MCom

The Effect of Foreign Exchange Accumulation on Macroeconomic Stability in Post-Liberalized South Africa

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ABSTRACT

This study examines the impact of foreign exchange reserve accumulation on macroeconomic stability in South Africa over the period 1995-2016 using a vector error correction model. The results show that foreign exchange reserve accumulation has a positive impact on macroeconomic stability.

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List of Key Terms

BoP	Balance of Payments
CA	Balance of Payments Current Account
CF	Capital Flows
ECM	Error Correction Model
FDI	Foreign Direct Investments
FER	Foreign Exchange Reserves
FS	Financial Stability
GDP	Gross Domestic Product
IMF	International Monetary Fund
LLR	Lender of Last Resort
MS	Macroeconomic stability
OLS	Ordinary Least Squares
RA	Reserve Adequacy
SARB	South African Reserve Bank
ST	Short-Term Debt
USD	United States Dollar
VAR	Vector Autoregressive
VECM	Vector Error Correction Model
X	Exports

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Chapter 1:

Introduction

1.1 Background to the Study

The South African Reserve Bank (SARB) defines Foreign Exchange Reserves (FER) as the official readily available public sector foreign assets (currencies). These assets are under the control of monetary authorities and they use them to finance the imbalances in the economy. Foreign assets are also used to indirectly regulate various imbalances by intervening in foreign trade markets and for liquidity management (South African Reserve Bank, 2014). African countries have increased their FER holdings especially in commodity exporting and foreign funded countries. For the reasons of stabilising the macroeconomy; as a national economic policy and foreign aid conditionality priority, African countries get motivated to hold reserves so they can give monetary authorities some flexibility to intervene in the markets, and thus giving them access to control the exchange rate and inflation (Elhiraika, Adam; Ndikumana, 2007). Adequate reserves also allow for international borrowing and hedging against instabilities, and against the uncertainties of external capital flows.

But reserve accumulation can have high economic and social costs, including high opportunity costs arising from minimal returns on reserve assets, losses due to reserve currency volatility and forfeited gains from investment, as well as social expenditures that could have been financed by these reserves. Therefore, reserve managers and policy makers in African countries need to understand the determinants and the economic costs of reserve accumulation so they can design strategies that will optimise these factors, minimising costs while maximising gains from the resource inflows (Elhiraika, Adam and Ndikumana, 2007).

FER contributes to economic growth by improving both the investment (GDP) ratio and capital productivity. (Polterovich & Popov, 2010) FER accumulation causes Real Exchange Rate (RER) undervaluation which is expansionary for the economy in the short run. However, these devaluations could have long term effects if they are carried out irregularly and unexpectedly.

Financial stability is described by the South African Reserve Bank as a pivotal pre-condition in sustainable economic growth (SARB, 2015). It refers to a financial system that is buoyant towards financial shocks and current account vulnerabilities whilst facilitating financial intermediation and mitigating macroeconomic costs of disruptions to maintain confidence in the financial system.

According to Fleming and Mundell (1960 - 1970) policymakers are faced with an impossible trilemma whereby it is only possible to achieve two objectives out of the three of financial integration, exchange rate stability and monetary autonomy (Boughton, 2002). Over the last two decades, the weighted average exchange rate stability has been decreased because of globalisation and monetary autonomy, which has unintentional consequences involving capital flight that is a big funding generator in developing countries. For this reason, Aizenman, Chinn, & Ito (2010) adds financial stability to the trilemma thus forming a quadrilemma.

Obstfeld, Shambaugh, & Taylor (2008) explore the interaction of financial stability and financial openness with foreign exchange reserves in the modern era of globalised capital markets, and this dissertation seeks to explore this interaction in a South African context. In 2001, the Rand lost 40 percent of its value, which triggered macroeconomic instability. The SARB then raised interest rates, which then resulted in slower domestic growth and therefore low GDP. That is one of the reasons why South Africa has a floating rate regime, an autonomy and non-regulated or limited regulation of capital flows (Lipuma & Koelble, 2009). It can thus be deduced that currency instability may trigger macroeconomic instability and ultimately financial instability, which is why the SARB has been given the new financial stability mandate. However, given the new financial stability mandate, question arises how policy makers can optimally balance the various factors. South Africa adopted the emerging market practise of coupling growth and financial integration with sizable reserve accumulation in 2007. OECD countries initiated some deleveraging in 2008 which may have provided some countries within the emerging markets to implement limited regulation of capital controls thereby regulating inflows of short-term funds.

1.2 Research Problem Definition

According to Moghadam, Ostry, & Sheehy (2011), in recent decades, foreign exchange reserve accumulation increased to unprecedented levels in emerging market economies. Regardless of the impacts this excessive accumulation, Machulp theory[1] suggests that policy makers follow reserve accumulation trends instead of focusing on what reserve level is suitable for macroeconomic stability.

In common with many other emerging countries, South Africa has also accumulated significant reserves since financial lliberalisation after the first democratic election in April 1994. The aim of this study is thus to determine whether this accumulation has had an effect on macroeconomic stability. According to van Vuuren (2015), studies that consider this question with regards to South Africa are limited and this study therefore seeks to bridge this gap.

1.2.1 Foreign exchange reserve accumulation

International reserves have experienced a downward trend since 2014, declining by seven percentage points from the first quarter in 2014 to the first quarter of 2016 mostly because of the 13 percent reduction in reserves by emerging and developing countries as opposed to a 4,5 percent increase in developed countries during the same period.

Figure 1 below presents the annual changes in global reserves and as can be seen, from the year 2001, South Africa almost doubled its reserves annually, which is the year that the reserve bank was mandated with the financial stability objective.

[1] Machulp theory insinuates that countries continue to accumulate reserves irrespective of the level of reserves they are already holding.

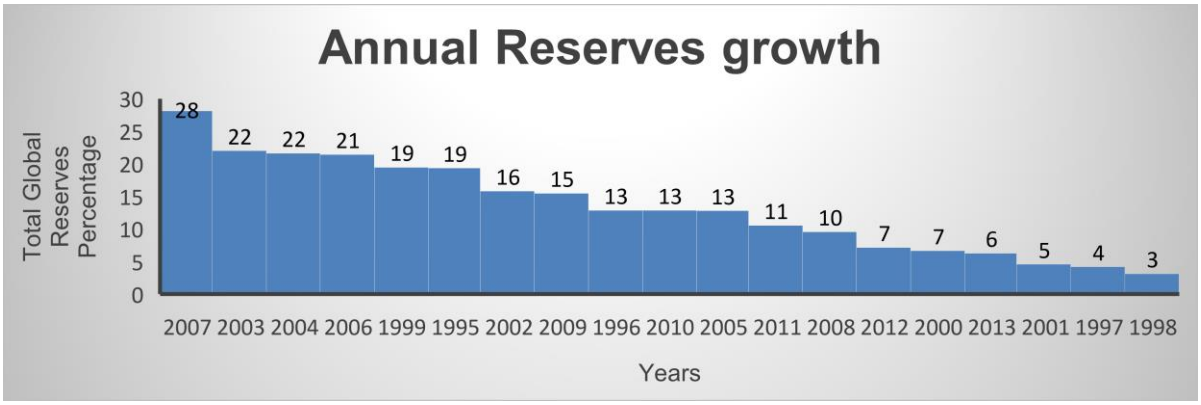


Figure1: Year on year percentage variations in global reserves (source: IMF)

One of globalization's characteristics has been an increase in private financial movements, which increased from $90 billion in 2002 to $600 billion in 2007 (IMF, 2010a). In 2014 however, capital flows to emerging markets declined to $1,1 trillion, $250 billion less than the 2013 record high of 1,35 trillion (Rao, 2015). Increased capital inflows may exacerbate asset price irregularities, inefficient allocation of resources and liquidity risks for foreign funding. They can also stimulate pressures that appreciate currencies, which obscure the management of the macro economy. As a result, policy makers have resorted to buffering their economies from those inflows by accumulating reserves (IMF, 2010b).

However, holding reserves has financial consequences. The uneven distribution of reserves in emerging countries, which come in either sterilisation costs or opportunity costs as the liabilities in the Central Banks' balance sheet, could have been alternatively distributed in higher yielding domestic assets. This gap between the yield on reserves and sterilisation costs is made of very low to negative returns generated by traditional reserve investments undermines the objective of capital preservation (Myburgh, 2014).

Nevertheless, the benefits of capital preservation include tapping into foreign savings to fund infrastructure developments, which improves employment and creates funding to service the associated debt. Benefits also include transfer of technology and development of financial markets and innovation, which assists in improving the absorption capacity of flows without distorting macroeconomic fundamentals. The IMF

recommends that capital flow liberalisation should be implemented in phases prioritising non-regulation of stable like foreign direct investments before less stable flows such as portfolio flows (Mminele, 2017).

1.2.2 Foreign exchange reserve accumulation and adequacy in South Africa

The SARB describes FER as readily available official public sector foreign assets controlled by monetary authorities to finance payment of imbalances, regulating the magnitude of those imbalances and meeting ad hoc monetary policy objectives. These objectives translate to maintaining assurance in the monetary, financial stability and exchange rate policies. South Africa has grown its FER from $6 billion in 2002 to $50 billion in 2018 through open market purchases, proceeds from FDIs and proceeds from foreign bond issues. There was a gain of 7,8 percent in the growth of reserves for June 2014 and a 6 percent average per annum over a three-year period. Monetary authorities' involvement had grown from 40 percent over a ten-year period, amounting to 67 percent of total assets making central banks in emerging markets' share of 7 percent over that period.

