ultimate objective of monetary policy in South Africa is to establish a stable financial environment to support sustainable real economic growth over the medium and long term. This can be severely hampered to the extent that external forces

and shocks have adverse effects on the South African economy, and on the autonomy that the SARB has in influencing domestic policy. Assessing the nature of linkages between South Africa's money markets and the money markets of the major world economies will therefore provide some insight on the susceptibility of South Africa's economy to unanticipated external shocks. Also, from an efficient monetary policy point of view, if the domestic money market reacts more to international central bank rates than it does to the domestic monetary policy stance, then the domestic central bank will not be able to achieve its policy objectives. The importance of the links to investors cannot be understated. International firms and investors consistently monitor money market relationships as they manager world-wide payments. Also, investors are constantly on the look out for market imperfections that present profit making opportunities (Hsieh *et al.*, 1999:2).

Empirical research on money market links has focused mainly on developed countries (cf. Karfakis & Moschos, 1990; Katsimbris & Miller, 1993; Centeno & Mello, 1999; Barassi *et al.*, 2000). These studies are discussed in more detail in the next chapter. These studies however provide conflicting results regarding the existence of long-run interrelationships. The studies did not also agree on which countries were more dominant with regards to driving the links across countries, with Germany and/or the US being the two countries most studies appeared to identify as being the key drivers of the linkages. Very little research has been done on emerging markets, with most of such research focusing on the Asian markets. The few researches involving South Africa were done focusing on regional integration between South Africa and its neighbouring countries. Aziakpono (2006), Nielsen *et al.* (2005), Sander & Kleimeier (2006), and Aziakpono *et al.* (2008) all find South Africa to be the driving force for linkages within the Southern African Customs Union (SACU). No research has been conducted analysing the links between South Africa's money markets and money markets in the Europe, America and Asia regions.

The motivation for this study is therefore firstly to fill the gap in this area of research with regards to emerging markets in Africa. According to the Global Competitiveness Report (2008) South Africa is the most advanced country in Sub-Saharan Africa. Furthermore, in terms of financial indicators such as the market size and financial market sophistication, South Africa is ranked 23rd and 24th respectively out of 134 countries. Therefore it is essential to fully investigate the dynamics of money market relationships between South Africa and major world economies. Additionally, from a domestic point of view, the inflation targeting framework is highly

dependent on the strength of the SARB to influence other interest rates through the repo rate. An examination of the link between the repo rate and short-term interest rates such as the Treasury bill, money market and lending rates is vital to monetary policy authorities in order to fully assess the efficiency of the repo rate as the inflation targeting tool. This study also aims to investigate the presence of any profit-making opportunities within the South African money market by analysing arbitrage opportunities between the domestic market and international money markets.

1.2 OBJECTIVES OF THE STUDY

The main goal of the study is to examine the linkages between South Africa's money market and the money markets of the EU, Japan, UK and US. To achieve this, the following specific objectives shall be pursued:

- To analyse the extent to which the SARB repo rate is linked to the central bank rates of South Africa's major trading partners. This will help to assess the extent to which South Africa's monetary policy is influenced by the monetary policy of other countries.
- To compare the response of the money market in South Africa to the SARB's repo rate with the response of the money market to the central bank rates of other countries. This will help to determine the relative influence of the domestic and foreign monetary policy stance on South Africa's money market.
- To examine the long run relationship between the South African money market and the money markets of its major trading partners. The aim here will be to establish the extent of arbitrage opportunities between South Africa's money market and international money markets.

1.3 ORGANISATION OF THE STUDY

The rest of the thesis will be organized as follows: Chapter two will contain the Literature Review. This will be organised into a theoretical and empirical literature review of money market linkages. Chapter three focuses on the methodology of the study. The variables and data to be used in the research will be explained. Also, Chapter three presents the econometric techniques employed in the study. These are the principal components analysis, four tests for cointegration and stationarity tests of the interest rate spreads/risk premiums. Chapter four presents and discusses the results. The fifth chapter concludes the study.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter examines the links between interest rates in the money market across different countries. The focus will be to establish how the dynamic links occur across and within central bank rates and money market interest rates. Key issues discussed include how the links occur, the forces driving these linkages and the implications of money market linkages on the domestic economy. The interest rate parity framework is also reviewed and the empirical literature on the subject of money market linkages is examined. The chapter begins by providing a brief conceptual description of the money market and the importance of the money market to both monetary policy and to investors.

2.2 THE MONEY MARKET: A CONCEPTUAL OVERVIEW

The money market refers to the system in which borrowers of short-term¹ funds, mainly households, governments and business sectors come into contact with the lenders of these short-term funds (Botha, 2007:1). The money market is made up of the primary market for trade of new securities, the secondary market, and the interbank deposit/loan market (Faure, 2006:1). In the domestic money market, short-term funds are borrowed and lent in the local currency, subject to the control of the regulatory authorities of that country, in most cases the central bank. This is quite distinct from the Eurocurrency market, which is an international market where banks take deposits and make loans in a variety of currencies outside their home currency, and without the direct control of the central banks responsible for those currencies (Chisholm, 2002: 11). The focus of this study is on the degree of links between domestic money markets across different countries.

The money market serves a variety of important purposes for the financial sector and broader economy as a whole. Botha (2007: 6) outlines some of these roles as ff:

- Monetary Policy – the central bank uses the money market on a daily basis to manage liquidity/cash reserves in the banking sector
- Financing the corporate and banking sector – the short-term fund needs of companies, as well as the needs of banks in attracting deposits are provided in the money market

¹ Short-term refers to any period less than 12 months

- Cash management – used to invest excess cash
- Price discovery

The importance of the money market to monetary policy arises through the ability of the central bank to carry out its policy objectives by participating in the primary and secondary money markets. This is done with the intention of influencing the liquidity in the banking sector, and subsequently impacting interest rates (Faure, 2006: 1). The overall objective of the central bank here is to use the interest rate as a channel through which monetary policy changes can be effected quickly and efficiently. The foremost instrument used to target inflation in South Africa is the repo rate. This is the rate at which the South African Reserve Bank (SARB) charges private banks for borrowed cash reserves and it is the most important rate in the South African money market (De Angelis *et al.*, 2006:1).

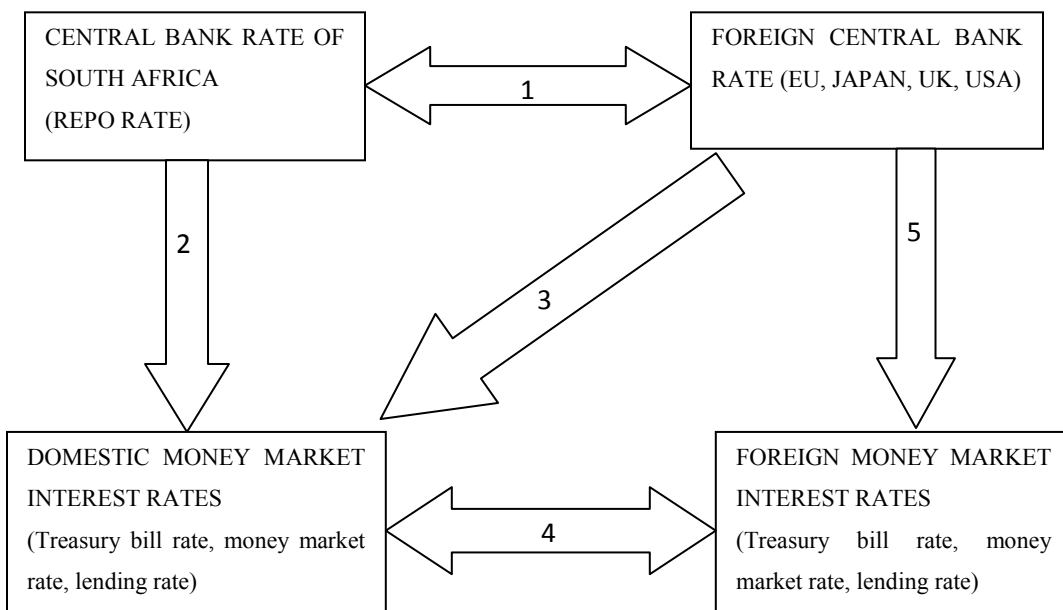
The repo rate is therefore the primary rate at the discretion of the SARB through which other money market rates are impacted. Faure (2006: 67) states that in order to make the repo rate effective, the SARB makes sure that the private sector banks are always indebted to it. This creates a money market 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 (Aron & Muellbauer, 2005: 7).

Interest rates in the money market are vital not only for monetary policy effectiveness but also provide investors with an estimate of their cost of borrowing, or alternatively the return on their investment. However, both these roles can be significantly influenced by the level of linkages between the domestic money market and international money markets. History has shown that changes in interest rates in one country can have a significant effect on another country. According to Frankel *et al.* (2004), the hike in U.S. interest rates from 1999-2000 were reflected in the interest rates of other developed and developing nations, as has also happened in past instances. In emerging markets, the increases were in many cases proportionally larger than the initial change in the U.S. The rest of this chapter focuses on the potential linkages between money markets across countries. The next section identifies these links and how they might occur.

2.3 MONEY MARKET LINKAGES

The concept of interaction between the money markets of different countries has been noted since the 1960s. Klopstock (1965: 1) observed that the rapid emergence of broad international money markets, notably the Eurocurrency markets, and the growing inter-linkage of major national money markets, has increased the actual and potential flow of funds into countries. This has become an important factor for domestic and foreign monetary policy formulation. The study of the international transmission of interest rates by Hendershott (1967) was another important early study on the subject. His study assumed a one way dominance of the US over other money markets. Figure 2.1 illustrate the potential linkages between South Africa's money market and foreign money markets.

Figure 2.1 Money Market Linkages: A Schematic



Source: compiled by author

As Figure 2.1 above demonstrates, a variety of links could exist across money markets. These may be among the central bank rates, between central bank and money market rates, and between the money market rates, both within a country or across countries.

This study is concerned with the following links²:

- Between the central bank rate of South Africa (the repo rate), and the central bank rates of the other countries, as shown by arrow 1.
- The links between the money market interest rates of South Africa and central bank rates, of both the SARB and foreign central banks. This is depicted by arrows 2 and 3.
- Thirdly, the links between the money market rates of South Africa and the money market rate of the other countries, indicated by arrow 4.

With regards to the relationship between the central bank rate of South Africa and the central bank rates of other countries, this will help to identify the degree to which South Africa's monetary policy is influenced by the monetary policy of other countries. Concerning the second link, for the effective transmission of monetary policy, the domestic money market should respond strongly and quickly to changes in the SARB's repo rate. It is possible that domestic money market rates may respond to changes in central bank rates of other countries, depending on the level of influence that the foreign country has on the domestic economy, due to factors such as policy convergence and the extent of capital mobility between the countries³. Finally, there is the potential connection between the domestic money market and the money market of a country's major trading partners. In a highly open and integrated world financial market environment, interest rates in a country could be sensitive to the activities of other money market rates in another country with strong links.

2.3.1 Underlying forces driving money market linkages

It is clear that the first condition for short-term interest rate links to exist depends on the extent to which a country's economy is open to international markets, and the removal of capital restrictions. Barriers to international capital flows can dampen the response of local rates to changes in international rates, allowing monetary authorities to maintain different interest rate levels from their trading partners for extended periods (Frankel *et al.*, 2004: 4). South Africa and the other countries examined in this study have progressively minimized the restrictions to international capital flow thereby reducing the impact of such barriers.

² There is also the link between the foreign central bank rates and the money market rates of their respective countries (arrow 5) which is not explored in this paper

³ These factors will be discussed further in the section on the forces driving linkages

Barassi *et al.* (2000) identifies two main causes as the basis for interest rates to equalize over time and thus the underlying forces driving the notion of interest rate links. Firstly, is the presence of arbitrage opportunities, and secondly, policy convergence. Frankel *et al.* (2004) also presents the exchange rate regime employed by a country and common shocks, as forces that could determine the extent of the linkages between countries. These four factors are discussed in more detail below.

Arbitrage opportunities

The concept of arbitrage opportunities follows on from the law of one price⁴ and a uniform interest rate across countries. In a situation where the interest rates of two countries are found to be significantly different, Howells & Bain (2005: 385) argue that assuming the absence of exchange rate risk, and assuming a high capital mobility and perfect information, capital should move from the capital-rich country in which the real rates of return on capital is low to the relatively capital-scarce country with high real rates of return on capital. It is referred to as interest rate arbitrage because the movement of capital seeks to take advantage of interest rate differentials. Barassi *et al.* (2000: 5) noted that under this system interest rates are viewed as similar to prices of other assets, and therefore their trend over time are seen as being caused by movements of financial assets across highly liquid capital markets. Arbitrage opportunities are more likely to be a driving force in terms of link 4 identified in the schematic above, which is between the domestic money market rates of South Africa and the corresponding rates of the other countries. It is not expected that arbitrage opportunities will drive links involving central bank rates.

The extent to which arbitrage opportunities identified above exist will determine the ease and level of flow of capital from a low return market to the higher return market. Arbitrage activities cease when the interest rates of assets with similar maturity are equal across countries after the risk factors have been accounted for. The arbitrage opportunities drive the interest rate linkage process because investors are expected to exploit any differentials between similar interest rates in different money markets.

⁴ The law of one price states that assets which are highly comparable should produce the same return irrespective of the country from which they originate and the currency in which they are denominated (Aziakpono, 2006: 3).

Policy convergence

Secondly, interest rate similarity among countries could arise from the idea that interest rates are policy instruments rather than an alternate asset class. In this view, the value of interest rates over time arises through a policy objective such as an exchange rate policy or an inflation targeting policy (Barassi *et al.*, 2000: 5). Policy convergence most likely occurs where one country ties its interest rate and/or its broader monetary policy with that of a more dominant economy. Frankel *et al.* (2004: 4) assert that if business cycles are closely matched across countries, domestic and foreign rates will tend to move closely together. Globalisation and international trade have tended to harmonise the policies of countries following similar targets. Amongst the countries included in this study, South Africa and the UK have both adopted the inflation targeting policy. There is therefore the potential driving force for linkages between the central bank rates and the money market rates of these countries. Links 1, 2, and 3 above can all be strongly influenced by the extent of policy convergence between South Africa and the major world economies included in this study.

Policy convergence may also occur within an economic and monetary union where monetary policy originates from one governing body, such as the European Central Bank (ECB) which controls monetary policy in the European Economic and Monetary Union (Aziakpono, 2006: 9). Interest rate linkages have therefore been observed in terms of a specific policy framework such as the exchange rate mechanism (ERM). The policy convergence approach resulted in the so-called „German Leadership Hypothesis’, under which Germany was perceived to be the dominant player in Europe and thereby monetary authorities in other countries are unable to diverge from the direction set by the Bundesbank⁵ (Caporale and Williams, 1998:1). Policy convergence is to an extent influenced by the exchange rate regime employed by a country, as seen below.

Exchange rate regime

Linkages between interest rates do not occur in complete isolation from the foreign exchange markets. As stated above, the exchange rate regime that a country employs is expected to be important in the integration of its financial markets with international financial markets. Fixing the exchange rate has some advantages including reduced transactions costs and exchange rate risk, which discourage trade and investment, and secondly it provides a credible nominal anchor

⁵ Empirical evidence on the GLH is mixed.

for monetary policy (Frankel *et al.*, 2004: 2). The advantages of a flexible exchange rate are quite significant, and can be summed up in one major property- it allows the country to pursue an independent monetary policy. Other positive aspects of a flexible exchange rate are that the government retains seignorage, the central bank can act as a lender of last resort, and that floating allows smooth adjustment to real shocks even in the presence of price frictions (Frankel *et al.*, 2004: 2).

Under a fixed exchange-rate regime, market integration involves a high degree of convergence of short- and long-term interest rates and a greater synchronization in their movements over time. This implies that interest rates are not determined by a single country but by all parties in concert, generating a reduced opportunity for independent monetary policy by any individual country. This implies that fixing the exchange rate works to increase the opportunity for policy convergence described above to occur. Frankel *et al.* (2004: 2) strongly argues that under the combination of fixed exchange rates and complete integration of financial markets, monetary policy becomes highly ineffective. By contrast, under flexible exchange rates short- and long-term interest rates are primarily determined by domestic conditions and monetary authorities retain their ability to influence the long-term rates (Laopodis, 2003: 2). Under this regime, the domestic interest rate should be less sensitive to changes in international interest rates,

However, Calvo and Reinhart (2001) argue that even countries which are supposedly following a flexible exchange rate regime, may suffer from what they describe as a “fear of floating.” This holds that other factors like a lack of credibility, exchange rate pass-through, and foreign currency liabilities prevent countries from pursuing a completely independent monetary policy, and thereby enhance convergence of policy and interest rates. As a result, many countries which employ a floating exchange rate policy, are adopting the monetary policy of major countries, such as the US (Frankel *et al.*, 2004: 3). Interest rates in developing countries with flexible exchange rates might sometimes be further sensitive to US rates in because these countries suffer from having to pay risk premiums (both a currency premium to compensate for devaluation risk and country specific premium to compensate for default risk) and that these premiums may be susceptible to world interest rates (Frankel *et al.*, 2004: 3).

Common shocks

In the era of increased financial liberalisation and enhanced capital mobility, the potential for a shock in one country to be transmitted to another country has significantly increased. Therefore countries which are more vulnerable to common shocks that have important influences on their financial markets will tend to have linkages between their interest rates over time as monetary policy adjusts to contain such shocks. More especially smaller countries are highly exposed to shocks that occur in a larger country and as a result often experience volatility independent of domestic policy (Giovanni & Shambaugh, 2005: 2). Common shocks could be financial or climatic, and would tend to affect the countries simultaneously. Thus, monetary authorities who would normally adopt an independent monetary policy stance would be likely to choose similar policies as their counterparts experiencing the same shock, and hence similar interest rate patterns (Frankel *et al.*, 2004: 5).

There is however the argument as to whether common shocks are the cause of integration or actually a consequence. Aziakpono (2006: 13) argues that the extent of common shocks across countries would be heightened when their financial systems are already integrated. Therefore, whether co-movement in interest rates is due to actual common shocks without integration first, or that common shocks arise because there is integration already becomes difficult to identify (Aziakpono, 2006: 13). There is also the idea that common shocks are more easily transmitted under a fixed exchange rate mechanism than in flexible regimes. Frankel *et al.* (2004) ties common shocks to the exchange rate regime. Countries operating under a fixed regime will be more exposed to the same shocks and may find it more difficult to adjust monetary policy to respond to such shocks.

Financial liberalisation

Although this is not considered as a direct force driving interest rate linkages, financial liberalisation has provided the avenue for these linkages to occur. It is through the opening of individual countries' financial markets to international financial flows that the possibility for arbitrage opportunities, policy convergence and common shocks has arisen. The progressive removal of interest rate and exchange rate controls combined with lower restrictions on international capital movements are the major reasons why the world's financial markets have become much more closely integrated (Ahmad & Sarver, 1994:1). Important structural changes in the financial services market, improved communication, and enhanced information and

production technology have all contributed to the enhanced move towards liberalisation of financial markets in both developing and developed countries (Anoruo *et al.*, 2002: 1). In the case of developing nations the effect of liberalisation has been more evident due to the fact that most developing countries⁶ were previously characterized as financially repressed and separated from external influences. Bremnes *et al.* (2001) acknowledges the consequence of financial deregulation on emerging economies in that the removal of official trade barriers along with a general movement towards globalization of financial markets implies that small countries will reflect interest rate and inflation policies from abroad into their domestic economies. After identifying the driving forces of the linkages illustrated in Figure 2.1, the next section discusses the implication of these links.

2.3.2 Implications of money market linkages

The question arises as to why it is important for an emerging country like South Africa to understand the links between its money markets and the money markets of the major world economies. With the increasing integration of financial markets, the linkages stated above have become more relevant to both the public and private sector of the economy. The impact of these links on the public sector is felt through the effect they have on the government's ability to carry out its monetary policy objectives amid external influences. The private financial sector also assesses foreign forces on domestic money markets, in an attempt to maximize the profits from money market transactions.

According to Holman and Neumann (2002), if monetary policy is spread internationally, then countries that are more closely tied to one another should exhibit the strongest transmission of the more dominant country's policies to the other countries. In the current global context where financial integration is high between developed countries, it is also probable that countries that are not necessarily tied together by common policies could have correlation between their central bank rates, due to external factors discussed below. If the SARB's repo rate is significantly influenced by the central bank rates of other major economies such as the US, monetary policy in South Africa will not be autonomous but will follow on from the monetary policy of other countries⁷.

⁶ Mainly in the sub-Saharan Africa, South America and Asia regions

⁷ This could occur even if the foreign country is not following an inflation targeting policy like South Africa does

If the local money market is highly integrated with the international money market rather than the domestic market, then domestic monetary policy objectives may not be effectively achieved if short-term money market instruments are the main tool used, and thereby some autonomy of national monetary policy is lost (Hsieh *et al.*, 1999:2). Where the local money market rates are not highly sensitive to changes in the domestic central bank's refinancing rate, the transmission of desired changes in interest rates to monetary policy target variables may not occur as quickly as required or the policy instrument may not be as effective in achieving the desired outcome in the target variable. This has very serious implications for the ability of the domestic central bank to carry out its policy. This is vital for an emerging market like South Africa. Also, if foreign central bank rates greatly influence money market rates in South Africa, the price discovery process of interest rates in the money market will be hampered as the domestic money market rates will not be representative of the circumstances prevalent in the domestic market. Commercial banks and investors, as part of their operations, are highly attentive to changes in foreign interest rates, therefore it is possible that South African commercial banks may adjust their money market interest rates such as lending rates in response to changes in the central bank rates of other major economies, even before the SARB responds to changes in these foreign central bank rates.

Also, it is necessary to analyse short-term interest rate links because financial institutions and companies rely on interest rate movements in their activities. This arises as international capital flows are on the rise among countries, and as banks increasingly assess international financial markets for indications on interest rate movements. Hsieh *et al.* (1999: 2) state that international firms and investors are continually observing money market relationships in their process of making world-wide payments and development of long-term strategies for their businesses. Further, investors and speculators search for market inefficiencies, such as low integration and high interest rate differentials, which could present profit making opportunities. For businesses whose cost of capital is sensitive to interest rate movements, and whose profits depend upon successful interest rate risk management, knowledge of the complex nature of international money market relationships is crucial (Anoruo *et al.*, 2002: 5).

The ability of a foreign economic shock to hamper the domestic economy and the paths through which such shocks occur can limit the country's capability to use monetary and exchange rate policies to achieve macroeconomic objectives (Anoruo *et al.*, 2002: 5). This creates another

important reason for understanding possible linkages that emerge. Potential financial crisis that occur in a major economy could have a ripple effect to other markets whose rates respond strongly to either the central bank or other money market rates of the country under crisis. This was observed recently with the sub-prime mortgage crisis in the US. The effects were felt not only by banks and consumers in the US, but the European⁸ and Asian markets also felt the shocks of the crisis, depending on the extent of their link to the financial market of the US.

Furthermore, for emerging economies, the increasing connection between domestic short-term interest rates and foreign short-term rates not only increases their susceptibility to external shocks, but also puts added pressure on regulators to establish a well defined framework that sets ground rules for the safe operation of all financial institutions. Bank supervisors are increasingly concerned with indirect or secondary risks (Anoruo *et al.*, 2002: 5). Policymakers now have a greater number of issues to consider when conducting policy due to the potential external factors that could affect the domestic economy. This was noted by Mboweni (2000) who stated that the disadvantage of the greater integration of financial markets is that it reduces the ability of domestically focused policies to deal with the problems arising in the respective domestic financial markets.

2.4 EMPIRICAL REVIEW

There has been an increase in the number of studies focusing on financial integration over the last few decades. This is as a result of the increase in globalization and the international financial liberalisation of most of the world's major economies. Much of the previous research has focused on the industrialised nations such as the US, Germany, UK and other major European nations (cf. Ciampolini & Rohde, 2000; Bremnes *et al.*, 2001; Ehrmann & Fratzscher, 2002; Ehrmann *et al.*, 2005). The early studies were based on the US dollar and mainly the Eurodollar currency, which was mostly represented by dollar yields in London. Developing economies increasingly account for a larger portion of the world's growth in trade, and have become key players in the international financial market (Anoruo *et al.*, 2002: 1). With the increased freedom of capital movement into developing countries, the potential for short-term interest rates in these countries to be affected by movements in foreign short-term interest rates has increased. There is therefore the need to focus attention on potential links between developing countries like South

⁸ Northern Rock Bank in the UK is just one example of a foreign financial institution collapsing as a result of the sub-prime crisis in the US

Africa and the major international economies. The empirical review begins with studies done on the developed countries and then moves on to discuss research done on developing countries.

2.4.1 Developed Countries

Nellis (1982) is one of the earlier works done on international financial integration⁹, investigated under both fixed and floating regimes using a principal components analysis¹⁰. The result of this paper was that whilst evidence of integration was found, it was higher under a fixed regime than with floating regimes. Karfakis and Moschos (1990) explored interest rate linkages in the European Monetary System (EMS), using monthly domestic nominal rates. Cointegration tests did not reveal the existence of systematic interest rate relationships in the long run between Germany and the EMS countries. However Granger-causality tests found some evidence of unidirectional interest rate linkages from Germany to the other EMS countries, supporting the notion of the dominant role of Germany¹¹. This result has been contested by Katsimbris and Miller (1993) who argue that the inclusion of a third variable, namely, a world nominal interest rate, would have altered the result found by Karfakis and Moschos (1990). Katsimbris and Miller (1993) found a link between the US interest rate and other EMS rates, but not between Germany and the other EMS countries. This result is confirmed by others such as Fratianni & von Hagen (1990), Edison and Krole (1995), and Borio and McCauley (1996). They all acknowledge that interest rates within the EMS respond to each other, but do not distinguish Germany as the most dominant market; rather they found a stronger role for the US interest rates.

Many studies done confirmed a dominant role for the US in driving money market interest rate linkages. Ahmad & Sarver (1994) explore linkages between money markets for ten major world economies using a vector autoregressive (VAR) analysis, and find that the US money market plays a leading role, in that the after effects of a shock in the US are much stronger and last much longer than a shock elsewhere. Bremnes *et al.* (2001) investigate Eurocurrency deposit rates for the US, Germany and Norway. Based on the Johansen (1988) cointegration methodology, a two-way linkage of the interest rates is found, with the US interest rates having a stronger influence on the German and Norwegian rates, while the reverse effect is modest. The money markets studied respond very rapidly to a shock in any one country. Other studies include Fung and

⁹ Klopstock (1965) was an even earlier study on money markets. The focus of his study however was on the emergence of the Eurocurrency market, and not on linkages between domestic money markets.

¹⁰ This method is discussed in the next chapter

¹¹ See Caporale & Williams (1998) for a discussion on the dominant role of Germany and the German Leadership Hypothesis

Isberg (1992), who use U.S. and Eurodollar certificates of deposit, Fung & Lo (1995), who analyze U.S. interest rates and Eurodollar futures, Fung, Lee, & Pan (1996), who examine the London Interbank and Europound markets, and Arshanapalli & Doukas (1994). They all also found two way linkages, with the US or Germany being the most dominant money markets.

A study that estimated the extent of integration in both the money market and the bank lending market is Centeno & Mello (1999). They use money market rates and lending rates for six European Union countries. Their study employs two empirical techniques, cointegration tests based on the Engle and Granger (1987) method, and stationarity tests of the interest rate differentials between two countries, based on the uncovered interest rate parity condition. Results of their study show that the money market rates are closely linked to each other, whereas little evidence of cointegration is found between the lending rates of different countries. Among the more recent studies, Barassi *et al.* (2000) explore causal links between 3-month Treasury bills for the G-7 countries. Their results indicate a US worldwide leadership and reject the hypothesis of a German leadership in Europe. Holman & Neumann (2002) analysed the transmission of monetary shocks between the US and Canada, using short and long term interest rates. Strong evidence is found that US monetary shocks affect Canada, and the reverse is also true.

