Evaluating the determinants of systemic risk in the South African financial sector

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To

My wonderful parents

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ABSTRACT

Systemic risk affects the aggregate global financial sector – banking and non-banking financial institutions – and is seen as one of the most important financial risks, yet it remains one of the least understood. The 2007/2008 global financial crisis and subsequent failure of financial institutions put the need to understand the nature and propagation of systemic risk at the centre of regulatory authorities' attention. This crisis illustrated how systemic risk could rapidly propagate in the financial sector through common shocks, counterparty and informational contagion. The increased interconnectedness of financial institutions increases the ease with which shocks are propagated. Although large levels of systemic risk are not an inherent part of the South African financial sector, South Africa's high degree of concentration could increase the ease with which financial difficulties spread and pose systemic problems. This possible contagion and systemic problems was efficiently mitigated by the swift intervention of the South African Reserve Bank (SARB) with the failure of African Bank in 2014. The development level, country-specific characteristics and degree of financial integration of countries should be considered when assessing their systemic risk. Considering that the structure of the banking and non-banking sector differs, it follows that the factors influencing systemic risk will also differ. As a result, the effective implementation of and subsequent adherence to regulatory measures will differ between these two sectors.

Given the nature of systemic risk and that it manifests differently in different economies, a consensus with regards to a specific definition cannot be reached. In a broad context, systemic risk refers to the capital shortfall a financial institution is likely to experience conditional on a significant market decline, resulting in the undercapitalization of the aggregate financial sector. Systemic risk is proxied by the Systemic Risk Index (SRISK) and Long Run Marginal Expected Shortfall (LRMES).

This study empirically investigates the relationship between systemic risk and various firm-specific and country-specific variables in the South African banking and non-banking sector. A panel data approach covering the period 2003-2017 for the banking sector and 2005-2017 for the non-banking sector is employed on annual data from publicly listed South African financial institutions. Given the differing characteristics of the banking and non-banking sector, the nature of the relationship between systemic risk and the various factors also differs. Findings indicate the existence of a significant long run cointegrating relationship between a non-bank financial institution's size and activities with systemic risk and a short run relationship between the size and profitability of the financial institution with systemic risk. Only firm-specific factors were found to have a significant effect on systemic risk in the non-banking sector. In contrast, the banking sector does not display a long run cointegrating relationship between systemic risk and any of its determinants. The banking sector's panel regression found both firm-specific characteristics, such as the bank's leverage as well as country-specific factors, such as capital inflows to be significant determinants of systemic risk.

In light of these findings, the regulatory implications and recommendations for both these sectors differ. For the non-banking sector, a decrease in the financial institution's size combined with an increase in their activities and profitability is likely to decrease the amount of systemic risk produced by the non-banking sector. For the banking sector, it would be of importance to re-examine the regulations relating to a bank's leverage. Also, considering the volatile nature of capital flows and the possible swift reversals thereof, it is recommended that internal factors affecting capital flows - such as domestic interest rates and credit ratings - should be investigated in detail. Regulations addressing the activities, size and profitability of non-bank financial institutions as well as the leverage and size of banks need to be addressed. Financial institutions need to adhere to both the Basel accords as well as country-specific regulations, whilst ensuring that they have adequate capital reserves as to mitigate the effects of potential systemic crises.

Keywords: Systemic risk; SRISK; LRMES; Financial contagion; Common shocks; SIFIs; Regulation; Banking sector; Non-banking sector; South Africa

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CHAPTER 1 INTRODUCTION

1.1 Introduction

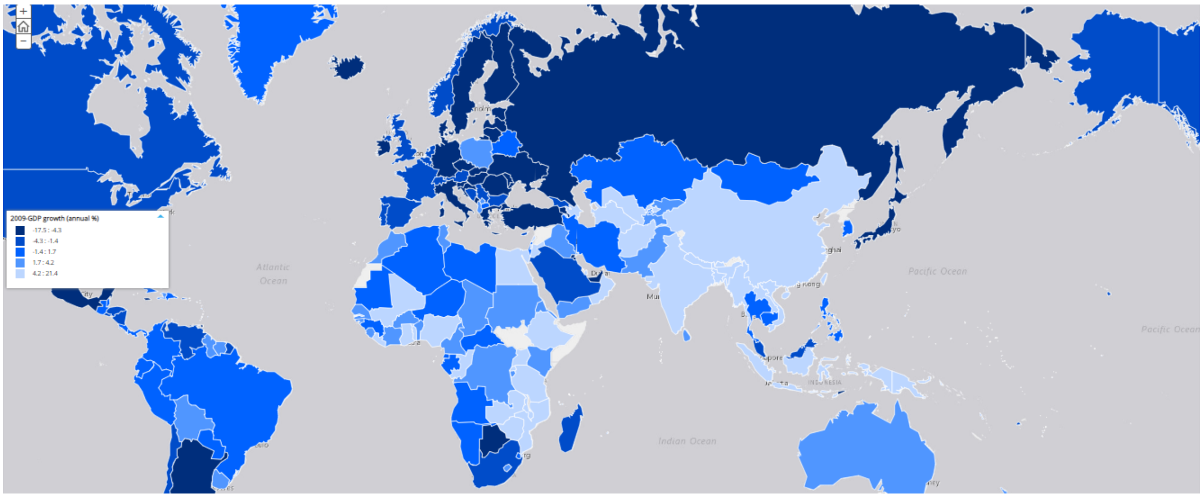
The most important economic concept for understanding the origin and spreading of financial crises lie in the understanding of systemic risk. The spreading of financial crises occurs due to many reasons, of which systemic risk is the most important element. The need to better understand the nature and origin of systemic risk intensified after the recent global financial crisis in 2007/2008. As the complexity and interconnectedness of the global financial system have progressed, so has the creation of systemic risk (BIS, 2009:4). The concept of systemic risk has contagion effects at its heart and also includes simultaneous financial instabilities as an aftermath of aggregate shocks (De Brandt & Hartmann, 2000:5).

Systemic risk is a negative externality that influences the real economy and aggregate financial system arising from bank distress (Bernanke, 2009). De Brandt, Hartmann and Peydró (2009:636) expand this definition and define systemic risk in both a narrow and broad sense. The narrow definition encompasses contagion effects in the interbank market, while the broad definition includes mutual shocks to several financial institutions and markets. The Financial Stability Board (FSB), International Monetary Fund (IMF) and Bank for International Settlements (BIS) provide a comprehensive definition of systemic risk, stating that it’s the disruption to financial services caused by the impairment of the financial system – either the entire system or parts – with the potential to have a significant negative influence on the real economy (IMF, BIS & FSB, 2009:2). The failure of an individual financial institution would therefore not only severely affect the financial sector, but correspondingly the aggregate economy.

Background

The most recent global financial crisis of 2007/2008 illustrated how the collapse of an individual financial institution impaired the functioning of the global economy. This was the first ever crisis since the Great Depression in the 1930s to lead to a global negative gross domestic product (GDP) growth, as illustrated by Figure 1.1 below and Figure A1.1 in Annexure A. The United States’ (US) GDP growth rate declined from 3% in 2005 to 0% in 2008, entering the recession with -3% growth in 2009 (World Bank, 2015). This financial crisis not only influenced the US’ economy, but financial markets around the world, as evident in Figure A1.1. This may be due to the increased level of interconnectedness as a result of advanced information technology, enabling a larger degree of connection among global financial markets (Kim & Ryu, 2015:20).

Figure 1.1: Global annual GDP growth in 2009



Source: World Bank (2019)

The globalised financial system and advanced information technology enable investors to easily invest in foreign markets, especially in emerging markets that propose larger expected returns. Investments across countries link global investors and global financial markets, creating a positive link. Emerging markets grow easier as a result of increased global investments and information efficiency of developed markets (Kim & Ryu, 2015:20). Despite the positive linkages, bad news in one market immediately spreads and negatively affects other markets in three ways: contagion, informational spill-overs and common shocks (Kim & Ryu, 2015:21).

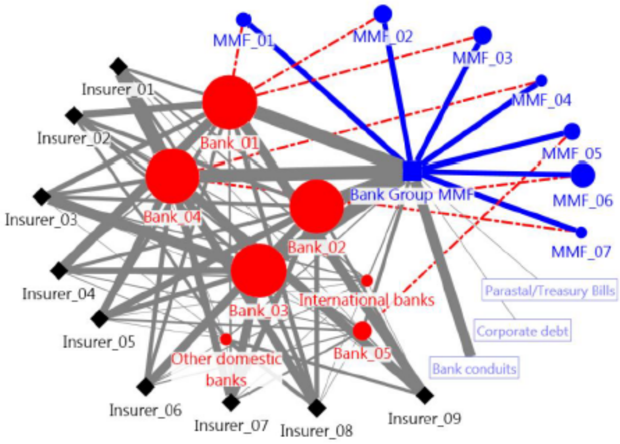
Contagion refers to the direct linkages between financial institutions, for example borrowing in the interbank market. Informational spill-overs and contagion are alike, but the linkages are indirect in nature. For example, bad news about one financial institution in a particular country may result in a negative perception of similar financial institutions in the given country, resulting in risk adverse investors to withdraw their money, causing bank runs and market panic. Common shocks refer to indirect linkages between financial institutions holding similar assets or investors being from identical firms. These aforementioned elements of interconnectedness therefore ensure that an adverse shock in one financial sector spreads and has the potential to impair other financial institutions, the real economy as well as the entire global financial sector.

The effect of interconnectedness differs between emerging markets and developed economies. Claessens and Ghosh (2013:107) found that large capital inflows in emerging markets were numerous times followed by economic slowdowns or capital reversals in the domestic banking sector. Net capital flows to emerging markets therefore tend to be volatile, contributing to an increase in systemic risk.

The level of interconnectedness and corresponding systemic risk posed by financial institutions should be closely monitored and considering the effects of the global financial crisis, the mitigation thereof should become of increased importance (Foggit, 2016:2). The global financial crisis exhibited that although individual financial institutions complied with the regulatory requirements, the compliance of the financial system as a whole could not be measured (Foggit, 2016:4). BIS (2009:125) emphasises the need to identify the sources of systemic risk in the three most essential elements of the financial system: instruments (loans, bonds, equities and derivative instruments), markets (over-the-counter (OTC) and structured exchanges) and institutions (banks, pension funds and insurance companies), since all these elements generate systemic risk that requires mitigation to prevent the failure of the financial system. The mitigation of systemic risk would improve financial stability, which is a main component of sustained macroeconomic stability.

Even as an emerging market, South Africa experiences a great extent of interconnectedness in global financial markets and is therefore more susceptible to possible contagion than most of its counterparts. Contagion can include the transfer of negative financial shocks across country borders through either direct or indirect counterparty contagion or informational contagion and, subsequently, increases the overall level of systemic risk. South Africa experiences a large degree of concentration in the financial sector and although it does not have any systemically important financial institutions (SIFIs), it does have domestic systemically important financial institutions, i.e. Nedbank, Standard Bank, ABSA, FirstRand Bank and Investec (Foggit, 2016:7). The banking sector is dominated by these five banks, accounting for 90.5% of the total banking sector assets, of which 95% are domestic banking assets (IMF, 2014:10). The same degree of concentration is also evident in the insurance sector with the five largest insurance companies accounting for 74% of the insurance market and the seven largest fund managers in control of 60% of unit trusts (IMF, 2014:10). Non-bank financial institutions (NBFIs) account for approximately two thirds of financial assets in South Africa, very much larger when compared to other emerging markets. Most major banks have affiliations with insurance companies, either as holding companies or as direct owners.

Figure 1.2: Interconnection between bank and non-bank financial institutions



Source: IMF (2014:11)

The South African financial sector is not only a concentrated structure, but is also categorised by a high degree of interconnectedness. Figure 1.2 illustrates the transactions within the financial sector, particularly those undertaken by banks and NBFIs. A broader band is representative of a stronger link between the institutions, while a larger node denotes the institution's size. This concentrated structure displays South Africa's large degree of interconnectedness, making South Africa highly susceptible to possible contagion during times of financial crises.

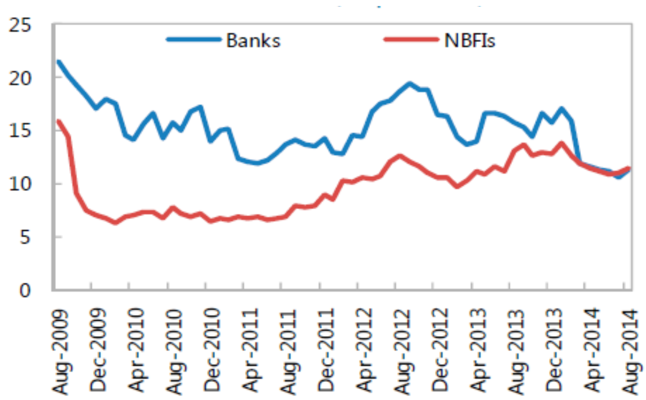
Although the South African economy was not unaffected by the global financial crisis, it did not experience a banking crisis. South Africa experienced strong economic growth with an annual 4.6% expansion in output between 2002 and 2007, together with inflation that remained within the 3% to 6% target range (World Bank, 2019). The issue of credit in the private sector rapidly expanded to an average 17.5% a year, while house prices increased with an average 11% a year between 2002 and 2007 (Foggit, 2016:28). South Africa also experienced a fiscal deficit of 2.3% in 2003/2004, but improved to a 0.3% surplus in 2006/2007 and 0.6% in 2007/2008 (National Treasury, 2009:3). South African regulators were concerned with the accelerating credit growth and implemented a variant counter-cyclical capital buffer from 2003 to 2007 as control for the credit boom, potentially harmful for financial stability (Havemann, 2018:56). Regulatory intervention[1] contributed to the increase in the overall capital adequacy levels from 11.96% in March 2003 to 13.67% in March 2005 (Havemann, 2018:58). South Africa had higher than required levels of regulatory capital, together with a sound bank regulatory framework and a credible monetary policy framework (National Treasury, 2011:4), allowing the financial system to remain fairly stable during the global financial crisis.

[1] The implementation and changes of the BASEL accord will be discussed in detail in Chapter 2.

Although South Africa did not experience a banking crisis in the aftermath of the global financial crisis, systemic risk can still be experienced by smaller financial institutions due to globalised financial markets. The collapse of African Bank Limited (African Bank) in 2014 displayed that systemic risk can be produced by small financial institutions even if they are not perceived to be systemically risky. A great part of the non-bank financial sector also poses potential systemic risk to the South African financial sector (SARB, 2013:34). The reason for this is that non-bank financial intermediation has increased in the financial sector, providing customers an alternative mode of access to credit (SARB, 2013:34).

South Africa experienced a potential systemic risk crisis with the failure of African Bank in 2014 and the IMF (2014:7) considers the collapse thereof to be a significant event. African Bank specialises in unsecured lending to low-income households and their vulnerabilities became apparent in August 2014. The failure was a result of too many loans and credit cards extended to low-income families at high interest rates, while accepting too little deposits. The failure of customers to pay their monthly payments and repay their loans resulted in losses of approximately R 6.4 billion. The SARB acted proactively and placed African Bank under curatorship in order to limit contagion (IMF, 2014:7).

Figure 1.3: South African financial spill-over coefficients (in percentage)



Source: IMF (2014:13)

Throughout the African Bank incident, the vulnerability of South African financial institutions to contagion remained relatively low, as depicted by Figure 1.3. South Africa's entire financial system remained sound and well capitalised, with a tier 1 capital ratio increasing to 13% in 2014 from a 12% in 2011, acting as a buffer against shocks (IMF, 2014:13).

High levels of systemic risk are not an inherently part of the South African financial sector (Foggit, 2016:4), but South Africa's high levels of concentration and interconnectedness together with increased reliance on external (volatile) capital flows could potentially be a source of systemic risk. Volatile capital flows and a large degree of interconnectedness pose as sources of systemic risk in emerging market economies. In order to optimally mitigate systemic risk to promote financial stability, individual financial firms that pose large amounts of systemic risk in emerging markets need to be identified (Foggit, 2016:4). In addition, the possible factors that contribute to systemic risk must also be identified to prevent an aggregate capital shortage and to improve current systemic risk identification.

1.2 Problem statement

There is a large degree of concentration in the South African financial sector. South Africa's banking sector is dominated by the five largest banks, accounting for 90.5% of total banking sector assets. The same degree of concentration is evident in the rest of the financial sector where the five largest insurance companies account for 74% of the insurance market. The South African financial sector is increasingly interlinked in the global economy and is not only categorised by a large degree of concentration, but also by a large degree of interconnectedness, increasing the likelihood of contagion and systemic risk during financial turmoil.

1.3 Research question

What is the level of systemic risk in the South African financial sector and what are the potential determinants?

1.4 Research aim and objectives

This study focuses on the banking and non-banking sectors of the South African financial sector. The latter comprises of insurance companies, pension funds and money market funds (MMF). Banks are included in this study since they were at the centre of the 2007/2008 global financial crisis that caused distress to the real economy and are considered to be the point of origin for systemic risk given their role in financial intermediation (Laeven, Ratnovski and Tong*,* 2014:3). Non-banking companies are included since most major banks have some degree of connection with insurance companies, either as holding companies or as direct owners as well as their affiliation with fund managers (IMF, 2014:10).

1.4.1 Primary objective

The primary objective of this study is to compare historic levels of systemic risk at firm level in the South African financial sector and to identify the factors that contribute to the varying levels of systemic risk. In order to achieve this primary objective, various secondary objectives must also be achieved.

1.4.2 Secondary objectives

The secondary objectives of this study include:

i. comparing historic levels of systemic risk and identifying possible trends between the banking and non-banking sectors in South Africa[2];
ii. identifying the determinants of systemic risk in the South African financial sector;
iii. examining the differences in the bank and non-bank financial institutions' contributions to systemic risk for South Africa; and
iv. providing sector-specific strategies to hedge against systemic risk (policy objectives).

1.5 Research design

This section is divided into two subsections to ensure that a constant order in the methodology takes place. Firstly, the projected data and software is explained, followed by the methodology.

The research for this study follows the work of Brownlees and Engle (2012), Laeven *et al.* (2014), Baselga-Pascual, Trujillo-Ponce and Cardone-Riportella (2015) and Foggit (2016). The variables included in this study are therefore obtained from literature and include international, national and firm-specific indicators. A quantitative analysis forms the basis of this study, whereafter a qualitative analysis follows. Firm level data of companies' financial statements are obtained from IRESS Expert Dataset (2019). The data cover the period 2003-2017 for the banking sector and 2005-2017 for the non-banking sector, since it includes major events such as the global financial crisis, European sovereign debt crisis of 2012, failure of African Bank and liquidation of VBS Mutual Bank. EViews™ 8 is used to conduct the econometric analysis.

A panel data analysis comprising six firms for banking and seven firms for non-banking (five insurance firms[3] and two investment firms) is conducted in order to identify the statistically significant determinants for the different financial industries. Data sourced from New York University Stern Volatility Laboratory (V-lab) provide indicators such as the Long Run Marginal Expected Shortfall (LRMES) and Systemic Risk Index (SRISK) as measures of systemic risk. Previous studies, such as that of Foggit (2016), calculated their own SRISK, but part of this study's

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[2] I wanted to expand my study to include other African countries, but IRESS Expert (2019) did not have sufficient data, hence this study only pertains to the South African financial sector.

[3] Four life insurance firms and one non-life insurance firm.

contribution is using V-lab as an external source to enable the comparison between this study's results and previous empirical results. These various indicators will be compared in order to analyse the historic levels of systemic risk in South Africa.