Figure 2 below shows South Africa's reserve characteristics. As can be seen the SARB aims to maintain a level of reserves that enables it to be liquid at all times determined based on levels of external short-term debt, probability of a capital flow bubbles, imports, exports and GDP growth and the costs and returns of holding FER (SARB, 2014).

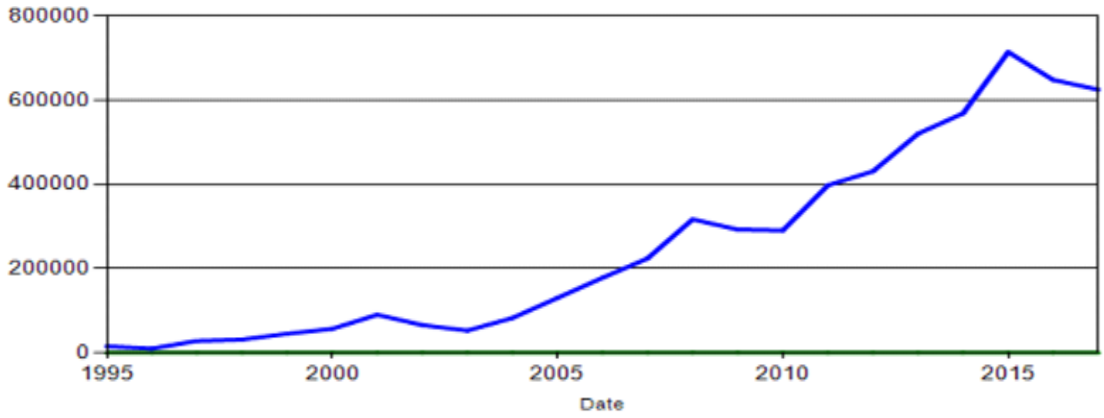


Figure 2: South Africa's Annual Reserve Holdings (source: South African Reserve Bank)

1.2.3 Macroeconomic stability

From the 1990s, a number of emerging countries started liberalising their capital flows so they could benefit from increased inflows, which bring about investments in the economy and improve productivity, that are brought by liberalised capital flows whilst mitigating the risks of reversal of capital and sudden stops of capital inflows. Between 2013 and 2016, the number of measures to control capital flows that were put in place summed up to 851 with approximately sixty percent representative of emerging markets. China, Colombia, India, Indonesia, Malaysia, South Africa and Thailand announced about 127 de-regulating provisions. 233 tightening measures were introduced in that period over 50 percent of which were in emerging economies (Zhu, 2011).

South Africa has progressively liberalised its capital flow measures since 1995 to attract investment into the country and has not had to reimpose them to date but instead have had to limit regulating residents to enable international expansion for domestic firms. The result of non-restricted capital inflows has been the adequate financing the balance of payments current account shortfall. The country adopted a phased outflow measures imposition to ensure financial stability maintenance, starting with current account activities, then eliminating controls on non-residents capital flow, direct foreign investments by South African corporates and allowing portfolio

diversification by institutional investors. The floating rate is the shock absorber (Mohamed, 2012).

Exchange control restrictions on foreign investments by private individuals have been progressively relaxed since 1997 and currently has no constraints. The remaining exchange controls are estimated to be restricting less than three percent of the individuals. Outward foreign direct investments' limitations have been eliminated. Institutional investors are subjected to a foreign exposure limit currently sitting at either 25 percent or 35 percent reliant on the type of the institutional investor (Exchange Control Department, 2016).

1.3 Research Questions

The primary research question to be investigated is:

Has reserve accumulation affected macroeconomic stability in South Africa from 1995 to 2016?

In addition, the following secondary research questions will also be explored:

i. What is the relationship between reserve accumulation and macroeconomic stability?
ii. Are the effects of foreign exchange reserves immediate or delayed?

1.4 Scope of the study

This research is limited between March 1995 and June 2016. The start date covers the period from when South Africa started getting significant capital inflows after financial liberalisation in March 1995 (Gossel, 2011).

1.5 Organization of the study

This dissertation is organised in five chapters with the first chapter introducing the background of the topic. Chapter two discusses the theoretical and empirical literature. The third chapter then discusses the methodology and data used to conduct the

analysis. Chapter four discusses the empirical results and Chapter 5 then concludes the study with a summary conclusion, policy implications, and recommendations for future research.

Chapter 2

Literature Review

2.1 Introduction

The literature review below explores the theoretical frameworks relating to foreign exchange reserves and macroeconomic stability with a focus on the effects on economic growth, inflation, and capital flows. It is worthy of noting that the body of literature and the information available on FER in South Africa is very limited adding a limitation to what the researcher could explore. The literature review then concludes with a summary of the key themes.

2.1 Theoretical Studies

2.1.1 Foreign exchange accumulation and economic growth

2.1.1.1 How FER causes economic growth

Olokoyo, Osabuohien, and Salami (2009) argue that foreign exchange reserve accumulation stabilises the economy but can also determines the economy's' rating in the global markets which can be viewed as a motive to hold FER. Razzaque, Bidisha, & Khondker (2017) further state that in accordance with 'orthodox' economic theory, devaluations may have two expansionary effects. The first is an expenditure-switch away from imports to local productions; and second, by improving international competetiveness and strengthening exports. However, develuations may also negetively affect output productivity. Fukuda & Kon (2010) further assess the whether FER has an impact of macroeconomic stability factors or the factors infact stimulate FER accumulation; they report that an increase in FER leads to a permanent decline in consumption if the interest rates on the FER are low but if the tradeable sector is capital intensive then an increase in FER may increase investment thus improving economic growth.

2.1.1.1 How FER effects economic growth

Hoarding FER prevents government spending on infrastructural and social development which are pivotal for economic growth that is a vital source to boost

growth (Bentum-Ennin, 2014). Reserves overwhelm protective needs and excess reserves could be used to promote growth (Crus and Kriesler, 2008, 2010; Crus and Walters, 2008). FER has short-term expansionary effects as prices of tradeable goods increase compared to prices of non-tradeable goods. In the long run, these effects disappear as the investment of the increased profits leads to an increased demand of non-tradeable goods and labour. However, if there are unexpected rounds of FER accumulation that follow, then they may have an effect on growth in the long run.

2.1.1.1 Studies on both the causes and effects of FER on economic growth

In viewing whether FER stimulates macroeconomic factors or rather macroeconomic factors boost FER accumulation, currency under-valuations increase exports which fosters foreign trade and ultimately, productivity. The rise in productivity outweighs the current need to invest in infrastructure and social development. Currency undervaluation also reduces foreign currency prices of local real assets thus stimulating foreign direct investments (FDI). FER accumulation also gives an impression of liquidity thus enabling the economy to gain control and be able to afford costs so it can pursue consistent policy. Though FER accumulation outweighs FDI, FDI externalities may be able to stimulate growth on their own. Technologically lacking economies have a lot to gain from export externalities and FDI inflows hence FER accumulation is more beneficial to developing economies (Bentum-Ennin, 2014).

Thus, in summary, FER accumulation affects the economy in three ways. First investment in FER means less investment in infrastructure and social development, which hinders growth. Secondly, investment in FER results in currency devaluation; which boosts exports, improving productivity and economic growth. Finally, FER accumulation brings about an improved rating in the global markets.

2.1.2 Foreign exchange accumulation and CPI

2.1.2.2 How FER affects CPI

Steiner (2017) argues that FER accumulation may be inflationary because an increase in FER increases the monetary base if it is not sterilized, which in turn enables the money multiplier thus increasing money supply.

Heller's (1976) hypothesis of global monetarism posits that currencies are linked through fixed exchange rates shown by changes in prices that occur as a result of variations in reserve accumulation though these changes in prices may be delayed and the delays are much shorter and the impact smaller in developing countries.
More recently, Elhiraika & Ndikumana (2007) state that foreign exchange reserves stabilise the macroeconomy and allow monetary authorities to intervene in the markets and control currency and price level fluctuations (inflation).

2.1.2.1 How CPI stimulates FER

Khan (1979) counters however, that these relationships may arise from reverse causality whereby reserves respond to inflation. Rabin and Pratt (1981) argue that Heller's results were influenced by the short-run effects of FER accumulation and the 1970's rising inflation.

2.1.2.2 Studies on both cause and effects of FER

Kruskovic (2015) infers that FER is not inflationary if the rate of accumulation does not exceed the rate of economic growth and a slightly high inflation is really harmful for developing and emerging economies leading to monetary authorities being interested in holding higher reserves.

Thus in summary, FER accumulation is expansionary as it increases money supply which is inflationary, however, FER can also be used as a tool to sterilise the economy but to be effective, the inflation rate needs to be lower than the growth rate of the economy.