One of the few studies that involved the central bank rate is Sarno and Thornton (2001), who use daily data on the link between the Federal funds rate and the 3-month Treasury bill rates of the US. The objective of their study is to identify the nature of the correlation between the federal funds rate and the Treasury bill rate, using a nonlinear asymmetric vector equilibrium correction model. A long-run relationship between the two interest rates is found that is stable over the sample period and across monetary policy regimes. Zhou (2007) also examines the relationship between the federal funds rate of the US and the one, three and six-month Eurodollar deposit rates. The result of the study implies that a long-run equilibrium relationship exists between the Federal funds rate and the Eurodollar rate in recent periods.

2.4.2 Developing Countries

Relatively few studies did not focus only on the US and European markets. One study that included most of the Pacific Basin countries was Phylaktis (1999). Interest rates used were the 90-day Treasury bill rate for the US, the three-month Gensaki rate for Japan, the 3-month deposit rate for Hong Kong, and the three-month interbank rates for Singapore and Malaysia. For

Taiwan and Korea, short-term curb¹² rates were used. The objective was to examine if there had been an increase in the degree of integration in that region following the deregulation of financial markets. Cointegration methodology, based on the Johansen (1988) and Johansen and Juselius (1990) was used, as well as an impulse response analysis to examine the speed of adjustment following a shock in one of the rates. Phylaktis (1999) found evidence supporting an increased level of money market integration, with an overall greater integration of the Pacific Basin countries with Japan than with the US.

Anoruo *et al.* (2002) investigate the interest rate dynamics across seven developing economies in Asia. The motivation for their study is twofold, firstly that there is limited existing research on this issue for that region, and secondly that the experience of these countries provide potentially unique interest rate transmission mechanisms, which could be quite different from those of the large industrialized nations (Anoruo *et al.*, 2002: 3). Johansen (1988) Cointegration tests on 90-day Treasury bill rates indicate that interest rates within the Asian region respond well to each other. Hong Kong and Singapore turn out to be important, but not dominant players. Cheung *et al.* (2002) explores financial integration between China, Hong Kong and Taiwan using one-month interbank rates. Long-run links between all countries are found. Figueira *et al.* (2005) studied links between 3-month Treasury bill rates for seven countries in Europe, Asia and the USA. This was one of the few studies that performed both cointegration tests and principal components analysis in order to reach a robust conclusion on the nature of integration. They found some degree of linkages between all markets studied, but a higher degree of integration occurred amongst the European countries, thereby concluding that while liberalisation of money and capital markets has increased integration, the development of regional monetary unions has further increased this integration.

Research by Aziakpono (2006) analysed the links between interest rates of South Africa and the other SACU countries, using cointegration. A dominant role for South Africa was observed in the SACU countries in terms of monetary policy links. Nielsen *et al.* (2005) and Sander and Kleimeier (2006) both explored the extent of financial integration between the Common Monetary Area¹³ (CMA). Nielsen *et al.* (2005) tested the level of financial integration for the CMA countries in Southern Africa, using Treasury bill rates. Stationarity tests on interest rate spreads found that Lesotho, Namibia and Swaziland to be integrated with the South African

¹² See Phylaktis (1999) for description of curb rates.

¹³ South Africa, Lesotho, Namibia, Swaziland

market, whereas Botswana, Zambia and Zimbabwe do not show evidence of strong linkages with the South African market. Sander and Kleimeier (2006) use lending rates, deposit rates, discount rates and Treasury bill rates to examine the extent of interest rate pass-through between the CMA countries based on an empirical pass-through model. They find a degree of integration between these markets, with South Africa being the leading market. Another study by Aziakpono *et al.* (2008) builds on Aziakpono (2006) to examine the extent of integration of the banking sector in the SADC¹⁴ region. Both principal components analysis and an empirical pass-through model are used. Monthly central banks rates and retail banking rates are employed and the results indicate that the CMA countries are the most integrated followed by the SACU countries. Integration was also increasing over time for each interest rate examined.

No study has been done on money market linkages between South Africa and the European, United States or Asian markets. South Africa's sophisticated financial system compares favourably with those of most industrialised countries and surpasses those of many emerging-market countries (Mboweni, 2000: 2). One can therefore expect some degree of financial market integration between South Africa and the other major world economies such as the US, UK and Japan. There is therefore a need for research to be done in this area. This study aims to fill this gap by exploring money market linkages between South Africa, the EU, Japan, UK, and US. Different estimation techniques have historically been used in order to examine the nature of money market linkages. Principal components analysis, cointegration tests based either on the Engle and Granger (1987) or the Johansen (1988) and Johansen and Juselius (1990) method, and stationarity tests of the interest rate differentials have been the primary techniques used. Most studies use only one of these techniques. In this study, all three estimation techniques will be carried out.

2.5 CONCLUSION

This chapter reviewed the theoretical issues relating to money market linkages. A brief description of the money market was provided. The potential links that occur between money market interest rates across countries was illustrated using a schematic diagram. These are in three areas, between the central bank rates of different countries, between the money market rates in the domestic country (South Africa in this case) and the central bank rates of South Africa and other countries, and thirdly between the money market rates of the domestic and

¹⁴ SADC is made up of 14 countries including the 5 countries making up SACU.

foreign countries. Four primary factors could be responsible for driving the interest rate linkages across money markets. These are arbitrage opportunities, policy convergence, the exchange rate regime employed by a country, and common shocks that may occur. The implications of money market linkages were also highlighted.

A review of empirical literature reveals that most of the studies have been conducted on the developed countries. A dominant role has been observed for the US in most research, whilst there is mixed results on the influence of Germany as a driving force of linkages. Few studies have focused on the developing countries, and within these studies almost all have involved the Asian money markets. As noted, there has been no study involving South Africa and the major economies exploring money market interest rate linkages. The next chapter presents the empirical methodology for examining the links discussed in this chapter.

CHAPTER 3: METHODOLOGY AND EMPIRICAL FRAMEWORK

3.1 INTRODUCTION

As noted in the schematic in chapter 3, there are three main linkages that this study is concerned with. These linkages are firstly between the repo rate of South Africa and the central bank rates of EU, Japan, UK and US, between the money market of South Africa and the central bank rates of the other countries, and thirdly between the money market of South Africa and the money markets of the other countries in the study. This chapter presents the methodology used for the analysis. Three empirical techniques, principal components analysis, tests of cointegration and stationarity tests on interest rate differential are discussed. The chapter begins by presenting the data to be used.

3.2 VARIABLE DEFINITIONS AND PRELIMINARY ANALYSIS

3.2.1 Variable definitions and sources

This study uses monthly data from 1990 to 2007 for all the series. The period is chosen because it is from the 1990s that South Africa's economy became more open to the international markets, especially after the 1994 elections, therefore there is the expectation that financial liberalisation in South Africa began to increase around this period. Wesso (2002: 5) states that the achievement of independent price and financial stability in South Africa since the 1990s has been complicated by the openness of the economy since this period. The empirical research is done using a rolling window method. A nine year rolling period (108 observations) is chosen in this study with the first period being 1990-1998. Subsequently the next windows are 1991-1999, 1992-2000 and so on until the final period of 1999-2007. The rolling windows help to capture the dynamic development of the interest rate linkages in the money market and to further establish the trend of financial integration between South Africa and the major world economies over time.

The choice of countries for the study is not arbitrary, but based on their relationship with South Africa. The EU is one of South Africa's largest trading partners and is therefore a key region to include. Germany is used as a proxy for the EU before 1999. The Japanese market is one of the largest industrialised markets from the Asia region, and as such is included to represent this region. The UK has a historical importance to South Africa and still remains one of South

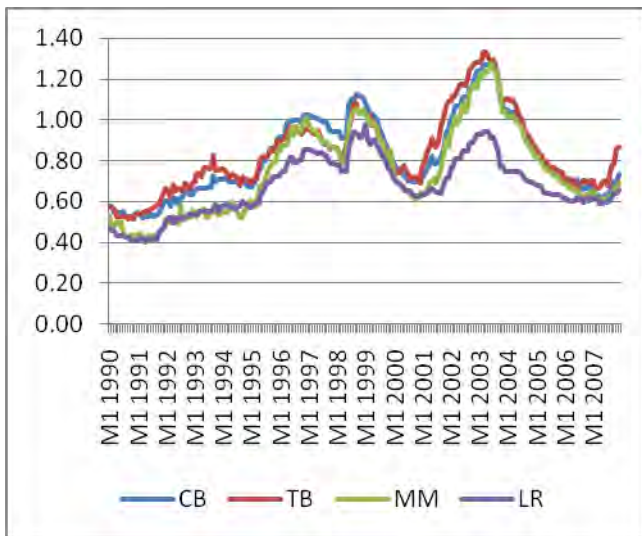
Africa's strongest financial trading partners. No study can be conducted without the inclusion of the US, the world's strongest economy. Most studies have found the US to be the most dominant force in international linkages. The repo rate for South Africa, the short-term repo for the EU, the basic discount rate for Japan, the clearing banks base rate for the UK and the Federal Funds rate for the US are used as the variables representing central bank rates. To represent the money markets, 91 day Treasury bill rates, 3 month money market rates and prime lending rates of all five countries are used as the other variables in the study. All interest rate series were obtained from Thompson DataStream and the IMF International Financial Statistics (IFS). Before proceeding to the estimation techniques, preliminary descriptive statistics of the data is provided.

3.2.2 Preliminary analysis

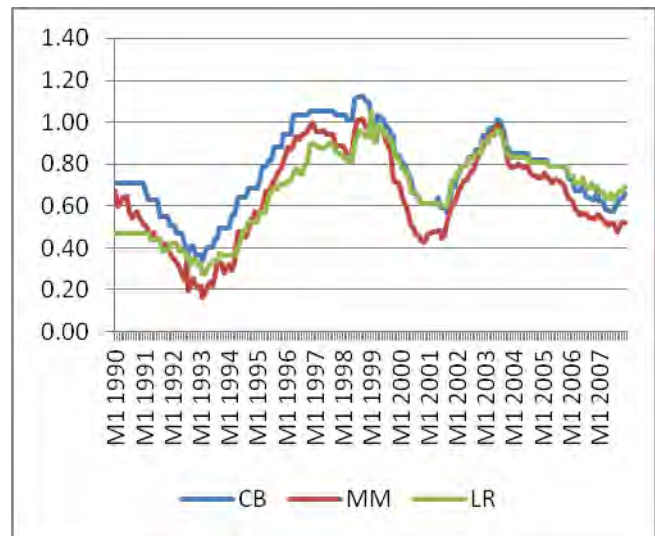
Prior to performing econometric tests for the level of integration between the interest rate series, it is useful to analyse any possible connections between the data series. The coefficient of variation (COV), which is a statistical measure of the dispersion of data points around the mean in a series, is used to provide an initial analysis to assist in making some inferences about the nature of links present. It is defined as the standard deviation of two or more interest rates divided by their mean (Aziakpono *et al.*, 2008: 9). The COV allows us to compare the degree of deviation between the interest rates included in the calculation. A high coefficient indicates a larger dispersion and vice versa. The COV is calculated for the whole period 1990-2007 for all the different interest rates. The calculation is initially done including all the countries for each of the interest rates, and subsequently repeated in pairs between South Africa and each of the other countries. Figure 3.1 presents the graphs of the COV.

Figure 3.1 Coefficient of Variations

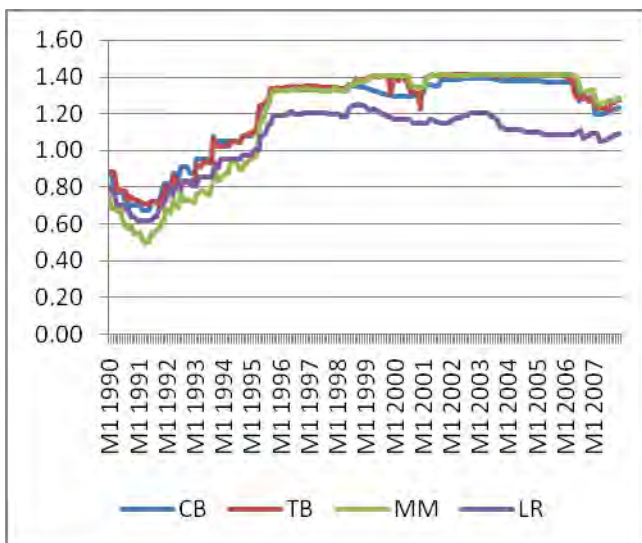
COV for all countries



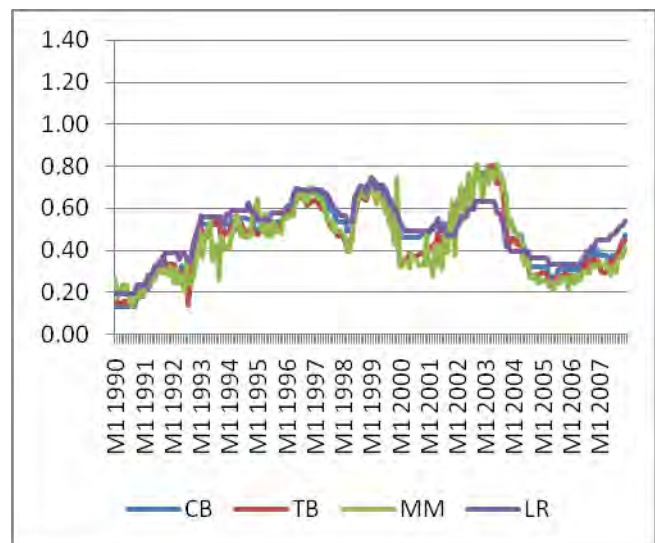
COV between South Africa and the EU



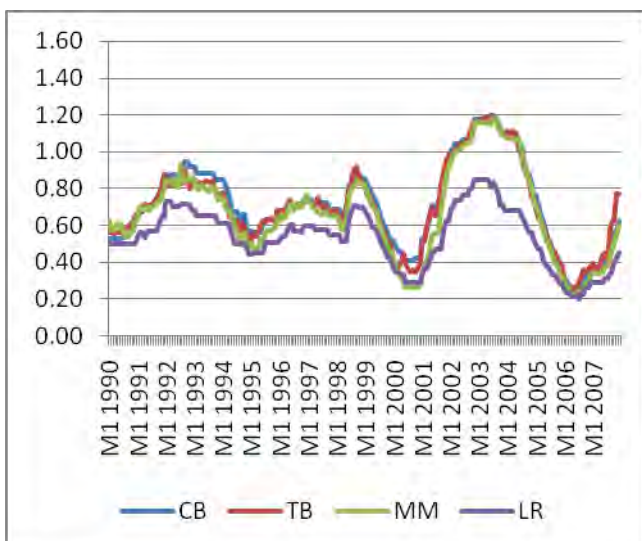
COV between South Africa and Japan



COV between South Africa and UK



COV between South Africa and US



Starting from an initial COV of between 0.4 and 0.6, the COVs for all the countries together gradually increases to about 1.0 around 1998, after which it declines back to about 0.6 by 2001. Subsequently the COVs rise again to about 1.3, except for that of the lending rates which only rise slightly to just below 1.0. A steady decline is observed for all the series thereafter till 2006, after which there is a slight increase. The upward and downward movements of the COV indicates that the dispersion between the interest rates of South Africa, The EU, Japan, UK and US has been changing over time. The COVs for South Africa and each of the other countries separately for all the interest rate series allows further observations to be made about the nature of the dispersion between South Africa's interest rates and those of each of the other countries, and to compare these with the COVs for all countries together, to identify for each country whether their dispersion with South Africa is above or below the dispersion for all the countries together.

The COVs between South Africa and the EU for the central bank rates, Treasury bill rates and lending rates declines from an initial level of 0.6 to between 0.2 and 0.4. From 1993 there is a steady increase to a COV of 1.0 in 1999, indicating a rising dispersion between the SA and EU rates. Thereafter the trend of downward and then upward COVs is similar to that of the COVs for all countries. There is a steady decline for all three rates from 2003. This shows that the dispersion between the interest rates for the SA and EU appears to be diminishing slowly, a possible signal of increasing integration.

It is evident from figure 3.1 above that the dispersion between South Africa's interest rates and those of Japan are higher than the average for all countries. The COVs begins at an initial level of about 0.8, rising steadily to 1.3 for the central bank, Treasury bill and money market rates, and 1.2 for the lending rates by 1996. Thereafter the COV remains almost constant till 2006 when there is a slight decrease in the rates. The high and constant COV implies that interest rates between Japan and South Africa do not appear to be converging over time.

The UK presents the lowest dispersion with South Africa compared with the other countries. Beginning from a low COV of 0.2, there is a gradual increase to 0.7 by 1999. All the interest rates move together with relatively the same COV. The highest COV value of 0.8 is observed in 2003, after which there is a decline down to 0.2 again in 2005. One can therefore make the initial inference that South Africa may have the greatest link with the UK for its money market rates.

The COVs between South Africa and the US begins at around the same value as the COVs for all the countries combined. There is a slight fluctuation around this value until 1999 where a significant decline begins from 0.9 down to 0.3 in 2001. The COVs then rises to 1.2 by 2003 except the lending rates which rise to just above 0.8. Subsequently a large decline is observed back to 0.2 by 2006, after which there is an upward movement again to about 0.6 in 2007. This indicates changing trends in the linkages between short-term interest rates of South Africa and the US.

Overall, the COVs have provided an initial insight into the possible linkages between South Africa and the EU, Japan, UK, and US. Although there are distinct differences for each country observed, some common trends were also evident. There was an initial increase in the dispersion for all countries with South Africa, until about 1999. With the exception of Japan, the COVs began to experience a general decline from 1999, although there were short periods of increase afterwards. In the next section, the different estimation techniques that this study will use to determine the extent of integration between the interest rates are discussed in detail.

3.3 ESTIMATION TECHNIQUES

Majority of the empirical work done on money market interest rate linkages has been based on the cointegration methodology. This is because the observation that most time series are nonstationary but cointegrated has moved the study of the interrelationships to the framework of error correction models. Felmingham and Leong (2005) is however one of a few studies that have used the ordinary least squares (OLS) method to examine linkages. However, Felmingham and Leong (2005: 4) note that most researchers prefer cointegration techniques to the OLS method because the former focuses on long-run relationships which can be combined with error correction to determine short run adjustments.

Cavoli *et al.* (2004: 28) proposed that an important area for research into the linkages would be to develop a multivariate methodology such as a Principal components analysis. Nellis (1982) employed a principal component analysis in measuring interest rate linkages for major world economies. A third approach tests the stationarity of the spreads and risk premiums between interest rates of two countries. By observing the trend towards the stationarity of the spreads/risk premiums, inferences can be made about the extent of integration between any two countries.

By performing different estimation approaches, the aim is to provide a more robust conclusion on the extent of integration between South Africa's money markets and the money markets of the other countries. This study therefore explores these three techniques for money market integration between South Africa and the EU, Japan, UK and US. These empirical approaches are discussed in more detail below, beginning with the Principal components analysis, then the cointegration tests and thirdly the stationarity tests of the spreads/risk premiums.

3.3.1 Principal components analysis (PCA)

The idea of using PCA is to reduce the dimensionality of a set of data made up of a large number of variables which have some economic relation to each other, whilst maintaining as much as possible the variation present in the data set (Jolliffe, 2002: 1). In terms of integration between interest rates, PCA becomes useful in its ability to determine how many distinct factors, known as principal components, are responsible for the correlation among the interest rates. In this study, PCA is used to examine links 1 and 4 from Fig 2.1 in chapter 2. These are the links between the central bank rate of South Africa and the central bank rates of the EU, Japan, UK and US, and secondly between the Treasury bill, money market and lending rates of South Africa and those of the other countries stated above.

The principal components (PCs) are ordered in such a manner that the first few contain majority of the variation that exists in all of the original variables (Jolliffe, 2002: 3). If only one common factor accounts for the co-movement of the interest rates, then one can conclude that a high degree of integration exists between the interest rates, with the greater the number of factors, the lower the extent of integration. Many authors have employed PCA in examining the degree of financial integration (cf. Aziakpono *et al.*, 2008; Becker and Hall, 2008; Gilmore *et al.*, 2006; Figueira *et al.*, 2005; Nellis, 1982).

The PCA relation is expressed as

$$P = AX \tag{3.1}$$

Where P is a vector of orthogonal factors (PCs) which are a linear combination of the interest rate series (X), and A is a matrix of coefficients, known as factor loadings, where each coefficient indicates the weight of the corresponding original variable in the PC (Aziakpono *et al.*, 2008:

11). The first component or factor is derived in such a way that it maximizes the variance it explains, and may be seen as the single best summary of the linear relationships evident in the data (Figueira *et al.*, 2005: 6). The second factor represents the best linear combination of variables that accounts for the most residual variance after the effect of the first factor has been removed from the data, and this process continues until all the variance in the data is exhausted (Figueira *et al.*, 2005: 6).

The transformation of the variables can be done either using the correlation or covariance matrix methods. Jolliffe (2002: 21-23) provides the advantages and disadvantages of using either one of the approaches. The major argument for using the correlation matrix to generate the PCs is that results are more directly comparable than for analyses based on the covariance matrices, especially where statistical inferences are important. Since it is mean-centered, the correlation matrix is preferred when the variables have different scales of measurement, because the correlation matrix treats all variables on an equal level (Jolliffe, 2002: 24). Another disadvantage of covariance matrices is the sensitivity of the PCs to the units of measurements used for each element of X. Aziakpono *et al.* (2008) argue that the correlation matrix is more appropriate when examining interest rates across different countries due to the differences in national inflation and exchange rates. In this study therefore, the PCA is done using the correlation matrix.

The next step in the PCA is the determination of the explanatory power of each PC. Conventionally, two measures have been used, the cumulative R^2 or the eigenvalue of the PC. The cumulative R^2 uses a scale of ($0 \leq R^2 \leq 1$), where a value close to one indicates a high explanatory power of the PC (Figueira *et al.*, 2005: 8). For the eigenvalues, the Kaiser Rule of eigenvalue greater or equal to 1 (Kaiser, 1960)¹⁵ has been generally adopted. For a PC to be considered to be significant, it should have an eigenvalue of at least 1. This study follows the Kaiser Rule approach to determine the number of significant principal components. After identifying the significant PCs, the factor loadings of the significant PCs should be observed.

These factor loadings depict the extent to which each variable contributes to the related PC. When making inferences about the extent of integration between interest rates, the contribution of the factor loadings of each country's interest rate to the overall PC is of crucial value. By observing the contribution of the factor loading of South Africa to each of the significant

¹⁵ See Jolliffe (2002) for a discussion of the cumulative R^2 and the eigenvalue methods

principal components, the extent of co-movement between South Africa and the other countries can be further revealed. For instance if there are two significant PCs, the factor loadings indicate which PC each country belongs to. The analysis can be extended to identify if a convergence group is emerging, in terms of a group of countries moving together within a PC. It is possible to identify groups of countries which move together within a PC, or possibly an individual country which is the main driver of a significant principal component. Further conclusions can be drawn by dropping a country and repeating the test to identify the number of significant principal components. If by dropping South Africa, the number of principal components drops from 2 to 1, this implies that South Africa is the main driver of the second principal component and is not integrated with the other countries. In interpreting the factor loadings, it is normally the general pattern of the coefficients that is of interest, not their specific values to decimal places. Also the sign of any factor loading is completely arbitrary, except to aid in determining the pattern of variables moving together over time (Jolliffe, 2002: 66-67).

PCA can provide insight into the pattern of movement in interest rates across countries, but does not offer a quantifiable measure of the degree of integration. In assessing integration using PCA, the more consistent the loadings in term of size and sign, the greater the degree of integration (Becker and Hall, 2008: 8). A useful application of PCA is to perform it under a rolling window method (cf. Aziakpono *et al.*, 2008; Gilmore *et al.*, 2006). This helps to examine the progress of integration over time by both observing the number of significant PCs over time and also the contributions of the factor loadings to the significant PCs over time.

3.3.2 Tests for Cointegration

If two series appear to move together over time, they are said to be cointegrated. When using time series data, it is often assumed that the data are non-stationary, and thus that a stationary cointegration relationship(s) needs to be found in order to avoid the problem of spurious regression (Harris, 1995: 79). Tests for cointegration have either been residual based tests or maximum likelihood estimation based on the vector autoregressive (VAR) system.

The model that shows the long-run relationship between any two interest rates is normally specified as follows:

$$i_{t,k} = \alpha + \beta_1 i_{t,k}^* \quad (3.2)$$

Where $i_{t,k}$ represents South Africa's short-term interest rate and $i_{t,k}^*$ represents the short-term interest rate of the EU, Japan, UK and US. α and β_1 are parameters. α is the intercept coefficient while β_1 is the slope coefficient.

In terms of this study, Equation (3.2) is analysed using bi-variate cointegration analysis to examine the links between the short-term interest rates of South Africa and those of the other countries. The links to be investigated are between the repo rate of South Africa and the central bank rates of the EU, Japan, UK and US. The relationship between the money market rates of South Africa and the central bank rates, both of South Africa and of the other countries is another key link that this study is focused on. Thirdly, money market rates of South Africa are compared with the money market rates of the other four countries to identify any linkages. These linkages are illustrated in Fig 2.1 in the previous chapter. The relationship between the repo rate of South Africa and the central bank rates of the other countries is important in that it provides information as to how independent the repo rate of South Africa is to external influences. A strong long-run link between South Africa and any of the countries means that the repo rate of South Africa responds to movements in the other country's central bank rate. Monetary policy in South Africa in terms of setting the repo rate would therefore not be completely autonomous and would respond to changes in the central bank rate of the other country.

When examining the links between South Africa's money market rates and central bank rates, the cointegration approach is done firstly for the case of within country analysis where the domestic money market's response to changes in the SARB repo rate is considered, and then also the links between South Africa's money market and central bank rates of the other countries is examined. The objective is to identify the extent of dependence of domestic money market rates on the repo rate of South Africa in comparison to the dependence of these same rates on the central bank rates of the other four countries. For the within country case, marked by arrow 2 in Fig 2.1, evidence of cointegration will indicate a response of the domestic money market rates to the repo rate. This implies strong monetary policy autonomy of the SARB. However, this must be compared with the response of the local money market rates to the central bank rates of the other countries, arrow 3 in Fig 2.1, in order to draw a complete conclusion on the response of money markets rates in South Africa to the SARB. This is where analysis of the slope coefficient

becomes especially crucial. A stronger slope coefficient value for the link between the domestic money market rates and central bank rates of any of the other countries than for the link between domestic rates and the repo rate of South Africa will mean a stronger level of dependence of South Africa's money market rates on the foreign central bank than on the domestic policy rate.

In order to observe the presence of any arbitrage opportunities within the money market, the domestic money market rates are compared with the money market rates of the other countries, arrow 4 in Fig 2.1. Again the presence of a cointegrating relationship reveals the existence of integration between South Africa and the country with which the cointegrating relationship is found. This is important for investors because it reveals whether or not it is possible to have money market transactions and whether the opportunity for portfolio diversification exists. A long-run relationship means that the short-run interest rates compared move together over time, therefore reducing the opportunity for profit making due to arbitrage opportunities. The absence of cointegration means that the interest rates are not moving together over time, creating the possibility of profit making or hedging transactions for investors who wish to invest in markets which do not move together, in order to reduce risk.

For each of the three links discussed above, using a rolling window allows conclusions to be drawn not only about the existence of integration, but to observe the changing trends of financial integration between South Africa and the other countries over time. This helps to identify the pattern of monetary policy dependence and arbitrage opportunities that have emerged over the period of this study.

Residual based tests include the two-step Engle-Granger, and the three step Engle and Yoo approach, whereas the Johansen (1988) and Johansen & Juselius (1990) method follow the maximum likelihood approach. In this study, four tests of cointegration, which draw on the Engle-Granger (1987) and Johansen (1988) approaches, are employed. This helps to arrive at a robust conclusion regarding the nature of cointegration, if present, between South Africa's interest rates and those of the EU, Japan, UK and US. Before discussing the tests in detail, the process of unit root tests on the different series is discussed.