SRISK serves as the primary dependent variable in this multivariate regression model. Subsequent versions of the specification will replace SRISK with LRMES. The independent variables include:

- The size of the financial institution, measured as the total value of assets and transformed using the natural logarithm (López-Espinosa, Rubia, Valderrama & Antón, 2013:293)
- The size of financial institution *i* at time *t*, measured as the firm's market capitalisation (Malkiel & Xu, 1997)
- The size of financial institution *i* at time *t,* measured as the market capitalisation of the firm and transformed using the natural logarithm (Moreno, 2013)
- Firm activities with two alternative measures: Firstly, the share of loans in total assets (Foggit, 2016) and secondly, the share of non-interest income in total income (Moreno, 2013). A higher share of non-interest income in total income and a diminished share of loans in total assets display a greater degree of bank involvement in market-based activities (Laeven *et al.,* 2014:12)
- A funding structure with two alternative measures suggested: share of depository funding (Beltratti & Stulz, 2012) and unstable funding or funding fragility index (Baselga-Pascual *et al.* 2015:141) and Foggit (2016)
- Bank capitalisation, where Laeven *et al*. (2014:12) proposes the Tier 1 capital ratio and Poghosyan and Cihak (2011) propose total equity as a share of total assets
- Capital flows, proxied by portfolio investment liabilities (Foggit, 2016:192)
- Leverage of firm *i* at time *t*, with three alternative measures suggested: ratio of debt to assets (Chen & Shimerda, 1981); ratio of debt to equity (Goel, Chadha & Sharma, 2015); and the sum of the firm's market capitalisation and liabilities divided by its market capitalisation (Foggit, 2016)
- Liquidity of firm *i* at time *t,* with two alternative measures proposed, i.e. the net stable funding ratio and the liquidity coverage ratio (Acharya, 2012)
- Performance of financial institution *i* at time *t,* proxied by the return on equity (ROE) (Alber, 2015)
- Profitability of financial institution *i* at time *t,* proxied by the return on assets (ROA) (Varotto & Zhao, 2018)

- Efficiency of financial institution *i* at time *t,* proxied by the cost-to-income ratio (CIR) (Baselga-Pascual *et al.*, 2015)
- Economic growth proxied by the GDP (Borio & Lowe, 2002)
- Unemployment measured by the change in the unemployment rate (Bofondi & Ropele, 2012)
- Interest rates proxied by the South African Benchmark Overnight Rate (SABOR), Rand Overnight Deposit Rate (RODR) and the repo rate (Eichengreen & Arteta, 2000)
- Inflation proxied by the change in consumer price index (CPI) (Hardy, 1998)

This regression analysis will aid in identifying the largest and most significant determinants of systemic risk for both banking and non-banking financial institutions in South Africa.

1.6 Chapter layout

This rest of the study is set out as follows:

Chapter 2: Systemic risk and institutional framework

A comprehensive literature review is included in this study, which comprises Chapter 2 and 3. The literature review includes the following:

The definition and concept of systemic risk (Chapter 2) as well as its various aspects, focusing on:

a) financial contagion and common shocks (Section 2.2);
b) systemically important financial institutions (Section 2.3);
c) structure and role of the South African financial system (Section 2.4);
d) the regulation of systemic risk (Section 2.5); and
e) country specific regulations (Section 2.6).

This provides a comprehensive analysis of systemic risk, together with its many origins and consequences. This is followed by Chapter 3.

Chapter 3: Determinants of systemic risk

i. The firm-specific determinants of systemic risk within the banking and non-banking sectors (Section 3.1.1-3.1.10)
ii. The industry-specific and macroeconomic variables (Section 3.2.1-3.2.4)

Chapter 4: Methodology and data

The aim of this chapter is to answer the research questions. The modelling technique of the data as well as the usual panel data tests are discussed. After this is done, the effects of the explanatory variables on the dependent variable are examined through various panel data specifications.

Chapter 5: Empirical results

A panel regression analysis is undertaken and the results of the banking and non-banking sectors are discussed, comparisons are made and conclusions are set out in Chapter 6.

Chapter 6: Summary, conclusions and recommendations

In this last chapter findings are summarised and conclusions are drawn. Recommendations are provided, as well as suggestions for future studies.

CHAPTER 2 SYSTEMIC RISK AND INSTITUTIONAL FRAMEWORK

2.1 Defining systemic risk

“Systemic risks are for financial market participants what Nessie, the monster of Loch Ness is for the Scots (and not only for them): Everyone knows and is aware of the danger. Everyone can accurately describe the threat. Nessie, like systemic risk, is omnipresent, but nobody knows when and where it might strike. There is no proof that anyone has really encountered it, but there is no doubt that it exists.” – (Sheldon & Maurer, 1998:685).

The above statement indicates the worries of facing systemic risk fairly well. Systemic risk was already present prior to the 2007/2008 global financial crisis, but was considered to be individual risks distinctive to a financial institution (Smaga, 2014:2-3). Caruana (2010:3) suggests that systemic risk is imbalances of a collective system that have accumulated over time. Acharya, Pedersen, Philippon and Richardson (2010:1) comment that individual financial institutions probably take action to avoid their own collapse, but do not necessarily take action to prevent the collapse of the entire financial system. The failure of large and interlinked financial institutions during the global financial crisis illustrates how an individual financial institution could negatively influence the whole financial sector and real economy (Barth, Brummer, Li & Nolle, 2013:2), hence increasing the attention given to systemic risk. Financial institutions gambled with securities and loan portfolios (for example: AAA-rated sub-prime mortgage backed tranches) that displayed almost no idiosyncratic risk, although it displayed large amounts of systematic risk (Acharya *et al*., 2010:1). The global financial crisis had various negative effects on both international financial markets and the real economy. Kaufman and Scott (2003:371) define systemic risk as the probability that an entire financial system can break down as opposed to only parts of the system breaking down. Systemic risk must therefore not be seen as the risk of an individual institution, but rather that of a system. After the occurrence of the global financial crisis, the focus on systemic risk and the origins thereof intensified. The National Treasury (2011:13) states that regulators should intently monitor changes in systemic risk, hence increasing its importance to regulators.

Systemic risk is one of the most feared risks in the banking sector, which is considered to be the heart of global financial stability. In order to guarantee global financial stability, it is crucial to understand the origins, propagation as well as the negative effects of systemic risk. Systemic risk can be domestic or international and not only occurs in the banking sector, but can also occur in other parts of the financial system (Kaufman & Scott, 2003:372). For example, it can occur in securities markets when a substantial decline in prices of a large number of securities is simultaneously experienced either in a single country or across borders. The definition and concept of systemic risk is ambiguous and means different things to different people.

Prior to defining systemic risk in the financial sector, it may be useful to define and compare the definition utilised in the sciences and non-financial sector (biological sciences, vehicle manufacturers, energy and telecommunication companies). Hendricks (2009:2) defines systemic risk in these fields as the risk of a phase transition from an optimal level of equilibrium to a less optimal level of equilibrium. It is characterised by many self-supporting feedback mechanisms making it difficult to reverse (Hendricks, 2009:2). Financial markets are similar to telecommunication networks in the way that they can sometimes break down. Financial markets are also comparable to the human body (biology) in the sense that a disease can harm and wipe out a large part of the population, as systemic risk can significantly harm the financial system. It is therefore clear that there are similarities between the non-financial sector and financial markets and that the origin of the concept of systemic risk is therefore quite clear, although its interpretation in the financial sector is diverse.

Systemic risk exists in two dimensions and it is important to first clarify these dimensions before defining systemic risk. Caruana (2010:2) classifies these dimensions as the cross-sectional dimension and the time dimension. The structure of the financial system influences the way in which the financial system reacts to and propagate shocks in the cross-sectional dimension (Caruana, 2010:2). Contagion and spill-over effects arise as a result of common exposures and interconnectedness. Due to increased interconnectedness in the financial sector, shocks can easily propagate throughout the financial sector. The cross-sectional dimension refers to systemic risk at a certain point in time, in contrast with the time dimension that refers to the accumulation of risk over time in line with the macroeconomic cycle and the consequent pro-cyclicality of the financial sector (Caruana, 2010:2). In simple terms, pro-cyclicality refers to the interactions between the financial system and the real economy, which are mutually reinforcing (Sur, 2010). During an expansionary economic phase, rapid credit growth is experienced, leading to increased asset prices, coupled with low interest rates and the use of more untested financial instruments. The pro-cyclicality of systemic risk can therefore be seen as the underlying build-up of risk over time in areas that may be under-priced and during economic contractions these effects appear and amplify the cost-cutting that is already materialising. Pro-cyclicality can have disruptive effects and amplifies the amplitude of the business cycle, thereby heightening the risk to financial stability. The accumulation of systemic risk in line with the macroeconomic cycle can be viewed as an endogenous cycle and indicates that it builds up during economic contractions as well as expansions, suggesting that risk taking should be restrained in times of economic expansion when it is likely to be larger (Borio & Drehmann, 2009:3). The consequence of this definition is that a countercyclical approach may be the best for reducing pro-cyclical behaviour and for regulating systemic risk.

Oosterloo and De Haan (2003:10) state that there is no consensus regarding a single definition of systemic risk, but that the majority of definitions focus on aspects such as diminished investor confidence, linkages between financial institutions as well as a negative impact on the real economy. The aforementioned is supported by the findings of Bisias, Flood, Lo and Valavanis (2012:263) stating that the linkages in the financial sector result in correlated exposure of financial institutions, increasing the negative effect that the failure of a financial institution may have on the real economy. Systemic risk can be considered as a chain reaction of bankruptcies that prevents the financial system from fulfilling its intermediation role in the economy. With the occurrence of such a crisis, the initial shock spreads and eventually interrupts the functioning of the entire financial sector, adversely affecting the real economy, i.e. economic growth.

Borio, Furfine and Lowe (2001:5) indicate that widespread financial system distress seldom arises from domino effects associated with the failure of an individual financial institution, based purely on institution-specific factors. More frequently, financial sector problems have their roots in financial institutions that underestimate their exposure to a common factor, either in the financial or business cycle or the global economy as a whole. Borio *et al.* (2001:4) use a portfolio of securities to explain the relationship between the risk of individual financial institutions and the financial system as a whole. The financial system can be seen as the portfolio of securities, with each financial institution representing an individual security. The total risk of the portfolio is not only the sum of the risk of the individual financial institutions, but essentially depends on the correlation between them. For individual financial institutions, it not only entails assessing how the riskiness of each individual borrower changes over time, but also how the correlations between the borrowers changes. From the whole financial system's perspective, it is a further intricacy to understand and determine the correlations between individual financial institutions that arise from their exposure to common factors. Furthermore, while an individual financial institution may reasonably assume that the growth and the health of the economy is exogenous regarding their actions, it is not true for the financial system as a whole. The collective actions of financial institutions affect the health of the economy, while the health of the economy simultaneously affects the collective health of financial institutions.

One of the key issues in the regulation of the financial sector is the systemic importance of various financial institutions as well as how to deal with them. Systemic important financial institutions (SIFIs) are often defined in terms of turnover, but the role of the financial institution in the market should also be taken into account (Bédard, 2012:353). SIFIs are firms with characteristics such as a large size or a large degree of interconnectedness whose failure may destabilise the domestic financial system as well as the global economy (Foggit, 2016:83). Thomson (2010:135) argues that while size is one of the simplest ways to categorise SIFIs, it alone is not a sufficient criterion for classifying financial institutions that are systemically important. For example, a bank that may not have a significant size but assumes the role of a clearing house, prime broker or correspondent bank may be likely to pose a threat to the financial system and be a candidate for the status of a SIFI.

Thomson (2010:135) proposes the “four Cs” of systemic importance, namely: concentration, contagion, correlation and conditions. Concentration has two key aspects, the size of the firm’s activities relative to the market followed by the market’s contestability (Thomson, 2010:141). Concentration is therefore less likely to make financial institutions systemically important if, *ceteris paribus*, the activities of a troubled institution can easily be resumed by a new entrant into the market or by the expansion of an existing firm’s activities. The failure of Herstatt Bank in 1974, although quite a small bank, resulted in systemic events and had the potential to destabilise the international payments system, whilst imposing unnecessary losses on similar financial institutions (Acharya, 2012:9). In 2008, the Federal Reserve of New York aided JPMorgan Chase to acquire Bear Stearns that was on the verge of collapse as a result of losses in the mortgage market in order to attempt to limit the contagion effects. The failure of Lehman Brothers and AIG in the global financial crisis displayed how an individual financial institution can cause a common shock and result in contagion effects to the greater economy.

Correlation risk has two distinct dimensions (Thomson, 2010:140). First, financial institutions tend to take up more correlated risks, since policymakers are less likely to shut down an institution if various other institutions may possibly become decapitalised at the same time. This first aspect is similar to herding behaviour in financial markets, as displayed in the global financial crisis where financial institutions followed the example of other financial institutions and overexposed themselves to subprime mortgages and mortgage-backed securities. The second aspect is known as phase-locking behaviour (Lo, 2010:18). It comprises of the possibility that large, uncorrelated risk exposures can become increasingly correlated during times of financial distress, meaning that financial institutions that would, under normal circumstances, not pose a systemic threat might become systemically important under certain economic or financial-market conditions. The last “C”, conditions, refers to the reluctance of financial regulators to allow for the official failure of a distressed financial institution under certain financial and economic conditions (Thomson, 2010:142). Therefore, the conditions or the context in which the distress occurs are of systemic importance. This might partially explain why the Federal Reserve aided JPMorgan Chase in the acquisition of Bear Stearns to prevent bankruptcy in 2008, whereas Lehman Brothers was allowed to file for bankruptcy.

SIFIs are an imperative part of the financial system and their failure generates negative externalities for both developed economies and for emerging markets as well. SIFIs as well as the criteria for classifying SIFIs are therefore discussed in greater detail in Section 2.3. Systemic risk should thus not be considered in terms of the financial institution's failure, but rather in terms of their overall contribution to global system failure (Acharya, Engle & Richardson, 2012:59). Acharya *et al.* (2012:59) motivate this key feature of systemic risk. When a single financial institution' capital is low, the institution can no longer fulfil its role as financial intermediary, having minimal consequences since other financial institutions can fill this failed firm's void. When aggregate capital is low, however, the bankruptcy of one financial institution cannot be absorbed by other financial institutions (Brownlees & Engle, 2017:2), thus resulting in an aggregate financial intermediation breakdown with substantial negative consequences for the broader economy. A capital shortfall is not only dangerous to a financial institution and its bondholders, but also to the aggregate economy if it occurs when the rest of the financial sector is undercapitalised. Besar, Booth, Chan, Milne and Pickles (2011:196) propose systemic risk to be the breakdown of a financial system as a result of an initial shock that is easily transmitted through a network of interconnected firms, households and financial institutions. An implication of Besar *et al.*'s (2011:196) definition is that an event can be systemic without necessarily affecting every financial network. For example, the most recent global financial crisis severely affected the money markets and credit availability, but did not result in a breakdown of the payment and settlement systems. Acharya (2009:224) provides a similar definition as Besar *et al.* (2011:196). A financial crisis is systemic in nature when many financial institutions simultaneously fail or if the failure of one financial institution propagates as a contagion effect causing the failure of many financial institutions.

Central banks tend to use narrowly defined definitions of systemic risk, i.e. hazard to the financial system or the failure of a financial institution to meet its obligations, resulting in diminished functioning of the financial system (Smaga, 2014:4). A vast amount of literature has been dedicated to determine the origin as well as the costs of systemic risk. However, no consensus with regards to a precise definition has been reached yet. Taylor (2010:2) proposes three concepts similar to that of Kaufman and Scott (2003:373): (i) the risk of a great, triggering event; (ii) the risk of financial propagation through contagion; and (iii) the macroeconomic risk and how the financial disruption will negatively affect the entire economy. Triggering events can come from the public sector when the central bank suddenly contracts liquidity, an external shock such as when a terrorist attack destroys the payment system (e.g. 9/11 terrorist attack) or from the financial markets with the failure of a large financial firm. The propagation of risk can occur through either direct or indirect contagion. Direct contagion occurs through exchanging loans and deposits in the interbank market, while indirect contagion results from common exposure to borrowers and lenders. The macroeconomic linkages between the financial sector and real economy come through changes in interest rates, money supply and credit supply from banking and non-banking financial institutions. Foggit, Heymans, Van Vuuren and Pretorius (2017:1) explain that systemic risk occurs if and only if there is an aggregate shortage of capital in the financial sector, such that a reduction in lending by the failure of one bank cannot be offset by other financial institutions. An institution therefore experiences capital shortages due to a financial sector that is not functioning optimally.

Kaufman and Scott (2003:373) suggest three main concepts that should be taken into consideration, i.e. a “great” shock, propagation of the shock and common shocks. The first concept refers to a “great” shock that produces large, simultaneous negative effects on the financial system and real economy. A “great” shock normally occurs on a macroeconomic level. Here systemic risk refers to negative effects that arise for the entire banking sector, financial system or worldwide economy rather than for just a few financial institutions. Mishkin (1995:32) defines systemic risk as a sudden and unexpected event that disrupts the financial markets and diminish their ability to effectively channel funds to economic units with productive investment opportunities. Financial institutions play an integral role in the economy, acting as intermediaries between economic surplus units and economic deficit units, and without such intermediation it is difficult to get credit or perform financial transactions. Acharya, Pedersen, Philippon and Richardson (2017:1) consider systemic risk to be a widespread failure of financial institutions that has a negative externality on the rest of the economy. Acharya *et al*. (2017:1) also suggest that systemic risk results in the freezing up of capital, reducing the supply of intermediation in the financial system. The realisation of a great shock and how it propagates (how the contagion takes place) to individual financial institutions or the real economy and which units will be affected, are generally unspecified.

The second concept of systemic risk refers to the propagation thereof, i.e. contagion effects. The Bank for International Settlements defines systemic risk as the risk that the failure of a financial institution to meet its obligations will result in a chain reaction of other financial institutions defaulting, leading to far-reaching financial difficulties (BIS, 1994:177). Likewise, Kaufman (1995:47) defines systemic risk as the likelihood that losses accumulated from an individual event will result in a chain reaction in which interconnected financial institutions fail. These aforementioned definitions emphasise correlation with causation and require direct connections between financial institutions or markets. The initial domino falls on the next dominoes, causing them to fall, knocking other dominoes down and in turn creates a “knock-on” effect. Governor E.A.J. George of the Bank of England (1998:6) describes this chain reaction as happening “through the direct financial exposures which tie firms together like mountaineers, so that if one falls of the rock face others are pulled off too”. Keeping in mind that banks are connected through interbank markets, the failure of one bank will influence the remainder of the banks involved in the interbank market. If bank A defaults on a loan or deposit to bank B and it creates a loss greater than bank B’s capital and results in bank B defaulting on their payments to bank C, it creates a systemic chain reaction. In this second concept of systemic risk only one financial institution needs to experience this initial shock. Other financial institutions may be unexposed, but due to their interconnectedness this shock propagates along the transmission chain and results in the failure of several financial institutions. What makes this propagation of direct-causation systemic risk frightening, is the rapid speed with which it occurs and that it can affect both guilty firms, i.e. insolvent as well as innocent firms, i.e. solvent firms. The implication of this is that there is virtually no way to protect against its damaging effects.

The third concept of systemic risk focuses on how a single shock can cause the failure of several financial institutions that hold similar or identical portfolios. Correlations between small financial institutions’ portfolios are problematic for the financial system, but when correlations occur between large financial institutions’ portfolios, systemic risk arises (Foggit, 2016:56). Common shocks may therefore represent correlation without direct causation, due to the exposure to third parties (Kaufman & Scott, 2003:373).

The definition of systemic risk has changed considerably since the eruption of the global financial crisis of 2007/2008. Until this recent crisis, systemic risk was primarily understood to be the possibility that negative spill-overs can result in many defaults. Georg (2011:7) expands this definition to include two additional sources: common shocks, resulting in financial institutions to default simultaneously, and informational contagion, where negative news about one bank increases the refinancing costs of other banks. Bédard (2012:352) supports these findings and reports that the propagation of shocks in the financial system as a result of a failed SIFI materialises through financial contagion, which consists of two distinct categories: counterparty contagion and informational contagion. Contagion and common shocks are frequently used elements and it can therefore be argued that these elements give rise to the potential negative influence on the real economy and will therefore be examined in detail.