2.1.3 Foreign exchange accumulation and capital flows

2.1.3.1 How Capital flows stimulate FER accumulation

Reinhart & Reinhart (2008) argue that when there is an inflow of global capital flows and the economy would rather choose to have a stable exchange rate, then there is a need to hold reserves and the need for the central bank to hold reserves arises. Olokoyo, Osabuohien, and Salami (2009) concur and state that in capital-intensive economies, an increase in reserves enhances investments and economic growth. Fukuda and Kon (2010) support Olokoyo et al. (2009) and posit that reserve accumulation reduces the costs of liquidity risk and encourages investors to invest in emerging economies because it allows government to maintain stable policy decisions. Jeanne and Korinek (2012) agree but further argue that although emerging economies can benefit from holding foreign reserves, this may drive misaligned exchange rates, which then exposes the economy to credit booms and sudden stops. Bentum-Ennin (2014) state that reserve accumulation thus extends to consumption, capital stock, labour inputs and liquid and illiquid debt levels.

2.1.3.2 Foreign exchange accumulation affects capital flows

Calvo et al. (2008) suggest that FER could prevent sudden stops by managing the currency depreciation and can also act as a buffer should such a stop occur thus monetary authorities may hold more of reserves for higher security. Bentum-Ennin (2014) argues that economies therefore forego potential alternative investment income when investing in foreign exchange, which can in turn crowd out public investment vital for economic growth. Ventura (2003) argues that the international allocation of capital reduces the rate of return differentials among the different countries and leads to macroeconomic instability because they accumulate the impacts of productivity shocks enables expectational shocks.

2.1.3.3 Studies on the cause and effect by FER

However, Dhar (2012) and Steiner and Qian (2016) argue that the availability of foreign exchange reserves opens up global debt markets and allows countries access to cheap credit and carry trade investments even though there is the increased risk of capital flow volatility and asset price bubbles

Thus in summary, FER acts as a form of ‘insurance’ in times of sudden stops of capital and thus an economy will choose to hold FER if it prioritises a stable exchange rate. The reason being, because an increase in reserves enhances investments, by giving investors certainty on the ability of the economy to meet its obligations, and stimulates economic growth while decreasing liquidity risk.

2.2 Empirical Studies

The discussion on the empirical studies on foreign reserve accumulation and macroeconomic stability is structured according to the three main factors of interest starting with reserve accumulation and inflation studies followed by studies in reserve accumulation and growth and then studies devoted to reserve accumulation and capital flows.

2.2.1 Studies on FER and inflation

Heller (1976) analysed international reserves and world-wide inflation using quarterly percentage changes between 1958 and 1974 using the least squares regression model. He reports that global inflation was impacted by global reserves when various currencies were connected by fixed exchange rates because of the direct link between various national money supplies and the national rates of inflation. In addition, he finds that a significant change in global money supply results from changes in global reserves, and a similar relationship was also found between global reserves and global price level. Thus Heller concludes that global reserves significantly impacted the average global money supply and that a parallel relation between FER and national inflation rate existed.

Siegel (1981) investigated FER levels on financial assets which minimise inflation fluctuations in the United States from February 1952 to April 1973. The results show that applying the stochastic financial model to currency demand deposits led to an optimal reserve ratio and minimised price variability. The model illustrated these levels as a function of a structure of sudden stops to asset demands and are different from the levels that minimise the variations of both the nominal and real value of the assets which suggests that using policy instruments (like reserve levels) to stabilise money supply may lead to procedural destabilisation of prices and income. There were inconclusive views regarding maximum reserves or the criteria thereof, to position reserves for achieving macroeconomic stability. Siegel, unlike Heller (1976) who concluded that FER positively influences inflation, concludes that using policy instruments to stabilise money supply led to a systematic destabilisation of prices and income.

More recently, Obstfeld, Shambaugh, and Taylor (2008) examine the linkages between financial stability, the trilemma and international reserves in 134 countries for the period between 1980 and 2004. OLS analysis infers that financial stability and financial openness are responsible for the current state of global reserve holdings. They thus contend that FER accumulation is the key to manage local financial stability and exchange rates in global economic structure. Obstfeld *et al*. conclude that reserve levels just before a crisis can predict exchange rate movements for both emerging and developing countries.

Aizenman, Chinn, and Ito (2010) like Obstfeld, Shambaugh, and Taylor (2008) also analysed the effects of the trilemma on economic performance in emerging countries but using datasets that were organised into five-year panels from 1972 to 2006. The study employed the weighted least squares model and found that increased monetary independence has the ability to dampen output volatility while a more stable exchange rate increased output volatility. Higher monetary autonomy increased inflation and while a more stable exchange rate and greater financial openness decreased price levels. This meant that a stable exchange rate can increase output volatility when financial advancement is at a transitional phase. The study concluded that improved

financial openness accompanied by improved financial development reduced output volatility. Aizenman, Chinn, and Ito (2011) use fixed effects and system GMM to measure the extent that monetary independence, exchange rate stability and financial openness (the three policy choices) affected macroeconomic performances in Asia between 1972 and 2006. The results show that these policy choices influence output variability and the mid-term inflation level through investment and trade channels whereby increased monetary independence lowers output variability and a steadier exchange rate means increased output volatility that can be mitigated through reserves. They thus conclude that the sizeable amount of reserves in Asian countries improved stability of the trilemma, which concurs with Obstfeld, Shambaugh, and Taylor (2008) and Aizenman, Chinn, & Ito (2010).

Thus in summary, studies generally find that there is a relationship between international reserve accumulation, financial globalisation and exchange regimes. More specifically, studies show that international reserves significantly impacted aggregate money supply and the rate of national inflation rate. However, studies also show that reserves do not have a direct effect on price levels unless monetary authorities neutralise monetary changes via sterilisation or by private capital flows.

2.4.2 Studies on FER and growth

Elhiraika & Ndikumana (2007). test whether reserve accumulation is stimulated by the need for macroeconomic stabilisation in 21 African countries over the period of 1979 – 2005 using a two-step error correction model (ECM). The results show however that reserve accumulation cannot be justified by investment portfolio motives nor by stabilisation objectives, and has not been particularly effective in stimulating investment, which contrasts with studies of other regions in the world such as Kaminsky and Reinhart (1999), Obstfeld, Shambaugh, and Taylor (2004 and 2005), Gosselin & Parent (2005).

In order to answer the question of the factors that drive reserve accumulation, Bastourre, Carrera, and Ibarlucia (2009) conduct GMM analysis of 136 countries for the period 1973-2003. The study finds that openness, regional trends and consistency increase reserve accumulation. However, the results show that there is an inverted U-shaped relationship between FER, income levels and financial deregulation. Hence,

when economies are in the transitional phase of development and are increasing exposure to capital flows, FER accumulation can be regarded as a significant instrument to obtain successful incorporation thus suppleness can be viewed as complementing FER.

Olokoyo, Osabuohien, & Salami (2009) argue that countries accumulate reserves to secure macroeconomic stability. However, debate regarding the levels of accumulation has sparked up in developing countries like Nigeria with some arguing that reserve accumulation levels determine the economy's global rating. Fukuda & Kon (2010) suggest that increased foreign exchange reserves reduce the costs of liquidity risk by influencing consumption, capital stock and labour input as well as liquid and illiquid external debt. Thus, reserves increase liquid and total debt while shorting debt maturity leading to a reduction in consumption and stimulate investment and ultimately economic growth.

Steiner and Qian (2016) uses a notional model to explore how reserves alter the maturity structure of external debt with the using the yield curve flattening. Regarding the likely interdependence of private and public debt, fixed effect panel data regressions, two stage instrumental approaches and a vector Autoregressive (VAR) model covering a sample of 66 emerging and developing economies between 1984 and 2012, the results show that FER increases the share of long-term rather than external short-term debt. These results thus suggest that reserve accumulation impacts the maturity structure of the country's external debt.

Aizenman, Edwards, and Riera-Crichton (2011) use a dynamic error correction model (ECM) to analyse how Latin American countries adjusted to commodity terms of trade (CTOT) shocks during 1970-2007. The results show that reserve management not only lessens the short-term effects of CTOT, but also impacts the long-run adjustment of the real exchange rate as well. They thus conclude that in accordance with Aizenman *et al*. (2011), active reserve management substantially reduced the real exchange rate volatility.

With regards to Africa, Batuo, Mlambo and Asongu (2017) analyse the linkages between financial stability, liberalisation, development and economic growth for countries 41 in Africa over 1985-2010. Dynamic panel regression models show that development and liberalisation are positively related to financial instability, and that post-liberalisation economic growth improves financial stability, which concurs with Demirguc-Kunt & Detragiache (1998).

Thus, to summarise, emerging market studies found that foreign exchange reserves reinforce macroeconomic stability through external debt maturity composition and reduce the cost of liquidity risk.

2.4.3 Studies on FER and capital flows

Obstfeld *et al*. (2008) investigate the interlinkages between financial stability, trilemma and FER for 134 countries over the period of 1980 – 2004. The results show that as reserves increase, the currency strengthens while as money supply increases, the currency weakens. As the expected state of the future of the economy deteriorates, pressure is exerted on the currency caused by withdrawal of deposits from the banking system to speculate on FER leading to capital outflows. The reserve bank can regulate the current devaluation using FER but as Siegel (1981) points out, such regulation may lead to increased price levels. Steiner (2010) further suggests that these sterilisation policies might increasingly be offset by private capital flows making them less effective. Obstfeld *et al*. conclude that financial stability and financial openness go a long way in explaining reserve accumulation in the global economy.