The first step in the cointegration process involves determining the order of integration of the relevant time series. The objective of unit root/stationarity tests is to determine whether the

interest rate series are integrated of order one, I(1) so that the combination of these series will produce residuals that are integrated of order zero, I(0), thus indicating the presence of a cointegrating relationship between the interest rates. However, it is possible to include series that have different orders of integration such as I(0) and I(1) in the model (Harris, 1995: 76). Several statistical tests have been developed for investigating unit roots/stationarity. In this study, we employ the Augmented Dickey Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests to examine the stationary properties of the series¹⁶. The ADF tests the null hypothesis that there is a unit root against the alternative of stationarity, whereas the KPSS has the null hypothesis of stationarity, thus reversing the null and alternatives of the unit root test (Brooks, 2002: 382). After establishing the order of integration of the series, the four different tests for cointegration can be carried out. These tests for cointegration are discussed below.

i. Johansen test for cointegration

After establishing that the series are I(1), a VAR¹⁷ order must be specified. A VAR model of order k is specified as follows in the model:

$$X_t = A_1 X_{t-1} + \dots + A_k X_{t-k} + u_t \quad (3.3)$$

where X_t is an ($n \times 1$) vector of endogenous variables (interest rates), $X_t = (X_{1t}, \dots, X_{kt})'$, and u_t is an unobservable white noise error term.

In these models all variables are often treated as being *a priori* endogenous, and allowance is made for rich dynamics (Lutkepohl & Kratzig, 2004: 86). However, if the objective is in establishing cointegration relations among variables (short-term interest rates in this case), the VAR is not the most suitable framework because such cointegration relations do not emerge clearly under the VAR (Harris, 1995: 77; Lutkepohl & Kratzig, 2004: 86). The VAR model above is therefore turned into a Vector Error Correction Model (VECM) as follows:

$$c = \Pi X_{t-k} + \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-(k-1)} + u_t \quad (3.4)$$

¹⁶ For a full discussion of the ADF, PP and KPSS tests, see Brooks (2002: 377-386)

¹⁷ A VAR is a systems regression model used to capture the interdependencies between multiple time series. See Brooks (2002: 330-340) for a full discussion on VAR

Where X_t is a vector of I(1) short-term interest rate variables as identified above, all ΔX_t are I(0). Π is the matrix whose rank determines the number of cointegrating vectors among the variables and, Γ are $n \times n$ coefficient matrices which indicate the short-run dynamics of the model. Brooks (2002: 404) states that the Johansen test for cointegration involves observing the rank of the Π matrix via its eigenvalues. If $r = 0$, there are no cointegrating vectors, and if Π is of full rank ($r = n$), it indicates that the variables are level stationary (Takaendesa, 2006: 97). However if Π is of a reduced rank, ($r < n$) then there are $(n \times r)$ matrices of α and β such that:

$$\Pi = \alpha\beta' \tag{3.5}$$

Where α is the speed of adjustment matrix, representing the rate at which the system responds to deviations from equilibrium in the previous period, and β is a matrix of long run coefficients (Harris, 1995: 77).

The test for cointegration is dependent on the lag length used in the VECM, thus it is vital to select the lag length optimally. Brooks (2002: 334) advocates for the use of different information criteria (IC) such as the Akaike Information criterion (AIC), Schwarz criterion (SC), Hannan Quinn (HQ) and the Final Prediction Error (FPE). These IC ensure that the residuals are Gaussian. The lag length chosen must also produce as best as possible the number and form of cointegration relations that conform to the *a priori* information linked to the economic theory under study (Seddighi *et al*, 2000: 309). In some cases these IC provide conflicting results, and in such a situation the one which produces a white noise residual in combination with the most economically interpretable results based on theory is chosen. In this study, we choose a maximum lag length of 12, because it is expected that after 12 months, any possible links between interest rate series will have been captured.

The next step is to choose between the deterministic assumptions required by the Johansen procedure in order to test for cointegration. Eviews presents 5 deterministic trend assumptions¹⁸.

¹⁸ Assumption 1: the level data Y(t) has no deterministic trends and cointegrating equations do not have intercepts. Assumption 2: the level data Y(t) has no deterministic trends and cointegrating equations have intercepts. Assumption 3: the level data Y(t) has linear trends but the cointegrating equations have only intercepts. Assumption

These assumptions are based on whether there is a constant and/or trend in the cointegrating term, and whether there is a constant in the VAR equations. Assumptions 1 and 5 are rarely used in practice, whereas assumption 2 is chosen when none of the series appears to have a trend, but an intercept in the cointegrating equation and no intercept in the VAR. Assumption 3 indicates a linear deterministic trend which is stochastic, and assumption 4 represents a trend stationary series which is non-stochastic (Eviews Manual).

After the appropriate lag length and deterministic assumptions have been selected, the test for cointegration, which is a test of the rank of the Π matrix, can now be carried out. Johansen (1988) presents two likelihood ratio (LR) test statistics for cointegration. These are the trace (λ_{trace}) and the maximum eigenvalue (λ_{max}) statistics, which are specified below:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^N \ln(1 - \hat{\lambda}_i) \quad (3.6)$$

and

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (3.7)$$

$\hat{\lambda}_i$ represents the estimated value for the i th ordered eigenvalue from the Π matrix, and r is the number of cointegrating vectors under the null hypothesis. Under the trace test, the null hypothesis that the number of cointegrating vectors is equal to r is sequentially tested against the alternative that there are more than r . alternatively the maximum eigenvalue conducts separate tests on each eigenvalue, and has the null hypothesis that there are r cointegrating vectors against the alternative of $r + 1$ (Brooks, 2002: 405). In obtaining the rank of the Π matrix, the test statistics of both the trace and maximum eigenvalue tests are compared to the non-standard critical values.¹⁹ In both tests, if the test statistic is greater than the critical values, the null hypothesis that there are r cointegrating vectors is rejected in favour of the corresponding alternative hypothesis. The null hypothesis is therefore tested sequentially from low to high

4: the level data $Y(t)$ and the cointegrating equations have linear trends. Assumption 5: the level data $Y(t)$ have quadratic trends and the cointegrating equations have linear trends (E-views 5 manual).

¹⁹ Brooks (2002: 405) states that these critical values are provided by Osterwald-Lenun (1992)

values of r , and the testing procedure ends when the null hypothesis cannot be rejected for the first time.

The rejection of the null hypothesis indicates the presence of a cointegrating relationship between the two interest rates under consideration. The final step in the cointegration analysis is to perform a diagnostic test on the residual to ensure that they are white noise. If residuals are serially correlated and have non constant error variance, it may indicate that the model is not efficient and as such the parameters estimated could be biased (E-views 5 Manual: 577-579). The Autocorrelation LM test is used for the serial correlation tests, and has a null hypothesis that there is no serial correlation. Providing that no serial correlation is present, the results of the cointegration tests can be accepted as valid.

ii. Engle-Granger 2-step cointegration analysis

The existence of a long-run equilibrium interest rate relationship can also be established using the Engle & Granger (1987) method. This is a two step single-equation approach. Before proceeding with the estimations, initial unit root and stationarity tests must be performed to ensure that all series are I(1).

The first step in the Engle-Granger test involves estimating the following regression:

$$i_t = b_0 + b_1 i_t^* + u_t \quad (3.8)$$

Equation (3.8) above is described as the cointegrating regression. The test for cointegration involves saving the residuals obtained. The residual u_t should be stationary, i.e. I(0) if the two interest rates i_t and i_t^* are cointegrated (Brooks, 2002: 391). The residual is therefore tested for stationarity using the Augmented Dickey Fuller (ADF) test, which involves the estimation of the following equation:

$$\Delta u_t = \beta u_{t-1} + \sum_{i=1}^k \gamma_i \Delta u_{t-i} + \varepsilon_t \quad (3.9)$$

Two important things to note about the ADF tests for cointegration are firstly that equation (3.9) does not include a constant term; this is because the OLS residuals are centered around zero.

Secondly, the usual Dickey-Fuller critical values are not appropriate for this test since this is a test on residuals of a model. Engle and Granger (1987) tabulated a new set of critical values. For the purposes of this study where monthly data is used on a nine year rolling period, the number of observations per period is 108. Therefore the Critical values for the ADF Engle-Granger test are -3.09(10%), -3.39(5%) and -4.01(1%) (Seddighi *et al*, 2000: 350). The null hypothesis of a unit-root is rejected if the τ statistics are greater than the above critical values at 10% or high significance level. This will indicate that the residuals are stationary and therefore the two interest rate series are cointegrated.

The Engle-Granger cointegration test suffers from a few limitations. These are mainly based on the weakness of the ADF unit root test. Kremers *et al.* (1992:1) state that the ADF test may only marginally reject the null hypothesis of no cointegration, even when cointegration may be strongly present. This is due to the well documented finite sample problem of a lack of power in unit root tests based on the ADF test. There could also be a simultaneous equation bias if causality between the two interest rates runs in both directions. The single equation approach of the Engle-Granger method requires the normalization on one variable as the dependent variable (Brooks, 2002: 398). In this study, it is expected that South Africa, being an emerging economy, will indeed be the dependent variable in the bi-variate regressions with the EU, Japan, UK and US, which have more advanced financial systems, being exogenously determined. Therefore, it is not expected that a simultaneous equation bias could exist by specifying South Africa's interest rates as the dependent variables. In terms of the weakness of the ADF tests, the three other tests for cointegration discussed will help to confirm or contrast the results of the ADF cointegration tests, thereby enabling a robust conclusion to be reached on the nature of the long-run relationships examined.

iii. Cointegrating regression Durbin-Watson (CRDW) test

This test draws on the Engle-Granger cointegration test from Equation (3.8). The Durbin-Watson values are obtained from the potentially cointegrating regression. Under this test the null hypothesis is that $d = 0$ rather than $d = 2$. If the computed d value is larger than the critical values, the hypothesis of cointegration is accepted. The critical values for the CRDW test are as follows: 0.322 (10%), 0.386 (5%) and 0.511(1%) (Gujarati,1995: 726).

If the d value for the cointegrating regression between South Africa's interest rates and the interest rates of any of the other countries in the studies is above the critical values stated above, it would be concluded that a stationary linear combination of the non-stationary interest rate series exists. Therefore the two series can be said to be cointegrated.

iv. ECM statistic as a test for cointegration

After the residuals from Equation (3.8) have been obtained and tested for stationary using (3.9), an error correction model (ECM) including the residuals as one variable can be specified as follows:

$$\Delta i_t = b_0 + \Delta i_{t-1} + b_1 \Delta i_t^* + b_2 \hat{u}_{t-1} + v_t \quad (3.10)$$

where $\hat{u}_{t-1} = y_{t-1} - \hat{t}x_{t-1}$. (Brooks, 2002: 394).

The error term in (3.10), also known as the ECM statistic, captures the adjustment towards the long-run equilibrium. It reveals what proportion of the disequilibrium in the dependent variable is corrected in the next period (Gujarati, 1995: 729).

An interesting approach to establishing the presence of cointegration between two series involves observing the ECM statistic from (3.10). This test is based on the t -ratio of the coefficient on the error-correction term (Kremers *et al*, 1992: 2). Cointegration is deemed to be present if the coefficient of the lagged error correction term is significant at the 5% level. Artis & Zhang (1998: 5) argue that the ECM statistic for testing cointegration can generate more powerful tests than those based on the ADF statistic applied to the residuals in a static cointegration relationship.

v. Short-run estimations

After performing the different tests for cointegration, the study proceeds to observe the long-run slope coefficients for the cases in which cointegration is found to be present in any of the three links identified. In this study the slope co-efficient, b_1 for each bi-variate analysis is obtained from the long run Equation (3.8) above. The b_1 value is analysed to observe the extent of integration between the interest rates, both for the within country case and for the links between

South Africa and each of the other countries. Where the focus is on examining the link between South Africa's interest rates and those of any of the other countries, a low b_1 , close to 0, will indicate a low level of integration whilst a b_1 close to 1 indicates a higher level of integration and therefore a significant dependence of South Africa's interest rate on the interest rate of the other country. When analysing the links between South Africa's money market rates and the central bank rate of South Africa, a high b_1 close to 1 indicates close ties between domestic interest rates in South Africa and therefore a strong autonomy of monetary policy. In certain cases the b_1 value could be above 1, implying an over adjustment of the dependent interest rate to the other rate.

In the cases where no cointegration is found to be present, the estimation then proceeds to examine the short-run coefficients for the bi-variate estimations. These are obtained from equation (3.10) where the first differences of the two interest rate series are estimated with the residual. Since there is no cointegration present, and the series are I(1), the first difference of the series can therefore be expected to be stationary and provide an indication as to the short run links between the two interest rates series. b_1 from (3.10) provides the slope-coefficient for the short-run estimation.

3.3.3 Stationarity Tests of Spreads/Risk Premiums

If two countries are integrated, then a convergence of returns on financial assets can be expected. This can be applied to the study of integration of money market interest rates. This study uses this approach to test arrow 1 for the link between central bank rates, arrows 2 and 3 together, for the link between the money market rates of South Africa and the repo rate of South Africa *vis-à-vis* the central bank rates of EU, Japan, UK and US, and thirdly arrow 4 for the money market rates between South Africa and the other countries²⁰.

This estimation technique is based on the uncovered interest rate parity condition. Research based on interest parity aims to equate prices of similar assets across different economies. It is important to note that perfect integration (full interest rate parity) can rarely be achieved, even amongst the most advanced economies. This is due to the fact that barriers such as asymmetric

²⁰ See Fig 2.1 for the arrows

information, transactions costs, differences in tax systems, and political and sovereign risks will exist at different levels (Aziakpono, 2006: 3). The objective is to examine the extent to which interest rates across different countries or regions are related, if factors such as the exchange rate and country specific risk are accounted for. The Interest rate parity conditions can be analysed under four variants, namely closed interest parity, covered interest parity, uncovered interest parity and real interest parity. Following the study by Nielsen *et al.* (2005), this study focuses on the uncovered interest parity condition. This is because the uncovered interest parity condition is the most appropriate for studying countries where the exchange rate risk is not accounted for using systems such as currency pegs.

The uncovered interest parity condition (UIP) differs from the covered condition in that it does not protect returns on investment against currency risk. Rather, the UIP requires that unhedged returns on alternative investments in different currencies should be equal after considering expected changes in the exchange rate and a risk premium (Aziakpono, 2006: 7). As monetary integration increases, the links between the two respective interest rates should increase, and the risk premium should minimize. Therefore the extent of this risk premium can be interpreted as a measure of the integration of the market, in this case the money market (Kasman *et al.*, 2008: 3).

The strict version of the UIP can be expressed as follows:

$$\Delta s_t^e = i_t^* - i_t \quad (3.11)$$

where Δs_t^e is the expected exchange rate change in logarithms, i_t is the domestic interest rate and i_t^* is the foreign interest rate. Cavoli *et al.* (2004: 7) state that before formally testing the UIP, one must find a way to measure the expectation of the future exchange rate. One way around this is through assuming that the rational expectations theory holds. The strict version of the UIP can only hold if the domestic and foreign assets are perfect substitutes, which is rarely the case. In order to account for this problem, a risk premium is introduced as follows:

$$\Delta s_t^e = i_t^* - (i_t - \varphi_t) \quad (3.12)$$

where φ_t is the risk premium.

This can be re-written as

$$\varphi_t = (i_t - i_t^*) + \Delta s_t^e \quad (3.13)$$

In calculating the risk premium, the maturity of the interest rates has to be matched with the exchange rates. This can be achieved following Holtemoller (2005: 3) where

$$\Delta s_t^e = \frac{12}{k} (s_{t+k} - s_t) \quad (3.14)$$

For the Treasury bill rates, money market rates and lending rates, we use a maturity of 3 months ($k = 3$).

If there is sufficient financial integration between the two countries, this spread/risk premium can be expected to fluctuate around zero with a low variance. A consistently positive or negative risk premium is evidence of little or no monetary integration. The spread and/or risk premium is therefore assumed to be stationary in the case of financial integration (Holtemoller, 2005: 3-4; Nielsen *et al.*, 2005: 713). This forms the rationale for this methodology, in that the spread/risk premium can be tested for stationarity in order to determine the extent of integration. It is important to note here that for tests involving central bank rates, a risk premium is not required due to the absence of arbitrage opportunities. Therefore, for the tests between the central bank rate of South Africa and the central bank rate of the other countries, the spreads between the two interest rate series is used. The spreads are also sufficient for the tests between the Treasury bill, money market, and lending rates of South Africa and the central bank rates of South Africa and of the other countries. This is again due to the lack of arbitrage opportunities within this link. The stationary tests between the money market interest rates of all the countries is done firstly for the spreads alone and then is repeated with the risk premium added to the spreads to account for the presence of arbitrage opportunities. This is a crucial focus of this study because it provides insight as to whether the risk premium is an important factor in the integration process between South Africa's money market and the money markets of the other countries. If integration is found to be stronger when the risk premium is accounted for, it implies that the risk of investing in the South African money market plays a determining role in the extent of integration between South Africa's money market and the money markets of the EU, Japan, the UK and the US.

The first step in the empirical process is to test the stationarity of the individual series. If the series are found to be I(1), one can proceed to test the spreads and risk premiums. Following Nielsen *et al.* (2005), The Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests are employed to

tests the spreads and risk premiums between South Africa and the EU, Japan, UK and US. By testing the difference between local (South Africa) and foreign interest rates, a cointegrating vector of (1,-1) is imposed (Nielsen *et al.*, 2005: 717). The respective t-statistic and probability value of the unit root tests are recorded for each spread/risk premium. Both tests are performed with the intercept assumption, to conform to the unit root tests on the individual series.

Following from Nielsen *et al.* (2005: 717), whenever the p-value of the respective unit root test is significant, ie. below the 10%²¹ line, the differential can be considered to be stationary at the 10% level. In such a case the countries can be considered to be financially integrated. A rolling period of nine years is once again employed in this study to observe the trend of the p-values over time. A graphical plot of the p-values over the rolling period helps to identify the extent and development of financial integration over time.

3.4 CONCLUSION

This chapter set out the empirical framework to be used to examine the relationship between short-term interest rates of South Africa, and similar interest rates in the EU, Japan, UK, and the US. The chapter begun by describing the countries included in the study and the data to be used. Preliminary descriptive statistics provide an initial indication of the potential links between South Africa and the other countries. Principal components analysis, four tests for cointegration and thirdly tests of the stationarity of the spreads/risk premiums, based on the UIP are the three estimation techniques discussed in detail. The next chapter presents the results of these tests.

²¹ Nielsen *et al.* (2005: 717) use a stricter level of 5% in their test for the Common Monetary Area in Southern Africa. This study uses 10% because of the expected slightly lower level of integration between South Africa and the countries in this study.

CHAPTER FOUR:

EMPIRICAL RESULTS

4.1 INTRODUCTION

The objectives of this study, as outlined in Chapter 1, are as follows: (i) to identify if a long-run relationship exists between the repo rate of South Africa and the central bank rates of the EU, Japan, UK and US. The aim here is to establish the degree to which monetary policy decisions of the South African Reserve Bank (SARB) are responsive to the movements of the central bank rates of the other countries, (ii) to analyse the extent to which the domestic short-term interest rates respond to domestic monetary policy movements compared with international monetary policy decisions. This is achieved by comparing the link between the domestic Treasury bill, money market and lending rates with the repo rate *vis a vis* the central bank rates of the other selected countries. Identifying the strength of the autonomy of the SARB in influencing domestic rates is the key outcome of this objective, (iii) to examine if any arbitrage opportunities exist between South Africa's Treasury bill, money market and lending rates and similar interest rates of the other countries included in the study. The nature of such links between the domestic and international interest rates provides an indication of the opportunities for portfolio diversification.

In this chapter, the results of the empirical studies are presented and discussed. The three methodologies employed - principal components analysis, the tests for cointegration, and the stationarity tests of the spreads/risk premiums are discussed in that order.

4.2 PRINCIPAL COMPONENTS ANALYSIS RESULTS

The principal components analysis (PCA) investigates common movements or patterns between the interest rates. It provides a general indication as to whether integration exists between any group of interest rates e.g. central bank rates. In this study PCA is used to obtain an initial overall picture as to the nature of financial integration between South Africa's central bank rates, Treasury bill rates, money market rates and lending rates with corresponding interest rates from the EU, Japan, UK and US. Objectives (i) and (iii) above can therefore be achieved using principal components analysis.

The first step in the PCA is to identify the number of significant factors driving co-movements between a set of similar interest rates. Table 4.1 below reports the number of significant factors that explain the variation for each of the interest rates for each rolling period. This is based on the Kaiser rule of eigenvalue greater than one for a significant principal component (PC). Table A-1 in the appendix provides the specific values for the eigenvalues for the 1st and 2nd principal components.

Table 4.1 Number of Significant Principal Components

PERIOD	CB RATES	TB RATES	MM RATES	LND RATES
1990-1998	2	1	2	2
1991-1999	2	2	2	2
1992-2000	2	2	2	2
1993-2001	2	1	2	2
1994-2002	2	2	2	2
1995-2003	2	1	2	2
1996-2004	2	1	2	1
1997-2005	1	1	1	1
1998-2006	1	1	1	1
1999-2007	1	2	2	2

Note: CB- central bank, TB-Treasury Bill, MM-money market, LND – lending rates

This gives a first indication of the nature of integration between the five countries. For the central bank, money market and lending rates, there are two significant PC's for most of the periods. This means that there are two main factors driving the co-movement of these interest rates, an indication of minimal integration. The Treasury bill rates differ from the others in that there is only one main factor driving the Treasury bill rates for South Africa, Japan, UK and US²². There appears to be an increase in integration since for the central bank and money market rates the number of significant PCs drops to 1 from the period 1997-2005, and even earlier for the lending rates from 1996-2004. However in the final rolling period, 1999-2007, all the interest rates apart from the central bank rates move back to two significant factors, a signal of a reduction in their co-movements. After identifying the number of significant PC's between the groups of interest rates, the specific contributions of each country's interest rates to the principal component is examined. This is done by observing the factor loadings of each country to the significant PC. Figure 4.1 below presents the factor loadings for each country for the central bank, Treasury bill, money market and lending rates.

²² The EU is excluded for the Treasury bills.

Figure 4.1 Factor loadings for Central Bank, Treasury bill, Money Market and Lending rates

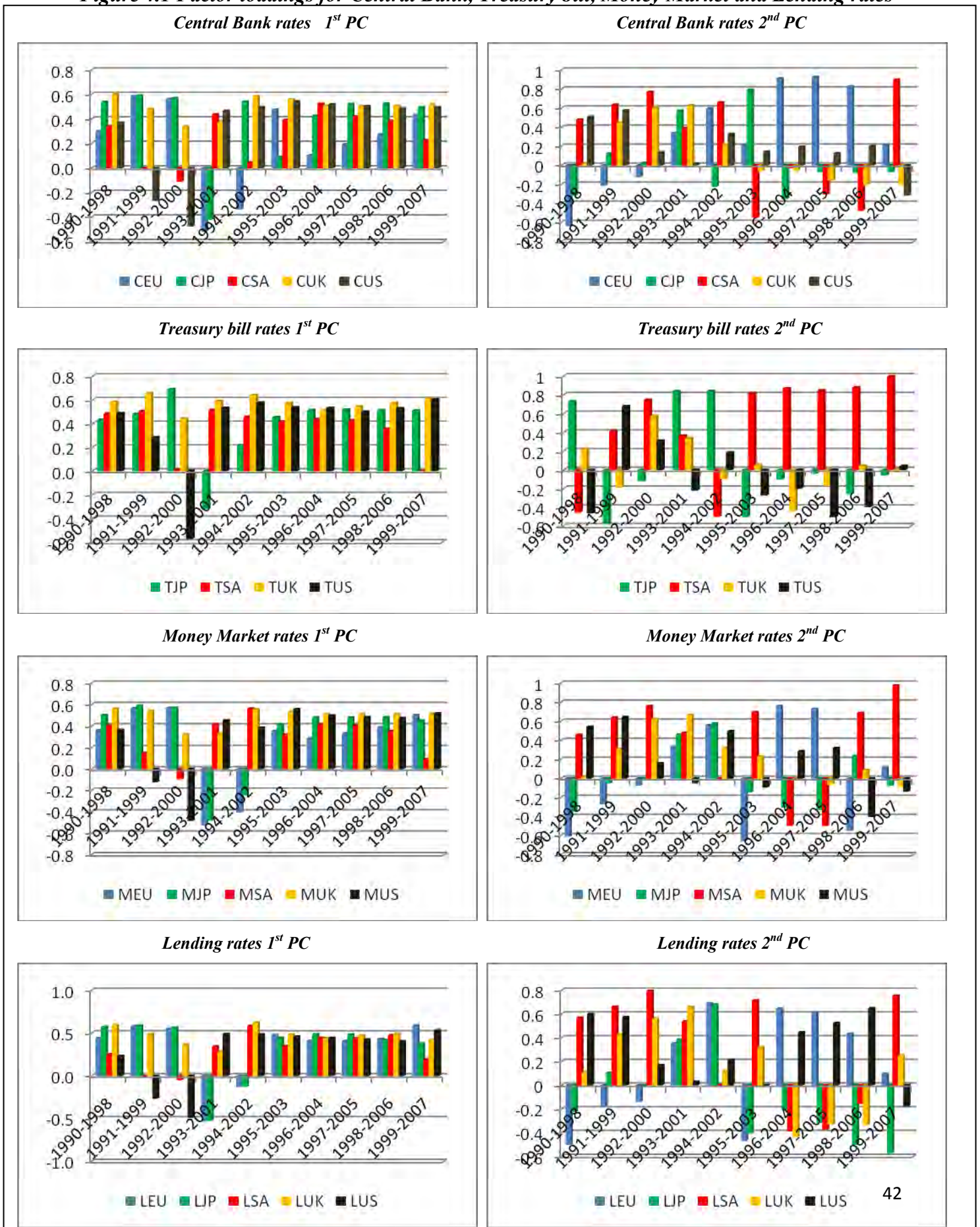


Table 4.1 above shows that for the central bank rates there are two significant PC's until 1997-2005; therefore the analysis is done for both graphs until that period. For the 1st PC, for the first five periods, South Africa's repo rate has a low factor loading to this PC, apart from in the 1993-2001 rolling window. South Africa appears to be the main driving force for the 2nd PC in these five periods. Initially, the US also contributes more to the 2nd PC, although its influence reduces over time. The contribution of the EU to the 1st PC reduces over time, whilst it appears to become more present in the 2nd PC. In the periods where there is only 1 PC with an eigenvalue greater than 1, South Africa's repo rate moves with the central bank rates of the other countries with a similar factor loading to the other countries. However in the final period, 1999-2007, even though there is only one significant PC, it is evident that the factor loading of South Africa is not contributing to the 1st PC and is more dominant in the 2nd PC. The eigenvalue for PC2 in 1999-2007 is 0.960, which is close to 1, even though it is not statistically greater than 1. South Africa's repo rate is the main driving force of this PC, with a factor loading of 0.899²³, as can be seen in Fig 4.1. In terms of sign, for the 1st PC, in most of the periods all factor loadings have the same positive sign except for in the period 1992-2000 where the US moves alone with a strongly negative factor loading, and in 1993-2001, where the EU and Japan move in an opposite direction to the UK, US and South Africa²⁴.

Overall, there does not appear to be a consistent move towards integration between South Africa's repo rates and those of the other countries. Although there is some general movement in some of the periods, the periods where South Africa appears to be moving in a different direction are more than where it moves together with the other central bank. Therefore even though there is only one significant PC in most of the rolling windows, South Africa is moving more on its own and is accounting for the 2nd PC which is almost significant. This clearly indicates that there is minimal integration between South Africa's repo rate and the other central bank rates in the final period.

For the Treasury bill rates, in the first three rolling windows, where there are 2 significant PCs, South Africa's appears to dominate the 2nd PC, especially in the period 1992-2000. Japan also strongly accounts for the 2nd PC in 1994-2002. From the period 1995-2003 onwards when there

²³ See Table A-2 in the appendix

²⁴ This movement in an opposite direction of the US in 1992-2000 and the EU and Japan in 1993-2001 also occurs for the treasury bill, money market and lending rates for these same periods.

is 1st PC, South Africa consistently has the smallest factor loading in PC1, while it is the main contributor for PC2, although this PC is not significant until the final period. In the last period, the 2nd PC is just significant with an eigenvalue of 1.003. South Africa's Treasury bill rate is the main driving factor for this PC, with a factor loading of 0.997²⁵ and is virtually absent from the 1st PC, whereas the other countries have virtually no contribution to this 2nd PC.