2.2 Financial contagion and common shocks

With the progression of the world's financial system, financial institutions became increasingly interlinked and dependent on one another. As a result of this increased correlation between financial institutions, the unpleasant and unwanted consequences if one institution should fail have a negative effect on the financial system as a whole (Smaga, 2014:2-3). Dornbusch, Park and Claessens (2000:177) define contagion as a substantial increase in linkages in markets after a shock in an individual country occurred. Forbes and Rigobon (2002:2224) support this definition and suggest that it is only apparent when the correlations between countries increase during a financial crisis. It can therefore be concluded that contagion is the propagation of market instabilities from one financial market to another, mainly with negative consequences. Regulating and controlling contagion is therefore important when attempting to mitigate systemic risk. Dornbusch *et al* (2000:177) emphasise that finance is an important link through which shocks are transferred, which makes it necessary to consider the correlations between the portfolios of institutions. In order to do so, the concept of common shocks must be addressed.

A noteworthy feature of South Africa's financial system is its high degree of interconnectedness and the incentives for linkages are driven mainly by the benefits of these linkages. Despite their various benefits, the linkages that exist between banks carry the risk of contagion. The downside of interconnectedness was displayed in the global financial crisis of 2007/2008 where the same interconnectedness that enhanced liquidity allocation during normal economic times, amplified shocks in a crisis. Even though the South African interbank market was able to escape severe problems and the effect on the financial system was not as severe as on other economies, systemic risk and the risk of contagion were still areas of concern for the SARB (Brink & Georg, 2011:5). The concept of systemic risk rests on the idea that contagion can only take place if there is some degree of connection between the financial parties, albeit direct or indirect (Kaufman, 1994:123). Contagion is not only considered to be more likely to occur in the banking sector than in any other sector, but also tends to be more severe when it occurs. Banks can be directly linked through interbank deposits, loans and payment-system clearings (Kaufman & Scott, 2003:375). Banks can also be indirectly linked by participating in the same loan or deposit markets (Kaufman & Scott, 2003:375). Banks' large degree of interconnection link the countries in which they operate, allowing shocks from one country to propagate faster to other countries along the transmission chain. The propagation mainly occurs through counterparty contagion, informational contagion and common shocks.

2.2.1 Counterparty contagion

Contagion is one of the channels through which negative externalities from excessive risk taking may spread (Bijlsma, Klomp & Duineveld, 2010:10) and can happen through two channels in the banking sector: the real exposure channel and the informational channel. These two channels can either work separately or in conjunction (De Brandt *et al.,* 2009:640). For the purpose of this study, the real exposure channel refers to counterparty contagion, while the informational channel refers to informational contagion. The former is applied and discussed in this section, while the latter is discussed in Section 2.2.2

Most public policies around the world reflect the fear of banking contagion, mainly in response to the perceptions of bank failures during the Great Depression of 1929-1930 (Kaufman, 1994:123) and the global financial crisis of 2007/2008. John Patrick LaWare, a former member of the Board of Governors of the Federal Reserve System, describes the magnitude of systemic risk and the potential destruction to the financial system attributable to contagion from the failure of large banks:

"Systemic risk that fails to be controlled and stopped at the inception creates a nightmare condition that is unfair to everyone. The only analogy that I can think of for the failure of a major international institution of a great size is a meltdown of a nuclear generating plant like Chernobyl. The ramifications of such a failure are so broad and happened with such lightning speed that you cannot after the fact control them. It runs the risk of bringing down other banks, corporations, disrupting markets, bringing down investment banks along with it...we are talking about the failure that could disrupt the whole system." (LaWare, 1991:985).

As mentioned earlier, contagion in the financial sector can either be direct through loans in the interbank market (Georg & Poschmann, 2010:1) or indirect via mutual exposure to borrowers and lenders (Kaufman, 1994:123). The financial sector experiences contagion if the shocks from one financial institution is transferred and experienced by another financial institution through various mechanisms in the financial sector (Bijlsma *et al.,* 2010:10). Direct counterparty contagion comes from counterparty risk, when the insolvency of a financial institution is directly spread to another. Interconnectedness arises from financial institutions' need for diversification and contagion through direct interconnectedness, which illustrates how hedging against a particular risk can constitute other risks. Banks exchange deposits in the interbank market without requiring the intervention of the South African Reserve Bank (SARB) in order to hedge against liquidity risk and with the exchange of every deposit they increase the link in the interbank market, exposing the system to direct contagion. Allen and Gale (2000:15) argue that a better-connected network of banks would be less susceptible to contagion than a weak-connected network of banks. Babus (2006:6) argues that there is a connectivity threshold when banks connect with each other to reduce the risk of contagion. Below the threshold contagion occurs, but above the threshold contagion does not occur (Babus, 2006:29). Banks form connections with one another to reach this threshold, but such increased connections mean shocks can more easily be transmitted through the financial system. Gai and Kapadia (2010:2421) confirm this and suggest that increased connections may reduce risks as well as the probability of contagion, but add that if contagion does occur, the severity thereof will intensify and more institutions will be affected. Increased connections will therefore contribute to global financial stability up to a point, whereafter the shocks will be severe, decrease financial stability and increase systemic fragility.

Indirect contagion occurs when financial firms are mutually exposed to borrowers and lenders. The failure of borrowers to meet their obligations pose financial troubles to the financial institution. The failure of the first financial institution to fulfil its financial obligations would transfer financial troubles to its creditors, who would pass on their financial troubles to their own creditors and so forth until the crisis is widespread (Bédard, 2012:353). However, the initial insolvent firm needs to lose significant value in order for its insolvency to be transferred to its creditors. Counterparty contagion therefore involves a shock negatively affecting one financial institution that then intensifies and transmits, due to increased interconnectedness and a large exposure, negatively influencing other financial institutions.

2.2.2 Informational contagion

The informational channel in the banking sector comprises of a shock that hits one financial institution, followed by market participants reassessing the possibility that other financial institutions could also be affected since they have similar characteristics to the originally affected institution (Foggit, 2016:54). Bédard (2012:353) suggests that informational contagion spreads when the financial troubles of the original insolvent institution are exposed, revealing information on a risk that may pertain to other financial institutions. Informational contagion can therefore be caused through an exogenous shock, causing investors and creditors of other financial institutions to review their beliefs.

Informational contagion is based on imperfect information arising through either mutual exposure or direct linkages across banks (Nier, Yang, Yorulmazer & Alentorn, 2007:2035). Factors such as unfavourable news about a category of assets, a fall in the financial institutions' credit rating as well as the failure of a similar institution could be triggering events and may prompt informational contagion. At that time, information about the source and severity of the shock as well as the financial institutions' exposure to it is not yet known. Information on how similar firms are affected by this third party risk is needed, but may not be readily available due to a lengthy and costly analysis, resulting in creditors basing their decisions on imperfect information.

The informational channel refers to funding problems such as contagious deposit withdrawals that arise when creditors have imperfect information, even when the firm is financially sound (Nier *et al*., 2007:2035). Subsequent creditors are, by nature, risk adverse. It prompts investors to question the solidity of similar financial institutions, resulting in a great withdrawal of their funds, market panic, bank runs and a confidence crisis. This is illustrated by herding behaviour of investors in financial markets. Herding behaviour in financial markets (especially in a financial crisis) results in information contagion taking place and usually intensifies the impact of systemic risk and how it affects financial institutions.

Should financial institutions (particularly banks) be able to withstand the exogenous shock of bank runs, creditors and investors will have obtained greater knowledge about the exposure of their debtors. When information gaps are bridged to a certain extent, most of the runs that took place in financial institutions that turned out to be solvent will be “reversed” and business will continue as before (Bédard, 2012:357). Informational contagion is a phenomenon that can cause the insolvency of a solvent institution even though it has not sustained a direct shock. This is confirmed by Diamond and Dybvig (1983:401) who report that the runs of financial institutions are self-fulfilling prophecies. The reason for this is that the creditors and investors are indifferent to new information and once they decide to run with their funds, nothing can stop them. Many creditors and investors do, however, update their beliefs based on new information regarding the particular situation, but the interpretation thereof and their reaction to it might not be quick and effective enough. This type of contagion can therefore result in severe losses in the financial sector and real economic damage (rather than only reflecting the problems) and not only influences insolvent institutions, but can affect solvent institutions alike. Informational contagion tends to be firm-specific rather than industry-specific, as investors and creditors direct their doubts to the institutions that have links with the initial shock, regardless if it is real or perceived.

A policy implication of counterparty and informational contagion is that if a financial institution was to be bailed out during financial difficulties in order to protect its creditors from counterparty losses, it does not prevent financial contagion, since it also travels through information and not only losses.

2.2.3 Common shocks

Irrespective of their importance, few literature studies have focused on the effects of common shocks to systemic risk, but have rather focused on the effects of contagion on systemic risk. This is evident by the proposal of the Financial Stability Board (FSB) (2010:4) to develop a policy framework that will address the moral hazards associated with SIFIs through reducing the interconnectedness of financial institutions as well as contagion risks by strengthening the main financial infrastructures and markets. Rochet and Tirole (1996), Kiyotaki and Moore (1997), Freixas and Parigi (1997) and Allen and Gale (2000) primarily focus on characterising the sources of contagion and examine the liability structure of banks, in contrast with Acharya (2009) examining the asset side of banks' balance sheets.

Acharya (2009:227) defines systemic risk as "the joint failure risk arising from the correlation of returns on asset side of bank balance sheets". Acharya (2009:224) also argues that bank regulation instruments that only focus on the bank's own risk might fail to diminish systemic risk. Whelan (2009:9) and Georg and Poschmann (2010:4) aver that common shocks are not subordinated to contagion, but in fact may be an even greater contributor to systemic risk. Wagner (2010b:97) suggests that one of the main reasons behind the severity of the 2007/2008 global financial crisis was that many financial institutions invested in identical assets (US subprime mortgages). This increased their exposure to a common shock and caused them to experience difficulties at the same time that these assets' performance deteriorated. When considered in isolation, these investment strategies were desirable since it resulted in the diversification of individual bank portfolios. Considering these investments from a systemic point of view, it had detrimental aspects since it increased the probability of joint failures of financial institutions (Wagner, 2010a:373). Considering the aforementioned, the diversification of financial institutions' portfolios benefit the stability of the financial sector, but also comes at a cost. Even though diversification decreases the individual probability of financial institutions' failure, financial institutions are now exposed to the same risks and are thus more similar, making systemic crises more probable.

Iori, Jafarey and Padilla (2006:530) developed a model where banks interact with one another through interbank loans. Banks' balance sheets consist of external assets (risk-free investments), interbank assets (loans, deposits and equity) as well as interbank borrowings as liabilities (Iori *et al.*, 2006). Banks transfer deposits towards productive investments and experience liquidity shocks through deposit fluctuations. Fluctuations in investment returns have to be compensated by banking capital, resulting in risky investments being a main cause of banking insolvencies. Deposit fluctuations are also a main cause of banking insolvencies as a result of maturity mismatches. A sudden increase in deposit withdrawals influences the liquidity of the bank and if the bank becomes illiquid it goes into insolvency. It is therefore necessary that the model of interbank markets accounts for the effect of deposit fluctuations and risky investments (Georg & Poschmann, 2010:6). Despite the probability to generate contagion, interbank lending usually stabilises the financial system up until a common shock takes place (Iori *et al.*, 2006:540). Iori *et al.* (2006:540) also report that interbank lending should be limited to banks that have similar liquidity characteristics to potentially minimise the effect of a common shock.

Georg and Poschmann (2010:6) followed the work of Iori *et al.* (2006) and Nier *et al.* (2007), but allow for the possibility of deposit fluctuations and risky investments whilst also including a central bank. They developed a model where banks optimise a portfolio of risky investments together with riskless[4] excess reserves in order to correspond to their risk and liquidity preferences. These banks were linked via the interbank market with loans and a supply of household deposits. Through the simulation of a defaulting bank it is found that common shocks are a greater threat to systemic stability than contagion (Georg & Poschmann, 2010:22).

Common shocks arise as a source of systemic risk when numerous financial institutions hold similar assets, with the implication being that an increased correlation between their portfolios may potentially lead to fire sales as well as severe losses for financial institutions (Georg, 2011:9). Banks are incentivised to increase the correlation amongst their portfolios as an attempt to prevent costs arising from potential informational contagion, but in the process increases the risk of an endogenous common shock (Acharya & Yorulmazer, 2008:216). Ladley (2011:1) finds that in a static network setting high interconnectedness helps to stabilise the financial system for small shocks, but that interconnectedness amplifies the initial impact for larger, economy-wide shocks. Georg (2013:2217) advocates a dynamic model where banks optimise their balance sheet structure and as a result the actual interbank market network structure. The results of the dynamic model complement those of the static model, indicating that the interbank network structure substantially influences financial stability in times of distress (Georg, 2013:2227).

Lehar (2005:2598) measures the correlation between bank asset portfolios for international banks in order to estimate the risk of a common shock. It illustrates a significant positive trend in the stock returns of large and complex banks, as also illustrated by De Nicolo and Kwast (2002:833) in large and complex financial institutions in the US in the 1990s. This may also result in an increased potential for systemic risk. Correlations among portfolios pose problems to the financial system when they occur between small institutions, but can become a systemic risk when it occurs between large and complex financial institutions. The conclusion is that common shocks are not subordinated to contagion, but are an equal, if not greater, contributor to systemic risk than contagion effects.

Despite the common effects of common shocks and contagion, they are fundamentally different. The concept of contagion refers to the swift transfer of losses from one bank to other financial institutions during financial distress. The concept of common shocks refers to how an individual

[4] Short-term investments held at the deposit facility of the central bank or could alternatively be held in the form of high liquidity treasury bills (Georg, 2013:2217).

shock to a financial system can severely affect various other financial institutions, because they hold identical or similar portfolios. Contagion not only takes place in a financial way, but also in a non-financial way through bad news that spreads in times of financial distress.

Contagion, as a source of systemic importance, together with other inherent characteristics of financial institutions play a role in the identification of systemically important financial institutions (SIFIs) and how systemic risk manifests itself in financial institutions. The occurrence of systemic risk in the financial sector causes vast risks to financial stability (Ostalecka, 2012), since systemic risk increases the uncertainty and diminishes the confidence of market participants about the effective functioning of the financial sector (Eijffinger, 2012). Systemic risk is therefore contagious, disturbs the stability and functioning of the financial sectors and adversely affects the real economy. However, regardless the variations in definitions, it remains certain that systemic risk in the financial system can hold severe risks to the stability of the entire financial system.

2.3 Systemically important financial institutions

The systemic importance of a financial institution may influence the speed with which systemic risk manifests in the institution as well as with which it propagates. It also has an impact on the regulatory framework and it is therefore essential to proactively deal with SIFIs. Understanding the origins and nature of systemic risk is an important foundation for creating regulations, policies and infrastructure that will prevent and mitigate the associated systemic risk. In order to do so, an effective definition of "systemically important" needs to be established. One the one hand, the definition is fairly simple, since a systemically important financial institution is expected to have a destabilising effect on the financial system due to contagion effects to other financial institutions as well as to private and institutional investors (Thomson, 2010:135). The failure of a SIFI would also impose negative externalities on the broader economy through numerous channels. This definition, however, does not provide guidance in practice. Due to numerous factors influencing a firm's systemic importance and two firms being considered systemically important for unrelated reasons, a one-size-fits-all definition is inadequate.

SIFIs are expected to have higher loss-absorbent capabilities and require intensive supervision and regulation in order to reduce moral hazards and also to take their relevance to the stability of the financial system into account (Brühl, 2017:107). In order to identify global systemically important banks (G-SIBs) and insurers (G-SIIs), an indicator-based approach is applied. The indicators for banks include their size, interconnectedness, substitutability, global activity and complexity (SARB, 2013:33; SARB, 2019a:6). These indicators are all deemed important and therefore the assigned weighting of systemic important banks in the South African financial sector will be discussed as part of the country-specific regulations in Section 2.6. The identification of G-

SIIs is based on a similar indicator-based approach, according to characteristics such as their size, global activity, interconnectedness, substitutability and asset liquidation (Brühl, 2017:108). A wide range of financial institutions exists outside of the banking and insurance sector (such as asset management companies, finance companies and market intermediaries) whose failure may trigger financial instability. Since these firms' underlying business models, transmission channels and risk profiles are heterogeneous, it is challenging to find a common methodology in order to identify these non-bank, non-insurers (NBNIs) as globally systemic important.

Considering size in isolation is not adequate in identifying SIFIs. Thomson (2010:137) argues that a size threshold – whether it is asset-based or activity-based or a combination of both - is not an adequate measure, but that size-based classification should account for both the level and nature of the financial institution's activities. For example, a bank with 5% of assets countrywide holding a portfolio of government securities is less likely to experience systemic problems than a similar bank holding a portfolio of industrial and commercial loans. The former bank holding lower risk, marketable securities is less likely to fail and even if it does, will not cause severe negative externalities, in contrast with the latter bank, holding a riskier portfolio.

Thomson (2010:137) identifies the following criteria as a starting point for considering a sized-based definition. A financial institution is considered to be a SIFI if:

- the associated entity holds 5% of countrywide banking assets together with fifteen percent or more in loans;
- the entity accounts for at least 10% or more of the total countrywide assets;
- the entity accounts for more than 10% of the countrywide banking assets after converting the off-balance sheet amounts to balance sheet equivalents;
- the entity accounts for more than 10% of the total value or number of life insurance products countrywide;
- the entity accounts for more than 15% of the total value or number of all insurance products – whether it is property, life or causality policies – countrywide.

A non-bank financial institution such as an investment bank - other than a traditional insurance firm – might be considered to be systemically risky if:

  - it accounts for more than 20% of underwritten securities (on average for the past five years);
  - it ranks among the top ten largest banks with its adjusted assets (i.e. accounts for off-balance sheet activities) in the country or its total assets rank among the top 20 banks in the country; or

  - if its total value of assets held is among the top ten largest banks in the country.

Thomson (2010:139) further argues that the four C's (as mentioned in Section 2.1) should be taken into account, since it can make a financial institution of systemic importance when considered either individually or collectively. The first "C" considers contagion effects and classifies a financial institution as systemically important if its failure could result in:

- the impairment of vital domestic or international payment systems;
- the breakdown of important financial markets; or
- a significant capital loss of financial institutions that accounts for a combined 30% of the financial sector's assets.

The level of correlated risks should also be taken into account when identifying a SIFI. The following thresholds may result in institutions being classified as SIFIs:

- The probability that a financial or economic shock destabilises a financial institution that accounts for 35% of the aggregate financial sector's assets or 20% of the aggregate banking sector assets
- The probability that a financial or economic shock decapitalises financial institutions that accounts for an aggregate of 15% of the financial sector's assets or 10% of the banking sector's assets, combined with countrywide share amounting to:
  - 15% of retail or wholesale payments;
  - 35% of a large credit (for example commercial, housing finance, consumer and agricultural) activity;
  - 30% of securities underwriting or 50% of securities processing over the past five-year average;
  - 20% of the total value or number of life insurance products; or
  - 30% of the total value or number of insurance products.

If the failure of dominant firms in the financial sector results in a freezing or disruption of the market, its systemic importance increases. If the activities of a distressed financial institution can be easily assumed by new market entrants, concentration will be less likely to increase a financial institution's systemic importance. The concentration threshold should therefore be adjusted to account for contestability. Thresholds that increase a firm's systemic importance include any financial institution (on a combined basis) that:

- processes more than 25% of the daily volume of a vital payments system;
- accounts for more than 30% of an important credit activity; or

- is responsible for the clearing and settlement of more than 25% of trading in an important financial market.

The last “C”, conditions, is the most difficult criteria to identify SIFIs by or to identify them in advance. This is due to regulators being reluctant to let a financial institution fail under certain financial or economic conditions if its solvency could have been resolved under normal market conditions. During periods of financial sector distress, phase locking behaviour can cause slightly correlated risk exposures to result in highly correlated risks. Due to this, a cluster of financial institutions might become systemically important, even if they were not systemically important under normal financial market conditions.