Kaminsky and Reinhart (1999) examine 76 currency and 26 banking crises over a period from the 1970s to 1995. An applied a stochastic financial model finds that problems in the banking sector normally lead to currency crisis because reserve backing diminishes when the central banks attempt to ease domestic balance sheet problems by acting as the lender of last resort (LLR). This is especially prevalent in emerging economies where undeveloped domestic bond markets may trigger speculative investments. Kaminsky and Reinhart conclude that strong banking regulations allow for a smoother financial liberalisation.

Obstfeld, Shambaugh, and Taylor (2004 and 2005) analyse the coherence of international interest rates and how the trilemma imposes limitations monetary independence and capital market openness. They use monthly international interest rates for over 130 years between

1870 and 1914. The results of the error correction model show that exchange rates of pegged currencies result in a closer relation to the home country interest rate than non-pegs. In addition, the interest rates in pegged economies responds more to variations in the base rate and are responsible for variations in local rates. Pegged economies thus lose considerable monetary independence over capital controls as hypothesised by the trilemma.

Steiner (2010) analyses the impact of reserves on financial stability and monetary policy using Granger causality for 126 economies covering the period 1970-2006. The output shows that FER holding increases the price levels on both the global and the country scales, which accords with Heller (1976). Steiner further argues that sterilisation policies might be offset by private capital flows making it less effective and thus central banks sterilising less, which could increase inflationary effects in the future. FER can thus poses a risk to monetary stability in accordance with Bastourre *et al*. (2009).

Creamer and Algu (2014) empirical investigate the trilemma (Aizenman et al., 2010) using a VAR model covering the period of 2000 - 2014. The results find that South Africa sacrifices exchange rate stability for free capital flows and monetary independence. Thus, Creamer and Algu conclude that in South Africa, reserve accumulation in effect has not significantly dampened the trilemma trade-offs. van Vuuren (2015) investigates the macroeconomic effects of FER in South Africa between 2000-2014. OLS analysis covering the period of 2000 to 2014 finds that GDP and imports influence the accumulation of reserves in South Africa, and van Vuuren thus concludes that policy makers do not necessarily consider the cost of reserves prior to their reserve accumulation decisions.

Thus in summary, studies on the determinants of FER in South Africa find that reserve accumulation has not had a significantly dampened the trilemma trade-off, possibly because the country has increasingly become linked to the international business cycle via interest rate channels. Consequently, policy makers do not necessarily consider the cost of reserves prior to their reserve accumulation decisions and the adequacy levels of reserves are largely unjustifiable by most adequacy measures.

2.5 Conclusion of Literature Review

Theory suggests that reserve accumulation enables intervention in global markets by monetary policies which brings about macroeconomic and financial stability however these effects may not be fully recognisable because of the fact that reserves may also be used for economic ratings in the global markets. Studies also highlighted that there is a relationship between reserve accumulation, financial globalisation and exchange rates. Studies have shown that international reserves impact aggregate money supply and a similar connection between FER and a nationwide price level exists but they do not have a direct effect on price levels unless monetary authorities neutralise such monetary changes via sterilisation, which may destabilise the economy. Although, these negative effects could be offset by private capital flows, because central banks sterilising these flows only seldomly, the FER's inflationary effects in the future could be bigger. The increase in reserves can pose a threat to monetary stability but greater financial openness accompanied by improved financial development tends to mitigate that risk.

In addition, financial stability and financial openness are found to be associated with reserve accumulation, reserve accumulation has not had a significantly dampened the trilemma trade-off, possibly because the country has increasingly become linked to the international business cycle via interest rate channels. Hence, while international studies tend to find that reserve accumulation is associated with financial and macroeconomic stability, this may not be the case for post liberalised South Africa.

Chapter 3:
Data and Methodology

3.1 Introduction

This chapter explores the research design, methodology and data used to conduct the empirical analysis. The chapter then ends with a summary of the limitations and assumptions associated with the empirical estimations.

3.2 Research Design

The study is of longitudinal nature, Salkind (2010) defines a time-series analysis as a statistical methodology appropriate for a longitudinal research design. These consist of repeated observations of the same variables over a set period of time (Cherry, 2017). The approach taken is that of statistical data analysis, dealing with data expressed as numbers rather than words which Carl Wisler, Datta, Silberman, & Picket (1992) define as a quantitative study. The data employed is of a quarterly frequency, starting in the second quarter of 1995, which is when South Africa undertook financial liberalisation, to the second quarter of 2016, which is the last period when data is available for the identified variables in the study. The key variables identified are inflation, economic growth and capital flows. Secondary data was collected from the SARB and world bank websites which minimised complications as the data was readily available, already tested and secondary data is widely accepted by government and private sector as reliable, valid and complete. The model chosen for the study is the Vector Error Correction Model (VECM) and the selection process is detailed below. This approach is similar to the one taken by Gossel (2011) when analysing South Africa's macroeconomic post liberalisation capital flows amongst others.

3.3 Methodology

The study uses econometric techniques to evaluate the relationship between foreign exchange reserve accumulation and macroeconomic stability in South Africa. The analysis is divided into the following five stages:

i) Test for stationarity and unit roots.

ii) Test for cointegration using the Johansen method to establish how many cointegrating factors there are and estimate their relationships (Johansen, 1988) if the data is not stationary.

iii) Vector Autoregressive (VAR) if no significant cointegration is found or a Vector Error Correction Model (VECM) if cointegration is detected this shall convert the data to stationary for the analysis as non-stationary data produces a spurious model. The ECM cannot be utilised as the model has multiple equations. This model corrects for any disequilibrium and guides the variables back to equilibrium (Kestel, 2008). Though the time series may be integrated, there are certain linear transformations that maybe stationary thus the use of two tests for cointegration.

iv) Test the stability of the model.

v) Carry out impulse responses and variance decomposition analysis.

3.3.1 Stationarity and unit root testing

Engle and Granger (1987) stated that stationarity testing should be the initial step in regression analysis so as to avoid spurious regression. According to Brooks (2002), stationarity may impact the behaviour of a time series because shocks to a stationary series slowly fade while those of a time series that is not stationary remain infinite.

The analysis will thus use the Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1981) and Phillips-Perron (PP) (Perron & Phillips, 1988) unit root tests and the KPSS (Kwiatkowski, Phillips, Schmidt, & Shin, 1992) stationarity test in cases where the ADF and PP unit root assessments derive contradictory results.

3.3.2 Cointegration analysis

The second step of the analysis is to establish if there is any cointegration between the non-stationary variables. Gujarati (2012) defines cointegration as a long-term or equilibrium relationship among two or more variables that are not stationary. There are two common methods to assess cointegration: the Engle-Granger regression method (Engle & Granger, 1987) and the Johansen multivariate approach (Johansen,

1988). This study uses the Johansen trace and max-eigen tests statistics because they are more suited to circumstances where there may be more than one cointegrating relationship (Brooks, 2012).

The trace test can be represented as:

$$H(0): \lambda_{trace}(r) = -T \sum_{i=r+1}^{n} + \ln(1-\lambda_i) \quad (1)$$

And

$$\lambda_{\max}(r, r+1) = -T \ln(1-\lambda_{i+1})$$

where *r* = cointegrating trajectories,

$\lambda_i = appoximate\ values\ of\ the\ characteristics\ extracted\ from\ \pi$ and T is the number of observations

Different cointegrating vectors are equal to or less than *r* against the general alternate. The further the estimated characteristic root is from zero, the more negative ln (1- λ_i) and the greater λ_{trace} .

The Max-Eigen test statistic is arrived at from the following equation:

$$H(1): \lambda_{\max}(r, r+1) = -T \ln(1-X_{r+1}) \quad (2)$$

The max-eigen tests the number of cointegrating vectors against the alternative of *r* + 1. Critical values have both been calculated by Johansen (1988). Should the statistic be greater than the critical value then the probability statistics will be less than the 5% significance, which indicates cointegration.

3.3.3 VAR or VECM

If the non-stationary variables are found to be non-cointegrated, then the analysis can be conducted using a Vector Autoregressive model (VAR) whereas if cointegration is detected then a vector error correction model is appropriate (VECM) Brooks (2002).

The unrestricted Vector Autoregressive model (VAR) will take the following form (Sims, 1972):

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t \quad (3)$$

where y_t is a vector or *k* potentially endogenous variables, *p* are the number of lags, A_t is a $k \times k$ matrix of the parameters and u_t is the error term.

However, if cointegration is found then the vector error correction model (VECM) is adopted with the following form (Johansen, 1988):

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t \quad (4)$$

where $\Pi = -(\mathrm{I}_k - A_1 - \ldots - A_p)$ and $\Gamma_i = -(A_{i+1} + \ldots + A_p)$ for $i = 1, \ldots, p-1$

Πy_{t-1} is the long-run relationship and Γ is short-run adjustments (Harris, 1995). Thus, by subtracting y_{t-1} from both sides and rearranging the terms, the VAR becomes a VECM, and only the long-run segment contains the differenced variables because the variables are at most in the first difference (Lutkepohl, 2004).