There are two significant PCs for the money market rates of the EU, Japan, South Africa, UK and US for all the periods except 1997-2005 and 1998-2006. In analysing the factor loadings for both PCs, the focus is on which PC South Africa is more dominant in. For the first four rolling windows, South Africa contributes more to the 2nd PC. The US also contributes to PC2 for the first two rolling windows whilst the UK is also strongly present for the next two rolling periods of 1992-2000 and 1993-2001. For 1994-2002, the money market rates of South Africa are a factor for the 1st PC, and appear to be moving closely with the UK money market rates. The two periods where there is only one significant PC indicates increased integration for the money market rates of all the countries for these rolling windows. In the final period there are again two significant PCs, with South Africa's money market rate clearly the main factor in PC2. All the other countries are more present in PC1 in this period with little contribution to PC2 except for that of South Africa, with a factor loading of 0.976 for PC2. This is consistent with the central bank and Treasury bill rates above where South Africa is distinctly on its own in the final period, a sign of a movement away from integration.

The trend for the lending rates is not different from the other interest rates analysed above. There are two principal components for most of the rolling periods. As is evident from the graph above, South Africa is the leading contributor to the 2nd PC for the first three periods, where the lending rate of the US is also strongly present for the first two periods. Integration is only evident in the periods 1996-2004, 1997-2005 and 1998-2006 where there is only one significant PC in each of these periods. Once again in the final period, the lending rate of South Africa has the lowest contribution to the 1st PC but the highest factor loading for the 2nd PC, a consistent feature of South Africa's interest rates in the last rolling period.

In summary, the PCA analysis has shown that there is no integration between South Africa's central bank rates and the central bank rates of the other countries. This implies that monetary

²⁵ See table A-3 in the appendix

policy decisions in terms of setting the repo rate occur independently and have no long-run linkages with the central bank rates of the EU, Japan, UK and US. The examination of the potential links between the Treasury bill, money market and lending rates of all countries including South Africa also show that there is weak evidence of integration between South Africa's short-term interest rates and international rates of similar financial assets. South Africa's interest rates consistently move separately and do not show any strong co-movement with the interest rates of the other countries. In most cases where there are two significant principal components, South Africa's interest rates account mostly for the 2nd PC, and even in cases where only one significant PC is present, the graphs and factor loading figures from Table A-2 in the appendix show that South Africa's interest rates do not contribute much to the single significant PC.. This is especially evident in the final periods where South Africa's interest rates are strongly moving separately.

Finally to conclude the study on integration using principal components analysis, the tests are repeated for all the interest rates for all the countries except South Africa. The objective here is to identify if financial integration between the countries increases when South Africa is not included.

Table 4.2 Number of Significant Principal Components When South Africa is Absent

PERIOD	CB RATES	TB RATES	MM RATES	LND RATES
1990-1998	2	1	2	2
1991-1999	2	2	2	2
1992-2000	1	1	1	1
1993-2001	2	1	2	2
1994-2002	2	1	2	2
1995-2003	1	1	1	1
1996-2004	1	1	1	1
1997-2005	1	1	1	1
1998-2006	1	1	1	1
1999-2007	1	1	1	1

It is immediately evident that when South Africa is removed, integration occurs earlier for all the interest rates. As early as in the third rolling period, 1992-2000, there is evidence of integration for all the interest rates. This is indicated by only one significant PC present in this rolling window. Apart from the periods 1993-2001 and 1994-2002, the trend of integration evidenced by

the 1 significant PC continues down for all the subsequent rolling periods²⁶. This clearly shows that integration is stronger between the EU, Japan, UK and US without South Africa. This supports the conclusion reached that there is no financial integration between South Africa's central bank, Treasury bill, money market and lending rates with similar rates from the other countries.

The next method for analysing financial integration involves the tests for cointegration and error correction models. The results of these tests are reported and discussed below.

4.3 TESTS FOR COINTEGRATION

The tests for cointegration are based on the Johansen and Engle-Granger methodologies. All three links are examined using these methods, and specific details on the degree of cointegration between South Africa and each of the other countries obtained. The four tests for cointegration are the trace and maximum eigen value tests based on the Johansen approach, the ADF stationarity tests on the residuals obtained from the Engle-Granger cointegration test, the CRDW tests, and finally the Error correction estimates. The rolling window approach provides further insight into the changing nature of any links over the period of the study. Before proceeding to discuss the results in relation to each objective, unit root tests were performed on each series to ensure that the series are all I(1).

4.3.1 Unit root tests

Table B-1 in Appendix B shows the unit root tests for the central bank, Treasury bill, money market and lending rates for the EU, Japan, South Africa, UK and US for each of the rolling windows. The tests were done with the intercept and „trend and intercept' deterministic assumptions. Since the results did not differ much under the assumptions, the results for the intercept are presented in Table B-1. Both the ADF and KPSS tests indicate that for most of the rolling windows, all the interest rate series appear to be non-stationary at levels but stationary when differenced once, ie. they are I(1). Based on this, the tests for cointegration could be carried out. The results for the cointegration tests are presented below. They are analysed in terms of the links identified in the schematic diagram in chapter 2.

²⁶ The specific factor loadings of the four countries to the significant principal components are not discussed here because the focus is on the impact of the removal of South Africa on the overall move towards integration, as shown by the number of significant principal components alone.

4.3.2 Cointegration between South Africa's Repo Rate and other Central Bank Rates

No evidence of cointegration is found between the repo rate of South Africa and any of the central bank rates of the other countries examined. Table B-2 in the appendix shows the trace and maximum eigenvalue tests for the Johansen approach, as well as the ADF and CRDW tests based on the Engle-Granger method. The Error correction model (ECM) coefficients and t-statistics are also presented in this table. The trace and maximum eigenvalue tests find cointegration in only two of the rolling periods for both the EU and Japan with the repo rate, whereas cointegration is only found in one period for the repo rate with the UK central bank rate. In all other periods no cointegration is found. For each of the periods for the link between the repo rate with the US central bank rate, no evidence of cointegration is found. Serial correlation tests for the periods where cointegration is found revealed that no serial correlation was present.

The ADF tests on the residuals generated from the OLS regressions show that none of the residuals is stationary at the 1%, 5% or 10% level. The t-statistics of the ADF tests for the link between the repo rate and central bank rates of each of the other countries for all rolling windows fall below the critical values required for a long-run relationship to be established. The CRDW test also confirms the result of the ADF tests. The Durbin-Watson values reported in Table B-2 for the regressions between South Africa's repo rate and each of the central bank rates of the EU, Japan, UK and US all fall below the critical values for each of the rolling periods. The final test for cointegration involves the error correction estimates. The ECM is only significant for series that are cointegrated, therefore if the ECM coefficients are negative and significant, it implies that there is some link between the two interest rate series in that there is a correction towards the long-run equilibrium. As is clear from Table B-2 in the appendix, the ECM coefficients are positive for most rolling windows apart from the final period, for each of the bi-variate analysis between South Africa's repo rate and the EU, Japan, UK and US. In the final period where the ECM coefficient has the correct negative sign in each bi-variate estimation, the coefficients are however not significant.

Thus, all four tests for cointegration show that there is no long-run link between the repo rate of South Africa and the central bank rates of the EU, Japan, UK and US. This result is consistent with the PCA results. Furthermore, even though no cointegration is present, none of the four countries compared with South Africa show a slightly stronger movement towards a significant ADF t-statistic or Durbin-Watson value over the rolling periods. The implication of this is that

the South African Reserve Bank appears to have an independent monetary policy, without a strong observable dependence on the monetary policy stance of the major world economies.

4.3.3 Cointegration between South Africa's money market interest rates and Central Bank Rates

In this section there are two important objectives. Firstly to establish the strength of the domestic link between the SARB's repo rate and the Treasury bill, money market and lending rates, and secondly to compare this link with the link between the domestic interest rates and the central bank rates of EU, Japan, UK and US. The discussion will therefore follow this path and analyse the domestic links first, followed by the international links and then will draw comparisons between the two.

Cointegration is found for each of the domestic rates with the repo rate. Table B-3 in the appendix shows all four tests for cointegration between Treasury bill rate of South Africa and the central bank rates, based on the Johansen and Engle-Granger methods. Tables B-4 and B-5 show the same tests for the domestic money market rate and lending rate respectively with the SARB's repo rate. For the link between the Treasury bill rate and the repo rate of South Africa, Table B-3 shows that both the trace and maximum eigenvalue tests find that cointegration is present at each rolling period. The LM serial correlation tests confirmed that absence of any serial correlation in the cointegrating relationships. The t-statistics for the ADF tests are significant for each period at the 1% level except in the final period where the t-statistic is significant at the 5% level. This is supported by the CRDW test where the d-values are above the 1% critical value of 0.511 in each rolling window, showing that the hypothesis of cointegration at the 1% level is accepted. The ECM coefficients are all negative and significant, a final confirmatory evidence that cointegration is present between the domestic Treasury bill rate and the repo rate of South Africa for each rolling period.

Cointegration is also present for the link between the domestic money market rate and the repo rate, as shown in Table B-4 in the appendix. Trace and maximum eigenvalue tests show cointegration for each rolling window. The t-statistics of the ADF are statistically significant at the 1% level in most of the periods. However, in the final three periods, the level of significance drops to the 5% level. The CRDW d-values are also only significant at the 1% level for the first five rolling periods, subsequently there are significant at the 5% level. Therefore although

cointegration is found in each period for the money market rate to the repo rate, there is a slight reduction in the significance level of the t-statistics and DW values. The error correction coefficients again move in line with the ADF and CRDW tests. In each period the ECM coefficients are negative and significant, providing evidence of cointegration. Again, the coefficients decline in value and strength of significance in the later periods, supporting the results of the ADF and CRDW tests that the strength of the cointegrating relationship between the money market rate and repo rate is declining slightly over the period. The cointegration test for the link between the domestic lending rate and the repo rate, as reported in Table B-5, follows a similar pattern to the Treasury bill rate and money market rate. For the domestic link between lending rates and the repo rate, each of the four tests for cointegration is consistent in finding evidence of cointegration. The ADF and CRDW tests are significant again at the 1% level except in the last period where the significance drops down to the 5% level. The error correction terms are all negative and highly significance, although once again a declining trend is observed in both the values of the error term coefficients and in their significance values.

In comparison, Table B-3 also provides results for cointegration tests for the domestic Treasury bill rates and the central bank rates of the EU, Japan, UK and US. Although the trace and maximum eigenvalue tests find cointegration in a few of the rolling periods, the periods where cointegration is not found exceed where cointegration appears to be present. Furthermore all three other tests indicate that there is no long-run link between South Africa's Treasury bill rate and the central bank rates of the other countries. Both the ADF and CRDW statistics are below the critical values even at the 10% level in all periods for each country's central bank rates with South Africa's Treasury bill rates. The error correction coefficients are positive and insignificant, substantiating the results of the ADF and CRDW tests. Overall, all four tests comprehensively show that there is no long-run linkage between South Africa's Treasury bill rates and the central bank rates of the other countries.

Table B-4 also shows that no cointegration is found between the domestic money market rate and the central bank rate of the other countries. For the link between the Treasury bill rate and the EU central bank rate, the Johansen method shows no cointegration in any period. For the link with the central bank rates of Japan, UK and US, the trace and maximum eigenvalue show cointegration in only two rolling periods in each case. All three other tests reveal that there is no long-run linkage between the Treasury bill rate of South Africa and the central bank rates of the

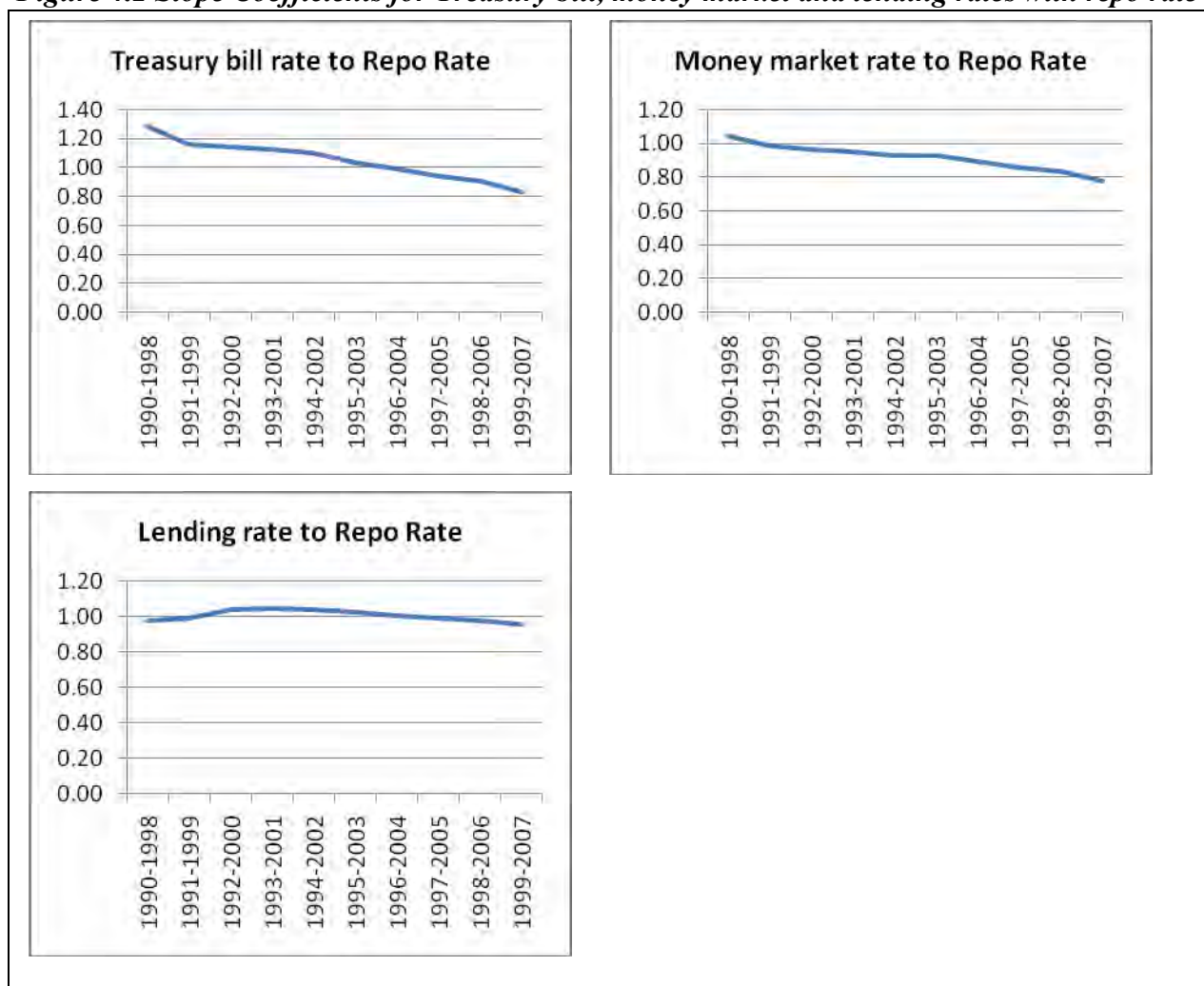
EU, Japan, UK and US. The ADF and CRDW t-statistics fall below the critical values at the 10% level, a clear sign of the absence of cointegration. The ECM coefficients are also mostly positive and insignificant. In the final three periods in each case where they are negative, their t-statistics are however insignificant. No evidence of cointegration is present between the domestic lending rate and the central bank rates of the EU, Japan, UK and US based on all four tests.

For the link between the domestic lending rate with the central bank rates of the EU and Japan respectively, the Johansen procedure finds no cointegration in any of the rolling periods. The Johansen method finds cointegration in only one period for the link with the UK central bank rate and in only two of the ten periods for the link with the US central bank rate. As with the Treasury bill and money market rates, the ADF and CRDW tests are insignificant in each rolling periods even at the 10% level. The ECM coefficients also prove that no cointegration is present since the coefficients are positive and insignificant in all the rolling periods for each link, except in the final period in each case, where although the coefficient possesses the correct negative sign, they are still insignificant.

The results above clearly show that the Treasury bill, money market and lending rates of South Africa have a long-run link with the repo rate of South Africa over the ten-year rolling periods beginning in 1990-1998 and ending in 1999-2007. In contrast, there is no evidence of cointegration between the Treasury bill, money market and lending rates of South Africa with the central bank rates of the EU, Japan, UK and US. The SARB therefore possesses a high level of autonomy in terms of influencing domestic short-term interest rates. International monetary policy decisions do not appear to affect South Africa's short-term interest rates.

After identifying that cointegration exists for the Treasury bill, money market, and lending rates only with the domestic repo rate and not with the central bank rates of the other countries, the next procedure is to observe the trend of the cointegrating relationship between the domestic rates with the repo rate. Estimation of equation (3.8) in chapter 3 provides long-run slope coefficients which help to observe how the domestic rates respond to a unit change in the repo rate. Table B-6 in the appendix shows the slope coefficients from the cointegrating relationship between the Treasury bill, money market and lending rate respectively with the repo rate of South Africa. Figure 4.2 below shows the trend in these slope coefficients over time graphically.

Figure 4.2 Slope Coefficients for Treasury bill, money market and lending rates with repo rate



The Treasury bill rate and money market rate start out with slope coefficients above 1 at 1.28 and 1.05 respectively. This indicates an over adjustment to the repo rate in that a unit change in the repo rate results in a larger change in the Treasury bill and money market rates. This reveals the extent of the influence that the SARB had on domestic rates in the period 1990-1998. There is clearly a very high level of autonomy that the SARB has over the domestic money market. However, after the first period, a gradual decline is observed in the slope coefficients for both the Treasury bill and money market rates. This decline continues for the rest of the rolling periods. The Treasury bill rate coefficient with the repo rate is nevertheless still strongly linked to the repo rate with a slope coefficient above 1 until the period 1996-2004 where it drops to 0.99. Subsequently it continues to fall slightly until the final rolling window where the slope coefficient is at 0.84. Money market rates also decline but at a slightly faster rate. By the second period the slope coefficient for the money market rate to the repo rate had dropped below 1. This

reduction continues until the final period where the slope coefficient for the money market rate is 0.78.

The lending rate slope coefficient with the repo rate follows a slightly different path to the Treasury bill and money market rate. The slope begins just below 1 at 0.97. Thereafter, there is an increase in the slope until 1993-2001 when it is at 1.04. This demonstrates an increasing influence of the SARB on domestic lending rates. After this period the lending rates begin to follow the pattern of the Treasury bill and money market rates by declining slowly, dropping below 1 in the period 1997-2005 and ending at 0.95 in the final period. The lending rates therefore still have a stronger link with the repo rate in the final period than both the Treasury bill and money market rates.

The slope coefficients observed above provide two very interesting results in terms of the relationship between the repo rate and the domestic money market. Firstly, the high value of the slope coefficients for the Treasury bill, money market, and lending rates with the repo rate indicate that domestic short-term interest rates respond strongly to monetary policy decisions. This result is consistent with that of Aziakpono *et al.* (2008). Secondly, and possibly more informative, is the trend of the slope coefficients over time. Both the Treasury bill rate and money market rates experience a steady decline in the values of their slope coefficients with the repo rate over the rolling periods. Although the lending rate initially increases in its response to change in the repo rate, a declining trend is also observed mid-way through the period under study. The autonomy of the SARB over these interest rates, while still very strong, appears to be loosening over time. This is a very important conclusion because it indicates that there is the potential for external forces to begin to affect the determination of the Treasury bill, money market and lending rates. If the trend in declining influence of the SARB continues, it is probable that although currently this study shows that there is no long-run link between the domestic rates and international central bank rates, such linkages could be observed in the near future.

4.3.4 Cointegration between South Africa's money market interest rates and corresponding rates of the other Countries

The third objective of this study was to examine if any long-run link exists between the money market in South Africa and the money markets in the EU, Japan, UK and US. This will help to identify if any arbitrage opportunities and therefore possibilities for portfolio diversification exist

between these markets. If there is no long run link, then one can conclude that it is possible to diversify between South Africa's money market and the other markets.

Tables B-7 reports the results for the Johansen, ADF residuals tests, CRDW test and ECM coefficients for the link between South Africa's Treasury bill rate and the Treasury bill rates of the other four countries. Tables B-8 and B-9 report the same tests for the domestic money market rate and lending rate respectively. No cointegration is found between all three domestic interest rates and the corresponding rates of the EU, Japan, UK and US. The Johansen test result in the three tables does not indicate cointegration is present in more than two of the ten rolling period for each bi-variate analysis. The ADF and CRDW t-statistics also fail to be significant at the 10% level for the Treasury bill, money market and lending rates for all countries with South Africa. The fourth cointegration test based on the ECM coefficient conforms to the first three tests. The error correction coefficients are mostly positive and insignificant. In the few cases where the coefficients are negative, they are still insignificant, proving that there is no long-run link.

Thus, overall, it is overwhelmingly evident that there is no linkage between South Africa's Treasury bill, money market and lending rates with corresponding money market interest rates of the EU, Japan, UK and US. This confirms the result that short-term interest rates are domestically determined and have little or no influence from international markets in the long-run. This is a positive result for investors because it implies that there is the opportunity for portfolio diversification by investing in South Africa and the EU, Japan, UK and US. Due to absence of a cointegrating relationship between these markets, a market shock or downturn in international markets will not necessarily spillover into the South African money market, therefore providing an opportunity for investors to hedge their funds by investing across these markets.

4.3.5 Short – run estimations

It has been established that no long-run linkages exist between South Africa's short-term interest rates and similar rates from the EU, Japan, UK and US. However, there is the potential that some short-run links could exist. Table B-10 presents short-run coefficients for the bi-variate estimations between South Africa and the other countries for all the interest rate series. The table includes the short-run coefficients as well as the R^2 for each pair wise estimation with South

Africa. The short-run coefficients were obtained by regressing the 1st difference of the interest rates for South Africa with the 1st difference of the interest rates for each of the other countries. The table shows that there t-statistics for the slope coefficients for the central bank, Treasury bill, money market and lending rates for all countries with South Africa are not significant. All R² values are also very low. This indicates that even in the short run, South Africa's interest rates are highly independent and are not significantly influenced by the EU, Japan, UK and US interest rates.

The cointegration tests have conclusively shown that there is no money market integration between South Africa and the EU, Japan, UK and US. On the other hand, there is a strong long-run link between the domestic Treasury bill, money market and lending rates with the repo rate. This reveals the independence of the SARB in setting its repo rate and also in determining the values of the domestic money market interest rates. This result is consistent with the results from the principal components analysis results detailed above in section 4.1. The final approach to measuring financial integration is discussed in the next section.

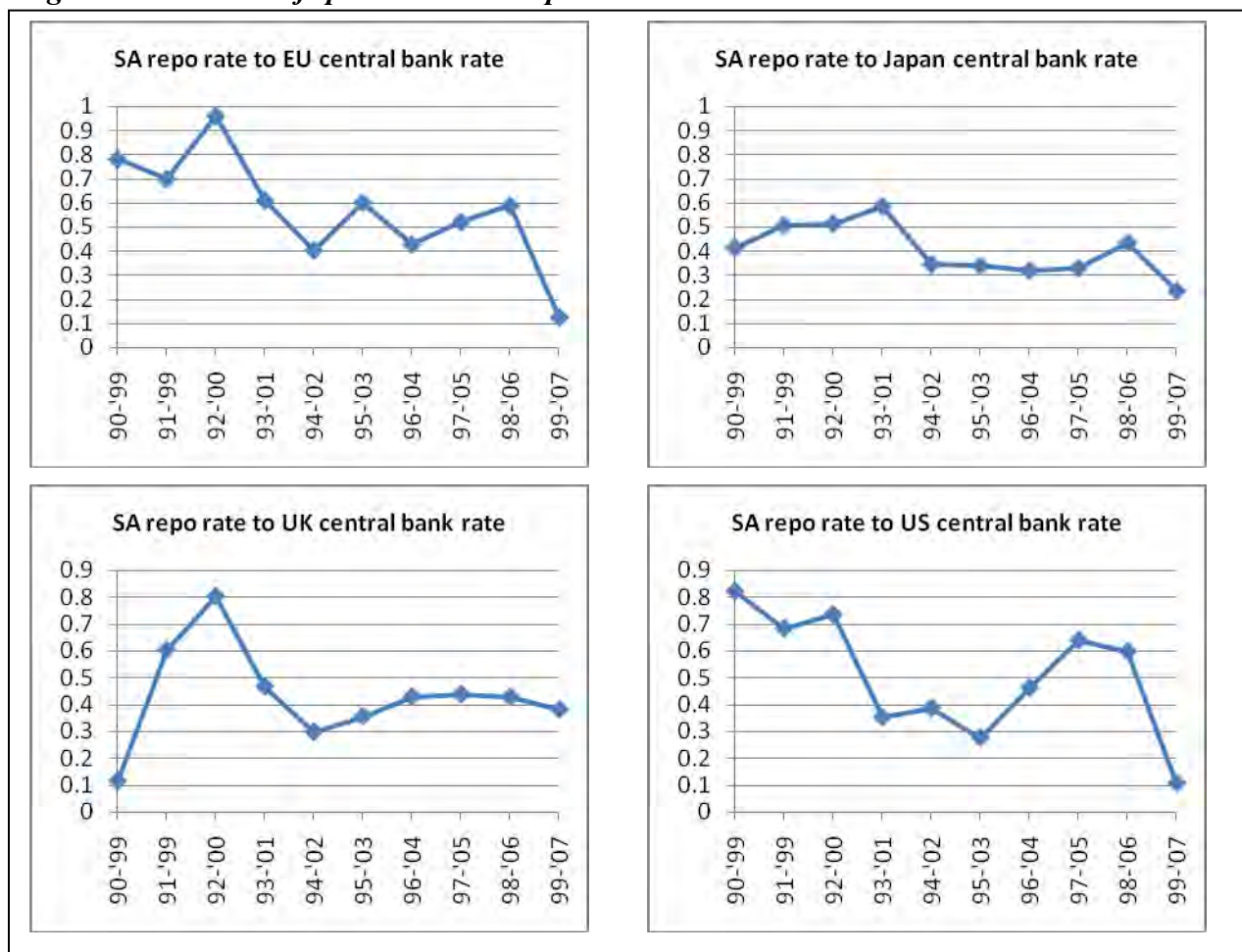
4.4 STATIONARITY TESTS OF SPREADS/RISK PREMIUMS

In this section, the results of the stationarity tests are presented. The approach here in analysing the results follows the pattern established in this study of observing integration based on the three links identified in Chapter 2. The first step was to identify if all the individual series to be examined are I(1). As Section (4.3.1) above shows, the ADF and KPSS tests on all the series for each rolling window indicates that all the series are indeed I(1). Therefore, one can proceed to perform the tests for the spreads and risk premiums. The idea behind these tests is that if financial integration exists between South Africa and the other countries, then the spread/risk premium between the two interest rates should be stationary since the interest rates should be converging in value. The ADF and Phillips-Perron tests were performed on the spreads. If the p-value was significant at the 10%, ie below 0.1, it can be said that there is integration between the two interest rates. The spreads and risk premiums were obtained as outlined in Section 3.3.3. This section now reports and discusses the results. The ADF and PP tests provide similar results for the stationary tests of the spreads/risk premiums, a shown in the appendix C tables. All graphs below therefore only show the p-values from the PP tests. Firstly, the links between South Africa's repo rate and the central bank rate of the EU, Japan, UK and US are discussed below.

4.4.1 Link between South Africa's Repo Rate and other Central Bank Rates

Table C-1 in appendix C shows the t-statistics and p-values for both the ADF and PP tests for the spread between the repo rate of South Africa and the central bank rates of the EU, Japan, UK and US. The diagrams below indicate the p-value of the respective unit root tests for each of the spreads over the rolling periods.

Figure 4.3 P-values of spread between repo rate and other central bank rates



There does not appear to be evidence of any integration between the repo rate of South Africa and the central bank rates of any of the other countries from the graphs above. The p-values in each of the four graphs are never below the significant level of 0.1 or 10%, an indication of no integration. The spread between the repo rate and the EU central bank rate begins at a high p-value level of 0.8 and rises to about 1.0 by the period 1992-2000. There appears to be a gradual decline after the 1992-2000 rolling window until in the final period where the p-value is almost significant at 0.12²⁷. For the spread between South Africa and Japan, it fluctuates around a p-

²⁷ Table C-1 in Appendix

value of 0.4, increases to around 0.6 during the 1993-2001 period, and then staying around 0.3 for most of the remaining rolling windows, until the final period when it is at 0.2. This indicates that there is no integration between the repo rate of South Africa and the central bank rate of Japan, and the trend does not appear to be changing over the period studied.