The systemic importance of financial institutions is therefore an important issue for regulators, legislators and policymakers, given the severe negative externalities that a SIFI can impose on other financial market participants and the broader real economy. An increased amount of formal regulation combined with a great degree of supervisory oversight may decrease the amount of SIFIs, as well as possibly the negative contagion. These regulations, applications and amendments for South Africa will be discussed in detail in Section 2.4-2.6.

2.4 Structure and role of the South African financial system

The financial system comprises of financial intermediaries operating in the financial sector of an economy, enabling an environment for economic growth, development, capital formation and job creation for sustainable development in South Africa. The South African financial system comprises of financial markets, financial institutions, development finance institutions (DFIs) as well as regulatory and supervisory authorities. The financial market comprises of two parts, namely the cash market and the derivatives market. The money and capital markets form part of the cash market and are considered to be a large part of South Africa’s financial market (Hassan, 2013:1), hence the increased focus on it in this section. The money market allows for the issuing, buying and selling of debt instruments with maturities less than one year (short term funds). Banks play an imperative role in the money market since they act as the vehicle through which the SARB intervenes in order to implement the monetary policy (National Treasury, 2018a:22). The capital market includes the bond (debt) market and the equity market (National Treasury, 2018a:17). The institutions (banks, insurance companies and mortgage banks) operating in the capital markets access them to raise capital for long-term purposes, such as to finance capital investments (National Treasury, 2018a:25). Financial instruments in the money market comprise of deposits and collateral loans, while capital markets use instruments such as stocks and bonds. The money and capital market is often used together to manage liquidity and risks for individuals, companies and governments. Financial institutions comprise of the banking sector and the non-banking sector (i.e. insurance companies, investment companies and pension funds), while the DFIs in South Africa include the Development Bank of Southern Africa (DBSA), Industrial Development Corporation (IDC) and Land and Agricultural Development Bank of South Africa (Land Bank) (Mondi, 2011:35).

South Africa's well-developed financial infrastructure includes a stock exchange, a Central Securities Depository (CSD), national payment system and credit bureaus (IMF, 2014:59). The Johannesburg Stock Exchange (JSE), South Africa's primary exchange, is the largest in Africa and offers both primary and secondary markets for financial products, ranging from equities and bonds to derivative instruments. Strate, South Africa's CSD, provides electronic settlement for South African money market funds, for securities such as warrants and Exchange Traded Funds (ETFs), as well as for equities listed on the Namibian Stock Exchange. The South African Multiple Option Settlement System, SAMOS, is owned and operated by the SARB and forms the core of the national payment system. SAMOS is a real-time gross settlement system and is responsible for the Rand settlement of all the financial market transactions, foreign exchange transactions with international banks as well as interbank transactions. South Africa has four large credit bureaus (NCA, 2019), namely TransUnion, Compuscan, Experian and XDS Credit Bureaus, containing business and consumer credit information. The National Credit Advisor (NCA) advises how the credit information held by credit bureaus must be reviewed, confirmed, amended and removed, while the National Credit Regulator (NCR) is responsible for the oversight of these bureaus.

The SARB is the primary regulator in South Africa and is responsible for bank regulation and supervision in order to ensure a sound and effective banking sector. South Africa's legislative framework determines that any person that conducts business as a bank must be registered and licensed as a bank (SARB, 2018:33). The SARB defines the business of a bank as the regular acceptance of deposits as a key feature of its business. The SARB performs this role by issuing banking licenses to banking institutions and by monitoring their activities in terms of the Banks Act (94 of 1990) and the regulations. The legislative framework provides three different types of bank licenses of which each is administered under a different Act, namely (SARB, 2018:33):

- a bank license in terms of the Banks Act (94 of 1990) (Banks Act);
- a mutual bank license in terms of the Mutual Banks Act (124 of 1993) (Mutual Banks Act); and
- a cooperative bank license for registered cooperative financial institutions in terms of the Cooperative Banks Act (40 of 2007) (Cooperative Banks Act).

The distinction between a bank, mutual bank and cooperative bank is based on the differences in their corporate structures as well as the regulatory requirements that apply to these entities. A bank is defined as a publically owned company by its shareholders, who do not have to be the depositors or customers of the bank. A mutual bank is a juristic person that is in principle owned by its depositors who qualify as members to be shareholders and are entitled to exercise control in the general bank meetings. A cooperative bank is a cooperative organisation whose members are employed by a mutual employer, who are employed within the same business district, have mutual membership in an organisation or reside within the same defined community or geographical area. Given the differences between these banks, regulation and supervision also differ.

Other primary regulators in South Africa include the Financial Sector Conduct Authority (FSCA), National Credit Regulator (NCR), JSE Limited, Financial Intelligence Centre (FIC), South African Revenue Services (SARS) and the National Treasury (Nedbank, 2018). The South African financial sector further comprises of the formal sector (banks and NBFIs) and the informal sector (domestic moneylenders). The formal sector is regulated by the SARB whose main objective is to maintain price stability as well as ensure the soundness of the financial system (SARB, 2019c), but the informal financial sector is not adequately regulated. A sound financial system is vital since it provides a structure to help create investments from savings, hence supporting economic growth (IMF, 2018). Due to the interconnectedness of the financial system, well-regulated and sound financial systems are important for both national and international financial and economic stability[5].

The structure of the South African financial system has undergone significant changes. These changes range from ownership structure, the number of financial institutions established, regulatory and supervisory frameworks as well as the general macroeconomic environment in which financial institutions operate. Two major South African banking groups are undergoing significant changes in their organisational structures. Barclays Plc announced its intention to sell its interest in the Barclays Africa Group in March 2016. It has subsequently been renamed Absa Group Limited (also includes the rebranding of its Africa subsidiaries) and the operational separation is expected to be completed by 2020. Investec Limited announced during September 2018 its intention to demerge the Investec Asset Management business. The SARB announced

[5] The PA supervises the safety and soundness of all financial institutions (i.e. banks, insurance companies) and is responsible for supervising all the institutions included in this study. The PA, FSCA and NCR are applicable to this study and therefore discussed in Section 2.4.1.

that these organisational changes are not expected to impose adverse effects on South Africa's financial system or on economic activity (SARB, 2019b:12).

The importance of South Africa's financial sector is best understood by considering Figure 2.1 below. In line with international trends, the banking sector's financial assets gradually declined since the global financial crisis. Despite of this, when considering the banking sector solely, banks still hold the largest percentage of financial assets, with its financial assets being stable at around 30% since 2015. Paradoxically, the share of financial assets held by other financial intermediaries (OFIs) increased constantly since 2008, amounting to approximately 21% in December 2018. This significant increase is largely due to the growth of multi-asset funds and the increased popularity of these funds are due to regulatory changes (SARB, 2019b:14). The Financial Advisory and Intermediary Services Act (FAIS) 37 of 2002 came into working in 2004 and directed diversification from financial advisors to investment managers, given the tax benefits of capital gains (SARB, 2019b:14). Furthermore, starting 2011, retirement annuities are compliant with Regulation 28 of the Pension Funds Act 24 of 1956 (Pension Funds Act) (SARB, 2019b:14). Given that the majority of multi-asset funds are Regulation 28 compliant, multi-asset funds are an increasingly preferred vehicle. Insurance companies and pension funds hold a relatively greater share of the total financial assets, with an aggregate share amounting to 31%. Although the banking sector's financial assets remains relatively stable, there is a gradual increase in NBFIs' financial assets after 2008. The majority of the banking assets are domestic, although banks have an expanding presence in Africa. The majority of the banking liabilities are domestic and short-term, with 87% domestic deposits and 60% of the deposits coming from NBFIs (IMF, 2014:10).

NBFIs are financial institutions that are not registered as banks and can therefore not take deposits. However, they compete with and complement banks through their provision of alternative financial services. NBFIs can be classified into two categories, i.e. contractual savings institutions and investment intermediaries (Mishkin, 2007:40). The former are financial intermediaries that acquire funds from institutions and individuals at regular intervals and on a contractual basis. These institutions primarily invest in corporate stocks, mortgages and bonds, and include short-term insurance, life insurance and pension funds. The latter are financial intermediaries that facilitate the purchase of money market instruments and capital, and include money market institutions, mutual funds and finance companies.

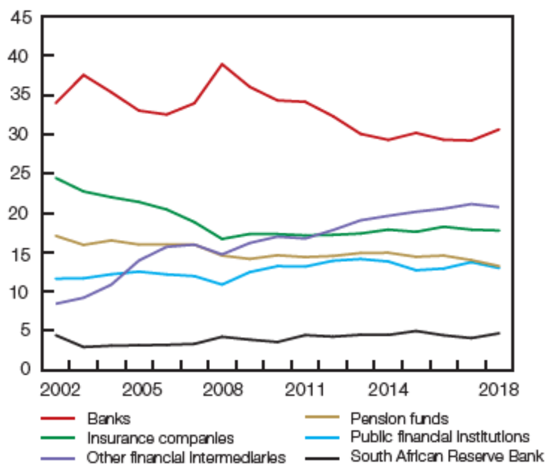
South Africa's large and well-developed financial sector's assets amount to approximately 298% of GDP, exceeding the ratio of most emerging market economies (IMF, 2014:10). NBFIs grew swiftly in the recent years, holding approximately two thirds of financial assets, as illustrated by

Figure 2.1 below. This rapid growth and high ratio is remarkably large for an emerging market (IMF, 2014:10):

- Pension funds' assets are approximately 110% of GDP, practically equal to the banking assets of 112%;
- Long-term insurers hold the majority of insurance assets, i.e. 64% of GDP. The greatest share is life insurance, with non-life insurance (short-term) only accounting for a small share; and
- Unit trusts holding assets of 42% of GDP, and is the fastest growing segment in the financial sector.

Considering the increased involvement of NBFIs in the financial sector and their credit intermediation activities, these institutions are likely to pose bank-like risks to financial stability. The aforementioned indicates the links between the banking and non-banking sector, the increased probability of financial contagion as well as the non-banking sector's increased importance to the financial sector.

Figure 2.1: Distribution of financial sector assets (percent)



Source: SARB (2019b:14)

South Africa's financial services sector is just as well developed as advanced economies' in such a way that regulatory problems are equally important to warrant the attention of both national and international authorities. Internationally, South Africa has a seat on the Financial Stability Board that is responsible for coordinating regulation on an international level and is a member of both the Group of 20 (G-20) countries and the Bank of International Settlements (BIS) (Botha & Makina, 2011:31). The SARB actively implements and adheres to the Basel accords and the IMF states that South Africa's financial system is well diversified and refined (IMF, 2008). South Africa's well-developed financial system is also supported by a well-developed legal infrastructure and effective regulatory framework.

2.4.1 South Africa's current regulatory structure

Financial market activities generate externalities that may deliver negative externalities for the real economy, decreasing financial stability and giving rise to the need for financial regulation. Financial stability is a significant requirement for sustainable economic growth, development as well as employment creation. It is also an indication of the financial systems' resilience to systemic shocks, it facilitates effective financial intermediation and alleviates the costs of disruptions in such a way to ensure and promote sustained confidence in the financial system. Financial regulation was a hot topic prior to the 2007/2008 financial crisis, but received renewed interest after the financial crisis when inadequate regulation and supervision of the financial sector were considered to be two of the leading causes. Inadequacies of the (then - 2007/2008) regulatory systems were revealed worldwide and subsequently most economies reformed their regulatory systems. The Financial Services Authority (FSA) in the United Kingdom (UK) developed a set of banking regulations as a response to the global financial crisis of 2007/2008 and the US endorsed the Dodd-Frank act to improve the financial services regulation (Botha & Makina, 2011:27).

The rationale for financial market regulation consists of two components: regulating the manner of doing business in financial markets and mitigating the risk of systemic events (Botha & Makina, 2011:29). Falkena, Bamber, Llewellyn and Store (2001:2) further state that the primary objective of financial regulation is to protect the consumer together with achieving a large degree of economic efficiency in the market. The need for consumer protection arises when the financial institution fails the client who holds funds with it or when the institution cannot effectively conduct business. Financial systems are also prone to instability and contagion when not properly regulated. Since the late 1970s and 1990s, 112 systemic banking crises have been reported in 93 countries (World Bank, 2001) and are more prevalent today than prior to the early 1900s (Eichengreen & Bordo, 2002:1). The risk of financial crises materialising due to systemic events are higher today as financial markets are highly integrated and globalised. Falkena *et al.* (2001:11) suggest three elements of a financial or banking crises, namely: incentive structures are not motivational, poor control systems within a bank and inadequate regulatory and supervisory systems. Since banks are at the heart of the payments network and the financial sector is highly integrated, the failure of one bank can cause systemic effects. This results in negative externalities that cannot easily be internalised. Banks do not take into account the potential external cost of their risk taking on the aggregate economy, therefore the aim of supervision is to prevent excessive risk taking by requiring banks to hold increased reserves and to approach their business activities with more careful attention to risk. Davies and Green (2008:40) argue that the abovementioned tend to be an explanation for a "lender of last resort" role that central banks play. A lender of last resort function comes at a high cost and Davies and Green (2008:40) further state that there should be a clear distinction between providing liquidity support to an essentially sound bank and providing solvency support. By continuously supervising and monitoring the increased capital reserves of a bank together with their risk management measures in place, it is likely to decrease the expected costs of central banks as "lenders of last resorts".

Prior to the 1980s, South Africa's regulatory structure followed international trends where regulators seldom considered activities beyond domestic borders (Botha & Makina, 2011:32). Financial regulation and supervision have traditionally been built on the silo (institutional) approach where the three general financial sectors – banking, securities and insurance sectors – have been regarded as separate national entities and therefore regulated separately (Botha & Makina, 2011:27). Financial markets have grown to be more interconnected, increasing the probability of financial contagion during a crisis. Goodhart, Hartmann, Llewellyn, Rojas-Suárez and Weisbrod (1998:143) suggest that financial conglomerates and increased interconnectedness pose a challenge to traditional regulatory systems brought about by the silo approach. There is no agreement on which regulatory structure is the best, but the choice essentially depends on the structure of an individual country and the development of their financial system. The four possible models include (National Treasury, 2011:29):

i. the silo (institutional) model, where every sector is supervised by a different agent according to their functional lines;
ii. the integrated (unified) model, where an individual regulator regulates all financial institutions;
iii. the Twin Peaks (horizontal) model, where regulation is performed according to objective with at least two regulators; one regulator being responsible for the safety and soundness of financial institutions and the other regulator focusing on the conduct of business regulation; and
iv. the functional (hybrid) model, where each business may be assigned its own functional regulator and the business is regulated based on its type of business performed.

South Africa followed an institutional approach, but metamorphosed to a functional approach during the late 1980s (Botha & Makina, 2011:27). During the 1990s, prior to transforming to a Twin Peaks model, South Africa's financial regulation was partially integrated, i.e. multi-layered, since various regulators practised silo regulation with the different role players in the financial markets (Botha & Makina, 2011:27; Van Heerden & Van Niekerk, 2017:154). Pertinent in the pre-Twin Peaks regulatory landscape was the SARB, being South Africa's central bank since its commencement in 1921 that regulates South African banks. The non-banking sector (insurers, fund managers and exchanges) was regulated by the Financial Services Board (FSB). The supervision of market intermediaries was shared by the FSB and the JSE (Van Heerden & Van Niekerk, 2017:154). The JSE supervised the listed institutions, while the Department of Trade and Industry (DTI) oversaw the unlisted institutions. The National Credit Regulator (NCR)[6] in its turn supervised lending processes and reported to the DTI.

The silo structure led to complex, fragmented regulation processes that were susceptible to regulatory arbitrage (National Treasury, 2018b:1). A well-known shortcoming was that market conduct regulation was neither part of the regulatory responsibility of the SARB nor part of the other regulators' responsibility in this institutional model (Schmulow, 2017:401). The NCR and Competition Commission did, however, "catch" some of the aspects on how banks conducted their business and constrained some of the risks that usually go hand in hand with banking business (Van Heerden & Van Vuuren, 2017:154). The global financial crisis of 2007/2008 erupted as the National Treasury was busy reviewing the financial sector. Although the financial sector was mostly unscathed by the global financial crisis, the National Treasury investigated the need for an all-inclusive macroprudential approach to financial regulation (National Treasury, 2011:13).

The 2007/2008 global financial crisis highlighted the need for a macro-prudential approach to financial stability, since macroeconomic risks (e.g. high degree of interconnectedness between large institutions, high levels of household debt and asset bubbles) may pass the microprudential regulators unobserved (Van Heerden & Van Niekerk, 2017:155). Microprudential regulation is concerned with the risk of individual financial institutions and the subsequent concentration risk within the individual institutions. Macroprudential regulation is concerned with safeguarding the entire financial system and considers common, herd behaviour amongst investors and financial institutions. While microprudential regulation is concerned about the concentration risk within individual financial institutions, macroprudential regulation is concerned with similar portfolio holdings amongst the various financial institutions. The Twin Peaks model was explored and chosen as the most appropriate model for South Africa's financial regulation, given the current (then – 2010/2011) regulatory structure, since it is the least likely to disrupt market participants and regulators (National Treasury, 2011:29). South Africa's transformation from a silo approach to a Twin Peaks model on 1 April 2018 was therefore not a reaction to the global financial crisis

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[6] Established in terms of the National Credit Act.

of 2007/2008, but was mainly driven by the desire to be aligned with international trends to ensure a safer financial system through macroprudential regulation (National Treasury, 2018b:1).

The Twin Peaks regulatory structure entails the establishment of two, independent, peak regulatory bodies where one is responsible for ensuring the safety and soundness of the financial system and the other one with preventing market misconduct and the abuse of clients in the financial sector (Schmulow, 2017:393). This regulatory structure will no longer allow for financial institutions to be regulated according to their industry, but rather according to their function. The Twin Peaks regulatory structure aims to improve policy coordination and consists of a Prudential Authority (PA) and a Market Conduct Authority, similar to the models used in the UK and Australia (IMF, 2014:23). The Twin Peaks model received its name because of the two regulatory authorities it creates. Established within the SARB, the PA supervises the safety and soundness of all financial institutions. The PA forms part of the SARB and the Market Conduct Authority is located outside of the SARB, known as the Financial Services Board (FSB) (National Treasury, 2018b:1). With the implementation of Twin Peaks, the Financial Services Board has a new name and a new mandate. The FSB closed down on 31 March 2018 and was transformed into the Financial Sector Conduct Authority (FSCA), which is responsible for the integrity of financial markets and aims to protect customers through enhanced efficiency of the financial system to promote financial literacy and capability and to ensure that customers are treated fairly by financial institutions (National Treasury, 2018b:1). The FSCA is also held responsible for the efficiency as well as integrity of financial markets.

Van Heerden and Van Niekerk (2017:155) argue that South Africa's implementation of the Twin Peaks model is not a "pure" Twin Peaks model as considered by Michael Taylor (Taylor, 1996). This Twin Peaks model actually consists of three large peaks and a few smaller "hills". The greatest features of the South African model is that it imposes an express financial stability mandate on the SARB and eliminates bank regulation as the responsibility of the SARB (Van Heerden & Van Niekerk, 2017:155). It also establishes the PA, located within the SARB as a separate juristic person and system-wide prudential regulator to oversee all financial institutions and not merely banks. The PA is responsible for regulating banks, insurance companies[7], financial conglomerates, cooperative financial institutions as well as certain market infrastructures (SARB, 2019d) and consists of four departments, namely: the Banking, Insurance and Financial Market Infrastructures Supervision Department; the Financial Conglomerate Supervision Department; the Risk Support Department; and the Policy, Statistics and Industry Support Department. The FSB has been replaced with the Financial Sector Conduct Authority (FSCA) - a new system-wide

[7] For more information on the regulation of NBFIs see Treasury (2018a).

market conduct regulator – which is also a juristic person and is located separately from the SARB and PA. The FSCA oversees market conduct of all financial institutions, including the banking sector. The National Credit Regulator (NCR) has not been assimilated into the FSCA and functions independently as a credit market regulator within the Twin Peaks model, but within the constraints of the network of mandatory co-operation and collaboration created by the Financial Sector Regulation Act (FSRA), signed into law on 1 August 2017.