3.3.4 Stability testing

Having assessed the stationarity and cointegration condition, the next step before making deductions from the VAR / VECM is to test the residuals to evaluate the stability of the models as well as test for any specification errors. The stability and specification are tested using the following four methods:

i) Characteristic roots to graphically represent the inverse unit roots as a autoregressive polynomial. If all the roots sit within a circle, then the model is deemed to be stable while the roots on the border of the circle represent the cointegrated equations (Swarts, 2016).

ii) The Breusch-Godfrey Lagrange Multiplier (LM) developed by Breusch (1978) and Godfrey, (1978) to test for autocorrelation among the specification errors with the null hypothesis being that there is no evidence of a correlation that exists among the variables.

iii) The Jarque and Bera (1987) graphical representation of the distribution to test the null hypothesis of a normal distribution.

iv) The white test (White, 1980) to examine the standard deviations of the error terms should the standard deviations differ in the various observations then the model is heteroscedastic.

3.3.5 Empirical model

Should the cointegration null hypothesis not be rejected (Johansen, 1988), then the study will employ the Vector Error Correction Model (VECM), which will determine the short-term dynamics between the variables by restricting the long-run behaviour of the variables. In examining the effect of foreign exchange reserve accumulation on macroeconomic stability, this study adopts the empirical model of Gossel (2011) and thus models the impacts of foreign exchange reserve accumulation on the macroeconomic stability components in South Africa using the following multivariate estimations where each variable is a function of its own lag and the lag of the other variable in the system:

$$D(FER_{t-1}) = D(\beta_0) + \beta_1 D(CPI_{t-1}) + D(\beta_2 CF_{t-1}) + D(\beta_3 GDP_{t-1}) + D(\beta_4 CA_{t-1}) + D(\beta_5 ST_{t-1}) + D(\beta_6 FX_{t-1}) + D(\beta_7 CPI_{t-1}) + \nu_t^y$$

(6)

$$D(CPI_t) = D(\beta_0) + D(\beta_1 CPI_{t-1}) + D(\beta_2 CF_{t-1}) + D(\beta_3 GDP_{t-1}) + D(\beta_4 CA_{t-1}) + D(\beta_5 ST_{t-1}) + D(\beta_6 FX_{t-1}) + D(\beta_7 FER_{t-1}) + \nu_t^y$$

(7)

$$D(CF_t) = D(\beta_0) + D(\beta_1 CF_{t-1}) + D(\beta_2 CPI_{t-1}) + D(\beta_3 GDP_{t-1}) + D(\beta_4 CA_{t-1}) + D(\beta_5 ST_{t-1}) + D(\beta_6 FX_{t-1}) + D(\beta_7 FER_{t-1}) + \nu_t^y \quad (8)$$

$$D(GDP_t) = D(\beta_0) + D(\beta_1 CF_{t-1}) + D(\beta_2 CPI_{t-1}) + D(\beta_3 GDP) + D(\beta_4 CA_{t-1}) + D(\beta_5 ST_{t-1}) + D(\beta_6 FX_{t-1}) + D(\beta_7 FER_{t-1}) + \nu_t^y \quad (9)$$

$$D(CA_t) = D(\beta_0) + D(\beta_1 CPI_{t-1}) + D(\beta_2 CF_{t-1}) + D(\beta_3 GDP_{t-1}) + D(\beta_4 CA_{t-1}) + D(\beta_5 ST_{t-1}) + D(\beta_6 FX_{t-1}) + D(\beta_7 FER_{t-1}) + \nu_t^y \quad (10)$$

$$D(ST_t) = D(\beta_0) + D(\beta_1 CF_{t-1}) + D(\beta_2 CPI_{t-1}) + D(\beta_3 GDP_{t-1}) + D(\beta_4 CA_{t-1}) + D(\beta_5 ST_{t-1}) + D(\beta_6 FX_{t-1}) + D(\beta_7 FER_{t-1}) + \nu_t^y \quad (11)$$

$$D(FX_t) = D(\beta_0) + D(\beta_1 CF_{t-1}) + D(\beta_2 CPI_{t-1}) + D(\beta_3 GDP) + D(\beta_4 CA_{t-1}) + D(\beta_5 ST_{t-1}) + D(\beta_6 FX_{t-1}) + D(\beta_7 FER_{t-1}) + \nu_t^y \quad (12)$$

3.3.6 Impulse responses and variance decompositions

After ensuring that the VECM is correctly specified and stable, impulse responses and forecast error variances are employed to measure the effects of shocks. The generalised impulse response functions capture the effects of possible future occurrences by factoring past performance of the expectation operator used to measure shocks and conditional dependence (Koop, Pesaran, & Potter, 1996). The study employs impulse responses to investigate how the three macroeconomic factors respond to variations in FER. The impulses measure the responsiveness of the

measures of financial stability to changes in FER investigating the long run effect and the shock will be applied to the error of each factor to monitor the effects of such on the model over time. Variance decompositions tabulate the variance of the factors based on their own shocks as opposed to shocks to the other variables that are transmitted to the variable (Brooks, 2002).

3.4. Data

The multivariate model makes use of four factors of interest and three control factors, selected on the basis of the relevant literature as explored in Chapter 2.

3.4.1 Factors of interest

Foreign Exchange Reserve Accumulation

The South African Reserve Bank (SARB) defines FER as official public sector foreign assets readily available to and controlled by monetary authorities to finance payment of imbalances, regulating the magnitude of those imbalances and meeting ad hoc monetary policy objectives. These objectives translate to maintaining confidence in the monetary, financial stability and exchange rate policies. SARB aims to maintain a level of reserves that enables it to be liquid at all times based on levels of short-term external debt, probability of a sudden stop of capital flows, imports, exports and GDP growth and the costs and returns of holding FER (South African Reserve Bank, 2014). FER data was obtained from the SARB website and converted to logarithmic form.

Real GDP

Gadanecz & Jayaram (2009) suggest that GDP signals the strength of the macroeconomy. FER accumulation prevents government spending on infrastructural and social development, which are pivotal for economic growth that is a vital source to boost growth (Bentum-Ennin, 2014) so a negative relationship can be expected between FER accumulation and GDP. GDP measures economic activity over a certain annual period thus translates to the overall size of the economy (Matshego, 2019). GDP is measured in R Mil and will be converted to logarithms.

Inflation (CPI)

This factor is included to account for fiscal and monetary policy stability (Alshubiri, 2017**)**. High inflation rates indicate structural weaknesses in the economy leading to tightened monetary policy, and thus, a negative relationship can be expected between inflation and macroeconomic stability (Gadanecz & Jayaram, 2009). Inflation is measured as a percentage thus no logarithm conversion is required.

Capital Flows (CF)

Calvo *et al*. (2008) note that FER could prevent sudden stops by managing the currency depreciation and can also act as a buffer should such a stop occur. Reinhart & Reinhart (2008) further argue that when there is an inflow of capital flows, and the economy seeks to maintain a stable exchange rate, then there is a need to hold reserves for the purposes of sterilisation. Economies therefore forego potential alternative investment income when investing in foreign exchange, which can in turn crowd out public investment vital for economic growth (Bentum-Ennin, 2014).

In addition to the domestic effects, the international allocation of capital reduces the rate of return differentials among different countries and tends to heighten macroeconomic instability productivity shocks enables expectational shocks while minimizing the potential for risk hedging (Ventura, 2003). It has been countered however, that in capital-intensive economies, an increase in FER enhances investments and economic growth (Olokoyo, Osabuohien and Salami, 2009). It is therefore not clear whether FER has a positive or negative relationship with capital flows into South Africa. The capital flow data used is the total assets flow measured in ZAR millions and is transformed into logarithms.

3.4.2 Control factors

The control factors have been selected based on the relevant literature. Since the study focuses on foreign exchange reserves, the control factors utilised as measures of macroeconomic stability are those classified as the external sector and consist of

the current account balance, exchange rate, and short-term debt levels. The control factor data was obtained from the World Bank.

Current Account Balance (CA)

Trunin (2008) states that when the net sales of financial assets are in excess of the balance of the current account, the central bank sells off the reserves to finance the current account deficit and maintain a balance of payments equilibrium. This leads to a worsening of the current account when reserves increase. Thus, it can be expected that reserves and the current account deficit should have a negative relationship as an increase in the reserves would indicate affordability in holding a larger deficit. The time series data to be used for this variable shall be obtained from the world bank website.

Exchange rate (FX)

A financial crisis may result from an over or under valuation of a currency due to significant capital outflows or a deterioration of the competitiveness in exports. According to Shah (2017) reserves stabilise exchange rates during current account fluctuations. It is thus anticipated that a more stable local currency shall bring about macroeconomic stability hence a positive relationship can be expected. This study uses a quarterly average as a dummy variable of the exchange rate to derive the volatility series in accordance with Ilzetzki, Reinhart, & Rogoff (2017).

Short-term Debt (ST)

Reserves are seen as an indicator of a country's ability to repay short-term debt thus it can be assumed that an increase in reserves would stimulate short-term debt. Hence, it is expected that there will be a positive relationship between reserves and short-term debt.

3.5 Assumptions and Limitations

3.5.1 Data assumptions

The data used in the analysis is publicly available secondary data obtained from the SARB website. The data utilised is presumed to be valid, accurate and complete.