The p-value for the spread between the repo rate and UK central bank rate begins just above the 0.1 significant level at 0.12. Thereafter, there is a sharp rise to 0.8 by 1992-2000. This shows that there is reducing convergence between the repo rate and UK central bank rate up to this period. The p-value drops down to 0.3 by 1994-2004, after which the p-value hovers around 0.4 for the remaining rolling windows. It is evident that the repo rate of South Africa is not integrated with the central bank rate of the UK. The p-values for the spread between the repo rate and US central bank rate are quite similar to those for the repo rate and EU central bank rate. It starts at a high p-value (low level of integration) of 0.82. There is subsequently a relatively steady decline to a p-value of 0.28 in the 1995-2003 rolling window, an indication of a tendency towards convergence. For the next two periods the p-value rises up to 0.64 after which it declines again down to 0.11 in the final period, being almost significant at the 10%.

On the whole, it cannot be said that there is integration between South Africa's repo rate and the central bank rates of any of the other countries. There is no evidence of significant convergence of the spreads between the rates at the 10% level of significance. There is however a slight movement over the periods towards convergence for the spread between the repo rate and EU central bank rate, and the spread between the repo rate and the central bank rate of the US. For the UK, there is only a declining trend for the 1992-2000 to the 1994-2002 rolling windows. With regards to the Japan central bank rates, there is no indication that the current state of no integration is reducing over the rolling periods. Therefore, although there is no integration, it can be said South Africa's repo rate appears to be approaching convergence with the EU and US central bank rates more than with the UK and Japan.

The next set of figures indicate the link between the Treasury bill, money market and lending rates of South Africa with the central bank rates of South Africa and the other countries.

4.4.2 Link between South Africa's money market interest rates and Central Bank Rates

The aim here is to compare the spread between the domestic short-term interest rates and the

repo rate with the spread between these same domestic interest rates and the central bank rates of the other countries. The nature of the convergence relationship will help to identify the extent of the SARB's influence on domestic rates in contrast to the influence of international monetary policy decisions. Tables C-2, C-3 and C-4 in appendix C present the ADF and PP t-statistics and p-values for the Treasury bill, money market and lending rates respectively with central bank rates. Figure 4.4 below shows the results from the PP tests graphically.

Figure 4.4 P-values for Spread between SA money market interest rates and central bank rates



A strong dependence of the Treasury bill, money market and lending rates on the repo rate of South Africa is observed in the first graph in the above Figure 4.4. The p-value is extremely significant at 0.00 for all the rolling periods for the Treasury bill rates. This indicates a very high degree of influence of the South African Reserve Bank on the Treasury bill rate. Although the Engle-Granger method revealed that the strength of the SARB's influence of the Treasury bill rates is reducing slightly over time, in terms of the spread between the two, it has remained constant through the rolling periods. For the money market rates, the figure above shows that the link between the money market rate and the repo rate is also very strong. The p-value for the spread is highly significant at 0.00 for most of the periods until 1995-2003 and 1996-2004 where it moves to 0.05 and 0.09 respectively, a sign of a somewhat lower level of significance. The p-value drops back to 0.00 in the next period, but then rises again in the last two periods to 0.03 and then 0.1, which is the threshold for stationarity in this test. The SARB's influence on the money market rate, although still extremely powerful, appears to be falling gradually in the final two periods. The dominance of the SARB over domestic interest rates is again confirmed by the strong stationarity of the spread between the lending rate and the repo rate of South Africa. The p-value from the PP test remains at the strongest significance level of 0.00 through all the rolling periods except the last period. In the final rolling period, the p-value drops to 0.09, just within the significance threshold of 0.1. This shows a slight reduction in the influence of the SARB over the period.

In contrast, none of the spreads between South Africa's Treasury bill, money market and lending rates and the central bank rates of the EU, Japan, UK and US are significant over the rolling periods. The spreads between the three domestic short-term interest rates with the central bank rate of the EU appears to be trending downwards slowly over time, with the Treasury bill spread reaching 0.19 in the final period, from a starting level of 0.75, the money market rate declining from a previous level of 0.65 to 0.14. The lending rate spread, from an initial p-value of 0.82 in the first period, in the final period has a p-value of 0.17, showing a trend towards convergence over time. It is therefore evident that the EU central bank rate, although not yet significantly integrated with the interest rates of South Africa, is increasing in its influence.

South Africa's Treasury bill, money market and lending rates all do not show any evidence of convergence with Japan, the UK and US over the rolling windows. All three domestic interest rates spread with the UK central bank rate appear to be diverging rather than converging towards stationarity. The Treasury bill spread with the UK actually begins at level which is just significant at 0.09 but then immediately rises to 0.33 and then rises even further in the later rolling periods to a final level of 0.54 in the final period. The money market, UK central bank rate spread is just above the stationarity level at 0.11 but then the divergence between the two interest rates increases sharply and subsequently fluctuates at a high p-value, occasionally dropping to a p-value of 0.37 but never trending towards stationarity. The lending rates of South Africa show a similar pattern in their spread with the UK central bank rate. The Treasury bill, money market and lending rate spreads with Japan and the US central bank rates spreads fluctuate up and down over the rolling periods without actually approaching the stationary level. Japan's central bank rate spread with South Africa's lending rate remains at a p-value level of between 0.4 and 0.6 for all periods except in the final period where it drops to 0.24. Despite this decline in the last period, it cannot be said that there is any suggestion that there is a movement towards increased convergence between the two interest rates

Therefore, whilst the SARB's strength may be declining slowly, the central bank rates of the other countries have not increased in their influence on the domestic short-term interest rates of South Africa. Only the EU central bank rate shows some sign of a movement towards convergence in the near future. The UK, Japan and US cannot be said to be financially integrated with the South African rates. In terms of objective (ii) of comparing the response of the three domestic short-term interest rates with the repo rate of South Africa and the central bank rates of the EU, Japan, UK and US, it has been shown that the domestic interest rates are strongly financially integrated with the repo rate, due to the stationarity of the spreads between them, whilst no integration is present with the central bank rates of the other countries. This result is consistent with the four tests of cointegration discussed above in Section 4.2

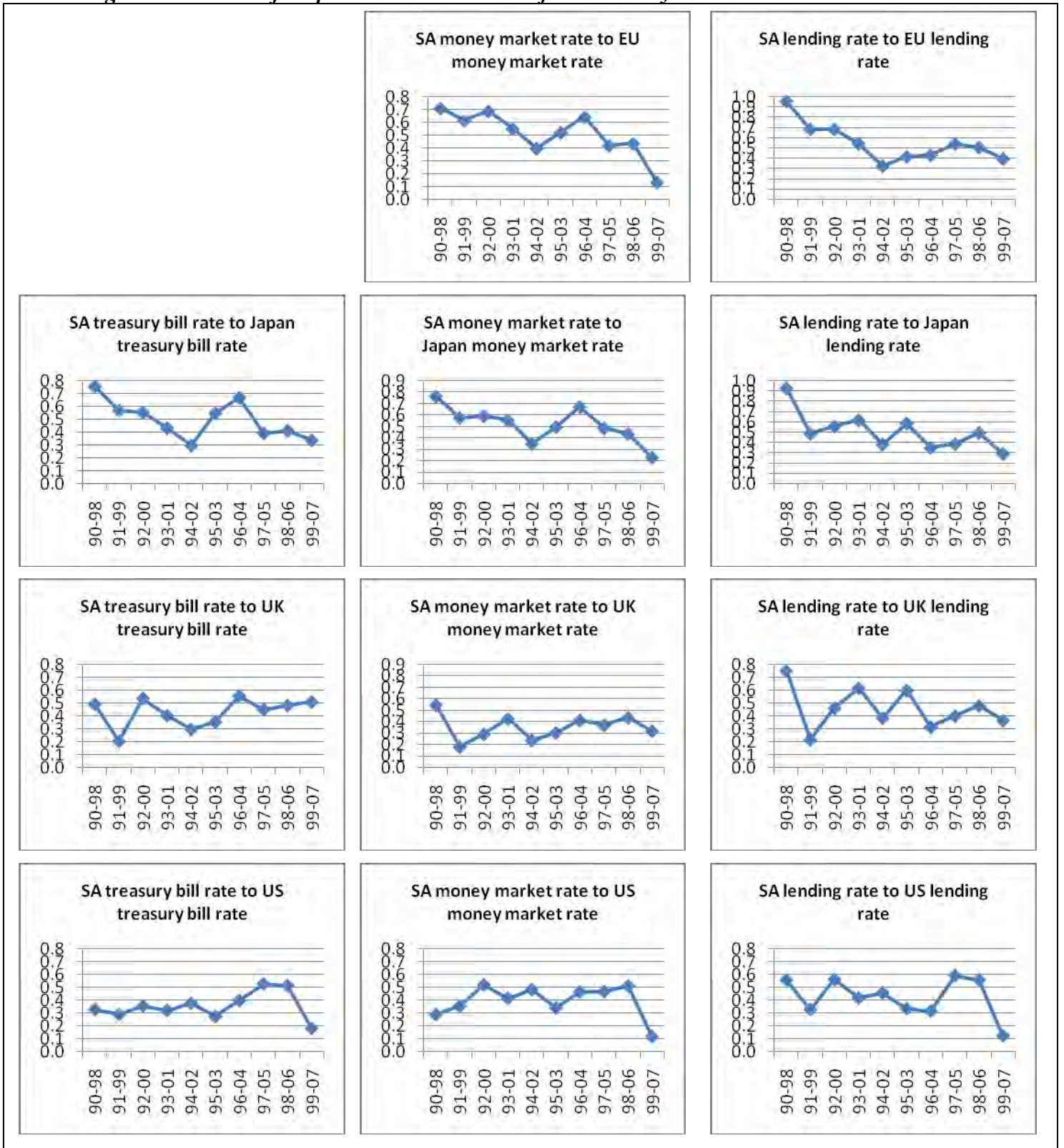
Finally, the opportunity for portfolio diversification is examined by observing the spreads and risk premiums between South Africa's Treasury bill, money market and lending rates with similar rates from the EU, UK, Japan and US.

4.4.3 Link between South Africa's money market interest rates and corresponding rates of the other countries.

In this section, the spreads between South Africa's Treasury bill, money market and lending rates with the corresponding rates of the other countries are tested for stationarity. As with sections 4.4.1 and 4.4.2, a p-value of 0.1 or below indicates a stationary spread, thus implying integration between the two interest rates. However, as noted in Chapter 3, that the strict version of the uncovered interest rate parity will only hold if the two assets are perfect substitutes, which is almost never the case. To account for this problem, a risk premium is introduced and added to the spread as detailed in Chapter 3. The stationarity tests are therefore performed firstly with the spread alone and then repeated with the risk premium added to the spread. This will provide insight into the importance of the risk premium in the linkages between South Africa's money market and the money markets of the other countries.

Table C-5, C-6 and C-7 present the results for the stationarity tests for the spread between Treasury bill rates, money market rates, and lending rates respectively. As was done with the two links above, the p-values from the PP tests are presented in Figure 4.5 below to aid in the analysis of integration between the interest rates.

Figure 4.5 P-value for spread between South Africa's money market interest rates and other



The graphs above clearly show that there is no integration between South Africa's treasury bill, money market and lending rates with the corresponding rates of the EU, Japan, UK and US. The p-values of all spreads are above the threshold of 0.1. The spread between South Africa's money market and lending rates with the corresponding rates of the EU do show a declining trend, this shows an increasing movement towards integration. Beginning at a p-value of 0.71, the p-value for the spread between the money market rates of South Africa and the EU reduce steadily until the p-value is just above the significant level at 0.13 in the final rolling window. The lending rates spread with the EU follow a similar trend.

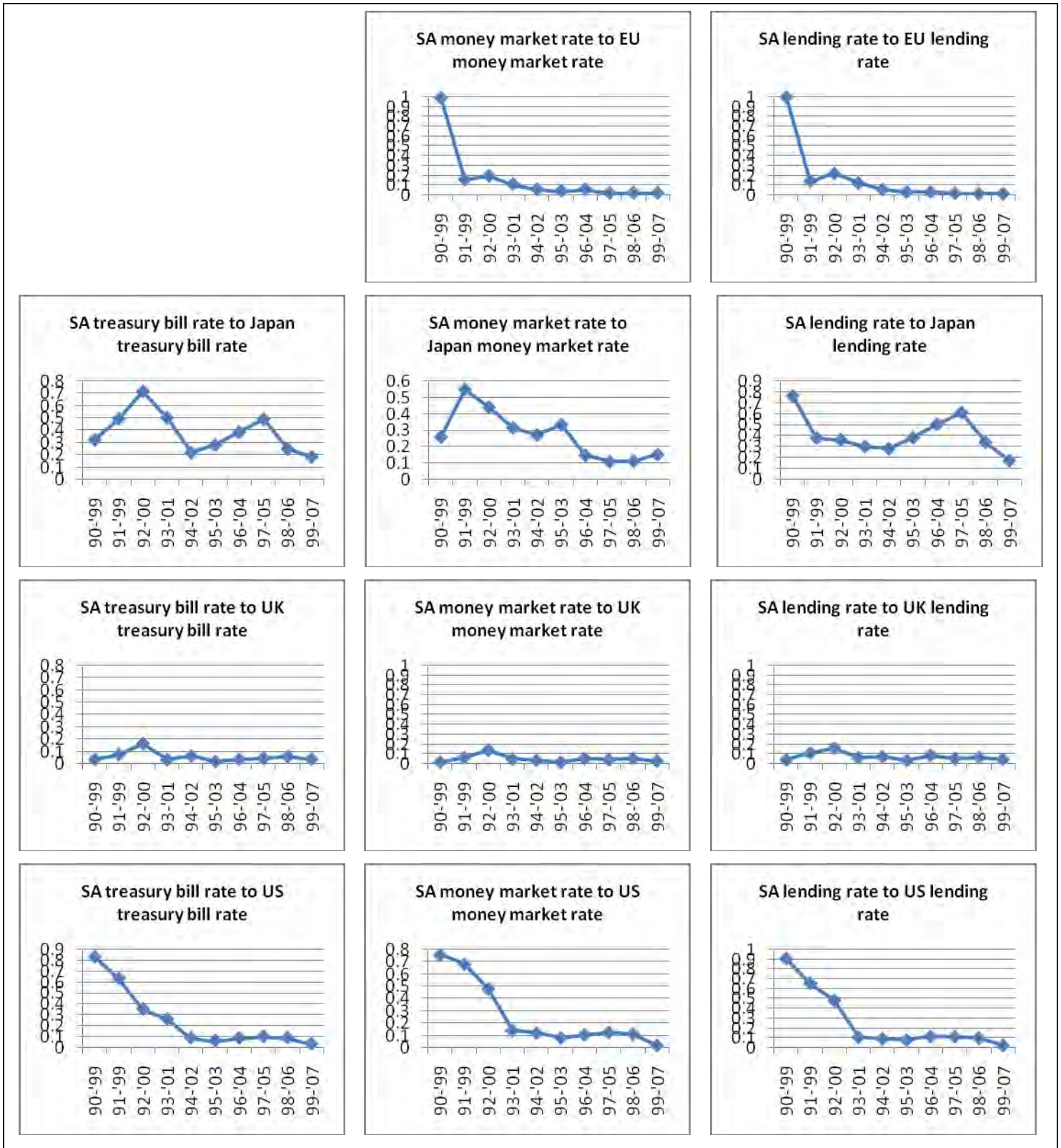
For the spread between South Africa's Treasury bill, money market and lending rates with similar rates of Japan, the UK and US, none of these spreads show a declining trend in their p-values. Japan's spreads with South Africa show the largest p-values, implying the lowest degree of convergence with South Africa. The UK and US short-term interest rates spreads with South Africa have p-values which fluctuate between 0.3 and 0.5 throughout the rolling windows.

This result conforms to the results of the cointegration analysis which found no long-run linkages between South Africa's money market and the money market of the other countries. Next, attention is turned to account for risk within money market transactions. This is especially important as investors consider risk when examining arbitrage opportunities. The stationarity tests from this Section 4.4.3 are therefore repeated, but with the risk premium added to the spread. The objective is to identify if the results for the risk premium included with the spread differs from the results above for the spreads only. This will reveal how important risk is in the process of integration between South Africa and the major international economies. Figure 4.6 below shows the results of the stationarity tests for the risk premiums added to the spreads.

Fig 4.6 below provides very interesting results which differ from the results for the spreads only. The addition of the risk premium to the spreads clearly has a significant impact on the results. The money market and lending rates of South Africa now have a stationary p-value with the EU money market and lending rates from 1993-2001 rolling window. Both interest rate series begin at a very high p-value of around 1.00, but thereafter fall sharply to be stationary by the fourth

period. This demonstrates a rapid convergence between South Africa and the EU in terms of the money market and lending rates.

Figure 4.6: P-value for risk premium between SA's interest rates and other interest rates



The Treasury bill, money market and lending rates of South Africa and the UK appear to be strongly financially integrated once the risk premium is accounted for. The Treasury bill rates of South Africa and the UK have a stationary risk premium in all of the rolling periods except in 1992-2000 where the p-value is at 0.16²⁸. As with the Treasury bill rates, 1992-2000 is the only period where the p-value for the money market and lending rates between South Africa and the UK is observed to be above the level of stationarity. These periods appear to be an outlier however, since in each of the three interest rates examined it is only in this period where integration appears to be absent. The significance of the p-values of all the other periods clearly demonstrates a steady level of integration with South Africa's three domestic interest rates.

On the other hand there is no evidence of integration of South Africa's Treasury bill, money market and lending rates with Japan's interest rates, even when the risk premium is accounted for. The p-value for the risk premium between the two countries for all three interest rates fluctuates largely over the rolling periods without any consistent downward trend towards integration. This result shows that the risk premium is not an important factor in the absence of integration between South Africa's money market and the money market of Japan. The p-value for the risk premium between South Africa's Treasury bill rate and the US Treasury bill rate begins at a highly non-stationary p-value of 0.83. However, a rapid decline is observed over the next three periods and the risk premium is found to be stationary by 1994-2002 where it has a p-value of 0.09. The p-value remains at this level of being just significant until the final period where its significance level strengthens to 0.04. Financial integration is therefore present between South Africa and the US Treasury bill rates from 1994-2002. The steady downward movement in the periods prior to 1994-2002 shows the vital role played by the risk premium in the convergence towards integration. Concerning the money market rate and lending rates, the hypothesis of non-stationarity can only be rejected in the first three rolling periods. The graph above shows a continued decrease of the p-values towards the stationary level, with the p-values hovering around the stationary level of 0.1 for the last five periods, and dropping to a higher stationary level in the final period. It is reasonable to conclude that there is clearly a tendency towards higher money market integration between the South African and the US Treasury bill, money market and lending rates, after risk premium is taken into account.

²⁸ Table C-5 in appendix C

This result differs from Nielsen *et al.* (2005) where the results from the spreads alone and from the risk premium did not differ, both methods found integration between South Africa and Lesotho, Namibia and Swaziland. This result is not surprising since most of these countries pegged their currency to the Rand, eliminating exchange rate risk. In that scenario, risk did not play a crucial part in the integration process. However, the results of this study show that the risk premium is an important factor in the linkages between South Africa and the EU, UK and US, but not with Japan²⁹. Once the risk premium has been accounted for, a significant degree of integration is found in almost all of the rolling windows.

4.5 CONCLUSION

This chapter presented and discussed the results of different estimation techniques carried out in order to analyse the linkages between South Africa's money market and the money markets of the EU, Japan, UK and US. The Principal components analysis, tests for cointegration and stationarity tests of the spreads/risk premiums between the interest rates were all carried for the three links under study. All three techniques provided similar results.

No links were found between the repo rate of South Africa and the central bank rates of the other countries. Furthermore, a strong domestic dependence of the Treasury bill, money market and lending rates on the repo rate was discovered, whilst these same rates did not show any links with the central bank rates of the other countries. In terms of the links between the three short-term interest rates and corresponding rates of the other countries, the principal components analysis and cointegration tests showed that again there were no links present. The stationarity tests however showed that once the risk premium was accounted for and included in the calculation of the spread, integration appeared to be evident between South Africa's interest rates and those of the EU, UK and US. No integration was found with Japan.

²⁹ Money market linkages with Japan are absent even when the risk premium is accounted for.

CHAPTER FIVE: CONCLUSION

5.1 SUMMARY OF STUDY AND FINDINGS

Financial integration has been on the increase globally due to the increased relaxation of restrictions on financial transactions and capital movements across countries and continents. This study set out to investigate any possible links between South Africa's money market and the money markets of the EU, Japan, UK and US. Monthly data spanning the period 1990-2007 was used in the study. The key objectives of the study were threefold. Firstly the extent to which monetary policy in South Africa, in terms of the setting of the repo rate, is dependent on the trends in central bank rates of the major world economies was identified. Secondly the money market in South Africa was examined by observing the degree to which the South African Reserve Bank has autonomy in influencing the Treasury bill, money market and lending rates, compared with the influence of the other central bank rates on these domestic money market interest rates. Finally any possible links between the three money market interest rates of South Africa and corresponding rates of the other four countries was explored.

A review of theoretical and empirical literature formed the basis on which the study proceeded. Important implications of money market links for both monetary policy and for investment decisions were discussed. Four main driving forces for potential money market linkages were highlighted. These were arbitrage opportunities, policy convergence, common shocks and the exchange rate regime. Any one of these factors or a combination of factors could cause an increased integration between money market interest rates of different countries. An extensive review of empirical literature covered research done on both developed and emerging markets. The literature on developed countries showed a dominance of the US in driving linkages with other major economies. There were contrasting results on the dominance of Germany in the European region. Research done on developing nations focused mainly on the Asia region, and their integration with the US and/or Europe. The research done involving South Africa has mainly focused on regional integration in the SADC and SACU regions. South Africa was found to be the dominant country in this region (Nielsen *et al.*, 2005; Aziakpono, 2006).

No research has been conducted examining the links between South Africa's money market and the major international economies such as the US and the EU. This study filled that gap. In terms of variables used, majority of the empirical studies used Treasury bill rates and money market rates. Centeno & Mello (1999) included lending rates whilst one of the few studies to actually explore links between central bank rates was Sarno & Thornton (2003). This study incorporates all four interest rates in order to obtain a more conclusive result on the nature of integration and to help explain the different objective stated above. Three estimation techniques were carried out to examine the links identified in Chapter 2. The principal components analysis was used to analyse links 1 and 3. Four different tests of cointegration, based on the Johansen (1998) and Engle-Granger (1987) methods were carried out to explore all three links. Stationarity tests of the interest rate spreads and risk premiums also explored all three links.

For the first objective of analysing the extent to which monetary policy in South Africa is dependent on the central bank rates of the EU, Japan, UK and US, all three tests conclusively found no long-run linkages. The Principal components analysis showed South Africa's central bank rates to be moving on its own, whilst all four tests for cointegration failed to find any long-run relationships. The stationary tests on the interest rate spreads confirmed the principal components analysis and cointegration tests results. For the link between the repo rate and central bank rates of the other countries, no stationary spread was obtained, indicating the absence of integration.

The link between the Treasury bill, money market and lending rates of South Africa with all central bank rates revealed a strong degree of response to the repo rate of South Africa, but a lack of integration with any of the other countries. This was observed based on the four tests for cointegration and the stationarity tests of the spreads. A slight declining trend is however observed in the slope-coefficients of these interest rates with the repo rate from the Engle-Granger method. This was confirmed by the stationarity tests where integration appeared to be loosening slightly over time. This is an important result because whilst it shows that there is currently no long-run or short-run response of the domestic money market to foreign central bank rates, the declining domestic influence of the repo rate indicates that there is the possibility for such external links to develop in the future.

Finally, the principal components analysis again found that South Africa's money market interest rates do not move closely with the corresponding interest rates of the other countries. An interesting finding was that when South Africa is removed from the analysis, the extent of integration among the other four countries increased. All four tests for cointegration as well as the stationarity tests on the spreads between the Treasury bill, money market and lending rates of South Africa with similar rates of the EU, Japan, UK and US follow a similar pattern of finding no linkages.

An interesting result came when the risk premium was included to help account for expected differential between the interest rates. It was noted that risk could play an important part in investment decisions. Therefore, the stationarity tests for the link between the South African money market and the money markets of the other countries were repeated with the risk premium added to the spread. The aim was to identify if the nature of integration changes when the risk is accounted for. Integration was found between South Africa's Treasury bill, money market and lending rates with the corresponding rates of the EU, UK and US, but not with Japan once the risk premium was included.

This vital result means that risk plays an important part in the money market integration between South Africa and the EU, UK and US. The principal components analysis and tests for cointegration for link 3 did not find any integration. This is possibly because these tests do not account for the risk factor in the integration of the Treasury bill, money market and lending rates across the countries.

5.2 POLICY IMPLICATIONS AND RECOMMENDATIONS

This study assessed the extent to which South Africa's central bank, Treasury bill, money market and lending rates are dependent on the EU, Japan, UK and US. The results from the empirical analysis have implications for both monetary policy and for investment decisions. From a monetary policy point of view, the result that the repo rate does not have a long-run or short-run dependence on the central bank rates of the other countries is crucial for monetary policy. It implies that the SARB has a strong sovereignty in setting the repo rate to influence the monetary

conditions in the domestic economy. Although international monetary policy trends will be taken into consideration in making monetary policy decisions, it is apparent that domestic trends in the economy, as well as other external non-monetary factors, such as the oil price, could have a strong weight in the determination of the repo rate values.

Inflation targeting is the monetary policy framework goal in South Africa, and is highly dependent on the ability of the repo rate to impact on inflation through market interest rates. The fact that the Treasury bill, money market and lending rates of South Africa respond strongly to changes in the repo rate but are not influenced by the central bank rates of the EU, Japan, UK and US means that the inflation targeting objectives can adequately be carried out using the repo rate. In light of the current global financial crises and banking sector collapse, the fact that South Africa's short-term interest rates are not strongly linked with international central bank rates is a positive outcome for South Africa's economy. It shows that South Africa will be in a stronger position to avoid the contagion effects of the financial crises from affecting the domestic money market. However, an area of concern is the declining strength of the response of the money market interest rates to the repo rate, as shown by the declining slope coefficients. This means that although the repo rate is still strongly determining the values of short-term interest rates, its influence is loosening slightly. By way of recommendation, the SARB must ensure that the current process of a slight decline does not continue to an extent where the Treasury bill, money market and lending rates are not strongly linked to the repo rate. If that was to happen, the inflation targeting framework, which is currently already under extreme pressure³⁰ due to the global financial crises, will be even harder to manage using domestic interest rates.

Another key finding was that the money market in South Africa is not well integrated with the money markets of the other four countries in this study. International investors therefore have the opportunity to diversify their investment portfolios by putting a proportion of their capital in the South African money market. However, investors must earn a premium for risk before investing in the South African money market. Once this risk premium is accounted for, a linkage exists between South Africa's money market and the money market of the EU, UK and US, but not

³⁰ Inflation has consistently been outside the band of 3-6% over the last year

with Japan. It is proposed therefore that future models aiming to examine long-run links between South Africa and international markets must account for the risk premium in their analysis.

5.3 AREAS FOR FURTHER RESEARCH

This study looked mainly at the links between the domestic short-term interests in South Africa and compared them with corresponding rates in four major world economies. The study did not however include the interbank market in its analysis. The interbank market plays an important role in financial integration mainly because it is the avenue where banks lend to each other, within a country and also between countries and across continents. The recent international financial crises have resulted in the reluctance of banks to lend to each other, leading to a rise in interbank rates such as the London Interbank Offered Rate (LIBOR). Because of time constraint, the South African interbank market could not be explored in this study. Future research could therefore include the interbank market to observe if the interbank market in South Africa is integrated with other major world interbank markets.