The FSRA summarises South Africa's first move towards a Twin Peaks model of financial regulation, explaining the regulatory architecture of the Twin Peaks model. The FSRA's objectives are: To ensure a stable financial system that functions in the interest of financial customers, supports and ensure balanced and sustainable economic growth in South Africa through establishing a regulatory and supervisory framework (in combination with other financial sector laws) that endorses financial stability; the fair treatment and protection of all financial customers; promotes the safety and soundness of financial institutions and the efficiency and integrity of the financial system; to prevent financial crimes and to increase the confidence in the financial system (National Treasury, 2011:2). This FSRA is applicable on all financial institutions that provide financial products and services in South Africa's financial system.

The fundamental objectives of the Twin Peaks model in South Africa is to develop a resilient and more stable financial system and to improve South Africa's approach to consumer protection and market conduct in financial services. The main objective of the PA is to ensure safe and sound financial institutions, while the main objective of the FSCA is to supervise market conduct in order to protect financial customers (Schmulow, 2018). The Twin Peaks model ensures that all financial institutions are regulated under the prudential peak (irrespective if they are banks or non-banks), while the other peak ensures that financial institutions conduct fair business. Since these two peaks are independent of one another and have clear responsibilities and accountability, the possibility of a systemic event materialising in South Africa is less (but still possible) than with the silo approach.

The Twin Peaks regulatory structure focuses on macroprudential regulations in South Africa, while Basel III and the Third King Report on Governance for South Africa (King III) are important microprudential regulations. The King III Code focuses on comprehensive risk management objectives as well as a code of good practice, while the Basel III Accords stipulate the required capital ratios that banks ought to meet. The failure to adopt the microprudential standards may limit financial institutions, for example: If the King III standards are not adopted, firms cannot be listed on the JSE and if Basel III is not implemented in the financial institution, it could lead to a significant loss in the firm's reputation (JSE, 2017:1). Both these codes are therefore important to effectively regulate financial institutions.

King III came into effect on 1 March 2010 and operative on 1 July 2010 and was proposed by the Institute of Directors in Southern Africa (IODSA) as a code of corporate governance (IODSA, 2019:1). King III is a prerequisite for firms to be listed on the JSE and addresses elements such as monitoring, disclosure, assurance and risk assessment (IODSA, 2009:21). King III states that South African financial institutions do not possess the same characteristics as global financial institutions (IODSA, 2009:8). Following the collapse of African Bank in 2014, Suresh Kana – a member of the King committee – suggested that King IV should be a simpler and more applicable approach for smaller institutions. King IV[8] attempts to have universal applicability and be easily implementable for public and private sector companies as well as non-profit organisations (IODSA, 2016:6).

The King III report does not consider systemic risk and it may be argued that this is because King III centres on risk management associated to corporate governance. The Basel Accords, however, consider systemic risk and focuses on the risk management of financial institutions and should therefore rather be considered on a macroprudential level.

2.5 The regulation of systemic risk

"More than anything else, it is the systemic risk phenomenon associated with banking and financial institutions that makes them different from gas stations and furniture stores. It is this factor – more than any other – that constitutes the fundamental rationale for the safety net arrangements that have evolved in this and other countries." – Gerald Corrigan, Former President of the Federal Reserve Bank of New York (Corrigan, 1991:3).

This statement of Gerald Corrigan, a former President of the Federal Reserve Bank of New York, indicates the uniqueness of banks and the need for government regulation. The global financial crisis of 2007/2008 highlighted potential areas of improvement, such as improved regulations and supervision for financial institutions in order to keep up with regular financial innovations as well as the measuring and regulating of systemic risk. This crisis also illustrated that although financial institutions may have complied with regulatory requirements on an individual level, there was no basis to measure the compliance of the aggregate financial system (Foggit, 2016:4). Arnold, Borio, Ellis and Moshirian (2012:3125) point out that specific institutions need to be set in place

[8] King IV is effective starting from 1 April 2017 and immediate transition is encouraged, since King IV will entirely replace King III (IODSA, 2016:38).

to carry out the aforementioned objectives and to monitor their implementation and adherence to them. Regulations will change based on the authorities' knowledge and understanding of how various factors contribute to increasing risk.

A great number of global regulations and supervisory measures are in place, but this study will only focus on regulations and measures that influence systemic risk and comprise of country-specific regulations and the Basel Accords. Systemic risk originates differently in developed economies than in emerging market economies and therefore the regulations addressing it, will also differ. The Basel Accords provide a sufficient framework for financial institutions, but given that country characteristics differ, each country may still have their distinctive and self-regulating approaches to regulations.

2.5.1 The Basel Accords

The Basel Accords are three series of international standards for bank regulations set up by the Basel Committee on Banking Supervision (BCBS). The BCBS originated in 1974 when the central bank governors of the Group of Ten (G10) reacted to the systemic events that occurred as a result of the failure of a small west German bank, Bankhaus Herstatt (Acharya, 2012:9). The initial aim of BCBS was to improve global financial stability through improved quality of banking supervision (BIS, 2014). The BCBS also aimed to close gaps in international supervisory regulations so that no bank would escape supervision and that the supervision would be sufficient and consistent across the banking sector. The purpose of these regulations was to ensure that banks have adequate capital to meet their financial obligations and to absorb any unexpected losses that may have systemic consequences. The Basel Accords were implemented with capital adequacy as the main concern together with the intention to progress over time to expand and improve on the previous accord (BIS, 2014). Basel I was therefore the foundation on which Basel II was built and improved on and so forth. Basel I and II laid the foundation for Basel III where the importance of regulating systemic risk first became an objective.

2.5.1.1 Basel I: The Capital Accord

Basel I was the first Basel Accord and came into effect in December 1992, even though its developments started four years earlier in 1988. Basel I mainly focussed on credit risk and the provision of capital to absorb losses arising from this risk together with the suitable risk weighting of assets (Kuvalekar, 2017:15). Based on their perceived credit risk, bank assets were grouped into five groups, ranging from a risk weight of 0% to 100%. Some assets were given no rating, while cash and domestic country debt such as treasuries received a 0% risk weight. Securitisations with AAA ratings received a 20% risk weight, municipal revenue bonds and home mortgages received a 50% risk weight, while most corporate debt received a 100% risk weight.

Internationally active banks were required to hold a minimum of 8% of their risk-weighted assets (RWAs) by the end of 1992, computed as the sum of the assets multiplied by their assigned risk weight (BIS, 2014). Tier 1 capital (mainly equity less goodwill) was required to be a minimum of 4% to risk-weighted assets and a total of 8% to risk-weighted assets for both Tier 1 and Tier 2 (including certain subordinated debt) capital (Blundell-Wignal & Atkinson, 2010:10).

This implemented capital to risk-weighted asset ratio was meant to decrease banks' risk taking, but did not have the anticipated effect. Instead, banks transferred the required capital amounts between on-balance sheet assets with different weights, whilst securitising assets and moving them off-balance sheet (Jackson, 1999:3). Banks accumulated the required capital through this regulatory arbitraging method, while still undertaking excessive risks. Principally, banks still held more than the required amount of capital, however, their riskiness increased substantially. The implication of this is that banks would not be able to cover their losses.

The Basel Accords were always intended to evolve over time (BIS, 2014). The Basel Committee issued an amendment of Basel I in April 1995 to announce the effects of bilateral netting of banks' credit exposures in derivative products and to increase the matrix of add-on factors. During April 1996, another amendment was published to announce how the Committee members propose to recognise the effects of multilateral lending. Since Basel I only addressed credit risk, an amendment was issued in January 1996 to take effect in 1997 to also incorporate market risk. This market risk amendment was designed to incorporate market risk arising from banks' trading activities and exposure to foreign exchange (BIS, 2014). Basel II was created and improved on Basel I as a response to the regulatory arbitrage.

2.5.1.2 Basel II: The New Capital Framework

Basel II was designed, like its forerunner Basel I, to prevent (best case scenario) and alert (worst case scenario) looming economic catastrophes by strengthening the soundness and safety of the global banking system (BCBS, 2006:2). The effort to implement Basel II was a major exercise and was undertaken over several years. Basel II was introduced in 2004 (BIS, 2014) to overcome the limitations of Basel I and in 2006 sections of the new accord had begun to be implemented globally by the time the financial crisis erupted (Van Vuuren, 2012:309). Basel I created a wider gap between economic capital and regulatory capital, giving rise to banks' tendency to undertake excessive risks with a smaller amount of capital. Basel I was mainly concerned with credit risk in banks and deemed operational risk to be part of credit risk. Due to increased growth in banks as a result of diversification and the extensive use of technology, banks were increasingly exposed to operational risk (Kuvalekar, 2017:16). Basel II recognised operational risk as a great but separate risk of banks and therefore distinguishes operational risk from credit risk (Kuvalekar, 2017:16). Basel I did not provide for market risk, thus this limitation was overcome in Basel II. Basel II was implemented to ensure that banks have sufficient capital to protect against financial and operational risks, and to protect the global financial system from problems that might arise in the event of the collapse of a major bank (Kuvalekar, 2017:18).

Basel II consisted of three pillars: (i) minimum regulatory capital requirements, (ii) the supervisory review process and (iii) market discipline through public disclosure requirements (BCBS, 2006:i). The capital requirements of Pillar 1 were based on the calculation of the total risk-weighted assets (prescribed in Basel I) and applied to credit risk, market risk and operational risk (BCBS, 2004:12). The total risk-weighted assets were calculated by multiplying the capital requirements for operational risk and market risk by 12.5 (the reciprocal of the 8% minimum capital ratio) and adding the resulting figures to the sum of the risk-weighted assets for credit risk (BCBS, 2006:12). The total capital ratio had to be a minimum of 8% and Tier 2 capital was limited to 100% of Tier 1 capital (BCBS, 2006:12). Basel II allowed banks to calculate the risk-weighted assets for market risk by using the value-at-risk (VaR) method or the modified duration under the standardised approach (Kuvalekar, 2017:17). The risk-weighted assets under operational risk could be calculated through the basic indicator approach, standardised approach and advanced measurement approach (Kuvalekar, 2017:17).

The risk-weighted assets covering credit risk can be calculated through three approaches, i.e. the standardised approach, foundation internal ratings-based approach as well as the advanced internal ratings-based approach (Kuvalekar, 2017:17). The standardised approach provides a simpler calculation where banks use prescribed risk weights for calculating their risk-weighted assets and is supported by external credit ratings, more appropriate for smaller banks (BIS, 2018:1). In contrast, the foundation internal ratings-based (IRB) and advanced internal ratings-based (IRB) approaches are more complex and more appropriate for larger banks (BCBS, 2004:15). The advanced IRB approach requires banks to calculate their own probability of default (PD), loss-given-default (LGD) and exposure at default (EAD), calculated by the bank's internal financial modelling (BCBS, 2004:48). The foundation IRB approach requires banks to only calculate their own PD (BIS, 2018:1). A major drawback of the IRB approaches, however, is the lack of comparability between banks' capital requirements.

Blundell-Wignall and Atkinson (2010:12) illustrate seven problems associated with Pillar 1, of which the five most relevant problems will be discussed. The first problem was the portfolio invariance. Portfolios were assumed to be effectively diversified, since the risk-weighting formula included a restriction that the required capital to back loans was only dependent on the characteristics of that specific loan and not on the characteristics of the entire portfolio in which it is included (Gordy, 2003:201). The importance of diversification as an influence of portfolio risk did not reflect in Pillar 1 and hence there was no concentration penalty. The second problem entailed the dependence on a single systemic global risk factor (Gordy, 2003:202). A single risk factor cannot adequately capture the bundling of firm defaults as a result of common exposure to changes in the global business cycle (Gordy, 2003:222). The single risk factor applied to a diversified global portfolio therefore does not consider country-specific risk and may considerably underestimate the amount of capital needed to support a particular country or region. The third problem arose with the creation of credit default swaps (CDS), since it created the opportunity for complete credit markets (Blundell-Wignal & Atkinson, 2010:13). Banks were now able to transform their buckets of risk themselves using derivative instruments, undermining the core principal of capital weights without needing to trade frequently on the underlying securities on primary markets, hence favouring assets with the lowest risk weights (Blundell-Wignal & Atkinson, 2010:13). Theoretically, by using this technique, ex ante risks would no longer exist in the bank (Blundell-Wignal & Atkinson, 2010:13). However, the opposite was true during the 2007/2008 global financial crisis. American Insurance Group (AIG) only sold credit default swaps and never bought any, staying on one side of these trades only. AIG was therefore unable to fund their credit default swaps when bonds started defaulting, resulting in losses for most counterparties in possession of them (Davidson, 2008).

The fourth and fifth problems involve contagion and pro-cyclicality, increasing its relevance to this study. Contagion and counterparty risks were some of the main trademarks of the global financial crisis. Both of these occurred since banks were involved in capital market activities for which they did not have adequate capital and counterparty risk increased in significance with the collapse of Lehman Brothers and AIG (Blundell-Wignal & Atkinson, 2010:13). The Basel system is known for its pro-cyclicality (Blundell-Wignal & Atkinson, 2010:13). There are several reasons for this, but the most common reason is that it tends to underestimate risks during upswings and overestimate risks during downswings. Other factors that contribute to this pro-cyclicality are the leverage ratios that are dependent on current market values, since it is low during bad times and high during good times. If asset values do not correctly mirror future cash flow prices, then it may result in pro-cyclicality.

Bank risk measurements also tend to reflect pro-cyclicality, since it does not measure the entire cycle, but are only at a specific point in time. Counterparty credit policies are also easier during economic upswings and tough during economic downswings. The last factor that contributes to pro-cyclicality is profit recognition and compensation schemes, since it encourages short-term risk taking, but do not adjust for risk taking over the business cycle. Under the Basel system, nothing was done to counter this pro-cyclicality. Since the risk inputs that banks use are subjective under Basel II's Pillar 1, it allowed banks to hold the least amount of capital through regulatory arbitrage and by varying bank capital more directly through dividend and share buyback strategies (Blundell-Wignall & Atkinson, 2010:14). This was achieved through high dividends and buybacks in the good times and vice versa. The definition of what capital essentially comprises of is unclear under Basel II, allowing for the possibility of regulatory arbitrage as aforementioned. This may in return hinder a bank's ability to effectively absorb losses during a crisis.

Pillar 2 and 3 aimed to address the risks that Pillar 1 neglected to address. Pillar 2 encompasses supervisory processes and the use of a stressed value-at-risk (VaR), requiring banks to hold more capital for both the banking and trading book for risks that were not captured in Pillar 1 (BCBS, 2011:3). Pillar 3 includes market discipline through effective public disclosure. The housing bubble that resulted in the 2007/2008 global financial crisis serves as a good example of the lack of informational contagion in the market. If the market was informationally efficient, it is possible that a bubble may not have occurred in the housing market since appropriate house prices would have been reflected, resulting in financial market participants reacting rationally. It is imperative that the minimum capital requirements of Pillar 1 are supplemented with robust implementation of Pillar 2. The third pillar must also be an effective complement to the other two pillars.

Basel II was implemented to diminish the probability that an individual bank would fail, since this should ensure a sound and stable global financial sector (Lehar, 2005:2578). Basel II was concerned with the measurement of an individual bank's risk, but failed to consider systemic risk which is the main rationale for bank regulation (Acharya, 2012:10). Basel II also disregarded the increasing fragility of banks (on their liability side), due to the increase in uninsured wholesale deposit funding (Acharya, 2012:10).

Kaserer (cited by Schwerter, 2011:340) argues that the main undertaking of regulation should however be to ensure the stability of the entire financial system and should not focus on microprudential regulation. Basel II focuses on microprudential regulation since it attempts to guarantee the safety of individual banks. Brunnermeier, Crockett, Goodhart, Helwig, Persaud and Shin (2009:24) state that Basel II subsidises financial institutions that cause negative externalities on market participants. The reasoning for this is that Basel II focused on the microprudential regulation of financial institutions and it created significant incentives for financial institutions to become "too big", "too interconnected" and "too many" to fail, since it increases the probability that they will be bailed out during a financial distress. Schwerter (2011:339) supports this criticism of Brunnermeier *et al.* (2009) and states that Basel II created systemic risk factors and should be improved by altering key areas such as the bank's size, degree of leverage, pro-cyclicality, maturity mismatch, interconnectedness, idiosyncratic risk as well as exposure to common risks.

Schwerter (2011:340) further argues that the bail-out of individual financial institutions should be avoided, since it is only a short-sighted intervention that is likely to result in short-term gains and will not be beneficial over the long term. An anticipated bailout implies indirect guarantees for “too big”, “too interconnected” and “too many” to fail financial institutions and are likely to weaken the financial system in the long run. Despite Schwerter’s (2011) aforementioned arguments, it is still imperative to support business units of systemically important financial institutions, since it supports the general objective to stabilise the entire financial system.

This accord failed to fulfil its task, due to a lack of concern for interconnectedness and systemic risk. Even though Basel II did not thoroughly focus on macroprudential risk alleviation, it is not to propose that the microprudential regulation is wrongly designed or unnecessary. The microprudential regulation can, however, be improved. This form of regulation is insufficient on its own and it is therefore important that it is used in conjunction with macroprudential regulation. Basel III was therefore proposed to repair the shortcomings of Basel II.

2.5.1.3 Basel III: Responding to the 2007/2008 global financial crisis

Risk management in the financial sector generally focussed on an individual financial institution’s market, credit and operational risk and disregarded the interconnectedness among financial institutions and hence their systemic risk. Basel III was developed in 2010 as a response to the 2007/2008 global financial crisis and addresses the aforementioned problem (BCBS, 2010b:3). Van Vuuren (2012:309) suggests that Basel III is an improvement on the existing rules of Basel II and aims to address the shortcomings in financial regulation that became evident during the global financial crisis. It is important to take note that Basel III was never intended to replace Basel II (nor does it), but merely improved the inadequate parts. Basel III intends to strengthen bank’s minimum capital requirements by implementing a capital buffer, a leverage ratio, two liquidity ratios together with charges for counterparty risk (Van Vuuren, 2012:310). The composition of regulatory capital and required capital for the trading book was also amended (Van Vuuren, 2012:310). Basel I and II mainly considered solvency risk, whereas Basel III mainly focuses on liquidity risk, but did not truly consider how these risks could result in systemic risk (Acharya, 2012:10). Basel III has, however, identified three sources of risks that might contribute to a financial institution’s failure (Acharya, 2012:10), i.e.:

a. Solvency risk, when the market value of assets substantially declines to below its financial obligations
b. Liquidity risk, where a firm cannot convert its illiquid assets into cash to meet its financial obligations

c. Funding liquidity risk, where financial institutions are unable to roll-over their maturing debt obligations (Ritchie, 2017)

These risks can easily be propagated through contagious runs, counterparty risk or fire sales, leading to systemic risk swiftly submersing the financial sector. Although Basel III was introduced to improve on Basel II, it is inadequate in the sense that it does not indicate when a financial institution's liquidity risk or solvency risk can lead to systemic risk (Acharya, 2012:10). Basel III mainly addresses the inadequacies of Pillar 1 of Basel II, although it includes changes in all three pillars (Georg, 2011:3). The changes to Pillar 2 include improved supervisory guidance of regulatory authorities (Georg, 2011:4). The authorities' capacity to act will increase in order to increase their ability to manage various kinds of risks, such as concentration risk, off-balance sheet and liquidity risk. Stress tests are also implemented to aid in identifying systemic risk. The standards for market disclosure are raised under Pillar 3 in order to enhance transparency. Under this increased market disclosure, banks need to disclose more details concerning their balance sheets, such as reporting the terms and conditions of all instruments on their regulatory capital base as well as the deductions that were applied. Banks' loss absorption abilities are improved through Basel III, hence decreasing the probability of bank failures. One of the main features of Basel III is the introduction of an additional non-risk based leverage ratio followed by the implementation of two liquidity ratios (Georg, 2011:3). The non-risk-based leverage ratio was introduced as a notion to capture the effects of off-balance sheet leverage not initially captured by the risk-based capital ratios (Foggit, 2016:92). The theoretical result of this is that a possible deleveraging process is controlled that could have led to the disruption of the aggregate financial system and global economy.