Therefore, the researcher does not have control over the quality of the data (Bryman et al., 2011). For the periods that publicly available data is not available, the process of interpolation has been employed using cubic spline estimates. Where the beginning points of data are not available for interpolation periods then the data is neutralised using zero as a value.

3.5.2 Methodological assumptions

The data analysis methods utilised are assumed to be sufficient give focus to epistemological evidence. By applying quantitative models, the methodology will eliminate biasness in the analysis, this will allow for factual conclusions and maintain the objectivity of the researcher. This study is therefore a quantitative study, following a numeric approach and views reality from an objective pattern (van Vuuren, 2015).

3.5.3 Data Limitations

This study is confined to the period from the beginning of South Africa's financial liberalisation in 1995 to the period of the latest available data according to the SARB website.

3.5.4 Methodological limitations

The VECM can only handle a maximum of eight variables before the model is overly complex and unstable (Brooks, 2002).

3.6 Ethics

The University of Cape Town research ethic's policy requires that clearance be obtained for any research conducted. Research that does not involve human participants or that has the review and analysis of information freely available on the public domain or research that has institutional audits undertaken can be exempted from ethics review. Secondary analysis is exempted from clearance if the data is a macro dataset and the re-analysis of the micro-data is derived from a recognised data service (UCT, 2018). This study meets these requirements as stated and does not require an application for clearance by the ethics committee.

Chapter 4

Research Findings Discussion

4.1 Introduction

This section discusses the analysis and the results of the study. The chapter commences with a discussion of the unit root results before examining the implications of Johansen cointegration tests. Thereafter, the stability of the VECM is tested before the results of the VECM are discussed. The chapter then moves to the results of impulse responses and variance decomposition analyses.

4.2 Pre-Testing

4.2.1 Unit Root Testing

This study used the Augmented Dickey-Fuller test (Dickey & Fuller, 1981) and Phillips Peron (PP) test by (Peron & Phillips, 1988) unit root tests, which compare the *t*-statistic to the critical values to determine if the null hypothesis should be accepted. If the probability value of the test is higher than 5% and the absolute value of the *t*-statistic is less than the critical value, then the variable is non-stationary and therefore free of unit roots is accepted. Non-stationary variables are converted to stationarity using differencing. In a case where the two tests have contradictory results, the KPSS stationarity test (Kwiatkowski *et al*., 1992) is used to resolve the disparity.

The results of the unit root tests are summarised in Table 2 in light of the contradictory results in the ADF and PP tests, the KPSS test has been used to confirm the stationarity of the variables and it confirms that CA, FER, FX and GDP are non-stationary in the data set and the use of the Johansen cointegration test is justifiable. Furthermore, as stated in the methodology, there are two common methods to assess cointegration: the Engle-Granger regression method (Engle & Granger, 1987) and the Johansen multivariate approach (Johansen, 1988).the study involves multiple variables thus the multivariate method is justified, namely, the Johansen multivariate approach.

Table 1: Unit Root Test results

	ADF with Trend and Intercept				PP with trend and Intercept				KPSS with trend and intercept			
Variable	**I(0)**		**I(1)**		**I(0)**		**I(1)**		**I(0)**		**I(1)**	
CA	-4,111	**	-4,409	***	-4,764		-3,468	***	0,102	***	0,146	***
CF	-9,254	***	-8,862	***	-9,261		-3,160	***	0,072		0,500	***
CPI	-3,479		-8,151	***	-3,731	**	-3,160	***	0,040		0,040	***
FER	-0,437	***	-7,704	***	-0,253		-3,160	***	0,316	***	0,050	***
FX	-1,758	***	-9,122	***	-1,795	***	-3,160	***	0,138	*	0,088	***
GDP	-10,448		-13,704	***	-10,429		-3,160	***	0,117	*	0,040	***
ST	-2,597		-9,111	***	-2,646	***	-3,160	***	0,095		0,065	***

*The tests included a maximum of 11 lags chosen based on the Schwartz Information Criterion (SIC). ***1% **5% *10% significance levels.*

Notes: CA=Current Account; FX=Foreign Exchange rate; ST=Short-term Debt; CF=Capital flows; CPI=Consumer price index; GDP=GDP Growth rate; FER=Foreign exchange reserve.

4.2.2 Cointegration Tests

The results of the Johansen trace and max-eigen tests (Johansen, 1988) are presented in Table 3. According to both there is at least one cointegrating equation and thus the VECM includes one cointegrating equation for simplicity purposes (Adeleye, 2018). This indicates that the time series has error-correction representation and reflects long run adjustment (Andrei & Anfrei, 2014.).

Table 2: Summary of the Cointegration test results with lag 1-1 (SIC)

		Trace Test			Max-Eigen Test		
Hypothesised No of CE (s)	**λ**	**Trace λ**	**5% CV**	**Prob****	**Max-Eigen**	**5% CV**	**Prob****
None**	0,397	150,009	125,615	0,001	40,921	46,231	0,166
At Most 1*	0,320	109,088	95,754	0,004	31,252	40,078	0,346

Notes: CA=Capital account; FX=Foreign exchange rate; ST=Short-term debt; CF=Capital flows; CPI=Consumer price index; GDP=GDP Growth rate; FER=Foreign exchange reserve. Lags interval (in first difference): 1 to 2; CE, cointegrating equations; CV, critical value. *denotes rejection of the hypothesis by trace test and ** denotes rejection by Max-Eigen test at the 0,05 level based on the MacKinnon, Heugh and Michelis (1999) *p*-values

4.2.3 Lag Selection

Having determined that a VECM is more appropriate than a VAR, the next step is to identify the appropriate lag level to be used in the model. The common methods used

to achieve this are the Akaike Information Criterion (AIC), Schwartz Information Criterion (SIC) and Hannan-Quinn (HQ) criteria. As can be seen from Table 3 below. The SC and HQ tests have identified one lag.

Table 3: Lag selection

Lag	AIC	SC	HQ
0	91.073	91.286	91.158
1	83.642	**85.347***	**84.324***
2	83.849	87.045	85.127
3	83.909	88.596	85.783
4	83.966	90.145	86.437
5	83.550	91.221	86.619
6	83.236	92.398	86.9
7	**82.704***	93.358	86.966

4.3 Stability Testing

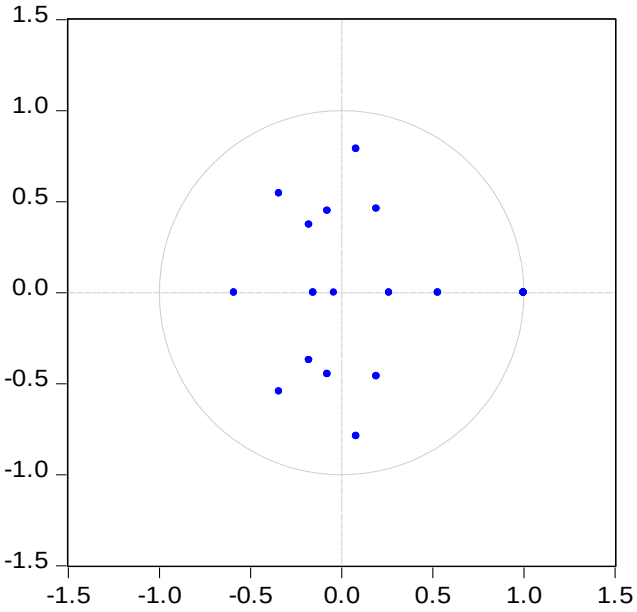
After the appropriate lag level has been selected, the VECM can be produced and a range of stability tests are employed to ensure that the VECM is stable.[2] The tests used to measure the stability of the model included the following:

1. The AR unit root characteristic plots.
2. The Jaqui-Bera normality test.
3. The Breusch-Godfrey Lagrange Multiplier (LM) test.
4. The whiteness heteroskedasticity test

The AR plot in Figure 3 below shows that the inverse roots are inside the circle with the cointegrating equation on the boundary as expected, which is a confirmation of the covariance and stability of the model.

[2] A set of dummy variables were also included to compensate for the most extreme outliers, these are listed in Appendix A.

Figure 3: Inverse Roots of AR Characteristic Polynomial



The results of the remaining diagnostic tests summarised in Table 4 below indicate that the model is stable and correctly specified.

Table 4(a): Test for Normality

Jaqure-Bera Normality Test

Component	Chi-sq	df	Prob
Jarque-Bera	9,551	7	0.794
Skewness	7,612	7	0,368
Kurtosis	1,939	7	7,963

Table 4(b): Whiteness Test for Heteroscedasticity

Null hypothesis: No serial correlation at lag h

Lag	LRE*stat	df	Prob.	Rao F-stat	df	Prob
1	42.985	49	0.714	0.860	(49.146.6)	0.725
2	50.098	49	0.430	1.024	(49.146.6)	0.443
3	0.873	49	0.873	0.749	(49.146.6)	0.879

Table 4(c): LM (Lagrange Multiplier) Test for serial correlation

Chi-sq	df	Prob.
1627.913	1624	0.468

4.4 VECM Results

The VECM is used to determine the short-term dynamics of factors by limiting their long run variations. This is done by limiting long run relations via cointegration and the error correction term is the deviation from the long run equilibrium (Kestel, 2008). Below is the discussion of these long and short run variations.