Another area for future research will be to look at integration in the money market across Africa, not just within the continents sub-regions such as the CMA. With the opening of most African economies, and the increase of international trade and financial transactions between South Africa and countries such as Ghana, Nigeria and Kenya, it would be useful to assess the development of any links between these countries money markets. This will be possible with the availability of data on these countries in the future.

A limitation of this study was a lack of data on certain countries. China, a growing world powerhouse would have been an important country to include, but a lack of data on China's interest rates prevented it from being included. Despite these limitations, this study has provided an important insight into the nature of the links between South Africa's money market and selected international money markets. The key conclusions arrived at in the study are relevant to both the public and private sector.

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APPENDIX A – PRINCIPAL COMPONENTS ANALYSIS

Table A-1 Eigenvalues of Significant Principal Components

	Central bank Rates		Treasury Bill Rates		Money Market Rates		Lending Rates	
	PC1	PC2	PC1	PC2	PC1	PC2	PC1	PC2
1990-1998	2.681	1.794	2.697	0.898	3.061	1.575	2.668	1.821
1991-1999	2.597	1.785	2.088	1.364	2.647	1.823	2.663	1.728
1992-2000	2.923	1.373	1.886	1.391	2.891	1.426	3.013	1.343
1993-2001	2.792	1.259	2.190	0.950	2.728	1.228	2.639	1.451
1994-2002	2.420	1.692	2.200	1.056	2.218	1.731	1.987	1.901
1995-2003	2.888	1.377	2.697	0.708	2.664	1.329	2.903	1.022
1996-2004	3.383	1.100	3.054	0.530	3.234	1.124	3.409	0.751
1997-2005	3.393	0.966	2.987	0.600	3.270	0.966	3.442	0.740
1998-2006	3.229	0.895	2.600	0.841	3.115	0.938	3.105	0.822
1999-2007	3.216	0.960	2.311	1.003	2.871	1.010	2.278	1.050

Table A-2 Factor loadings for 1st and 2nd Principal Components

	PC1					PC2				
Central Bank Rates										
	EU	JP	SA	UK	US	EU	JP	SA	UK	US
1990-1998	0.300	0.540	0.342	0.603	0.372	-0.638	-0.320	0.479	0.018	0.510
1991-1999	0.587	0.593	-0.018	0.481	-0.268	-0.211	0.125	0.636	0.450	0.576
1992-2000	0.564	0.572	-0.111	0.339	-0.476	-0.124	0.026	0.771	0.609	0.138
1993-2001	-0.519	-0.421	0.438	0.378	0.467	0.340	0.576	0.394	0.630	0.018
1994-2002	-0.338	0.541	0.045	0.586	0.497	0.597	-0.225	0.660	0.220	0.330
1995-2003	0.476	0.090	0.393	0.562	0.543	0.213	0.792	-0.551	-0.061	0.144
1996-2004	0.105	0.428	0.524	0.511	0.519	0.912	-0.353	-0.029	-0.060	0.196
1997-2005	0.196	0.523	0.422	0.504	0.506	0.928	-0.069	-0.305	-0.160	0.126
1998-2006	0.276	0.526	0.387	0.508	0.489	0.828	-0.078	-0.475	-0.204	0.203
1999-2007	0.433	0.497	0.229	0.517	0.495	0.212	-0.071	0.899	-0.205	-0.315
Treasury Bill Rates										
1990-1998		0.432	0.485	0.583	0.487		0.731	-0.454	0.221	-0.460
1991-1999		0.481	0.506	0.658	0.284		-0.578	0.412	-0.188	0.679
1992-2000		0.690	0.010	0.443	-0.572		-0.121	0.747	0.574	0.312
1993-2001		-0.322	0.515	0.590	0.532		0.840	0.363	0.339	-0.220
1994-2002		0.219	0.458	0.639	0.577		0.841	-0.499	-0.097	0.184
1995-2003		0.454	0.419	0.573	0.538		-0.502	0.819	0.055	-0.273
1996-2004		0.513	0.438	0.510	0.533		-0.100	0.870	-0.439	-0.199
1997-2005		0.519	0.427	0.546	0.501		-0.039	0.849	-0.167	-0.501
1998-2006		0.514	0.356	0.574	0.529		-0.255	0.881	0.047	-0.396
1999-2007		0.510	0.000	0.611	0.605		-0.058	0.997	0.007	0.042
Money Market Rates										
1990-1998	0.362	0.504	0.407	0.562	0.366	-0.610	-0.346	0.460	0.014	0.545
1991-1999	0.566	0.592	0.148	0.541	-0.124	-0.270	-0.051	0.642	0.310	0.645
1992-2000	0.570	0.572	-0.095	0.322	-0.485	-0.074	-0.014	0.761	0.623	0.161
1993-2001	-0.526	-0.483	0.417	0.331	0.454	0.333	0.461	0.480	0.667	-0.051
1994-2002	-0.405	-0.246	0.564	0.556	0.385	0.560	0.578	-0.005	0.325	0.497
1995-2003	0.354	0.415	0.319	0.537	0.558	-0.658	-0.144	0.696	0.230	-0.094
1996-2004	0.287	0.481	0.416	0.514	0.500	0.762	-0.304	-0.496	-0.017	0.286
1997-2005	0.331	0.480	0.409	0.509	0.484	0.731	-0.331	-0.499	-0.067	0.321
1998-2006	0.388	0.485	0.352	0.514	0.475	-0.547	0.236	0.689	0.090	-0.403
1999-2007	0.503	0.453	0.092	0.514	0.518	0.120	-0.077	0.976	-0.086	-0.137
Lending Rates										
1990-1998	0.443	0.574	0.253	0.596	0.235	-0.502	-0.225	0.570	0.110	0.601
1991-1999	0.582	0.592	-0.023	0.490	-0.264	-0.183	0.105	0.662	0.431	0.576
1992-2000	0.553	0.566	-0.048	0.365	-0.489	-0.140	-0.013	0.796	0.564	0.169
1993-2001	-0.531	-0.524	0.346	0.285	0.492	0.355	0.384	0.537	0.661	0.032
1994-2002	-0.128	-0.127	0.584	0.625	0.487	0.691	0.680	-0.009	0.122	0.212
1995-2003	0.478	0.444	0.353	0.487	0.461	-0.469	-0.408	0.715	0.320	-0.008
1996-2004	0.411	0.488	0.447	0.441	0.445	0.647	-0.205	-0.387	-0.435	0.447
1997-2005	0.409	0.484	0.440	0.473	0.426	0.612	-0.316	-0.373	-0.331	0.526
1998-2006	0.434	0.422	0.476	0.493	0.405	0.435	-0.501	-0.157	-0.336	0.650
1999-2007	0.592	0.381	0.197	0.423	0.536	0.097	-0.572	0.755	0.251	-0.176

APPENDIX B – TESTS FOR COINTEGRATION

Table B-1 Unit Root Tests

	Central Bank Rates				Treasury Bill rates				Money Market Rates				Lending Rates				
	ADF		KPSS		ADF		KPSS		ADF		KPSS		ADF		KPSS		
	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	
EU																	
1990-1998	-0.021	-9.185 ^A	0.954 ^A	0.246													
1991-1999	-0.517	-9.533 ^A	1.003 ^A	0.238													
1992-2000	-2.194	-8.876 ^A	0.817 ^A	0.769 ^A													
1993-2001	-4.321 ^A	-8.320 ^A	0.531 ^B	0.604 ^B													
1994-2002	-2.689 ^C	-8.638 ^A	0.234	0.319													
1995-2003	-1.438	-8.965 ^A	0.151	0.193													
1996-2004	-0.729	-8.510 ^A	0.207	0.183													
1997-2005	-0.86	-8.220 ^A	0.301	0.192													
1998-2006	-1.198	-8.340 ^A	0.347	0.156													
1999-2007	-1.772	-3.727 ^A	0.263	0.199													
Japan																	
1990-1998	-0.563	-9.958 ^A	1.044 ^A	0.215	-0.493	-10.558 ^A	1.057 ^A	0.201	-0.795	-2.873 ^C	1.059 ^A	0.157	-0.533	-4.839 ^A	1.045 ^A	0.163	
1991-1999	-3.196 ^B	-10.311 ^A	0.990 ^A	0.941 ^A	-2.814 ^C	-10.859 ^A	1.014 ^A	0.778 ^A	-3.947 ^A	-3.836 ^A	1.022 ^A	0.663 ^B	-4.944 ^A	-3.752 ^A	1.012 ^A	0.771 ^A	
1992-2000	-3.765 ^A	-10.809 ^A	0.953 ^A	0.812 ^A	-3.656 ^A	-10.716 ^A	0.983 ^A	1.003 ^A	-4.149 ^A	-9.099 ^A	1.023 ^A	0.702 ^B	-5.191 ^A	-7.095 ^A	1.002 ^A	0.968 ^A	
1993-2001	-3.862 ^A	-4.149 ^A	0.906 ^A	0.556 ^B	-3.667 ^A	-12.632 ^A	0.950 ^A	0.511 ^B	-2.384	-9.178 ^A	0.965 ^A	0.582 ^B	-3.859 ^A	-4.417 ^A	0.937 ^A	0.658 ^B	
1994-2002	-2.077	-10.328 ^A	0.792 ^A	0.249	-2.171	-11.592 ^A	0.824 ^A	0.183	-2.940 ^B	-7.395 ^A	0.848 ^A	0.288	-2.32	-3.769 ^A	0.798 ^A	0.268	
1995-2003	-5.440 ^A	-10.328 ^A	0.975 ^A	0.426 ^C	-4.699 ^A	-11.592 ^A	0.964 ^A	0.353 ^C	-6.957 ^A	-7.412 ^A	0.970 ^A	0.415 ^C	-5.266 ^A	-10.563 ^A	0.815 ^A	0.428 ^C	
1996-2004	-0.543	-7.881 ^A	0.986 ^A	0.232	-2.457	-12.844 ^A	0.994 ^A	0.031	-1.395	-7.714 ^A	0.948 ^A	0.101	-1.408	-10.296 ^A	0.932 ^A	0.087	
1997-2005	-0.842	-7.881 ^A	1.013 ^A	0.207	-2.760 ^C	-12.844 ^A	0.901 ^A	0.04	-2.134	-7.535 ^A	0.824 ^A	0.174	-1.876	-10.296 ^A	0.794 ^A	0.131	
1998-2006	-1.282	-9.198 ^A	0.781 ^A	0.393 ^C	-2.776 ^C	-12.299 ^A	0.31	0.183	-2.961 ^B	-6.352 ^A	0.487 ^B	0.381 ^C	-2.132	-10.198 ^A	0.403 ^C	0.398 ^C	
1999-2007	-0.415	-9.662 ^A	0.257 ^A	0.092	-1.616	-12.425 ^A	0.400 ^C	0.12	-0.199	-7.365 ^A	0.418 ^C	0.405 ^C	0.114	-10.278 ^A	0.487 ^B	0.455 ^C	

Continuation of Table B-1 Unit Root Tests

	Central Bank Rates				Treasury Bill rates				Money Market Rates				Lending Rates			
	ADF		KPSS		ADF		KPSS		ADF		KPSS		ADF		KPSS	
	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF	LEVEL	1ST DIFF
South Africa																
1991-1999	-1.902	-7.967 ^A	0.263	0.13	-2.313	-6.705 ^A	0.188	0.145	-2.094	-8.052 ^A	0.22	0.156	-2.118	-6.952 ^A	0.26	0.119
1992-2000	-1.809	-7.914 ^A	0.199	0.115	-2.211	-6.767 ^A	0.195	0.13	-1.737	-7.968 ^A	0.198	0.14	-1.834	-6.951 ^A	0.178	0.126
1993-2001	-1.26	-7.862 ^A	0.27	0.19	-1.983	-6.519 ^A	0.293	0.254	-1.727	-6.429 ^A	0.282	0.185	-1.428	-6.954 ^A	0.286	0.182
1994-2002	-1.428	-6.954 ^A	0.286	0.182	-2.238	-6.391 ^A	0.424 ^C	0.163	-2.095	-6.140 ^A	0.375 ^C	0.15	-1.804	-7.018 ^A	0.366 ^C	0.136
1995-2003	-0.986	-7.785 ^A	0.713 ^B	0.182	-1.828 ^A	-6.223 ^A	0.759 ^A	0.133	-1.729	-5.735 ^A	0.663 ^B	0.157	-1.646	-7.078 ^A	0.702 ^B	0.178
1996-2004	-0.926	-7.681 ^A	0.867 ^A	0.096	-1.655	-6.110 ^A	0.922 ^A	0.073	-1.592	-5.646 ^A	0.814 ^A	0.074	-1.518	-4.671 ^A	0.840 ^A	0.089
1997-2005	-1.155	-7.651 ^A	0.941 ^A	0.045	-1.849	-5.771 ^A	0.956 ^A	0.054	-1.651	-5.339 ^A	0.833 ^A	0.055	-1.696	-4.434 ^A	0.890 ^A	0.048
1998-2006	-1.656	-4.373 ^A	0.886 ^A	0.069	-1.972	-5.740 ^A	0.795 ^A	0.069	-2.061	-4.946 ^A	0.735 ^B	0.077	-1.638	-4.647 ^A	0.824 ^A	0.073
1999-2007	-2.087	-4.299 ^A	0.112	0.089	-2.593 ^B	-7.005 ^A	0.726 ^B	0.337	-2.083	-4.788 ^A	0.094	0.1	-2.001	-3.459 ^B	0.102	0.099
United Kingdom																
1990-1998	-1.849	-4.482 ^A	0.277 ^A	0.08	-1.484	-8.445 ^A	0.275 ^A	0.091	-1.245	-14.222 ^A	0.283 ^A	0.077	-1.603	-4.790 ^A	0.279 ^A	0.077
1991-1999	-2.386	-4.255 ^A	0.638 ^B	0.426 ^C	-2.647 ^C	-8.436 ^A	0.541 ^B	0.401 ^C	-2.938 ^B	-13.718 ^A	0.588 ^B	0.315	-2.39	-4.611 ^A	0.241 ^A	0.134 ^C
1992-2000	-3.986 ^A	-3.953 ^A	0.302	0.239	-3.549 ^A	-5.996 ^A	0.192	0.212	-3.543 ^A	-16.024 ^A	0.252	0.187	-4.014 ^A	-4.393 ^A	0.331	0.237
1993-2001	-2.481	-3.924 ^A	0.214	0.17	-1.637	-4.600 ^A	0.2	0.192	-2.144	-17.878 ^A	0.187	0.053	-2.839 ^C	-5.609 ^A	0.144	0.064
1994-2002	-1.71	-3.920 ^A	0.543 ^B	0.181	-1.557	-4.399 ^A	0.503 ^B	0.216	-1.687	-18.654 ^A	0.412 ^C	0.095	-2.993 ^B	-5.124 ^A	0.255	0.09
1995-2003	-1.479	-4.092 ^A	0.869 ^A	0.108	-0.893	-7.430 ^A	0.835 ^A	0.08	-1.078	-8.608 ^A	0.809 ^A	0.249	-2.765 ^C	-3.551 ^A	0.622 ^B	0.051
1996-2004	-1.506	-3.990 ^A	0.857 ^A	0.087	-1.527	-4.374 ^A	0.808 ^A	0.09	-1.513	-18.948 ^A	0.872 ^A	0.076	-2.553	-4.791 ^A	0.570 ^B	0.046
1997-2005	-1.603	-3.841 ^A	0.847 ^A	0.086	-1.725	-4.244 ^A	0.794 ^A	0.083	-1.029	-8.912 ^A	0.828 ^A	0.085	-2.532	-4.695 ^A	0.603 ^B	0.056
1998-2006	-2.475	-3.892 ^A	0.718 ^B	0.247	-2.635	-4.055 ^A	0.671 ^B	0.242	-2.478	-9.334 ^A	0.661 ^B	0.245	-5.998 ^A	-11.67 ^A	0.559 ^B	0.151
1999-2007	-1.762	-3.715 ^A	0.285	0.269	-1.394	-5.338 ^A	0.23	0.209	-1.088	-10.027 ^A	0.278	0.23	-2.261	-8.276 ^A	0.196	0.037
United States																
1990-1998	-2.776 ^C	-2.734 ^C	0.203	0.373	-2.379	-7.600 ^A	0.204	0.376 ^C	-2.678 ^C	-2.714 ^C	0.209	0.346	-2.101	-3.398 ^B	0.196	0.264
1991-1999	-1.779	-3.454 ^B	0.353 ^C	0.316	-1.767	-7.994 ^A	0.269	0.288	-1.93	-3.390 ^B	0.323	0.318	-1.578	-8.660 ^A	0.388 ^C	0.307
1992-2000	-1.892	-2.932 ^B	0.743 ^A	0.093	-0.829	-8.847 ^A	0.649 ^B	0.089	-1.163	-4.531 ^A	0.731 ^B	0.091	-1.039	-4.976 ^A	0.777 ^A	0.089
1993-2001	-1.885	-2.03	0.181 ^B	0.096	-3.276 ^B	-4.654 ^A	0.207	0.446 ^C	-1.401	-5.364 ^A	0.3	0.414 ^C	-2.083	-6.552 ^A	0.333	0.423 ^C
1994-2002	-1.07	-4.481 ^A	0.434 ^C	0.487 ^B	-0.088	-7.140 ^A	0.509 ^B	0.469 ^B	-0.89	-3.433 ^B	0.418 ^C	0.445 ^C	-0.727	-6.755 ^A	0.391 ^C	0.476 ^B
1995-2003	-0.534	-4.400 ^A	0.776 ^A	0.218	-0.075	-7.462 ^A	0.807 ^A	0.174	-0.282	-5.705 ^A	0.774 ^A	0.216	-0.064	-7.031 ^A	0.767 ^A	0.222
1996-2004	-1.192	-3.747 ^A	0.871 ^A	0.133	-0.78	-7.071 ^A	0.880 ^A	0.132	-0.878	-4.967 ^A	0.873 ^A	0.111	-0.677	-6.390 ^A	0.872 ^A	0.123
1997-2005	-1.755	-2.615 ^C	0.779 ^A	0.221	-1.401	-4.451 ^A	0.748 ^A	0.249	-1.262	-4.220 ^A	0.783 ^A	0.209	-1.661	-3.018 ^B	0.789 ^A	0.201
1998-2006	-1.75	-2.719 ^C	0.444 ^C	0.322	-1.243	-4.342 ^A	0.409 ^C	0.349 ^C	-1.306	-4.169 ^A	0.453 ^C	0.319	-1.627	-2.911 ^B	0.462 ^B	0.321
1999-2007	-1.866	-2.595 ^C	0.268	0.205	-1.755	-2.940 ^A	0.262	0.17	-1.467	-3.954 ^A	0.268	0.197	-2.065	-2.794 ^C	0.27 ⁷⁹	0.221

A - significant at 1%, B- significant at 5%, C- significant at 10%

Table B-2 Cointegration tests Between South Africa's Repo Rate and Central Bank rates of the other Countries

	Johansen Method					Engle-Granger Method		
	K	Trace Test		Max test		ADF	CRDW	ECM Coeff
		r<0	r<1	r<0	r<1			
EU								
1990-1998	1	20.54[0.05]	2.81[0.62]	17.73[0.03]	2.81[0.62]	-1.38	0.08	0.03[0.93]
1991-1999	3	16.85[0.03]	0.87[0.35]	15.98[0.03]	0.87[0.35]	-1.99	0.09	0.03[0.94]
1992-2000						-2.22	0.09	0.02[0.79]
1993-2001						-1.72	0.10	0.05[1.65]
1994-2002						-2.38	0.13	0.04[1.14]
1995-2003						-0.95	0.08	0.05[1.00]
1996-2004						-0.91	0.04	0.02[1.11]
1997-2005						-1.23	0.03	0.01[0.56]
1998-2006						-1.71	0.03	0.00[0.28]
1999-2007						-2.60	0.03	-0.03[-1.46]
JAPAN								
1990-1998						-1.02	0.08	0.04[1.26]
1991-1999						-1.90	0.09	0.03[1.14]
1992-2000	2	34.99[0.00]	3.67[0.46]	31.32[0.00]	3.67[0.46]	-2.04	0.08	0.02[0.88]
1993-2001						-1.14	0.07	0.04[1.42]
1994-2002						-1.73	0.06	0.02[0.74]
1995-2003	2	61.99[0.00]	2.50[0.68]	59.48[0.00]	2.50[0.68]	-1.68	0.08	0.04[1.49]
1996-2004						-1.92	0.09	0.03[1.27]
1997-2005						-1.89	0.08	0.03[1.05]
1998-2006						-1.16	0.08	0.01[0.55]
1999-2007						-2.11	0.04	-0.02[-1.16]
UK								
1990-1998						-0.87	0.10	0.06[1.03]
1991-1999						-1.86	0.10	0.04[1.37]
1992-2000						-1.72	0.08	0.03[1.18]
1993-2001	4	18.18[0.02]	1.06[0.30]	17.11[0.02]	1.06[0.30]	-2.11	0.10	0.02[0.61]
1994-2002						-1.82	0.09	0.04[1.21]
1995-2003						-1.94	0.10	0.04[1.25]
1996-2004						-1.39	0.08	0.03[1.10]
1997-2005						-1.50	0.06	0.01[0.59]
1998-2006						-1.85	0.05	0.01[0.52]
1999-2007						-1.98	0.03	-0.02[-1.19]
USA								
1990-1998						-1.17	0.12	0.05[1.36]
1991-1999						-1.87	0.11	0.04[1.03]
1992-2000						-1.80	0.08	0.03[1.18]
1993-2001						-1.69	0.07	0.02[0.91]
1994-2002						-1.77	0.07	0.02[0.89]
1995-2003						-1.67	0.08	0.03[1.17]
1996-2004						-1.49	0.06	0.02[0.99]
1997-2005						-1.14	0.05	0.02[0.75]
1998-2006						-1.71	0.04	0.001[0.41]
1999-2007						-2.10	0.03	-0.01[-0.85]

t-stats in []

critical values for EG ADF test : -3.09(10%); -3.39(5%); -3.90(1%)

critical values for CRDW test : 0.322(10%); 0.386(5%); 0.511(1%)

Table B-3 Cointegration tests Between South Africa's Treasury Bill Rate and Central Bank rates of all Countries

		Johansen Method				Engle-Granger Method		
	K	Trace Test		Max test		ADF	CRDW	ECM Coeff
		r<0	r<1	r<0	r<1			
SOUTH AFRICA								
1990-1998	1	30.57[0.00]	6.75[0.14]	23.82[0.00]	6.75[0.14]	-4.17	0.62	-0.26[-3.801]
1991-1999	1	35.41[0.00]	4.87[0.29]	30.53[0.00]	4.87[0.29]	-4.55	0.64	-0.28[-3.72]
1992-2000	2	33.36[0.00]	8.68[0.20]	24.68[0.01]	8.68[0.20]	-5.16	0.77	-0.377[-4.47]
1993-2001	1	21.76[0.03]	5.75[0.21]	16.01[0.05]	5.75[0.21]	-5.00	0.73	-0.372[-4.42]
1994-2002	3	30.01[0.01]	9.56[0.15]	20.45[0.04]	9.56[0.15]	-5.02	0.74	-0.381[-4.57]
1995-2003	1	18.34[0.02]	3.10[0.08]	15.23[0.04]	3.10[0.08]	-5.33	0.79	-0.411[-4.83]
1996-2004	3	16.01[0.04]	0.28[0.60]	15.73[0.03]	0.28[0.60]	-4.95	0.75	-0.41[-5.00]
1997-2005	2	29.22[0.02]	6.15[0.44]	23.06[0.01]	6.15[0.44]	-5.37	0.83	-0.491[-5.93]
1998-2006	3	30.35[0.01]	8.56[0.21]	21.79[0.02]	8.56[0.21]	-5.43	0.85	-0.514[-6.12]
1999-2007	3	27.01[0.03]	4.37[0.69]	22.63[0.02]	4.37[0.69]	-3.96	0.54	-0.299[-3.76]
EU								
1990-1998	1	20.91[0.04]	2.29[0.72]	18.61[0.02]	2.29[0.72]	-2.29	0.07	0.01[0.42]
1991-1999	2	21.27[0.04]	3.03[0.58]	18.24[0.02]	3.03[0.58]	-2.40	0.09	0.01[0.61]
1992-2000						-2.66	0.09	0.01[0.36]
1993-2001						-2.47	0.10	0.02[0.74]
1994-2002						-2.66	0.13	0.02[0.59]
1995-2003						-1.81	0.09	0.02[0.81]
1996-2004						-1.60	0.05	0.01[0.39]
1997-2005						-1.88	0.04	0.01[0.11]
1998-2006						-2.02	0.04	0.02[0.14]
1999-2007						-2.78	0.04	0.02[0.83]
JAPAN								
1990-1998						-2.05	0.07	0.02[0.75]
1991-1999	2	30.88[0.00]	5.75[0.21]	25.12[0.00]	5.75[0.21]	-2.26	0.09	0.02[0.59]
1992-2000	2	37.47[0.00]	4.92[0.29]	32.54[0.00]	4.92[0.29]	-2.47	0.08	0.01[0.58]
1993-2001						-1.97	0.07	0.01[0.55]
1994-2002						-2.23	0.06	0.00[0.16]
1995-2003						-2.27	0.09	0.02[0.69]
1996-2004						-2.50	0.09	0.01[0.48]
1997-2005						-2.55	0.08	0.00[0.12]
1998-2006						-2.17	0.07	0.00[0.05]
1999-2007						-2.51	0.05	0.01[0.81]
UK								
1990-1998						-1.52	0.10	0.03[1.04]
1991-1999						-1.52	0.10	0.02[0.73]
1992-2000	3	23.83[0.02]	4.25[0.38]	19.58[0.01]	4.25[0.38]	-2.19	0.09	0.02[0.75]
1993-2001						-2.25	0.12	0.01[0.40]
1994-2002						-2.05	0.09	0.02[0.55]
1995-2003						-2.07	0.10	0.01[0.33]
1996-2004						-2.08	0.08	0.01[0.22]
1997-2005						-2.14	0.07	0.01[0.28]
1998-2006						-1.66	0.06	0.01[0.36]
1999-2007						-2.53	0.04	0.02[0.86]

Continuation of Table B-3

	Johansen Method				Engle-Granger Method			
	K	Trace Test		Max test		ADF	CRDW	ECM Coeff
		r<0	r<1	r<0	r<1			
USA								
1990-1998	1	28.20[0.00]	5.53[0.23]	22.67[0.00]	5.53[0.23]	-2.46	0.13	0.02[0.71]
1991-1999	2	27.59[0.00]	3.22[0.54]	24.37[0.00]	3.22[0.54]	-2.34	0.12	0.02[0.75]
1992-2000	2	17.73[0.02]	1.04[0.31]	16.68[0.02]	1.04[0.31]	-2.17	0.08	0.03[1.17]
1993-2001						-2.23	0.07	0.01[0.36]
1994-2002						-1.86	0.07	0.01[0.28]
1995-2003						-1.84	0.07	0.01[0.28]
1996-2004						-2.14	0.06	0.01[0.26]
1997-2005						-1.96	0.05	0.00[0.08]
1998-2006						-1.66	0.04	0.00[0.08]
1999-2007						-2.53	0.04	0.01[0.50]

t-stats in []

critical values for EG ADF test : -3.09(10%); -3.39(5%); -3.90(1%)

critical values for CRDW test : 0.322(10%); 0.386(5%); 0.511(1%)

Table B-4 Cointegration tests Between South Africa's Money Market Rate and Central Bank rates of all Countries