The implementation of Tier 1 of Basel II (ratio between risk-weighted assets and core equity) did not have the anticipated constraining effect, since banks increased their leverage both for on- and off-balance sheet, while still adhering to the capital requirements. Basel III improves on this by implementing more stringent capital requirements. Tier 1 capital is the predominant capital and in terms of more stringent capital requirements, banks are now required to hold a minimum of 4.5% common equity instead of 2% (increased quantity) as well as a higher quality of capital, since the definition of common equity was adjusted (BCBS, 2011:13). The minimum Tier 1 ratio to unweighted assets would be 3% (BCBS, 2011:13). The minimum Tier 1 leverage ratio will be 3% for the period 1 January 2013 to 1 January 2017 (BCBS, 2011:61). Tier 2 capital is considered to be supplementary capital, while Tier 3 capital is eliminated in Basel III since it was only available to cover market risk (BCBS, 2010b:4). Beltratti and Stulz (2012:3) found that stronger capital regulations for banks were associated with less risk before the global financial crisis of 2007/2008, supporting Basel III's stringent capital requirements.

Basel III was agreed upon by BCBS in July 2010 with the proposal to be implemented from 1 January 2013 up to 1 January 2015, but the year for final implementation was however repeatedly extended to 31 March 2019 (BCBS, 2010b:3). Member countries were required to translate these rules set out by Basel III into domestic laws and regulations prior to implementation. Since Basel III is phased in, minimum requirements and deadlines for implementation need to be adhered to. The BCBS introduced transitional arrangements to implement the new rules to ensure that the banking sector can still support lending to the economy, while meeting the higher capital requirements. Table 2.1 provides a summary of the capital requirements and their timeline for implementation.

Table 2.1: Capital adequacy standards for Basel III

	Phase in arrangements						
	2013	2014	2015	2016	2017	2018	2019
Minimum common equity capital ratio	3.50%	4%	4.50%	4.50%	4.50%	4.50%	4.50%
Capital conservation buffer				0.63%	1.25%	1.88%	2.50%
Minimum Tier 1 capital	4.50%	5.50%	6%	6%	6%	6%	6%
Minimum total capital	8%	8%	8%	8%	8%	8%	8%
Minimum total capital plus new conservation buffer	8%	8%	8%	8.63%	9.25%	9.88%	10.50%

Source: BCBS (2011:69)

Basel III, in contrast with Basel II, includes a macroprudential approach since the 2007/2008 global financial crisis revealed that microprudential regulation alone is inadequate to respond to systemic risk, as it only focuses on firm-specific risks. Macroprudential regulation considers the interconnectedness of financial institutions as well as the risks that arise from interactions between the financial institutions, thus aiming to stabilise the entire financial system. Basel III introduces two capital buffers in an attempt to prevent and protect financial firms against systemic risk, i.e. capital conservation buffer and a countercyclical buffer (Georg, 2011:4). During an economic upswing, banks must build up a capital conservation buffer of 2.5% in order to increase the total common equity ratio to 7% (Georg, 2011:4). During times of economic distress, financial institutions can use this buffer as a cushion to absorb losses. Authorities are also authorised to raise an additional countercyclical buffer up to 2.5% to counteract excessive credit growth that might prompt systemic risk (Georg, 2011:4).

Even though high levels of capital are necessary to ensure bank sector stability, it is not sufficient when used in isolation. The global financial crisis illustrated that banks with adequate capital levels can still experience financial troubles as a result of liquidity shortages (BCBS, 2011:8). For this reason, Basel III includes two additional liquidity measures to diminish liquidity shortages, namely the liquidity coverage ratio (LCR) and net stable funding ratio (NSFR) (BCBS, 2011:9). The LCR is the short term minimum liquidity standard for banks. It is the ratio of the bank's high quality liquid assets to its net cash outflows over a 30-day period under a prescribed stress scenario. This scenario is simulated based on events of the global financial crisis and includes both shocks to financial institutions as well as systemic shocks (BCBS, 2011:9). In order to determine the LCR, Basel makes the following assumptions[9] (BCBS, 2011:9):

i. A substantial downgrade in the credit rating of the financial institution
ii. A loss of some deposits
iii. A loss of unsecured wholesale funding
iv. A substantial increase in secured funding haircuts
v. An increase in calls on contractual and non-contractual off-balance sheet exposures, including committed credit and liquidity lines

This ratio of the bank's high quality liquid assets (cash and government securities) to its net cash outflows (outflows wholesale funding, retail deposits etc.), should exceed 100% (Acharya, 2012:12). The LCR encourages banks to retain high quality liquid assets in order to cover its cash outflows for 30 days to survive a system-wide shock.

The NSFR is computed as the bank's current available stable funding (stable short-term deposits and capital long-term liabilities) to its required amount of stable funding (value of bank's assets held multiplied by a factor representing the liquidity of the bank's assets) over a one-year horizon (Acharya, 2012:12). The objective of this ratio is to limit the over-reliance on short-term wholesale funding during times of high liquidity and to encourage improved assessment of liquidity risk across all on- and off-balance sheet items (BCBS, 2011:9).

Apart from the principle of stable funding and the increased liquidity support, a few other measures were also proposed to promote the accumulation of increased countercyclical capital buffers during an economic upswing and also to reduce the pro-cyclicality that inherently arises from the Basel regulations. The primary objectives of these measurements are to diminish any excess cyclicality of the minimum capital requirement, to encourage forward looking provisions, to encourage the conservation of capital in order to build up increased buffers for both individual banks as well as the banking sector for times of distress, whilst achieving the larger

[9] These assumptions are not worst-case scenario, but for significant stress.

macroprudential goal of protecting the whole banking sector from periods of excessive credit growth (BCBS, 2011:5).

Basel III also underwent reforms in 2017, addressing weaknesses revealed by the global financial crisis (BIS, 2018:1). As mentioned in Section 2.5.1.2, credit risk can be measured by means of the standardised approach, foundation internal ratings-based or the advanced internal ratings–based approach. Major drawbacks of the internal ratings-based approach include the lack of comparability between banks' internally modelled capital requirements and the unnecessary complexity of the internal ratings-based approaches. The Basel Committee on Banking Supervision addressed these drawbacks by implementing the following revisions (BCBS, 2017b:5): (i) the option to use the advanced IRB approach was removed for certain asset classes; (ii) implemented "input floors" for measures of PD and LGD to guarantee a minimum level of stable parameters for asset classes where the IRB approach can still be applied; and (iii) provided increased specification of parameter estimation practices. The leverage ratio of global systemically important banks (G-SIBs) also increased under these reforms (BCBS, 2017a:2), constraining the build-up of debt and reducing the risk of a deleveraging spiral during an economic downturn.

By implementing the aforementioned changes, Basel III aimed to address the shortcomings of Basel II. Basel III strengthened the capital standards and implemented solvency ratios as well as liquidity standards to improve banks' resilience to acute short-term stress and to enhance long-term funding. Capital buffers to be built up in prosperous times and to be drawn down during periods of stress were also introduced. This is the first accord to address systemic risk by means of a macroprudential approach. Basel III also enhanced the standards for supervision and risk management (Pillar 2) and public disclosures (Pillar 3) and introduced a leverage ratio to prevent excessive leverage build-up in the financial sector. This demonstrates why Basel III is considered to be the global standards for banking regulation and supervision. The Basel Accords are international standards to regulate financial institutions, but the implementation thereof remains the responsibility and choice of the individual country. Although a number of improvements have been made and Basel II's shortcomings mitigated, a few problems and oversights still remain. The criticism of Basel III is discussed in Section 2.5.2, while the mitigation of Basel II's shortcomings is reviewed in Section 2.5.3.

2.5.2 Criticism of the Basel III Accord

The implementation of the capital conservation and countercyclical buffer may result in problems. These capital buffers may create incentives to invest in countries with lower capital buffers and also increase political pressures to lower capital buffers as a way to increase a country's competitiveness (BCBS, 2010b:5). No incentives are provided for financial institutions to address negative externalities that may arise from the increased interconnectedness between financial institutions that may result in systemic risk. The NSFR (which measures the long-term liquidity standards) encourages higher liquidity standards. In contrast, the higher liquidity standards that are encouraged through the NFSR motivate banks to implement structural changes in their liquidity profiles (BCBS, 2010a:1). This results in a move away from short-term funding towards more stable, long-term funding to provide for liquidity shortages.

Following from the critique against Basel III as well as the incentives that this accord create for banks, it is necessary to consider the extent to which Basel III was able to mitigate the various shortcomings of Basel II. This is discussed in Section 2.5.3.

2.5.3 Basel III and the mitigation of Basel II's shortcomings

Basel III provides a broad reaction to Basel II's shortcomings and is displayed by Table 2.2.

Table 2.2: Basel III's responses to Basel II's shortcomings

Basel II's shortcomings	Basel III's response
Systemic (liquidity risk)	Liquidity standards
Procyclicality	1. Build an additional capital buffer
	2. Avoid excessive credit growth
	3. Use stressed data to calculate counterparty credit risk
Transparency	1. Increased disclosure of capital and liquidity requirements
	2. Disclose the leverage ratio and national countercyclical buffer
Sustainability	1. Implemented an enhanced capital base
	2. Widened risk coverage
	3. Implemented new liquidity standards (e.g. the NSFR)
Too-big-to-fail (TBTF), too-many-to-fail (TMTF) and too-interconnected-to-fail (TITF).	Nothing
Macroprudential view	1. Capital conservation buffer is implemented
	2. Countercyclical buffer is implemented
International coordination	At least 27 members of the committee will implement this approach

Source: Schwerter (2011:346)

Since the primary objective of Basel III is to achieve a more stable and resilient banking sector, all of the improved proposals contribute, to some extent, to the reduction of systemic risk. This is mainly because Basel III does not lead to the increased stability of an individual financial institution, but because it increases the overall stability of the financial system (Schwerter, 2011:345). Additional proposals that focus wholly on systemic risk are, however, still lacking. The new, implemented liquidity standards – especially the NSFR – contributes to diminishing systemic liquidity risk. Procyclicality has been addressed through the implementation of the capital conservation and countercyclical buffer in order to build up additional capital that can be utilised as a cushion to absorb losses and to counteract excessive credit growth. The need for improved transparency is met through the increased disclosure of capital and liquidity standards as well as the publication of the leverage ratio and the national countercyclical buffers. The lack of sustainability is improved through an enhanced capital base and wider risk coverage followed by the implementation of new liquidity standards, especially the NSFR. The too-big-to-fail, too-many-to-fail and too-interconnected-to-fail problems have not been addressed in Basel III. Basel III has also been able to achieve a significant increase in international coordination, since 27 member countries indicated with its development that they will implement this framework. Basel III includes an imperative banking area that will result in improved consistency in the regulatory environment. International coordination does, however, have its restrictions. For example, the countercyclical buffers must be implemented on a national domain since it takes the economic environment of each country into account. Further regulations that are forward-looking are needed to help strengthen the aforementioned aspects. The essential reduction of systemic risk as well as the macroprudential view are supported by the BCBS's effort to address interconnectedness and systemic risk. They also attempted to reduce cyclicality of the minimum capital requirements followed by the development of more forward-looking proposals and provisions in order to diminish procyclicality.

From the abovementioned it is clear that Basel III has improved upon many of Basel II's shortcomings. Basel III considers systemic risk through a macroprudential regulatory approach. This includes measures such as the countercyclical capital buffer as well as how to regulate systemically important financial institutions through additional capital charges based on the size of the SIFI. Although Basel III presents a few new regulations and improved upon Basel II's, the extent to which it has the desired effects need to be determined. The Basel III accord is a universal framework and remains the responsibility of each individual country to implement it. Individual countries may, however, implement their own country-specific regulations in addition to the Basel accord to ensure broad financial system stability.

2.6 Country-specific regulations

Systemic risk manifests differently in emerging market economies and therefore the country-specific regulations of South Africa will differ from those of a developed economy, such as the US. In Chapter 1 it was illustrated that South Arica's banking sector is dominated by the five largest banks and that the insurance sector is dominated by the five largest insurers and seven largest fund managers. Due to a lack of literature relating to the manifestation and regulation of systemic risk in the South African financial sector, reports from the SARB and IMF will be relied upon.

South Africa's financial sector consists of 32 banks and 45 NBFIs (BASA, 2018; IRESS, 2019). The banking sector is mainly dominated by the following banks: Absa, FirstRand, Nedbank and Standard Bank being the four largest banks; Investec, a medium-sized investment bank; followed by African Bank and Capitec, two smaller banks specialising in unsecured lending to low-income households (IMF, 2014:10). The four largest banks have a total of 46 foreign subsidiaries, of which 39 are located in Africa (IMF, 2014:10). Due to South Africa's five largest banks accounting for 90.5% of the total banking sector assets, South Africa's financial sector exhibits a great degree of concentration and interconnectedness. A similar degree of concentration is evident in the insurance market, with the five largest insurers accounting for 74% of the insurance market and the seven largest fund managers accounting for 60% of the unit trusts. A significant amount of interlinked party transactions exist between these financial institutions.

Three of South Africa's five largest banks used to have strong ownership links with the UK. Barclays UK (global systemically important bank) had a bank holding company, Barclays Africa Group, in South Africa that used to own the majority stake of Absa (IMF, 2014:57). Barclays reduced its shareholding in Barclays Africa Group to less than 50% and the name subsequently changed to Absa Group Limited. This entire process is expected to be completed by June 2020 (Dludla, 2018). Investec (comprising of Investec Ltd and Investec Plc) is dual listed on the JSE and the London Stock Exchange (LSE), with the UK holding company overseeing the non-African activities. As mentioned in Section 2.4, Investec Ltd announced its intention to demerge from Investec Asset Management in September 2008. Old Mutual in the UK owns a major South African insurance subsidiary and used to indirectly own Nedbank. Old Mutual had a 52% stake in Nedbank and unbundled the majority of its shareholding on 15 October 2018 (Old Mutual Limited, 2019) to a 19.9% minority shareholding (Nedbank, 2019).

In addition to the aforementioned, other major banks are also affiliated with insurance companies. The Standard Bank Group, Standard Bank's holding company, owns the majority of shares of 53.62% in Liberty Group (IRESS, 2019), one of the largest insurance companies in South Africa. These bank-affiliated insurance companies are responsible for underwriting a significant portion of private pension fund assets, while some banks also own asset management companies that offer unit trusts (IMF, 2014:57). Some of these banks have started to expand their operations to other Sub-Saharan African countries, with the leaders being Standard Bank, Absa and Nedbank. Four of the top five banks have 39 subsidiaries in 17 sub-Saharan African countries (IMF, 2014:57) and although the sizes of their operations are small relative to the entire group, South Africa's banking industry has strong cross-border and cross-sectoral connections. Since the non-bank financial institutions (NBFIs) are not as sufficiently regulated as the banking sector, growth in these institutions could pose systemic risks to the entire financial sector[10].

[10] For a detailed discussion on the regulation of NBFIs see Carmichael and Pomerleano (2002) and Treasury (2018a).

The failure of African Bank in 2014 symbolises an important example of how South Africa's regulatory authorities efficiently mitigated a bank failure that could have imposed systemic effects. Shareholders and wholesale funders lost confidence in the bank's ability to effectively generate earnings for sustained business growth and returns on investments (SARB, 2014a:17). The bank experienced increased provisions against non-performing loans and as a result, reported losses for three successive periods. African Bank Investments Limited (ABIL), holding company of African Bank, raised R 5.5 billion in capital through a rights issue during December 2013 (SARB, 2014:2b), which briefly improved prospects. However, during March 2014 both the share price and credit rating of ABIL declined when provisions had to be increased to R 2.5 billion and losses of R 3.1 billion were reported. Additional credit impairments relating to its liberal unsecured lending portfolios were seen during August 2014 and posted an R 6.4 billion expected headline loss for September 2014 (SARB, 2014a:17).

The SARB placed African Bank under curatorship during August 2014 with their assets being R 58 billion, contributing to 1.44% of total banking sector assets (SARB, 2014a:6). The reason for this curatorship was to avoid contagion effects from the possible failure of African Bank, since the shareholders and funders lost their confidence in this bank. Under this curatorship, the SARB took ownership of the non-performing assets, while the performing assets were transferred to another well-performing bank that was parented by a bank holding company capitalised with R 10 billion in share capital.

Following the curatorship, African Bank remained operational, but had to reduce their risk appetite and had to follow more stringent lending criteria. Since the SARB guaranteed the retail deposits, no runs were observed and no evidence of contagion on funding markets relating to wholesale or retail funding was observed. The SARB used the "Key attributes of effective resolution regimes for financial institutions" package outlined by the Financial Stability Board (FSB, 2014). This package contributed to mitigating the contagion effects, enabling the bank to stay in operation. African Bank's debt accounted for 1.3% of the assets held by 43 money market funds, resulting in the prices of ten of these units falling (Foggit, 2016:113). Although some spill-over effects into money market funds, bond markets and pension funds did occur, the SARB effectively limited contagion and the larger banks were mostly unaffected. During this time, the interconnectedness of South Africa's financial sector was exposed (SARB, 2014a:18). Although African Bank's small size would not have suggested systemic implications, its problems serve as a reminder that asset quality can rapidly deteriorate in a weak economy and that even small financial institutions can cause systemic risk due to high interconnectedness (IMF, 2014:7).

Due to the level of interconnectedness between the banking and non-banking financial institutions (NBFIs) in South Africa's financial sector, the activities of NBFIs play an imperative role in financial intermediation, potentially contributing to systemic risk and amplifying risks (SARB, 2014a:21). Non-bank financial institutions – such as money market funds – invest great amounts of their assets through short-term instruments, such as deposits, in large banks (SARB, 2014a:16). These transactions expose the NBFIs to counterparty risk, while simultaneously exposing banks to liquidity risk. The reason for this being that a significant withdrawal of funds could stress bank liquidity and if a bank fails, it negatively impacts on the NBFI's asset quality. Furthermore, the interconnectedness between insurance companies and large banks also poses a threat to financial stability. South African banks not only have cross-ownership and equity investments, but also acquire a large portion of funding from long-term insurers. Due to this interconnectedness, the potential for a shock to be propagated from one sector to another exists and it can potentially become systemic in nature. This potential exists partly since regulation of the banking and non-banking sectors used to be fragmented, making regulation challenging. South Africa's transformation to a Twin Peaks regulatory structure – as discussed in Section 2.4.1 – essentially improves the ease and effectiveness of financial regulation.

Regarding country-specific risks, the IMF (2014:16) reports that South Africa's dependence on external financing makes the economy vulnerable to capital flows as well as the re-pricing of global risk. Banks do not, however, rely substantially on external funding. Capital flows required to fund the large current account and fiscal deficits affect the pricing in the domestic funding market, which in turn affect banks. As investors' demand for South African assets fluctuate and can push banks' funding costs higher, large banks' reliance on short-term wholesale funding followed by their active trading in the over-the-counter (OTC) derivatives market increase their susceptibility to external shocks and global re-pricing of risk (IMF, 2014:16). The flexible exchange rate and capital control limits have buffered the economy against volatile capital flows and mitigated these risks to a certain extent, but South Africa's external position still remains weaker than fundamentals and policies would imply (IMF, 2014:16).