4.4.3 Long-Run Results

The long-run results summarised in Table 5. The study analyses the impacts FER has on macroeconomic stability thus FER shall be treated as the dependant variable. The results show that the most positively significant factors are CF at 16.756 (5.545) and CPI at 13.410 (7.131). With regards to capital flows, this significant impact may be a result of the fact that South Africa is not capital intensive and relies on international sources for capital so higher reserves are beneficial for the inflow of capital (Gossel & Biekpe, 2012). Obstfeld, Shambaugh, & Taylor (2005) define the trilemma as the choice between open trade, flexible exchange rate or independent governance. South Africa has a flexible exchange and open trade flows. Reinhart & Reinhart (2008) argue that when there is an inflow of global capital flows and the economy would rather choose to have a stable exchange rate, then there is a need to hold reserves as this would enhance the county's ability to do so. For this reason, increased reserve holdings stabilise the exchange rate. In the case of inflation, in accordance with Akpan (2016), the positive relationship could be because the central bank uses the Rand to acquire foreign exchange for reserves, leading to an increased supply of Rand, thus fuelling inflation. There is also a positive long-run relationship between FER and CA at 2.494 (3.078) which supports the assertion by Trunin (2008) that the reserve bank utilises financial assets to aid the current account. Variations in FER have the least positive long-run impact on itself of only 0.271 (1.093). This implies that an increased

foreign exchange accumulation improves production, but the effect is minimal, which is in line with Bentum-Ennin (2014).

Among the negative coefficients are short-term debt at -2.136 (-3.276) and the exchange rate at -0.715 (-0.747). This is not unexpected as foreign currency adjustment is commonly used to stabilise current account fluctuations (Shah, 2017) and therefore is affected positively by foreign currency reserves. According to Steiner (2010), foreign exchange reserve accumulation compensates for capital market liberalisation by replacing a microeconomic policy distortion of capital controls with a macroeconomic policy of reserve accumulation. Hence, the negative coefficient could reflect the economy's reactivity to internal monetary policy than to external factors. Finally, FER is negatively associated with GDP at -1.729 (-3.841), Affirming the assertion by Lipuma & Koelble (2009) that failure to invest in social and infrastructural projects by emerging markets because of accumulating reserves may negatively impact that economy.

Thus, the long-run results indicate that capital flows, inflation, and the current account have positive effects whereas short-term debt, GDP and the exchange rate have negative effects. Foreign exchange reserve accumulation is insignificant.

Table 5: Long-Run Effects

	Coeff	Std Error	T-Stat
CA.L1	2.494	0.810	3.078
CF.L1	16.756	3.022	5.545
FER.L1	0.271	0.248	1.093
CPI.L1	13.410	1.880	7.131
GDP.L1	-1.729	0.450	-3.841
FX.L1	-0.715	0.960	-0.747
ST.L1	-2.136	0.652	-3.276
ECT (-1)	-2.667	0.331	-0.805

4.4.4 Short-Run Results

As shown in the table below, 1.2% of the disequilibrium is corrected in the period after the disturbance indicating that FER naturally adjusts itself in the long term. A

1% change in FER accounts for a 2.6% change in capital flows, 7.6% in inflation and 1.9% in GDP. These results reflect the countries open economy and consequently, capital inflows impact the exchange rate and inflation, these are stimulated by the accumulation of central bank reserves for periodic sterilisation and policy stability (Reinhart & Reinhart, 2008; Olokoyo, Osabuohien, and Salami, (2009; Gossel and Biekpe, 2012).

Table 6: Short-Run Effects

ECT	ΔCF	ΔCA	ΔCPI	ΔFX	ΔFER	ΔGDP	ΔST
CointEq1	-0.043	-0.128	-0.096	0.026	-0.012	-0.053	0.016
	(0.022)	(0.086)	(0.015)	(0.010)	(0.007)	(0.116)	(0.012)
	[-1.920]	[-1.480]	[-6.334]	[2.777]	[-1.672]	[-0.459]	[1.292]
ΔCF (-1)	-1.093	-0.485	0.146	-0.077	-0.026	0.002	0.016
	(0.096)	(0.371)	(0.065)	(0.040)	(0.031)	(0.500)	(0.052)
	[-11.279]	[-1.307]	[2.230]	[-1.870]	[-0.806]	[0.004]	[0.305]
ΔCA (-1)	0.124	-0.691	0.232	-0.052	0.016	0.289	-0.053
	(0.053)	(0.219)	(0.038)	(0.024)	(0.019)	(0.295)	(0.031)
	[2.316]	[-3.153]	[6.020]	[-2.143]	[0.851]	[0.979]	[-1.729]
ΔCPI (-1)	0.307	1.827	0.468	0.108	0.076	0.486	-0.203
	(0.247)	(0.945)	(0.169)	(0.104)	(0.081)	(1.274)	(0.134)
	[1.242]	[1.933]	[2.802]	[-1.033]	[0.935]	[0.381]	[-1.521]
ΔFX (-1)	-0.903	-2.875	-1.194	-0.378	-0.037	-2.698	-0.030
	(0.356)	(1.361)	(0.240)	(0.150)	(0.117)	(1.835)	(0.192)
	[-2.540]	[-2.111]	[-4.970]	[-2.514]	[-0.315]	[-1.470]	[-0.153]
ΔFER (-1)	-0.175	0.375	-0.151	-0.251	0.595	2.653	-0.403
	(0.417)	(1.644)	(0.290)	(0.182)	(0.141)	(2.216)	(0.232)
	[-0.407]	[0.228]	[-0.520]	[-1.381]	[4.204]	[1.197]	[-1.733]
ΔGDP (-1)	-0.059	-0.088	-0.097	0.038	-0.019	-0.877	0.031
	(0.043	(0.163)	(0.029)	(0.018)	(0.014)	(0.220	(0.023)
	[-1.377]	[-0.542]	[-3.340]	[2.128]	[-1.375]	[-3.971]	[1.352]
ΔST (-1)	-0.205	-0.345	-0.555	0.078	0.013	-0.807	0.417
	(0.251)	(0.917)	(0.162)	(0.101)	(0.079)	(1.236)	(0.130)
	[-0.856]	[-0.377]	[-3.430]	[0.767	[0.168]	[-0.653]	[3.217]
C	0.013	0.065	-0.011	0.020	0.016	-0.215	0.045
	(0.056)	(0.215)	(0.038)	(0.004)	(0.019)	(0.290)	(0.030)
	[0.223]	[0.303]	[-0.292]	[-0.278]	[0.885]	[-0.742]	[1.467]
R-Squared	0.879	0.833	0.791	0.723	0.547	0.738	0.635
Adj R-squared	0.794	0.715	0.644	0.527	0.226	0.553	0.377
F-Statistic	10.280	7.062	5.362	3.684	1.705	3.984	2.461
Log likelihood	19.437	-75.880	47.244	80.552	98.177	-97.087	62.929

Note: Dummy and exogenous variables are excluded to conserve space. T-stat in [ ].

4.4.5 Impulse Responses

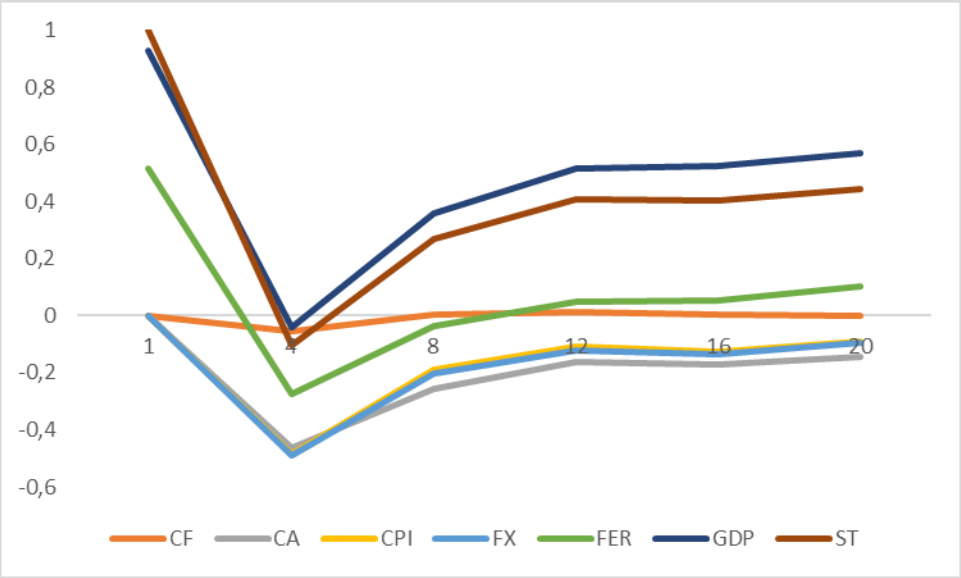
Impulse responses measure the reaction of variables to shocks. The results of the Cholesky impulse responses are presented in Figure 6 below. The impulse responses capture a period of five years. Generally, FER Innovations have positive long-run impacts on GDP, reserve accumulation (*FER*), and inflation (*CPI*); and negative associations with short-term debt (*ST*) and the current account (*CA*) while the effects are marginal for capital flows (*CF*) and the exchange rate (*FX*).