	Johansen Method				Engle-Granger Method			
	K	Trace Test		Max test		ADF	CRDW	ECM Coeff
		r<0	r<1	r<0	r<1			
SOUTH AFRICA								
1990-1998	1	21.11[0.04]	1.67[0.84]	19.44[0.01]	1.67[0.84]	-4.87	0.53	-0.25[-4.13]
1991-1999	1	29.36[0.00]	5.54[0.23]	23.82[0.00]	5.54[0.23]	-5.19	0.77	-0.37[-5.14]
1992-2000	2	30.17[0.01]	10.18[0.12]	19.99[0.04]	10.18[0.12]	-5.64	0.93	-0.43[-5.39]
1993-2001	3	25.50[0.01]	8.67[0.60]	16.82[0.04]	8.67[0.60]	-4.26	0.63	-0.27[-4.29]
1994-2002	3	31.17[0.01]	8.96[0.18]	22.20[0.02]	8.96[0.18]	-4.16	0.57	-0.24[-4.08]
1995-2003	2	30.76[0.01]	10.53[0.10]	20.22[0.04]	10.53[0.10]	-4.02	0.41	-0.18[-3.63]
1996-2004	3	17.47[0.01]	2.23[0.14]	15.24[0.03]	2.23[0.14]	-3.66	0.40	-0.14[-3.25]
1997-2005	4	30.22[0.01]	4.75[0.63]	25.47[0.01]	4.75[0.63]	-3.13	0.36	-0.11[-2.10]
1998-2006	2	23.35[0.02]	3.97[0.42]	19.37[0.01]	3.97[0.42]	-3.49	0.34	-0.10[-3.00]
1999-2007	3	21.63[0.03]	3.06[0.57]	18.57[0.02]	3.06[0.57]	-3.11	0.37	-0.08[-2.66]
EU								
1990-1998						-2.14	0.07	0.09[0.66]
1991-1999						-2.20	0.09	0.02[0.62]
1992-2000						-2.16	0.09	0.02[0.86]
1993-2001						-2.20	0.09	0.02[0.75]
1994-2002						-2.59	0.13	0.01[0.50]
1995-2003						-1.20	0.09	0.02[0.89]
1996-2004						-1.51	0.04	0.00[0.24]
1997-2005						-1.65	0.03	-0.00[-0.18]
1998-2006						-1.74	0.03	-0.01[-0.55]
1999-2007						-2.24	0.03	-0.01[-1.36]

Continuation of Table B-4

Johansen Method						Engle-Granger Method		
K	Trace Test		Max test		ADF	CRDW	ECM Coeff	
	r<0	r<1	r<0	r<1				
JAPAN								
1990-1998					-1.79	0.08	0.04[1.69]	
1991-1999	2	29.78[0.00]	4.55[0.34]	25.23[0.00]	4.55[0.34]	-2.02	0.09	0.02[1.01]
1992-2000	2	35.54[0.00]	3.72[0.46]	31.82[0.00]	3.72[0.46]	-1.95	0.08	0.03[0.97]
1993-2001						-1.50	0.06	0.01[0.59]
1994-2002						-1.64	0.05	0.00[0.04]
1995-2003						-1.88	0.06	0.01[0.29]
1996-2004						-2.30	0.07	0.01[0.32]
1997-2005						-2.25	0.06	-0.00[-0.02]
1998-2006						-1.77	0.06	-0.01[-0.58]
1999-2007						-2.25	0.03	-0.02[-1.58]
UK								
1990-1998					-1.49	0.13	0.07[1.17]	
1991-1999						-1.56	0.11	0.04[1.40]
1992-2000	3	20.55[0.05]	3.17[0.55]	17.38[0.03]	3.17[0.55]	-1.60	0.08	0.03[1.28]
1993-2001	4	16.21[0.04]	0.79[0.37]	15.41[0.03]	0.79[0.37]	-2.29	0.08	0.00[0.04]
1994-2002						-1.79	0.07	0.00[0.29]
1995-2003						-2.00	0.07	0.00[0.03]
1996-2004						-1.67	0.06	0.00[0.11]
1997-2005						-1.96	0.05	-0.00[-0.26]
1998-2006						-1.66	0.05	-0.01[-0.44]
1999-2007						-2.12	0.03	-0.01[-1.60]
USA								
1990-1998	1	25.81[0.01]	5.51[0.23]	20.30[0.01]	5.51[0.23]	-1.83	0.15	0.02[0.54]
1991-1999	2	21.60[0.03]	3.67[0.46]	17.93[0.02]	3.67[0.46]	-1.40	0.12	0.01[0.16]
1992-2000						-1.69	0.08	0.02[0.67]
1993-2001						-1.96	0.06	0.00[0.21]
1994-2002						-1.69	0.06	0.00[0.09]
1995-2003						-1.75	0.06	0.00[0.01]
1996-2004						-1.62	0.05	0.00[0.01]
1997-2005						-1.78	0.04	-0.33[-1.06]
1998-2006						-1.68	0.04	-0.01[-0.50]
1999-2007						-2.59	0.03	-0.02[-1.20]

t-stats in []

critical values for EG ADF test : -3.09(10%); -3.39(5%); -3.90(1%)

critical values for CRDW test : 0.322(10%); 0.386(5%); 0.511(1%)

Table B-5 Cointegration tests Between South Africa's Lending Rate and Central Bank rates of all Countries

		Johansen Method				Engle-Granger Method		
	K	Trace Test		Max test		ADF	CRDW	ECM Coeff
		r<0	r<1	r<0	r<1			
SOUTH AFRICA								
1990-1998	1	29.46[0.02]	9.46[0.15]	19.99[0.04]	9.46[0.15]	-7.22	1.32	-0.681[-8.87]
1991-1999	3	19.71[0.01]	3.70[0.05]	16.01[0.03]	3.70[0.05]	-8.32	1.57	-0.794[-9.93]
1992-2000	4	30.64[0.01]	10.59[0.10]	20.04[0.04]	10.59[0.10]	-6.85	1.25	-0.618[-7.82]
1993-2001	2	23.29[0.02]	1.99[0.78]	21.29[0.01]	1.99[0.78]	-5.58	0.92	-0.433[-5.94]
1994-2002	1	17.59[0.02]	2.93[0.09]	14.65[0.04]	2.93[0.09]	-5.12	0.78	-0.356[-5.10]
1995-2003	1	27.98[0.03]	5.74[0.49]	22.24[0.02]	5.74[0.49]	-4.77	0.71	-0.340[-5.04]
1996-2004	3	28.94[0.02]	5.97[0.46]	22.96[0.01]	5.97[0.46]	-4.23	0.58	-0.281[-4.44]
1997-2005	2	28.55[0.02]	6.40[0.41]	22.14[0.02]	6.40[0.41]	-4.10	0.55	-0.267[-4.30]
1998-2006	4	34.89[0.00]	8.08[0.25]	26.81[0.00]	8.08[0.25]	-3.95	0.54	-0.260[-4.22]
1999-2007	4	28.15[0.03]	2.12[0.96]	26.02[0.01]	2.12[0.96]	-3.57	0.40	-0.150[-2.95]
EU								
1990-1998						-1.89	0.07	0.02[0.84]
1991-1999						-2.21	0.09	0.02[0.72]
1992-2000						-2.16	0.07	0.01[0.51]
1993-2001						-1.76	0.08	0.03[1.15]
1994-2002						-2.52	0.13	0.03[0.91]
1995-2003						-1.07	0.08	0.04[1.57]
1996-2004						-1.00	0.04	0.02[0.82]
1997-2005						-1.73	0.03	0.00[0.31]
1998-2006						-1.62	0.03	0.00[0.03]
1999-2007						-2.47	0.03	-0.03[-1.51]
JAPAN								
1990-1998						-1.63	0.07	0.02[0.94]
1991-1999						-2.13	0.08	0.02[0.62]
1992-2000						-1.97	0.07	0.01[0.61]
1993-2001						-1.29	0.06	0.02[0.89]
1994-2002						-1.65	0.05	0.01[0.42]
1995-2003						-2.04	0.07	0.03[1.14]
1996-2004						-1.84	0.07	0.02[0.97]
1997-2005						-2.40	0.06	0.02[0.75]
1998-2006						-1.65	0.07	0.01[0.28]
1999-2007						-2.24	0.04	-0.02[-1.32]
UK								
1990-1998						-1.52	0.09	0.04[1.53]
1991-1999						-2.12	0.09	0.03[0.92]
1992-2000	3	25.27[0.01]	3.11[0.56]	22.15[0.01]	3.11[0.56]	-1.77	0.07	0.02[0.86]
1993-2001						-2.26	0.08	0.01[0.30]
1994-2002						-1.91	0.07	0.02[0.81]
1995-2003						-2.06	0.08	0.02[0.82]
1996-2004						-2.15	0.06	0.02[0.68]
1997-2005						-2.15	0.05	0.01[0.28]
1998-2006						-1.63	0.05	0.01[0.26]
1999-2007						-2.13	0.03	-0.02[-1.24]

Continuation of Table B-5

	Johansen Method				Engle-Granger Method			
	K	Trace Test		Max test		ADF	CRDW	ECM Coeff
		r<0	r<1	r<0	r<1			
USA								
1990-1998	1	23.62[0.02]	5.51[0.23]	18.10[0.02]	5.51[0.23]	-1.90	0.10	0.04[1.26]
1991-1999						-2.18	0.10	0.03[0.79]
1992-2000	1	20.51[0.05]	2.76[0.63]	17.75[0.03]	2.76[0.63]	-1.83	0.07	0.03[1.19]
1993-2001						-1.76	0.06	0.01[0.54]
1994-2002						-1.71	0.06	0.01[0.55]
1995-2003						-1.78	0.06	0.02[0.86]
1996-2004						-2.18	0.05	0.01[0.64]
1997-2005						-1.93	0.04	0.01[0.40]
1998-2006						-1.55	0.03	0.00[0.12]
1999-2007						-2.05	0.03	-0.02[-1.24]

t-stats in []

critical values for EG ADF test : -3.09(10%); -3.39(5%); -3.90(1%)

critical values for CRDW test : 0.322(10%); 0.386(5%); 0.511(1%)

Table B-6 Slope Coefficients for Cointegration Between SA's domestic rates and repo rate

	Treasury Bill rate	Money market rate	Lending rate
1990-1998	1.28[29.91]	1.05[34.03]	0.97[66.89]
1991-1999	1.17[38.32]	0.99[31.96]	0.99[67.76]
1992-2000	1.15[45.02]	0.97[36.87]	1.03[67.81]
1993-2001	1.13[49.32]	0.95[42.65]	1.04[73.15]
1994-2002	1.10[47.52]	0.93[42.39]	1.04[73.75]
1995-2003	1.04[43.30]	0.92[45.32]	1.02[74.19]
1996-2004	0.99[48.97]	0.89[53.32]	1.00[87.58]
1997-2005	0.94[57.16]	0.86[63.51]	0.98[104.28]
1998-2006	0.91[55.58]	0.84[62.58]	0.97[100.62]
1999-2007	0.84[38.67]	0.78[55.56]	0.95[79.81]

t-stats in []

Table B-7 Cointegration tests Between South Africa's Treasury Bill Rate and Treasury Bill rates of the other Countries

	Johansen Method				Engle-Granger Method			
	K	Trace Test		Max test		ADF	CRDW	ECM Coeff
		r<0	r<1	r<0	r<1			
JAPAN								
1990-1998	2	26.87[0.04]	2.32[0.95]	24.54[0.01]	2.32[0.95]	-2.03	0.07	0.016[0.63]
1991-1999	2	25.44[0.01]	5.88[0.20]	19.56[0.01]	5.88[0.20]	-2.26	0.08	0.01[0.57]
1992-2000						-2.45	0.08	0.01[0.58]
1993-2001						-1.96	0.07	0.02[0.66]
1994-2002						-1.83	0.06	0.00[0.20]
1995-2003						-2.00	0.08	0.00[0.34]
1996-2004						-2.00	0.17	0.01[0.24]
1997-2005						-1.99	0.16	0.01[0.52]
1998-2006						-1.50	0.07	0.01[0.33]
1999-2007						-2.54	0.04	0.01[0.57]
UK								
1990-1998						-2.19	0.12	0.03[1.14]
1991-1999						-2.42	0.12	0.02[0.82]
1992-2000	4	19.37[0.01]	2.85[0.10]	16.52[0.02]	2.85[0.10]	-2.14	0.10	0.02[0.77]
1993-2001	4	17.76[0.02]	1.65[0.20]	16.10[0.03]	1.65[0.20]	-2.44	0.12	0.01[0.25]
1994-2002						-2.00	0.10	0.02[0.53]
1995-2003						-2.10	0.10	0.01[0.35]
1996-2004						-1.97	0.08	0.01[0.25]
1997-2005						-2.02	0.06	0.01[0.29]
1998-2006						-1.63	0.06	0.01[0.34]
1999-2007						-2.56	0.04	0.01[0.70]
USA								
1990-1998	2	25.55[0.01]	6.89[0.13]	18.65[0.02]	6.89[0.13]	-2.31	0.12	0.01[0.35]
1991-1999	3	21.47[0.03]	3.74[0.45]	17.72[0.03]	3.74[0.45]	-2.26	0.11	0.01[0.42]
1992-2000						-2.20	0.08	0.02[0.70]
1993-2001						-2.24	0.07	0.01[0.29]
1994-2002						-1.90	0.07	0.00[0.19]
1995-2003						-1.89	0.08	0.00[0.20]
1996-2004						-2.22	0.07	0.00[0.17]
1997-2005						-1.97	0.05	0.00[0.00]
1998-2006						-1.65	0.04	0.00[0.04]
1999-2007						-2.54	0.04	0.02[0.80]

t-stats in []

critical values for EG ADF test : -3.09(10%); -3.39(5%); -3.90(1%)

critical values for CRDW test : 0.322(10%); 0.386(5%); 0.511(1%)

Table B-8 Cointegration tests Between South Africa's Money Market Rate and Money Market rates of the other Countries

	Johansen Method				Engle-Granger Method			
	K	Trace Test		Max test		ADF	CRDW	ECM Coeff
		r<0	r<1	r<0	r<1			
EU								
1990-1998	1	22.97[0.02]	3.33[0.52]	19.63[0.01]	3.33[0.52]	-1.98	0.07	0.03[1.26]
1991-1999						-2.16	0.08	0.03[0.96]
1992-2000						-2.09	0.08	0.03[0.94]
1993-2001	2	21.41[0.04]	2.25[0.73]	19.16[0.02]	2.25[0.73]	-2.02	0.07	0.02[0.83]
1994-2002						-2.02	0.08	0.01[0.57]
1995-2003						-1.12	0.06	0.02[0.73]
1996-2004						-1.20	0.04	0.00[0.12]
1997-2005						-1.72	0.03	-0.00[-0.32]
1998-2006						-1.71	0.03	-0.01[-0.59]
1999-2007						-2.80	0.03	-0.01[-1.50]
JAPAN								
1990-1998						-1.67	0.08	0.04[1.40]
1991-1999						-2.03	0.08	0.03[0.94]
1992-2000						-1.90	0.08	0.03[1.11]
1993-2001						-1.64	0.05	0.01[0.57]
1994-2002						-1.66	0.05	-0.00[-0.02]
1995-2003						-1.98	0.06	0.00[0.03]
1996-2004						-2.13	0.10	-0.02[-0.70]
1997-2005						-2.46	0.08	-0.02[-0.95]
1998-2006						-1.66	0.07	-0.02[-1.15]
1999-2007						-2.62	0.03	-0.02[-1.29]
UK								
1990-1998						-1.78	0.16	0.08[1.39]
1991-1999						-1.97	0.14	0.05[1.49]
1992-2000						-1.90	0.14	0.04[1.33]
1993-2001						-2.33	0.38	0.00[0.13]
1994-2002						-2.89	0.28	0.00[0.15]
1995-2003						-2.49	0.22	-0.00[-0.09]
1996-2004						-2.24	0.22	-0.04[-0.21]
1997-2005						-1.68	0.19	-0.01[-0.51]
1998-2006						-1.96	0.16	-0.02[-0.91]
1999-2007						-2.14	0.03	-0.02[-1.40]
USA								
1990-1998	4	26.42[0.04]	6.68[0.38]	19.73[0.05]	6.68[0.38]	-1.82	0.16	0.03[0.79]
1991-1999						-1.47	0.13	0.00[0.04]
1992-2000						-1.67	0.08	0.02[0.59]
1993-2001						-1.92	0.06	0.00[0.22]
1994-2002						-1.68	0.06	0.00[0.11]
1995-2003						-1.74	0.06	0.00[0.08]
1996-2004						-1.61	0.05	-0.00[-0.00]
1997-2005						-1.81	0.04	-0.00[-0.16]
1998-2006						-1.66	0.04	-0.01[-0.46]
1999-2007						-2.59	0.03	-0.02[-1.49]

t-stats in []

critical values for EG ADF test : -3.09(10%); -3.39(5%); -3.90(1%)

critical values for CRDW test : 0.322(10%); 0.386(5%); 0.511(1%)

Table B-9 Cointegration tests Between South Africa's Lending Rate and Lending rates of the other Countries

		Johansen Method				Engle-Granger Method		
K		Trace Test		Max test		ADF	CRDW	ECM
		r<0	r<1	r<0	r<1			Coeff
EU								
1990-1998						-1.92	0.07	0.02[0.77]
1991-1999						-2.21	0.09	0.01[0.66]
1992-2000						-2.01	0.07	0.01[0.73]
1993-2001						-1.36	0.06	0.02[1.11]
1994-2002	3	30.84[0.01]	5.40[0.54]	25.43[0.01]	5.40[0.54]	-1.64	0.06	0.01[0.60]
1995-2003	4	27.04[0.04]	7.15[0.33]	19.88[0.04]	7.15[0.33]	-1.45	0.06	0.02[0.89]
1996-2004						-1.40	0.06	0.01[0.26]
1997-2005						-1.25	0.05	-0.00[-0.06]
1998-2006						-1.56	0.05	-0.00[-0.24]
1999-2007						-2.44	0.04	-0.03[-1.01]
JAPAN								
1990-1998						-1.60	0.07	0.02[1.14]
1991-1999						-2.13	0.08	0.02[0.69]
1992-2000	1	34.77[0.00]	3.22[0.54]	31.55[0.00]	3.22[0.54]	-1.94	0.07	0.01[0.59]
1993-2001						-1.39	0.05	0.02[0.92]
1994-2002						-1.65	0.05	0.01[0.52]
1995-2003						-1.69	0.06	0.02[0.96]
1996-2004						-2.01	0.12	-0.00[-0.08]
1997-2005						-1.46	0.11	-0.01[-0.32]
1998-2006						-1.17	0.09	-0.01[-0.62]
1999-2007						-2.03	0.03	-0.02[-1.14]
UK								
1990-1998						-1.53	0.09	0.04[1.48]
1991-1999						-2.07	0.09	0.03[0.89]
1992-2000	3	21.27[0.04]	3.10[0.56]	18.17[0.02]	3.10[0.56]	-1.70	0.07	0.02[0.90]
1993-2001	4	22.40[0.03]	1.97[0.78]	20.42[0.01]	1.97[0.78]	-2.20	0.10	0.01[0.24]
1994-2002						-2.16	0.10	0.00[0.12]
1995-2003						-2.01	0.10	0.02[0.58]
1996-2004						-2.24	0.09	0.00[0.18]
1997-2005						-2.37	0.08	-0.01[-0.41]
1998-2006						-1.93	0.08	-0.02[-0.68]
1999-2007						-2.17	0.03	-0.02[-1.09]
USA								
1990-1998	2	21.43[0.03]	5.20[0.26]	16.22[0.04]	5.20[0.26]	-1.90	0.11	0.03[0.95]
1991-1999	2	21.40[0.03]	3.30[0.53]	18.09[0.02]	3.30[0.53]	-2.18	0.10	0.02[0.74]
1992-2000						-1.84	0.07	0.03[1.35]
1993-2001						-1.77	0.06	0.01[0.57]
1994-2002						-1.69	0.06	0.01[0.58]
1995-2003						-1.76	0.06	0.02[0.93]
1996-2004						-2.12	0.05	0.01[0.82]
1997-2005						-1.91	0.04	0.01[0.36]
1998-2006						-1.54	0.03	0.00[0.02]
1999-2007						-2.05	0.03	-0.02[-1.33]

t-stats in []

critical values for EG ADF test : -3.09(10%); -3.39(5%); -3.90(1%)

critical values for CRDW test : 0.322(10%); 0.386(5%); 0.511(1%)

Table B-10 Short Run slope Coefficients

	EU		JAPAN		UK		US	
	slope	r ²	slope	r ²	slope	r ²	slope	r ²
SA Central bank rate to other Central bank rates								
1990-1998	0.08[0.30]	0.01	0.11[0.41]	0.01	0.51[1.53]	0.09	0.26[0.81]	0.02
1991-1999	0.08[0.30]	0.06	0.06[0.18]	0.06	0.63[1.76]	0.12	0.23[0.64]	0.06
1992-2000	0.12[0.41]	0.06	0.12[0.28]	0.06	0.66[1.77]	0.13	0.26[0.67]	0.07
1993-2001	0.11[0.34]	0.07	0.07[0.13]	0.07	0.14[3.52]	0.17	0.31[0.11]	0.08
1994-2002	0.07[0.18]	0.07	0.19[0.27]	0.07	0.30[3.73]	0.18	0.31[0.09]	0.08
1995-2003	0.24[0.65]	0.08	0.09[0.12]	0.08	0.16[0.81]	0.14	0.34[0.97]	0.08
1996-2004	0.28[0.67]	0.08	0.42[0.811]	0.08	0.06[1.67]	0.14	0.30[0.88]	0.08
1997-2005	0.51[1.20]	0.09	0.29[0.79]	0.08	0.09[1.77]	0.14	0.34[0.73]	0.14
1998-2006	0.56[1.39]	0.10	0.87[0.48]	0.09	0.28[1.91]	0.15	0.35[0.09]	0.09
1999-2007	0.57[1.36]	0.18	0.24[0.31]	0.12	0.07[0.23]	0.12	0.15[0.79]	0.12
SA treasury Bill rates to Central Bank rates								
1990-1998	-0.87[0.38]	0.15	-0.28[0.38]	0.13	0.34[1.71]	0.15	0.54[1.78]	0.15
1991-1999	-0.73[0.39]	0.16	-0.41[0.40]	0.16	0.51[1.26]	0.20	0.52[1.53]	0.18
1992-2000	-0.49[0.39]	0.15	-0.41[0.39]	0.15	0.55[1.29]	0.19	0.72[1.90]	0.18
1993-2001	0.21[0.42]	0.17	-0.61[0.42]	0.18	0.79[1.43]	0.22	0.38[1.44]	0.19
1994-2002	-0.45[0.44]	0.19	-1.03[0.44]	0.20	0.88[1.69]	0.24	0.40[1.55]	0.21
1995-2003	0.20[0.46]	0.21	-1.14[0.46]	0.22	0.51[1.34]	0.23	0.43[1.38]	0.23
1996-2004	0.27[0.47]	0.22	0.20[0.47]	0.22	0.44[1.21]	0.23	0.38[1.27]	0.23
1997-2005	0.72[0.51]	0.27	0.18[0.52]	0.27	0.28[0.81]	0.27	0.36[1.36]	0.28
1998-2006	0.78[0.52]	0.28	0.51[0.52]	0.27	0.27[0.69]	0.28	0.37[1.42]	0.29
1999-2007	2.18[0.34]	0.20	-0.48[0.38]	0.16	0.19[0.69]	0.16	0.11[0.63]	0.14
SA treasury Bill rates to other treasury bill rates								
1990-1998			0.10[0.35]	0.13	0.10[0.65]	0.13	0.38[1.29]	0.14
1991-1999			0.08[0.24]	0.16	0.17[0.90]	0.16	0.39[1.21]	0.17
1992-2000			0.19[0.52]	0.15	0.19[0.94]	0.16	0.30[0.88]	0.16
1993-2001			0.22[0.49]	0.17	0.63[1.13]	0.21	0.32[1.19]	0.18
1994-2002			0.21[0.41]	0.19	0.79[1.62]	0.24	0.34[1.25]	0.20
1995-2003			0.16[0.31]	0.21	0.62[1.91]	0.24	0.43[1.40]	0.23
1996-2004			1.32[1.77]	0.25	0.53[1.63]	0.24	0.46[1.55]	0.24
1997-2005			1.25[1.77]	0.29	0.32[0.98]	0.25	0.34[1.29]	0.26
1998-2006			1.20[1.79]	0.30	0.32[0.92]	0.28	0.38[1.40]	0.29
1999-2007			0.35[0.81]	0.16	0.09[0.36]	0.16	0.09[0.61]	0.16
SA money market rate to Central Bank rates								
1990-1998	0.17[0.45]	0.00	-0.14[-0.39]	0.00	0.47[1.72]	0.02	0.03[0.09]	0.00
1991-1999	0.10[0.30]	0.06	-0.30[-0.68]	0.06	0.62[1.23]	0.10	0.14[0.34]	0.06
1992-2000	0.11[0.32]	0.06	-0.27[-0.57]	0.06	0.60[1.08]	0.10	0.33[0.72]	0.06
1993-2001	-0.17[-0.56]	0.20	-0.19[-0.37]	0.20	0.77[1.36]	0.28	0.05[0.18]	0.20
1994-2002	-0.24[-0.72]	0.22	-0.48[-0.71]	0.22	0.97[1.95]	0.28	0.10[0.38]	0.22
1995-2003	-0.02[-0.08]	0.27	-0.54[-0.82]	0.27	0.90[1.48]	0.31	0.25[0.82]	0.27
1996-2004	0.10[0.29]	0.28	-0.98[-0.39]	0.28	0.80[1.34]	0.32	0.24[0.84]	0.29
1997-2005	0.22[0.70]	0.34	-0.98[-0.44]	0.33	0.66[1.08]	0.38	0.23[0.95]	0.36
1998-2006	0.24[0.80]	0.39	-0.43[-0.32]	0.38	0.62[1.45]	0.41	0.19[0.80]	0.39
1999-2007	0.25[1.63]	0.53	-0.42[-0.86]	0.52	0.25[1.33]	0.53	0.05[0.50]	0.52

SA money market rate to other money market rates								
1990-1998	-0.07[-0.14]	0.02	0.36[0.89]	0.00	0.11[0.86]	0.07	0.14[0.33]	0.00
1991-1999	-0.23[-0.53]	0.06	0.29[0.68]	0.06	0.10[0.87]	0.06	0.21[0.46]	0.06
1992-2000	-0.07[-0.18]	0.06	0.59[1.13]	0.07	0.06[0.57]	0.06	0.37[0.74]	0.06
1993-2001	0.02[0.08]	0.20	-0.38[-0.60]	0.20	0.04[0.54]	0.20	0.06[0.20]	0.20
1994-2002	0.15[0.39]	0.22	-0.46[-0.67]	0.22	0.05[0.56]	0.22	0.11[0.39]	0.22
1995-2003	0.33[0.83]	0.27	-0.59[-0.86]	0.27	0.03[0.43]	0.27	0.14[0.42]	0.27
1996-2004	0.23[0.54]	0.28	0.78[1.02]	0.29	0.01[0.18]	0.28	0.19[0.60]	0.28
1997-2005	0.16[0.44]	0.33	0.19[1.35]	0.36	0.01[0.16]	0.33	0.27[1.03]	0.34
1998-2006	0.22[0.60]	0.39	0.79[1.17]	0.41	0.00[0.06]	0.39	0.21[0.82]	0.39
1999-2007	0.11[0.63]	0.52	0.42[0.58]	0.52	0.01[0.48]	0.52	0.08[0.06]	0.22
SA lending rates to Central Bank rates								
1990-1998	-0.14[-0.54]	0.11	0.38[1.50]	0.11	0.42[1.24]	0.15	0.46[1.62]	0.13
1991-1999	-0.13[-0.51]	0.14	0.52[1.54]	0.15	0.57[1.67]	0.19	0.41[1.23]	0.15
1992-2000	-0.13[-0.47]	0.14	0.64[1.72]	0.16	0.58[1.56]	0.19	0.49[1.36]	0.15
1993-2001	-0.02[-0.08]	0.14	0.02[0.05]	0.14	1.21[1.14]	0.26	0.18[0.70]	0.15
1994-2002	0.04[0.12]	0.13	0.10[0.16]	0.13	1.19[1.66]	0.23	0.18[0.68]	0.13
1995-2003	0.22[0.65]	0.14	0.01[0.01]	0.14	0.99[1.57]	0.19	0.14[0.41]	0.14
1996-2004	0.15[0.40]	0.14	0.97[0.39]	0.14	0.90[1.44]	0.19	0.19[0.60]	0.14
1997-2005	0.37[0.97]	0.13	0.86[0.33]	0.13	0.95[1.55]	0.18	0.21[0.75]	0.13
1998-2006	0.42[0.76]	0.17	0.14[0.09]	0.16	1.033[1.58]	0.21	0.23[0.81]	0.16
1999-2007	0.54[1.14]	0.14	0.01[0.08]	0.08	0.04[0.15]	0.08	0.01[0.07]	0.08
SA lending rates to other lending rates								
1990-1998	0.07[0.26]	0.10	-0.01[-0.04]	0.10	0.34[1.78]	0.11	0.34[1.26]	0.12
1991-1999	0.06[0.32]	0.13	-0.11[-0.31]	0.13	0.37[1.87]	0.16	0.35[1.20]	0.15
1992-2000	0.08[0.40]	0.13	-0.25[-0.55]	0.14	0.46[1.08]	0.17	0.71[1.79]	0.17
1993-2001	0.11[0.56]	0.14	-0.01[-0.02]	0.14	0.54[1.76]	0.17	0.33[1.29]	0.16
1994-2002	0.07[0.37]	0.13	0.50[0.68]	0.13	0.65[1.69]	0.16	0.28[1.06]	0.14
1995-2003	0.14[0.63]	0.14	0.38[0.50]	0.14	0.63[1.63]	0.16	0.02[0.04]	0.14
1996-2004	0.15[0.69]	0.15	3.11[1.22]	0.15	0.65[1.68]	0.16	0.10[0.32]	0.14
1997-2005	0.26[0.45]	0.16	2.80[1.10]	0.16	0.54[1.35]	0.15	0.11[0.37]	0.15
1998-2006	0.26[0.61]	0.17	0.83[0.45]	0.16	0.56[1.27]	0.18	0.11[0.39]	0.16
1999-2007	0.48[0.47]	0.11	0.32[0.31]	0.08	0.53[1.07]	0.09	0.08[0.41]	0.08

t-stats in []