The SARB implemented the Basel III regulations consistently with the internationally agreed upon timeline uniformly to all banks and banking groups in South Africa (BCBS, 2015:4). The fact that South Africa's financial institutions are Basel compliant is an encouraging sign. The South African banking sector is relatively well capitalised, maintaining a higher than demanded common equity Tier 1 capital adequacy ratio as well as a Tier 1 capital adequacy ratio, illustrating South Africa's adherence to Basel. The former ranged from 12.8% to 13% during February 2018 to July 2018, while the latter ranged from 13.3% to 13.5% for the same period (SARB, 2018:45). Basel III's requirements entail a domestic systemically important financial institution capital requirement, countercyclical capital buffer and conservation buffer that replaced the previous 1% systemic risk charge imposed on banks (IMF, 2014:22). The leverage ratio is kept at 4%, while banks are required to keep 5% of their total liabilities in liquid assets and 2.5% of their total liabilities in cash. A liquidity coverage ratio was also phased in during 2015, requiring banks to meet the minimum of 60%. Banks who are unable to meet this ratio on their own will receive support from the SARB in the form of a committed liquidity facility (CLF), an alternative framework approved by Basel (IMF, 2014:20).

Basel III's implementation, changes and requirements were discussed in detail in Section 2.5.1.3 to 2.5.3. The SARB developed an indicator-based methodology to identify domestic systemically important banks (D-SIBs) and based its own approach broadly on Basel's global systemically important banks (G-SIBs) approach. Since South Africa's characteristics differ from those of other economies, the SARB adjusted some of the indicators and weightings as to reflect the characteristics of the domestic financial sector. South Africa's approach therefore accounts for the country-specific characteristics as well as the overall state of stability of the domestic financial system. South Africa's altered approach and Basel's approach is compared in Table 2.3 below, with each indicator being based on a number of sub-variables.

Table 2.3: Comparison between South Africa's and Basel's systemically important banks assessment methodology

Indicator	SA's D-SIB methodology indicators	Basel's G-SIBs methodology indicators
	Weighting (%)	Weighting (%)
Size	40	20
Global activity	10	20
Interconnectedness	20	20
Substitutability	20	20
Complexity	10	20

Source: SARB (2013:33) and (SARB, 2019a:6)

The indicators included in South Africa's D-SIBs methodology have sub-indicators and are as follows:

- Size (the bank's total assets as well as off-balance sheet exposures) - The larger a financial institution is the more likely its failure is to disrupt the economy and financial markets and to harm confidence. It will be more difficult to swiftly replace its service offerings or to control the wide spread impact on clients, customers and employees. Size is considered to be an important indicator, due to the concentrated nature of South Africa's banking sector. The SARB's 20% increase in this indicator indicates the importance of the size of banks to the SARB.

- Global activity – Global activity is considered to be less relevant for the D-SIBs methodology than for the G-SIBs methodology – indicated by the 10% decrease in this indicator - since domestic banks could have restricted cross-jurisdictional activities. Spill-over effects to other jurisdictions are not only caused by G-SIBs, but can also be caused by D-SIBs with cross-border operations. South Africa does, however, have large banks operative in parts of Africa and therefore cross-border externalities are included in the D-SIB methodology, although it is a lower weighting than Basel's G-SIBs framework.
- Interconnectedness – The degree of interconnectedness in a financial system determines both the channels and speed through which banking distress is spread to the rest of the system. Due to South Africa's high level of concentration in the financial sector, interconnectedness is also significantly large. This indicator takes the exposures to and from other financial institutions into account and is in line with the 20% proposed by the BCBS.
- Substitutability – This indicator mainly reflects the participation in the financial market infrastructure. The less substitutable a financial institution is the more systemically important it becomes, particularly if its functions are considered to be critical to the functioning of the broader economy. This weighting is in line with the BCBS's proposed 20%.
- Complexity – The complexity of a bank's business and operating model as well as its organisational and group structure influences the systemic impact of a bank's failure. South Africa's weighting assigned to this indicator was reduced, mainly because South African banks' involvement in complex activities such as complex derivative and trading activities are limited.

Although formal systemic protection is limited in South Africa, the SARB has intervened in the past with bank failures, when capital and liquidity injections were needed to prevent deposit contagion and to ensure and maintain financial stability (IMF, 2014:58). With the implementation of the Twin Peaks regulatory approach, South Africa can focus more on a macroprudential approach. This will allow the SARB to implement macroprudential tools in line with adequate systemic risk analysis. The SARB should, according to the IMF (2014:26), be given greater resources to carry out its function as a systemic risk regulator. The SARB must be able to collect more granular data in order to facilitate the use of macroprudential instruments, since it is normally more targeted than monetary policy tools. Furthermore, the SARB should have the capability to conduct system-wide stress tests as an attempt to monitor systemic risk, specifically focussing on systemically important financial institutions. Considering the importance of non-bank financial institutions in South Africa, increased expertise is needed in this area, although it could be argued that the high standards of corporate governance in South Africa is already paying attention to it (IMF, 2014:59).

South Africa's main corporate governance approach is the Third Report on Governance (King III) and is an imperative part of risk management in South Africa. All listed companies on the main board of the JSE need to adhere to this report and implement it in their company structure. King III was discussed in detail in Section 2.4.1, but, in a nutshell, it focuses on the importance of annual reporting and the positive and negative effects that the firm has on the economic climate of the community in which it operates. Emphasis is also placed on how the firm plans to capitalise on the positive effects and minimise the negative effects during the following year.

From this section it is quite clear that South Africa faced a significant test with the failure of African Bank in 2014, but due to the SARB's rapid intervention, contagion and systemic consequences could be mitigated. South Africa's regulatory structure transformed to a Twin Peaks regulatory model as an attempt to better regulate the entire financial system, due to a fragmented financial sector. South Africa's significant reliance on capital flows followed by the large degree of financial sector interconnectedness create potential areas of concern. The increase in the D-SIBs indicator to 40% indicates the significance and importance of the banking sector in South Africa and also indicates the SARB's concerns about large banks and their contribution and susceptibility to systemic risk.

The control and mitigation of systemic risk is important, since it contributes to financial stability and is a key element for sustained macroeconomic stability (Blanchard, Dell'Ariccia & Mauro, 2013:6). In order to optimally regulate systemic risk in the financial sector, it is vital to determine which individual financial institutions contribute the most to systemic risk and also what the greatest determinants of financial institutions' systemic risk are. It is also necessary to identify the amount of systemic risk that individual financial institutions contributes to the financial sector as a whole. As soon as the individual financial institutions and determinants have been identified, it would enable the enhancement of the current systemic risk identification and regulatory measures (Mayordomo, Moreno & Peña, 2014:84).

CHAPTER 3 DETERMINANTS OF SYSTEMIC RISK

"One of the most feared events in banking is the cry of systemic risk. It matches the fear of a cry of 'fire!' in a crowded theatre or other gatherings. But unlike fire, the term systemic risk in not clearly defined" (Kaufman & Scott, 2003:371).

The outbreak of the 2007/2008 financial crisis and the subsequent financial turmoil stimulated the awareness in the understanding and analysis of systemic risk. The importance of early detection of risky financial institutions intensified after this crisis, enabling institutions to solve their problems earlier at a lower cost (Baselga-Pascual *et al.*, 2015:139). The negative externalities, such as the high bailout costs associated with the financial crisis, indicate the need for better understanding of the determinants of systemic risk.

The identification of the determinants for inclusion in this study is based on literature from both national and international academics. Baselga-Pascual *et al.* (2015:140) and Alber (2015:118) propose that the determinants should be divided into two groups: first the determinants that are specific to each financial institution and secondly factors that influence the industry as well as the macroeconomic environment within which the financial institutions function. The first group of determinants includes the size of the institution, the activities of the financial institution, funding structure, capitalisation, leverage, liquidity, performance, profitability and efficiency. The latter group contains economic growth, unemployment rates, interest rates and inflation rates. Given the differences in the structure of countries' financial sector, the factors contributing to systemic risk may differ vastly. These determinants may differ between developed countries when internal banking factors differ and also differ between developed market economies and emerging market economies. It is of great importance that the country-specific variables contributing to systemic risk are known in order to effectively regulate and monitor systemic risk.

3.1 Firm-specific variables

3.1.1 Size of the financial institution

The size of financial institutions has become increasingly important during and after the financial crisis of 2007/2008. The interest in the size of banks in particular received much more attention as indicated by the dramatic increase in studies relating to bank size, too-big-to-fail and systemic important banks (SIBs). Laeven, Ratnovski and Tong (2016:25) highlight three possible reasons why bank size receives much more attention now. First, large banks were at the centre of the financial crisis. Second, the size of large banks increased significantly over the last two decades and third, large banks are likely to have lower capital ratios, fewer stable funding and increased exposure to risky market activities.

An increase in the size of the institution may be riskier due to a moral hazard problem, since they know they will be bailed out, thus amplifying risk taking and diminishing market discipline (Baselga-Pascual *et al.*, 2015:143). Brownlees and Engle (2012:9) support the idea that larger banks are more prone to systemic risk since the probability of capital shortage increases with the increase in bank size. Afonso, Santos and Traina (2014), Alber (2015:118), Baselga-Pascual *et al.* (2015) as well as Laeven *et al.* (2016:33) confirm the aforementioned findings. Foggit (2016:237) found that internal characteristics such as the bank's size is positively related to systemic risk in developed economies, but is not a significant determinant for emerging market economies such as South Africa. Large banks have increased organisational complexity, contributing to the banks' default and systemic risk (Beck, Demirgüc-Kunt & Levine, 2006).

Laeven, Ratnovski and Tong (2014:3) support the idea that bank size contributes to systemic risk. Large banks significantly contribute to systemic risk, but it is not only because of their size. Large banks are more prone to engage in market-based activities outside of traditional bank lending and tend to have lower capital levels as well as less stable funding (Laeven *et al*., 2014:3). Large banks are inclined to be more organisationally complex than small- and medium-sized banks, suggesting a possibly more fragile business model. Organisationally complex banks and banks with these low levels of capital and less stable funding together with increased engagement in market-based activities create more systemic risk, even though they are not individually riskier.

Laeven *et al.* (2016:33) report that systemic risk is highly correlated with bank size, since a one standard deviation increase in the banks' total assets results in half a standard deviation increase in the banks contribution to systemic risk. These are large effects, but might undervalue the true systemic risk of large banks since the market believes that the bank will be boosted by government support, resulting in increased market value of the bank's equity (Laeven *et al.*, 2016:33). The failure of large banks tend to disrupt the financial system more than the failure of small banks, because large banks produce liquidity stress in the banking sector and small banks cannot easily replicate their activities that rely on economies of scope and scale. The market capitalisation (Malkiel & Xu, 1997), logarithm of market capitalisation (Moreno 2013) and logarithm of total assets (Baselga-Pascual *et al.*, 2015) are all proposed as proxies for a financial institution's size.

Paradoxically, there is also ample evidence to support the theory that large banks do not contribute to systemic risk due to their managerial capacity and efficiency. Varotto and Zhao

(2018:45) argue that although an increase in the bank's size results in increased systemic risk, smaller banks still pose considerable threats to the safety of the financial sector and systemic risk. López-Espinosa, Moreno, Rubia and Valderrama (2012:3150) found that the size of international banks do not contribute to propagating systemic risk globally. This is in line with the findings of López-Espinosa, Rubia, Valderrama and Antón (2013:298) that reflected that size, whether it is in absolute level or relative to GDP, does not contribute to systemic risk in large banks. Although López-Espinosa *et al*. (2013:298) acknowledge the possibility that a larger bank poses a greater loss given default (LGD), they also acknowledge the possibility that larger banks may benefit from wider diversification opportunities brought about by market segmentation. Brunnermeier, Dong and Palia (2019:15) report that bank size alone is statistically insignificant for contributing to systemic risk, but that bank size contributes to creating systemic risk through other factors such as non-interest income. The size of banks may therefore not be a persistent indicator of systemic risk and smaller banks' contribution to systemic risk should not be disregarded.

3.1.2 Financial institution activities

While the size of the financial institution is a major indicator of and contributor to systemic risk, Moore and Zhou (2014:3) consider non-traditional activities to be a great contributor to the systemic importance of a financial institution as well as to the systemic risk it imposes. The activities of a financial institution can be measured using two alternative measures, i.e. the share of non-interest income in total income and the share of loans in total assets (Vodová, 2015:94; Foggit, 2016:178). An increased share of non-interest income in total income and a decreased share of loans in total assets indicate a greater degree of involvement in market-based activities (Foggit, 2016:19).

3.1.2.1 Activities: Share of non-interest income in total income

Prior to the 2007/2008 financial crisis, non-interest income generated a higher proportion of profit for banks than net interest income (Brunnermeier *et al.*, 2019:1). Non-interest income includes commissions and fees arising from brokerage, investment banking and advisory as well as trading and securitisation and differ from traditional banking activities such as lending and deposit-taking (Brunnermeier *et al.,* 2019:1). Various literature provide evidence of a negative relationship between non-interest income and systemic risk, while vast studies detect a positive relationship between non-interest income and systemic risk.

Banks engaging in non-interest based activities tend to exhibit increased volatility in their earnings (Stiroh, 2004:879). This tendency is confirmed by Mercieca, Schaeck and Wolfe (2007:1995), finding that non-interest income activities impose a higher level of risk on banks than traditional banking activities. Similarly, De Jonghe (2010:45) emphasises that retail banks with a large portion of deposits and loans in their total assets are more financially stable and therefore contributes less to systemic risk. The results of Moore and Zhou (2014:23) and Bostandzic and Weiss (2018:38) were consistent with the aforementioned, finding that non-traditional banking activities impose negative externalities on the financial sector by increasing banks' contribution to systemic risk. The reasoning for this being that financial innovation enables financial institutions to participate in non-interest profit generating processes, such as securitisation and derivatives trading. These banking activities allow banks access to different markets, increasing their diversification. As these levels of diversification increase across the financial sector, banks that engage in similar activities will hold similar positions. Subsequently, this heightens the possibility that banks will suffer from common shocks to the asset side of their balance sheets, increasing their systemic importance and contribution to systemic risk. Moore and Zhou (2014:23) found that while size was a great contributor to systemic risk before the global financial crisis of 2007/2008, non-traditional banking activities were predominant during times of an economic contraction or crisis.

Paradoxically, Foggit (2016:224) reports a significantly negative relationship between systemic risk and bank activities in the South African banking sector. This negative relationship indicates that an increase in market-based activities - such as securitisation and derivatives trading - contributes to decreasing systemic risk. The effect of this is that market-based activities in the South African financial sector are not viewed to be mainly risky and may even be less systemically risky than purely bank-based activities. This may indicate the safety and soundness of South Africa's financial sector, since market-based activities do not produce more systemic risk. Furthermore, market-based activities may be easier to observe and regulate due to the increased transparency to regulators, enabling the effective regulation and mitigation of systemic risk.

3.1.2.2 Activities: Share of loans in total assets

The share of loans in total assets (Foggit, 2016:19) serves as an alternative measure of the financial institution's involvement in market-based activities. The lower this ratio, the greater the level of involvement in market-based activities such as trading and securitisation. An increased percentage of loans in total assets indicates that the financial institution is more focussed on lending activities. Vodová (2015:99) suggests that this ratio is also an indirect measure of the financial institution's liquidity, showing the percentage of the financial institution's assets that is tied up in illiquid loans. A lower value of this ratio subsequently indicates lower liquidity risk. The lower this ratio, the more financial institutions are involved in securities trading and other market-based activities and the more banks are involved in both the aforementioned and interbank lending (Männasoo & Mayes, 2009:248).

Banks with lower levels of non-interest income and therefore a lower share of non-market-based activities tend to be less risky. This is supported by Laeven *et al.,* (2014) finding that financial institutions - especially larger banks – produce less systemic risk when they are not engaged in market-based activities. Williams (2016:16) reports that banks with lower levels of non-interest income are less systemically risky, but adds that even though non-interest income tend to be risk increasing, some forms of non-interest income are risk reducing when the firm's specialisation effects are taken into account. For the banking sector, traditional banking activities such as lending and deposit-taking may increase financial stability, hence decreasing the bank's contribution to systemic risk.

3.1.3 Funding structure

The funding structure of financial institutions form part of their internal characteristics, consisting of two distinct categories: depository funding and non-depository funding. Given that financial institutions need to be registered as licensed banks prior to taking deposits (SARB, 2018:33), this variable is only applicable to the banking sector.

Non-deposit funding is considered to be unstable funding due to the dependence on short-term wholesale funding in order to support illiquid long-term assets (Baselga-Pascual *et al.,* 2015:141). Wholesale funding is mainly raised on a short-term, rollover basis with instruments such as commercial paper, large-denominated certificates of deposits, repurchase agreements, government funds and brokered deposits (Huang & Ratnovski, 2011:248). A financial institution's dependence on short-term wholesale funding to fund long-term illiquid assets increases a firm's vulnerability to runs by its creditors. Through wholesale money markets, banks obtain cash surpluses from other financial institutions, non-financial institutions as well as households (via money market funds). Short-term wholesale funding is computed by López-Espinosa *et al.* (2013:293) as the sum total of wholesale funding, repo funding and short-term liabilities divided by the total assets of a bank and is considered to be a proxy for interconnectedness. The interconnectedness of financial institutions, due to their dependence on the liability side, increases the financial instability as well as firms' vulnerability to runs by its creditors.

Even though short-term wholesale funding holds several benefits – such as the refinancing of unexpected retail withdrawals – and is easier to attract compared to deposit funding, it imposes a higher risk due to its increased exposures to shocks originating in the market. Short-term wholesale financers may withdraw their money immediately based on negative public signals without prior costly analyses of the financial institution. Considering the interconnectedness of banks and their greater exposure to market conditions and liquidity risk, these negative public signals might amplify rapidly, resulting in investor runs and the subsequent undercapitalisation of banks. López-Espinosa *et al.* (2012:3151) found that a one percentage point increase in short-term wholesale funding results in a 43 basis points increase in the contribution to systemic risk in a one-year time period. The findings of Demirgüc-Kunt and Huizinga (2010:626) and Laeven *et al.* (2014:18) are similar to the aforementioned, finding that larger banks with increased sources of unstable funding are at an increased cost of bank fragility and are more responsible for producing systemic risk.

Foggit (2016:229) supports the abovementioned findings that unstable funding (i.e. of a non-depository nature) increases the SRISK values. These findings correspond with empirical studies done by Beltratti and Stulz (2012:16) and Laeven *et al.* (2016:29), suggesting that banks that relied greatly on deposit funding (measured as the ratio of deposits to assets) rather than non-deposit funding performed better during the 2007/2008 financial crisis. The reason for this being that depository funding improves bank performance and decreases their riskiness, resulting in an inverse relationship with systemic risk. Increased reliance on funds raised from the short-term money market increases the firm's vulnerability to fluctuations in the market. Beltratti and Stulz (2012:5) measure the reliance of firms on non-depository funding as a ratio between its short-term borrowings, deposits from other banks and other deposits as a fraction of their total deposits, money market and short-term funding and this ratio is known as the funding fragility index (FFI), also supported by Foggit (2016). Acharya *et al.* (2010:5) similarly found that reliance on short-term capital market funding might have amplified the negative effects of the global financial crisis of 2007/2008. Acharya *et al.* (2010:5) explain their reasoning as follows: With the collapse of Lehman Brothers, the value of its short-term debt resulted in the largest money market fund, the Prime Reserve Fund, to "break the buck", causing the entire system to run. Banks' increased reliance on short-term debt therefore imposes a multidimensional effect on risk, since it not only increases their vulnerability to creditor runs and insolvency, but also increases the possible spill-over effect to the remainder of the financial system, increasing their susceptibility and contribution to systemic risk.

Despite the various benefits of wholesale funding, it can create significant risks for "modern" banks (that are involved in market-based activities outside of traditional lending) that hold mostly an arm's length of assets with readily available, but noisy, public signals on their values (Huang & Ratnovski, 2011:259). Large banks dependent on short-term wholesale funding have an increased likelihood of being affected by international re-pricing and external shocks (Foggit, 2016:114). The funding structure of a bank is therefore an important driver of systemic risk.

Keeping in mind the high degree of interconnectedness and that South African banks obtain great portions of funding from long-term insurers (IMF, 2014:72), the potential for a shock to be transmitted from one sector to another and to become systemic in nature is great. Larger banks, and especially those with greater sources of unstable funding, are therefore responsible for producing more risk.