More specifically, FER has the most significant immediate impact on itself at 7.50% followed by GDP at 6% and ST at 1.05%. In the long-run, FER impulses have the most significant effect on GDP at 29,93%, which suggests that increased foreign exchange accumulation improves production (Bentum-Ennin, 2014) and that failure to invest in social and infrastructural projects by emerging markets may negatively impact the economy (Lipuma & Koelble,2009). The most negative reaction to a FER shock is CPI at -9.28%, which accords with Akpan (2016) that the central bank uses the Rand to acquire foreign exchange for reserves, leading to an increased supply of Rand, thus fuelling inflation. The next most negative reaction is short-term debt (*ST*), which has an immediate reaction of 1.05% and converges to -3.53% by period four with a decrease that to -6,93% by period eight where it becomes significant. ST rapidly decreases to -7% by period twelve and settles there until period twenty where there is a further decrease to -8.13%. The significance is indicative of the assertion that FER provides confidence to lenders (Broner, Lorenzoni, & Schmukler, 2013).

With regards to the less significant responses, capital flows react negatively at around -0.031% in the short-run and level off at around 0.001% in the long-run. A possible reason for this is because an increase in capital flows depreciates the exchange rate, which in turn stimulates foreign trade (Ögren, 2003), and because the central bank may use interest rates rather than reserves to sterilise and stabilise the economy (Gossel & Biekpe, 2017). Hence, it is not unexpected that the responses of the exchange rate are steady at around 0%.

The results of the impulse responses show that shocks to reserve accumulation affect GDP immediately, whereas capital flows and the current account respond after four periods, and inflation and short-term debt respond most significantly after eight periods (the exchange rate does not significantly respond). Hence, these results indicate that reserve accumulation impacts productivity, followed by the macroeconomic factors, and then the financial factors thereafter.

Figure 4: Foreign Exchange Reserve Accumulation Impulse Responses



4.4.6 Variance Decomposition

The next step of the analysis is to determine the proportions of the variances of foreign exchange reserves arising from its own shocks versus shocks to the other factors. The variance decomposition results are presented in Table 7 below.

Innovations on FER have the most impact on itself at 88% in period one, decreasing by almost 10% in period two to 79% and thereafter to settle at around 69% from period 5 onwards. At the same time, the variations in capital flows (*CF*), foreign exchange (*FX*) and the current account (CA) increasingly explain more of the variance in FER. CF increases from 10,07% to 16% by period four and then settles at around 15% from period 6 while FX increases from 1% to around 11% and CA increases marginally from

0.3% to 3% over the same time. The remaining factors of inflation (CPI), production (GDP) and short-term debt (ST) remain relatively insignificant throughout.

Table 7: Variance Decompositions by FER

PERIOD	GDP	CA	CF	CPI	FER	FX	ST
1	0,000	0,300	10,060	0,300	88,220	1,120	0,000
4	1,000	2,000	16,000	0,200	73,000	7,600	0,200
8	0,072	3,020	15,776	0,380	69,828	10,781	0,143
12	0,058	3,068	15,667	0,427	69,233	11,442	0,105
16	0,063	3,066	15,560	0,438	69,066	11,718	0,089
20	0,059	3,095	15,504	0,434	68,896	11,931	0,080

Notes: CF=Capital flows; CPI=Consumer price index; GDP=GDP Growth rate; FER=Foreign exchange reserve; CA=Current account; FX=Foreign exchange rate; ST=Short term debt

Chapter 5

Research Conclusion and Recommendations

This study analysed the interaction between foreign exchange reserves and macroeconomic stability in South Africa over the post-financial liberalisation period of 1995-2016 using a Vector Error Correction Model (VECM) with impulse responses and variance decompositions.

The aim of this study was to answer the following primary and secondary research questions.
The primary research question investigated was:

How has reserve accumulation impacted macroeconomic stability in South Africa from 1995 to 2016?

In addition, the following secondary research questions were explored:

i. What is the relationship between reserve accumulation and macroeconomic stability?
ii. Are the effects of foreign exchange reserves immediate or are they delayed?

This section utilises the results of the VECM analysis discussed in Chapter 4 to summarise the conclusions in answering these questions.

5.1.1 Has reserve accumulation impacted macroeconomic stability in South Africa from 1995 to 2016?

The VECM results show that reserve accumulation has impacted productivity, the budget balances, and the financial factors to varying degrees. In general, reserve accumulation is found to have a negative association with productivity, and the financial factors of inflation and short-term debt whereas the budget balance factors of capital flows and the current account are positively associated with reserve accumulation. Hence, it can be concluded that South Africa's foreign exchange

reserve accumulation has affected macroeconomic stability which agrees with the findings by (Andrei & Andrei, 2014).

5.2.1 Is the relationship between reserve accumulation and macroeconomic stability positive or negative?

The results of the analysis show that in the short-run and long-run, reserve accumulation is positively associated with the current account and inflation which concurs with findings by Trunin (2008) and Akpan (2016) respectively; and negatively associated with the exchange rate and GDP agreeing with Reinhart & Reinhart (2008) Lipuma & Koelble (2009) respectively. In contrast, the relationship between reserve accumulation and capital flows is negative in the short-run (Gossel & Biekpe, 2012), but becomes positive in the long-run whereas short-term debt is positive in the short-run and becomes negative in the long-run(Shah, 2017).

These results thus suggest that there is a positive relationship between reserve accumulation and macroeconomic stability as evidenced by the significant and positive relationship with capital flows, the current account and inflation. In addition, the negative associations with the exchange rate, GDP and short-term debt indicates that the South African economy is impacted by endogenous monetary policies rather than external factors.

5.2.2 Are the effects of foreign exchange reserves immediate or delayed?

The results of the impulse responses show that shocks to reserve accumulation affect GDP immediately, whereas capital flows and the current account respond after four periods, and inflation and short-term debt respond most significantly after eight periods (the exchange rate does not significantly respond). Hence, these results indicate that reserve accumulation impacts productivity (Bentum-Ennin, 2014), followed by the

macroeconomic factors, and then the financial factors thereafter (Andrei & Andrei, 2014).

5.3 Recommendations for Future Research

This study only analysed the relationship of foreign exchange reserve accumulation with macroeconomic stability over the period of 1995-2016. Future studies could therefore expand this research as follows:

- Using reserve adequacy measures as a dependent variable to study how reserves can be managed to maximise benefits for macroeconomic stability.
- To expand the study period to include pre- and post-liberalisation samples to explore the historic effects of the country's changing financial economic policy regimes.
- Study factors used to measure macroeconomic stability to see if they may be determinates of foreign exchange reserve accumulation in South Africa and may be leading to excessive accumulation rather than reserve adequacy management.

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8. Appendix A: Dummy variables

FX		GDP		LST		CF		CPI		CA		FER	
98Q1	1,675	98Q4	3,383	98Q4	11,761	97Q1	4,085	97Q4	1,944	96Q4	7,778	96Q2	10,510
98Q4	1,793	01Q3	3,720	02Q1	12,279	98Q2	4,228	98Q3	1,921	98Q3	7,991	97Q2	10,878
99Q1	1,793	03Q4	3,997	05Q2	12,297	01Q3	3,916	00Q3	1,776	00Q2	7,686	02Q4	12,266
01Q1	2,260	05Q1	3,397	06Q3	12,663	02Q3	4,247	01Q1	1,906	02Q3	7,512	03Q4	12,049
02Q1	2,326	05Q4	3,103	09Q1	12,143	03Q3	4,361	02Q3	2,201	03Q2	7,961	04Q3	12,319
08Q1	2,074	07Q2	3,302	10Q1	11,978	04Q3	4,277	03Q3	1,897	04Q3	9,484	05Q1	12,566
09Q1	2,115	08Q3	3,843	11Q1	12,337	05Q3	3,663	04Q4	1,047	07Q2	10,152	06Q2	13,060
11Q1	1,994	09Q1	3,259	15Q3	12,904	06Q2	4,015	06Q1	1,347	09Q1	9,770	08Q1	13,484
13Q1	2,245	13Q3	4,848			07Q2	4,006	08Q4	2,281	10Q3	9,845	08Q4	13,710
14Q1	2,368	14Q3	3,698					09Q3	1,921	11Q2	9,966	09Q2	13,746
15Q1	2,492	15Q1	4,039					03Q4	1,802			11Q3	13,917
		15Q4	4,860					11Q1	1,753			13Q4	14,247
								14Q1	1,774			14Q2	14,297
								15Q1	1,630				

9. Appendix B: Impulse responses

Period	CF	CA	CPI	FX	FER	GDP	ST
1	0	0	0	0,021225	0,071879	0	0,038559
4	-0,0501	-0,28209	0,016169	0,017834	0,11753	0,012305	0,010664
8	0,026498	-0,06521	0,040316	0,02416	0,068203	0,074092	0,006516
12	0,026919	-0,08234	0,029374	0,021138	0,092718	0,004822	0,020204
16	0,01953	-0,04727	0,02605	0,020721	0,081285	0,112628	0,018849
20	0,010885	-0,0186	0,019805	0,020883	0,088062	0,01317	0,021523