APPENDIX C – STATIONARITY TESTS

Table C-1 Unit root tests of spread between SA Repo Rate and other central bank rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA Repo Rate to EU central bank rate				
1990-1998	-1.56	0.8	-1.62	0.78
1991-1999	-1.66	0.76	-1.80	0.70
1992-2000	-0.83	0.96	-0.83	0.96
1993-2001	-1.48	0.54	-1.34	0.61
1994-2002	-1.64	0.46	-1.75	0.4
1995-2003	-2.1	0.54	-1.36	0.6
1996-2004	-2.29	0.44	-2.31	0.43
1997-2005	-2.09	0.55	-2.14	0.52
1998-2006	-2.5	0.33	-2.01	0.59
1999-2007	-2.75	0.22	-3.05	0.12
SA Repo Rate to Japan central bank rate				
1990-1998	-2.28	0.44	-2.33	0.41
1991-1999	-1.52	0.52	-1.55	0.51
1992-2000	-1.46	0.55	-1.53	0.51
1993-2001	-1.39	0.58	-1.39	0.58
1994-2002	-1.85	0.36	-1.87	0.34
1995-2003	-2.2	0.48	-2.48	0.34
1996-2004	-2.53	0.31	-2.52	0.32
1997-2005	-2.46	0.35	-2.5	0.33
1998-2006	-2.95	0.15	-2.29	0.43
1999-2007	-2.12	0.24	-2.71	0.23
SA Repo Rate to UK central bank rate				
1990-1998	-2.76	0.22	-3.08	0.12
1991-1999	-1.87	0.66	-1.98	0.60
1992-2000	-1.56	0.80	-1.56	0.80
1993-2001	-1.63	0.46	-1.62	0.47
1994-2002	-1.89	0.34	-1.97	0.30
1995-2003	-1.56	0.50	-1.85	0.36
1996-2004	-2.21	0.48	-2.30	0.43
1997-2005	-2.12	0.53	-2.28	0.44
1998-2006	-2.86	0.18	-2.30	0.43
1999-2007	-2.21	0.20	-2.39	0.38
SA Repo Rate to US central bank rate				
1990-1998	-1.33	0.88	-1.50	0.82
1991-1999	-1.79	0.70	-1.83	0.68
1992-2000	-1.66	0.76	-1.72	0.74
1993-2001	-1.75	0.40	-1.85	0.35
1994-2002	-1.66	0.45	-1.78	0.39
1995-2003	-1.80	0.38	-2.02	0.28
1996-2004	-1.45	0.55	-1.63	0.46
1997-2005	-1.12	0.71	-1.27	0.64
1998-2006	-2.52	0.32	-1.99	0.60
1999-2007	-2.10	0.24	-2.55	0.11

Table C-2 Unit root tests of spread between SA treasury bill rates to other central bank rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA treasury bill rate to SA repo rate				
1990-1998	-2.38	0.39	-4.77	0.00
1991-1999	-2.48	0.34	-4.92	0.00
1992-2000	-2.68	0.25	-5.28	0.00
1993-2001	-2.18	0.21	-5.00	0.00
1994-2002	-2.50	0.12	-5.03	0.00
1995-2003	-2.39	0.15	-5.26	0.00
1996-2004	-4.83	0.00	-4.82	0.00
1997-2005	-6.38	0.00	-6.35	0.00
1998-2006	-5.65	0.00	-7.57	0.00
1999-2007	-3.31	0.07	-4.74	0.00
SA treasury bill rate to EU central bank rate				
1990-1998	-2.04	0.57	-1.69	0.75
1991-1999	-1.91	0.64	-1.91	0.64
1992-2000	-1.21	0.90	-0.95	0.95
1993-2001	-1.92	0.32	-1.69	0.43
1994-2002	-2.03	0.28	-1.90	0.33
1995-2003	-1.78	0.39	-1.42	0.57
1996-2004	-2.79	0.21	-2.27	0.45
1997-2005	-2.72	0.23	-2.10	0.54
1998-2006	-2.62	0.27	-2.04	0.57
1999-2007	-2.83	0.06	-2.83	0.19
SA treasury bill rate to Japan central bank rate				
1990-1998	-2.84	0.19	-2.27	0.45
1991-1999	-1.95	0.37	-1.46	0.55
1992-2000	-1.72	0.42	-1.38	0.59
1993-2001	-1.91	0.33	-1.70	0.43
1994-2002	-2.32	0.17	-1.97	0.30
1995-2003	-2.91	0.16	-2.45	0.35
1996-2004	-1.75	0.41	-2.57	0.29
1997-2005	-1.92	0.32	-2.35	0.40
1998-2006	-2.58	0.29	-2.3	0.43
1999-2007	-2.61	0.09	-2.57	0.30
SA treasury bill rate to UK central bank rate				
1990-1998	-4.00	0.01	-3.21	0.09
1991-1999	-2.85	0.18	-1.91	0.33
1992-2000	-2.10	0.54	-1.37	0.59
1993-2001	-2.31	0.17	-1.48	0.54
1994-2002	-2.44	0.13	-2.02	0.28
1995-2003	-2.38	0.15	-1.87	0.35
1996-2004	-2.79	0.20	-2.31	0.42
1997-2005	-2.72	0.23	-1.64	0.46
1998-2006	-2.75	0.22	-2.13	0.52
1999-2007	-2.39	0.15	-2.11	0.54

Continuation of Table C-2 Unit root tests of spread between SA treasury bill rates to other central bank rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA treasury bill rate to US central bank rate				
1990-1998	-2.41	0.37	-1.77	0.71
1991-1999	-2.37	0.39	-1.89	0.66
1992-2000	-2.04	0.57	-1.74	0.73
1993-2001	-2.24	0.20	-1.91	0.33
1994-2002	-2.06	0.26	-1.72	0.42
1995-2003	-2.36	0.16	-1.95	0.31
1996-2004	-2.14	0.23	-1.75	0.40
1997-2005	-1.92	0.32	-1.49	0.53
1998-2006	-2.10	0.54	-1.87	0.66
1999-2007	-1.75	0.40	-1.88	0.66

Table C-3 Unit root tests of spread between SA money market rates to other central bank rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA money market rate to SA repo rate				
1990-1998	-4.18	0.01	-3.96	0.01
1991-1999	-4.30	0.00	-4.01	0.01
1992-2000	-4.41	0.00	-4.37	0.00
1993-2001	-3.53	0.01	-3.31	0.02
1994-2002	-3.59	0.01	-3.30	0.02
1995-2003	-2.47	0.13	-2.90	0.05
1996-2004	-2.93	0.05	-2.64	0.09
1997-2005	-2.85	0.18	-4.38	0.00
1998-2006	-2.47	0.34	-3.63	0.03
1999-2007	-2.39	0.38	-3.14	0.10
SA money market rate to EU central bank rate				
1990-1998	-2.01	0.59	-1.99	0.60
1991-1999	-1.95	0.62	-1.91	0.64
1992-2000	-0.88	0.95	-1.14	0.70
1993-2001	-1.77	0.39	-1.41	0.58
1994-2002	-1.90	0.33	-1.74	0.41
1995-2003	-1.72	0.42	-1.44	0.56
1996-2004	-1.60	0.48	-2.08	0.55
1997-2005	-2.45	0.35	-1.69	0.43
1998-2006	-2.25	0.46	-1.90	0.65
1999-2007	-2.31	0.17	-2.97	0.14
SA money market rate to Japan central bank rate				
1990-1998	-2.65	0.26	-2.61	0.28
1991-1999	-1.61	0.47	-1.50	0.53
1992-2000	-1.48	0.54	-1.36	0.60
1993-2001	-1.79	0.38	-1.43	0.56
1994-2002	-2.18	0.21	-1.80	0.38
1995-2003	-2.93	0.33	-1.49	0.37
1996-2004	-2.98	0.14	-2.35	0.40
1997-2005	-2.94	0.15	-2.30	0.43
1998-2006	-2.53	0.25	-1.73	0.42
1999-2007	-2.21	0.21	-2.83	0.19

Continuation of Table C-3

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA money market rate to UK central bank rate				
1990-1998	-2.96	0.15	-3.10	0.11
1991-1999	-1.45	0.84	-1.90	0.65
1992-2000	-1.39	0.48	-1.57	0.49
1993-2001	-2.00	0.28	-1.53	0.51
1994-2002	-2.16	0.22	-1.79	0.38
1995-2003	-2.24	0.19	-1.82	0.37
1996-2004	-2.64	0.26	-1.41	0.58
1997-2005	-2.55	0.30	-1.82	0.37
1998-2006	-1.77	0.40	-1.65	0.45
1999-2007	-2.12	0.24	-2.41	0.37
SA money market rate to US central bank rate				
1990-1998	-1.78	0.71	-1.74	0.73
1991-1999	-1.43	0.85	-1.82	0.69
1992-2000	-1.48	0.81	-1.60	0.79
1993-2001	-1.97	0.30	-1.75	0.40
1994-2002	-1.89	0.33	-1.62	0.47
1995-2003	-2.31	0.17	-1.90	0.33
1996-2004	-2.03	0.27	-1.64	0.46
1997-2005	-1.76	0.40	-1.63	0.47
1998-2006	-1.83	0.36	-1.55	0.50
1999-2007	-2.12	0.53	-2.12	0.53

Table C-4 Unit root tests of spread between SA lending rates to other central bank rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA lending rate to SA repo rate				
1990-1998	-7.38	0.00	-7.41	0.00
1991-1999	-8.30	0.00	-8.31	0.00
1992-2000	-6.39	0.00	-7.36	0.00
1993-2001	-5.14	0.00	-5.23	0.00
1994-2002	-4.71	0.00	-4.73	0.00
1995-2003	-4.59	0.00	-4.59	0.00
1996-2004	-4.21	0.01	-4.11	0.01
1997-2005	-4.43	0.00	-4.45	0.00
1998-2006	-3.15	0.03	-3.84	0.00
1999-2007	-2.13	0.52	-3.18	0.09
SA lending rate to EU central bank rate				
1990-1998	-1.90	0.65	-1.50	0.82
1991-1999	-1.84	0.68	-1.77	0.71
1992-2000	-1.26	0.65	-1.13	0.70
1993-2001	-1.62	0.47	-1.36	0.60
1994-2002	-1.70	0.43	-1.69	0.43
1995-2003	-1.28	0.64	-1.36	0.60
1996-2004	-1.56	0.50	-1.11	0.71
1997-2005	-2.70	0.24	-2.02	0.58
1998-2006	-1.72	0.42	-1.61	0.47
1999-2007	-2.60	0.28	-2.89	0.17

Continuation of Table C-4 Unit root tests of spread between SA lending rates to other central bank rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA lending rate to Japan central bank rate				
1990-1998	-2.78	0.21	-2.13	0.53
1991-1999	-1.77	0.40	-1.59	0.48
1992-2000	-1.59	0.48	-1.42	0.57
1993-2001	-1.54	0.51	-1.36	0.60
1994-2002	-1.88	0.34	-1.80	0.38
1995-2003	-1.85	0.36	-2.45	0.35
1996-2004	-1.60	0.48	-2.43	0.36
1997-2005	-1.76	0.40	-2.35	0.41
1998-2006	-1.65	0.45	-1.58	0.49
1999-2007	-2.07	0.26	-2.69	0.24
SA lending rate to UK central bank rate				
1990-1998	-3.37	0.06	-2.97	0.14
1991-1999	-2.29	0.23	-2.04	0.18
1992-2000	-1.82	0.37	-1.65	0.45
1993-2001	-1.81	0.37	-1.55	0.51
1994-2002	-1.93	0.32	-1.84	0.36
1995-2003	-2.19	0.21	-1.78	0.39
1996-2004	-2.77	0.21	-2.21	0.48
1997-2005	-2.74	0.22	-1.43	0.57
1998-2006	-2.63	0.27	-2.12	0.53
1999-2007	-2.21	0.20	-2.33	0.42
SA lending rate to US central bank rate				
1990-1998	-2.03	0.58	-1.59	0.79
1991-1999	-2.11	0.54	-1.86	0.67
1992-2000	-1.57	0.50	-1.42	0.57
1993-2001	-1.82	0.37	-1.78	0.39
1994-2002	-2.13	0.24	-1.67	0.44
1995-2003	-2.41	0.14	-1.97	0.30
1996-2004	-2.18	0.22	-1.60	0.48
1997-2005	-1.91	0.33	-1.35	0.64
1998-2006	-1.69	0.44	-1.45	0.56
1999-2007	-2.19	0.49	-2.09	0.55

Table C-5 Unit root tests of spread between SA treasury bill rate to other treasury bill rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA treasury bill rate to Japan treasury bill rate				
1990-1998	-1.40	0.58	-0.98	0.76
1991-1999	-1.77	0.39	-1.42	0.57
1992-2000	-1.68	0.44	-1.45	0.55
1993-2001	-1.91	0.33	-1.69	0.43
1994-2002	-2.34	0.16	-1.97	0.30
1995-2003	-1.93	0.32	-1.46	0.55
1996-2004	-1.74	0.41	-1.20	0.67
1997-2005	-1.91	0.33	-2.37	0.39
1998-2006	-1.98	0.30	-2.33	0.41
1999-2007	-1.95	0.62	-2.48	0.34
SA treasury bill rate to UK treasury bill rate				
1990-1998	-1.92	0.32	-1.57	0.49
1991-1999	-2.39	0.15	-2.21	0.20
1992-2000	-2.14	0.23	-1.49	0.54
1993-2001	-2.26	0.19	-1.75	0.40
1994-2002	-2.33	0.16	-1.97	0.30
1995-2003	-2.33	0.16	-1.85	0.35
1996-2004	-1.86	0.35	-1.45	0.56
1997-2005	-1.98	0.30	-1.66	0.45
1998-2006	-1.88	0.34	-2.20	0.48
1999-2007	-1.82	0.69	-2.15	0.51
SA treasury bill rate to US treasury bill rate				
1990-1998	-2.27	0.18	-1.91	0.33
1991-1999	-2.27	0.18	-2.00	0.29
1992-2000	-2.02	0.28	-1.85	0.35
1993-2001	-2.25	0.19	-1.93	0.32
1994-2002	-2.15	0.22	-1.81	0.37
1995-2003	-2.40	0.14	-2.03	0.27
1996-2004	-2.23	0.20	-1.76	0.40
1997-2005	-1.94	0.32	-1.50	0.53
1998-2006	-1.90	0.33	-1.53	0.51
1999-2007	-1.72	0.42	-2.28	0.18

Table C-6 Unit root tests of spread between SA money market rate to other money market rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA money market rate to EU money market rate				
1990-1998	-0.99	0.75	-1.11	0.71
1991-1999	-1.33	0.61	-1.33	0.61
1992-2000	-1.19	0.68	-1.16	0.69
1993-2001	-1.87	0.35	-1.46	0.55
1994-2002	-2.09	0.25	-1.77	0.40
1995-2003	-1.84	0.36	-1.52	0.52
1996-2004	-1.66	0.45	-1.27	0.64
1997-2005	-1.72	0.42	-1.72	0.42
1998-2006	-1.80	0.38	-1.69	0.43
1999-2007	-2.58	0.29	-3.03	0.13
SA money market rate to Japan money market rate				
1990-1998	-0.87	0.79	-0.96	0.77
1991-1999	-1.50	0.53	-1.41	0.58
1992-2000	-1.46	0.55	-1.37	0.59
1993-2001	-1.79	0.38	-1.45	0.56
1994-2002	-2.21	0.20	-1.86	0.35
1995-2003	-1.96	0.30	-1.57	0.50
1996-2004	-1.65	0.45	-1.20	0.67
1997-2005	-1.68	0.44	-1.59	0.49
1998-2006	-2.06	0.26	-1.69	0.43
1999-2007	-2.15	0.51	-2.73	0.23
SA money market rate to UK money market rate				
1990-1998	-1.65	0.45	-1.47	0.55
1991-1999	-2.28	0.18	-2.28	0.18
1992-2000	-2.02	0.28	-1.99	0.29
1993-2001	-1.70	0.43	-1.71	0.42
1994-2002	-2.00	0.29	-2.12	0.24
1995-2003	-1.71	0.42	-1.96	0.30
1996-2004	-1.27	0.64	-2.33	0.41
1997-2005	-1.63	0.47	-1.82	0.37
1998-2006	-1.87	0.35	-1.68	0.44
1999-2007	-2.32	0.42	-2.52	0.32
SA money market rate to US money market rate				
1990-1998	-1.90	0.33	-2.00	0.29
1991-1999	-1.49	0.54	-1.85	0.35
1992-2000	-1.47	0.54	-1.52	0.52
1993-2001	-1.92	0.32	-1.73	0.41
1994-2002	-1.84	0.36	-1.60	0.48
1995-2003	-2.21	0.20	-1.88	0.34
1996-2004	-2.25	0.46	-1.63	0.46
1997-2005	-1.80	0.38	-1.63	0.46
1998-2006	-1.89	0.34	-1.54	0.51
1999-2007	-1.93	0.32	-2.51	0.12

Table C-7 Unit root tests of spread between SA lending rate to other lending rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA lending rate to EU lending rate				
1990-1998	-0.38	0.91	0.00	0.96
1991-1999	-1.24	0.66	-1.18	0.68
1992-2000	-1.22	0.67	-1.17	0.68
1993-2001	-1.76	0.40	-1.47	0.54
1994-2002	-1.97	0.30	-1.91	0.33
1995-2003	-1.48	0.54	-1.72	0.42
1996-2004	-1.28	0.63	-2.30	0.43
1997-2005	-1.37	0.59	-2.09	0.54
1998-2006	-3.85	0.02	-1.55	0.51
1999-2007	-2.56	0.10	-1.86	0.40
SA lending rate to Japan lending rate				
1990-1998	-0.62	0.86	-0.22	0.93
1991-1999	-1.65	0.45	-1.58	0.49
1992-2000	-1.46	0.55	-1.45	0.56
1993-2001	-1.59	0.48	-1.32	0.62
1994-2002	-1.89	0.34	-1.79	0.38
1995-2003	-1.77	0.40	-1.38	0.59
1996-2004	-1.55	0.51	-2.46	0.35
1997-2005	-1.70	0.43	-2.38	0.39
1998-2006	-1.61	0.47	-2.18	0.50
1999-2007	-2.09	0.25	-2.58	0.29
SA lending rate to UK lending rate				
1990-1998	-1.29	0.63	-1.00	0.75
1991-1999	-2.29	0.18	-2.17	0.22
1992-2000	-2.11	0.24	-1.63	0.46
1993-2001	-1.39	0.59	-1.32	0.62
1994-2002	-2.17	0.22	-1.79	0.39
1995-2003	-1.84	0.36	-1.36	0.60
1996-2004	-1.62	0.47	-2.53	0.31
1997-2005	-1.78	0.39	-2.36	0.40
1998-2006	-1.52	0.52	-2.21	0.48
1999-2007	-2.05	0.57	-2.42	0.36
SA lending rate to US lending rate				
1990-1998	-1.88	0.34	-1.44	0.56
1991-1999	-2.16	0.22	-1.91	0.33
1992-2000	-1.67	0.44	-1.44	0.56
1993-2001	-1.83	0.36	-1.72	0.42
1994-2002	-1.70	0.43	-1.64	0.46
1995-2003	-2.30	0.18	-1.90	0.33
1996-2004	-1.62	0.47	-2.53	0.31
1997-2005	-1.89	0.34	-1.37	0.59
1998-2006	-1.68	0.44	-1.44	0.56
1999-2007	-2.16	0.50	-2.49	0.12

Table C-8 Unit root tests of risk premium between SA treasury bill rate to other treasury bill rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA treasury bill rate to Japan treasury bill rate				
1990-1998	-1.96	0.31	-2.50	0.33
1991-1999	-2.39	0.15	-1.57	0.50
1992-2000	-2.36	0.44	-1.76	0.72
1993-2001	-2.44	0.36	-2.17	0.50
1994-2002	-2.32	0.17	-2.16	0.22
1995-2003	-3.00	0.04	-2.01	0.28
1996-2004	-2.68	0.08	-1.78	0.39
1997-2005	-2.59	0.10	-1.57	0.49
1998-2006	-2.61	0.09	-2.08	0.25
1999-2007	-3.32	0.07	-2.26	0.19
SA treasury bill rate to UK treasury bill rate				
1990-1998	-5.34	0.00	-3.59	0.04
1991-1999	-4.19	0.01	-2.72	0.07
1992-2000	-2.05	0.27	-2.33	0.16
1993-2001	-2.78	0.06	-3.08	0.03
1994-2002	-2.90	0.05	-2.80	0.06
1995-2003	-5.17	0.00	-3.28	0.02
1996-2004	-4.62	0.00	-3.02	0.04
1997-2005	-5.93	0.00	-3.50	0.04
1998-2006	-5.57	0.00	-3.38	0.06
1999-2007	-5.23	0.00	-3.50	0.04
SA treasury bill rate to US treasury bill rate				
1990-1998	-1.51	0.82	-1.47	0.83
1991-1999	-1.65	0.77	-1.93	0.63
1992-2000	-1.66	0.45	-1.85	0.36
1993-2001	-2.07	0.26	-2.64	0.26
1994-2002	-2.45	0.13	-2.63	0.09
1995-2003	-2.67	0.08	-2.78	0.06
1996-2004	-2.43	0.14	-2.64	0.09
1997-2005	-3.19	0.09	-3.14	0.10
1998-2006	-4.83	0.00	-3.21	0.09
1999-2007	-4.80	0.00	-3.03	0.04

Table C-9 Unit root tests of risk premium between SA money market rate to other money market rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA money market rate to EU money market rate				
1990-1998	1.12	1.00	0.60	0.99
1991-1999	-2.10	0.54	-2.93	0.16
1992-2000	-1.67	0.44	-2.24	0.19
1993-2001	-2.08	0.25	-2.54	0.11
1994-2002	-2.31	0.17	-2.83	0.06
1995-2003	-2.35	0.16	-2.98	0.04
1996-2004	-2.16	0.22	-2.81	0.06
1997-2005	-3.07	0.12	-3.79	0.02
1998-2006	-3.68	0.03	-3.77	0.02
1999-2007	-4.87	0.00	-3.23	0.02
SA money market rate to Japan money market rate				
1990-1998	-2.59	0.29	-2.65	0.26
1991-1999	-2.48	0.34	-1.47	0.55
1992-2000	-1.97	0.30	-1.68	0.44
1993-2001	-2.20	0.21	-1.94	0.31
1994-2002	-3.07	0.10	-2.04	0.27
1995-2003	-2.70	0.08	-1.90	0.33
1996-2004	-4.02	0.01	-2.96	0.15
1997-2005	-4.22	0.01	-3.11	0.11
1998-2006	-3.92	0.01	-3.10	0.11
1999-2007	-3.31	0.02	-2.37	0.15
SA money market rate to UK money market rate				
1990-1998	-4.10	0.01	-3.88	0.02
1991-1999	-3.31	0.07	-3.37	0.06
1992-2000	-2.56	0.11	-2.42	0.14
1993-2001	-2.74	0.07	-2.90	0.05
1994-2002	-2.81	0.06	-3.03	0.04
1995-2003	-4.80	0.00	-3.36	0.01
1996-2004	-5.82	0.00	-3.42	0.05
1997-2005	-5.79	0.00	-3.55	0.04
1998-2006	-5.40	0.00	-3.42	0.05
1999-2007	-2.98	0.04	-3.12	0.03
SA money market rate to US money market rate				
1990-1998	-1.86	0.67	-1.67	0.76
1991-1999	-1.78	0.71	-1.83	0.68
1992-2000	-1.62	0.47	-1.59	0.48
1993-2001	-1.90	0.33	-2.41	0.14
1994-2002	-2.18	0.22	-2.49	0.12
1995-2003	-2.46	0.13	-2.67	0.08
1996-2004	-2.96	0.15	-2.56	0.11
1997-2005	-2.87	0.18	-3.04	0.13
1998-2006	-2.80	0.20	-3.09	0.11
1999-2007	-3.16	0.03	-3.24	0.02

Table C-10 Unit root tests of risk premium between SA lending rate to other lending rates

	ADF	ADF P-VALUE	PP	PP P-VALUE
SA lending rate to EU lending rate				
1990-1998	0.44	1.00	0.04	1.00
1991-1999	-2.75	0.22	-2.99	0.14
1992-2000	-1.65	0.46	-2.17	0.22
1993-2001	-2.07	0.26	-2.47	0.13
1994-2002	-2.42	0.14	-2.84	0.06
1995-2003	-2.48	0.12	-3.08	0.03
1996-2004	-3.10	0.11	-3.62	0.03
1997-2005	-3.26	0.08	-3.82	0.02
1998-2006	-3.80	0.02	-3.90	0.02
1999-2007	-4.55	0.00	-3.34	0.02
SA lending rate to Japan lending rate				
1990-1998	-0.69	0.85	-0.96	0.76
1991-1999	-2.11	0.24	-1.80	0.38
1992-2000	-2.09	0.25	-1.83	0.36
1993-2001	-1.82	0.37	-1.97	0.30
1994-2002	-1.95	0.31	-2.01	0.28
1995-2003	-1.73	0.41	-1.79	0.38
1996-2004	-1.49	0.53	-1.55	0.51
1997-2005	-2.11	0.24	-1.33	0.61
1998-2006	-3.80	0.02	-1.88	0.34
1999-2007	-2.19	0.21	-2.30	0.17
SA lending rate to UK lending rate				
1990-1998	-5.54	0.00	-3.58	0.04
1991-1999	-3.98	0.01	-2.54	0.11
1992-2000	-1.84	0.36	-2.35	0.16
1993-2001	-2.57	0.10	-2.81	0.06
1994-2002	-2.31	0.17	-2.74	0.07
1995-2003	-5.28	0.00	-3.07	0.03
1996-2004	-6.01	0.00	-3.23	0.08
1997-2005	-6.03	0.00	-3.43	0.05
1998-2006	-2.69	0.24	-3.35	0.06
1999-2007	-2.51	0.12	-2.94	0.04
SA lending rate to US lending rate				
1990-1998	-1.24	0.90	-1.21	0.90
1991-1999	-1.59	0.79	-1.89	0.66
1992-2000	-1.35	0.60	-1.60	0.48
1993-2001	-2.07	0.26	-2.54	0.11
1994-2002	-2.18	0.21	-2.61	0.09
1995-2003	-2.43	0.14	-2.67	0.08
1996-2004	-3.00	0.14	-3.08	0.12
1997-2005	-2.99	0.14	-3.09	0.11
1998-2006	-2.80	0.20	-3.15	0.10
1999-2007	-2.50	0.12	-3.14	0.03