3.1.4 Capitalisation

The level of capitalisation, as a firm-specific variable, is an imperative part of the financial industry. The implementing of capital requirements and regulating of capital serves as a disincentive for excessive risk taking. For the banking sector, capital requirements are aimed at influencing bank decision-making with regards to the quantity of bank lending as well as quality of loans issued (Kopecky & VanHoose, 2006:2236). Risk-adjusted capital adequacy requirements also lead banks to adopt a strict credit policy, decreasing insolvency and hence systemic risk (Bolt & Tielman, 2004:802). Subsequently, the regulation of capital decreases the expectation that an institution will be bailed out in the event of failure. However, risk-adjusted capital ratios also have a dark side, as some banks manipulated the calculation of their risk-adjusted assets and loans, resulting in insufficient capital. This validates the adoption of leverage ratios under Basel III.

Bank capital acts as a buffer during economic difficulties to absorb unexpected losses, reducing the exposure to risk, as well as the probability of bank insolvency and the repercussions of bank distress. Increased bank capital requirements result in increased retained capital as a buffer, improving the bank's overall credit quality in the banking system despite the initial uncertain effects on aggregate loan quality (Kopecky & Van Hoose, 2006:2253). This is in line with the findings of Santos (1999:1110), suggesting that increased bank capital reduces a bank's probability of default, increasing their credit worthiness. Banks with more Tier 1 capital than proposed by Basel III are less likely to experience or contribute to systemic risk (Beltratti & Stulz, 2012:16). This is reinforced by Laeven *et al.* (2016:30) concluding that systemic risk is considerably lower for well-capitalised banks since banks with more capital find it more expensive to take on risk. Insufficient bank capital was more significant to contributing to systemic risk during the 2007/2008 global financial crisis than bank funding or activities (Laeven *et al.* 2016:31). This validates Basel III's approach to address systemic risk of banks by implementing capital surcharges as opposed to restricting bank activities. Increased bank capitalisation is therefore a beneficial instrument for the regulatory authority to control the increased vulnerability of the banking sector, diminishing the probability of systemic risk.

Paradoxically, despite the ample evidence suggesting that increased capitalisation decreases systemic risk, Delis, Tran and Tsionas (2011) found bank capitalisation to not be sufficient to promote financial stability and may therefore contribute to producing systemic risk. While acknowledging the benefits of capitalisation, Gurrea-Martínez and Remolina (2019) state that a high degree of capitalisation may be socially undesirable, especially for poorer and less-developed countries pursuing to develop their economies. The reason for this being that increased capital requirements may diminish access to credit, which can be predominantly challenging for emerging market economies struggling with financial exclusion and less-developed capital markets.

Demirgüc–Kunt and Huizinga (2010:646) calculate financial institutions' capitalisation ratio as the portion of total equity to total assets and state that investment banks might be restricted from attracting retail deposits or are occasionally exempted from implementing the minimum capital requirements. Given that South Africa's legislative framework (as mentioned in Section 2.4) provides three different types of bank licenses (i.e. bank, mutual bank and cooperative bank license), which is each administered under a different act, it is clear that a distinction is made between the different banks based on their corporate structures and the regulatory requirements that apply to these entities. It can therefore be concluded that the type of bank (i.e. investment or commercial, etc.) can indirectly affect the bank's risk through their level of capitalisation. The implication of the aforementioned is that the level of capitalisation may differ from bank to bank, depending on their structure. Although the level of capitalisation directly influences a bank's contribution to systemic risk, it is also dependant on the type of bank and their implementation of and adherence to capital ratios.

3.1.5 Capital flows

Capital flows provide both economic benefits and drawbacks for the recipient emerging market. Benefits include the accumulation of foreign assets during confident times, while those assets may be depleted during an economic downturn, protecting against declining living standards when a shock occurs to domestic income and production (Bernanke, 2005:1). Capital inflows comprise of various components such as direct equity investment and portfolio equity investments. Direct equity investments are essentially considered to be foreign direct investment (FDI) where investors own either physical property, plants and equipment or a great portion of a firm's shares (Koepke, 2015:16). FDI is not sensitive to short-term financial fluctuations (Biglaiser & DeRouen, 2006:70) since it considers the economy as a whole, in contrast to portfolio equity investments. Portfolio equity flows can take place very swiftly, increasing its sensitivity to short-term financial fluctuations and broader economic news. Financial variables such as exchange rate volatility and asset returns influence equity flows (Baek, 2006:372).

The non-bank measure of capital flows is the net external financing provided by private creditors, including flows from non-bank institutions into bond markets as well as deposits kept in local banks by non-residents, other than banks. Koepke (2014:7) classifies these flows as portfolio debt flows. The commercial bank measure comprises of net expenditures from commercial banks and therefore includes bond purchases by commercial banks (Koepke, 2014:7). Non-bank flows, or portfolio debt flows, are not only influenced by global risk aversion (Milesi-Ferretti & Tille, 2011:328), but by an increase in the external interest rate environment as well (Dahlhaus & Vasishtha, 2014:12). Banking flows in emerging markets are increasingly attracted to domestic GDP growth as well as domestic return indicators, while country risk indicators also influence it (Bruno & Shin, 2015:131).

The drawback of capital flows for emerging markets may negatively influence key economic variables, such as the widening of current account deficits, inflationary pressures, exchange rate appreciation and decelerated growth, resulting in financial instability (Gossel & Biekpe, 2013:64). Acharya (2013:64) considers capital flows to be an important factor for emerging market economies. Great surges in capital flows may result in systemic risk for emerging markets, since it can cause rapid credit growth if it is intermediated through the banking system or can cause rapid growth in asset prices if it is intermediated through portfolio flows, indirectly causing financial fragility (Claessens & Ghosh, 2012:15). If an economy experiences an exceptionally large degree of interconnectedness, increased capital flows may have substantial negative consequences for the economy (Foggit, 2016:75). The reliance of emerging markets on external capital flows thus increases their vulnerability. The increased concentration between emerging markets' financial institutions accompanied by their vulnerabilities to external capital flows could result in shocks being transferred more easily.

A well-known example of the aforementioned is Iceland's banking sector. It displayed how large levels of foreign assets could increase its vulnerabilities. Iceland's ratio of foreign assets to GDP grew to large levels before their crisis, since they drained their domestic banking sector and had to rely on its international branches. The only way these international branches could remain competitive was to offer higher interest rates than the local banks could. Subsequently, the entire Icelandic economy broke down when the banking sector began to crash (Acharya, 2013:64).

South Africa's current account and fiscal deficits are reliant on external financing and although individual banks are not reliant on external capital flows, a withdrawal of capital flows could have systemic implications (IMF, 2014:16). Bearing in mind that the South African financial sector is highly integrated with the global economy and is dependent on external capital flows for financing the large current account deficit, the South African financial sector could be a potential source of systemic risk. Foggit (2016:175) reports that volatile capital flows is a significant determinant of systemic risk for South Africa. An increase in capital flows diminishes the amount of systemic risk in emerging markets, especially in the South African financial sector (Foggit, 2016:224). Due to the volatility of capital flows, a reversal thereof will increase the amount of systemic risk in South Africa by the same amount. His findings are in line with those of Claessens, Ghosh and Mihet (2013:7), who explain that there are strong links between volatile capital flows and banking system vulnerabilities, increasing systemic risk. The degree of financial openness and interconnectedness not only influences the degree to which various policies can be implemented, but mostly determines a country's exposure to volatile capital flows, resulting in increased vulnerabilities for the banking sector (Hahm, Shin & Shin, 2013:6).

3.1.6 Leverage

High levels of bank leverage have been held liable for the most recent global financial crisis. Shleifer and Vishny (2010), Mian and Sufi (2011) as well as Acharya, Schnabl and Suarez (2013) argue that high financial leverage, especially short-term leverage, prompted banks to engage in risky lending activities. That, together with securities trading, led to the widespread failure of the participating financial institutions. An increase in leverage prompts financial institutions to engage in illiquid lending activities, contributing to an increase in the collective fragility of the financial institutions, increasing systemic risk. However, high levels of leverage are considered to provide better asset choices and increased liquidity when institutions are observed individually, but an increase in leverage heightens the collective fragility of financial institutions (Acharya & Thakor, 2016:5). A higher individual leverage indicates that the financial institution is prone to produce systemic risk, while a higher aggregate leverage in the financial system indicates that the system is prone to cause externalities (Acharya *et al.,* 2017:11-12). A highly leveraged financial system is therefore one more susceptible to collapse.

Acharya and Thakor (2016:5) describe systemic risk as the dark side of leverage when creating liquidity. A bank's propensity to be undercapitalised increases when the financial system as a whole is undercapitalised, which increases with increased leverage (Acharya *et al.,* 2017:2). The level of leverage in the financial sector is substantially higher than in the non-financial sector and contributes significantly to systemic risk (Brownlees & Engle, 2012:11). This was confirmed by Brownlees and Engle (2017:15), reporting that non-financial firms aren't expected to be vulnerable or highly leveraged and that the channels through which the capital shortfall of non-financial firms adversely influences the economy is not yet clear.

Foggit (2016:224) reports that an increase in the leverage ratio of South African banks significantly contributes to increasing systemic risk in the banking sector. Foggit (2016:178) calculated a bank's leverage ratio as the sum of the total liabilities and market capitalisation divided by the bank's market capitalisation. The debt-to-equity and debt-to-asset ratios are both leverage ratios and are utilised in this study, even though they are underreported in the literature. Highly leveraged financial institutions are expected to produce systemic risk and even more so when financial turmoil spreads as a crisis occurs.

3.1.7 Liquidity

Leverage and liquidity creation can be viewed to go hand-in-hand, since Acharya and Thakor (2016:5) reports that a dark side of leverage-based liquidity creation is the associated systemic risk that arises from the inefficient, contagious liquidations. In order to protect against liquidity risk, banks exchange deposits on the interbank market (Allen & Gale, 2000:1). The interbank market is highly liquid and is one of the only forms of direct and regular transactions between banks. These regular transactions create connections that may expose the financial system to contagion (as discussed in Section 2.2), increasing its susceptibility to systemic risk.

Financial institutions that hold assets with long-term duration or low liquidity and liabilities of a short-term nature create fragile capital structures (Acharya, 2012:12). This was evident with the run on investment banks and money market funds after the failure of Lehman Brothers during the global financial crisis of 2007/2008. Liquidity requirements are therefore imposed on financial institutions with the same intention as implementing capital requirements, with the intention to reduce runs. The primary idea behind these requirements is to require financial institutions to hold a portion of short-term funding in liquid assets, i.e. assets that can be sold immediately at their current prices. This requirement should prevent runs as it increases financial institutions' cost to hold long-term asset-backed securities and take on carry trades (holding long-term assets using cheaper short-term funding) (Acharya, 2012:12). Basel III implemented two liquidity ratios that financial institutions are subject to, namely the LCR and the NSFR which were both discussed in greater detail in Section 2.5.1.3. The former is the bank's high-quality liquid assets to its net cash outflows over a 30-day period during an extreme system-wide shock and should exceed 100%. The latter is the bank's available stable funding over its required stable funding and this ratio should also exceed 100%.

Liquidity risk (ability to quickly convert assets or securities to cash) and funding liquidity risk (the mismatch of assets and liabilities) impose a significant threat for financial institutions and may result in systemic risk. It is therefore expected that the implementation of the liquidity ratios will impede institutions' risk taking, resulting in an overall decrease to SRISK.

3.1.8 Performance

A firm's financial performance is measured by its ROE and serves as an indication of how the firm's management uses equity in order to grow the firm. ROE is calculated as the firm's net income (annual return) divided by the total shareholders' equity. A stable or increasing ROE is an indication that the firm is able to generate value for the shareholders, thereby increasing the firm's productivity and profits (CFI, 2019). Theoretically, an increase in the firm's performance decreases systemic risk, since firms are able to generate adequate funds in order to meet all of their obligations, and will not result in the undercapitalisation of the institution. A declining ROE may serve as an indication that the firm's management poorly reinvests capital and does not generate adequate shareholder value (CFI, 2019). Alber (2015:112) considers ROE to be a market determinant when analysing the effect on systemic risk, but finds no evidence that ROE contributes to increasing systemic risk.

Rajan (2005) argue that the evaluation of a financial institution's true performance is a very complex task, since it involves the disentangling of the part of the performance that arises from true value creation from the part of performance that arises from increased, not easily observed, risks. Increased returns are obtained from taking increased risks, but if the risks are underestimated or hidden, the increased risk-taking may seem to be value-adding if risks have not materialized. Considering these imperfections, firms' excessive reliance on ROE can encourage unaccepted incentives as it can artificially inflate ROE through increased risk-taking. Moussu and Petit-Romec (2017) report a positive relationship between ROE and the destruction of shareholder value during the 2007/2008 global financial crisis, since monetary incentives encouraged bank managers to develop extreme risk-taking strategies. Considering the aforementioned, a higher ROE is therefore associated with higher risks, increased financial instability and an increased contribution to systemic risk.

3.1.9 Profitability

A widespread consensus has been reached with regards to the negative relationship that exists between a bank's profitability and aggregate levels of risk. Poghosyan and Cihak (2011:172) found that European banks that exhibited good earnings profiles are more unlikely to experience financial difficulties in the subsequent financial year. Louzis, Vouldis and Metaxas (2012:1026) support the aforementioned findings, reporting that poor bank performance may act as a leading indicator of impending problem loans. More profitable financial institutions are likely to have a higher franchise value, influencing their risk-taking appetite (Behr, Schmidt & Xie, 2010:154). Financial institutions with a higher franchise value may be more likely to retain more capital than required by regulators in order to retain well-diversified portfolios and limit their exposure to high-risk clients (Demsetz, Saidenberg & Strahan, 1996:3). Banks are also more likely to use derivatives in order to hedge against losses arising from interest rate and foreign exchange movements. The aforementioned strategies therefore diminish the probability that such banks will lose their franchise value through excessive risk taking resulting in insolvency. Franchise value can therefore have a disciplining effect on financial institutions' behaviour (Demsetz *et al.,* 1996:12) since they have much to lose should risky business strategies result in insolvencies, causing them to behave more carefully and taking less risks, possibly decreasing its overall contribution to systemic risk. On the other hand, a higher franchise value may increase the moral hazard of too-big-to-fail financial institutions, knowing that they will be bailed out in times of distress and increasing their overall contribution to systemic risk.

When considered individually, ROA indicates how effectively a financial institution is able to generate earnings from their balance sheet assets, i.e. profitability, and a higher profitability ratio is expected to decrease the institution's contribution to systemic risk. There is, however, a significant correlation between profitability, economic growth, loan interest rates, interest expenses and market interconnectedness (Festíc, Kavkler & Repina, 2011:316). Although the ROA directly influences an institution's level of systemic risk, ROA is affected by the aforementioned variables and hence these variables are indirectly influencing an institution's level of systemic risk. ROA is therefore influenced by a number of factors, shaping its relationship with and a firm's contribution to systemic risk.

3.1.10 Efficiency

The inefficiency of financial institutions – especially that of banks – creates a major source of risk. Following the work of Louzis *et al.,* (2012:1016) and Poghosyan and Cihak (2011:170), the cost-to-income ratio (CIR) is used as a proxy for the efficiency of financial institutions. Lower cost efficiency increases the future non-performing loans (NPLs) and since NPLs increase a bank's problems on the asset side and decreases the quality of their loan portfolios, it escalates the bank's individual risk as well as contribution to systemic risk.

More stringent capital requirements not only enhance the efficiency of large banks, but also of lower risk banks. These increased capital requirements provide a financial safety net for banks, decreasing its risk taking and moral hazard of too-big-to-fail and bolster its efficiency. This increased availability of financial safety nets specifically enhances the efficiency of African banks (Triki, Kouki, Dhaou & Calice, 2016:183). Aside from the impact of capital regulation on a bank's efficiency, banks are also more likely to be efficient in countries that display higher levels of GDP per capita and lower inflation rates (Triki *et al.,* 2016:194). Efficiency has various positive effects on the performance of a financial institution, therefore increased efficiency has the ability to decrease the firm's contribution to systemic risk.

3.2 Industry-specific and macroeconomic variables

Macroeconomic variables may be important predictors of systemic risk, since it influences the entire industry in which financial institutions function and can impose severe negative effects on the industry, resulting in the manifestation of systemic risk. This is supported by previous literature such as Berg, Borensztein and Pattillo (2004), Beck *et al*. (2006) and Alber (2015). The influence of macroeconomic variables on systemic risk is often difficult to capture, since these variables do not have an individual, but rather collective impact a country's financial stability. The following macroeconomic variables are often quoted in the literature and are investigated in this section: economic growth, unemployment, interest rates and inflation rates.

3.2.1 Economic growth

Economic growth (proxied by the GDP) is a critical element for countries, but even more so for emerging markets. Without sufficient economic growth, all of the other macroeconomic objectives - such as full employment and increased income equality - are challenging to achieve. Economic growth is the key factor that has historically proven to lift countries out of poverty. Economies at a higher growth rate tend to attract and retain substantial inflows of foreign direct investment (FDI), enabling them to push back against high levels of unemployment, inequality and poverty. Since low economic growth decreases the ability of achieving the vital macroeconomic objectives, it increases the instability of the macroeconomic environment, making it more susceptible to systemic problems. Borio and Lowe (2002:18), Poghosyan and Cihak (2011:175) and Festiç, Kavkler and Repina (2011:319) among others, support the statement that higher growth rates are associated with a more stable macroeconomic environment and a relatively low probability of systemic problems. Increased GDP growth in South Africa is therefore expected to decrease the susceptibility of the financial sector to systemic problems.

3.2.2 Unemployment

Unemployment creates significant problems for the macroeconomic environment and financial stability of a country. In various literature, unemployment negatively influences the quality of loan portfolios (Bofondi & Ropele, 2012:6). The negative consequences of unemployment has an impact on both individuals and businesses. The reason for this being that unemployed people have no means of income and are therefore unable to pay back their loans, increasing the number of NPLs and adversely affecting the quality of the loan portfolio. For individuals, NPLs are inversely related to real GDP growth and positively correlated with the unemployment and short-term nominal interest rates (Bofondi & Ropele, 2012:6). For financial institutions, NPLs are positively related to the levels of unemployment as well as the ratio of net interest expenses to gross operating profits, whilst also being inversely related to real GDP growth (Bofondi & Ropele, 2012:6). Unemployment therefore has a direct impact on NPL categories, whether it is consumer loans, mortgages or business loans and Louzis *et al.* (2012:1025) found that this impact is extremely significant. Unemployment therefore indirectly and positively influences systemic risk through factors such as NPLs and the low quality of loan portfolios. The low quality of loan portfolios is not only a characteristic of risk seeking banks, but might also indicate a bank's contribution and susceptibility to systemic risk (Williams, 2016:19).

Emerging markets experiencing high levels of unemployment, especially in a low economic growth environment, are more likely to be plagued with systemic problems. South Africa has a history of high unemployment that in its turn negatively influences economic growth and increases the probability of systemic problems. Although unemployment indirectly influences systemic risk, it is expected that a reduction in South Africa's unemployment rate could decrease the South African financial institutions' contribution and susceptibility to systemic risk.

3.2.3 Interest rates

Interest rates have a strong bearing on the health of the financial sector, especially in emerging markets and are important factors that indirectly influence financial stability (Hoggarth, Sorensen & Zicchino, 2005:9). Interest rates indirectly affect the financial stability through various factors, i.e. loans, asset prices, investments and credit extensions, to only name a few. Loans and interest rates are inversely related and especially influence NPLs, creating problems on the asset side of banks' balance sheets. A substantial change in interest rates has a significant impact on financial stability. However, an unexpected change in interest rates may have an even greater impact on systemic risk. The reasoning behind this is that borrowers are not prepared for an unexpected increase in interest rates, increasing the amount of NPLs and loan defaults, inducing a negative impact on financial stability. Paradoxically, an unexpected decrease in the interest rate may result in investors withdrawing their money in order to invest it somewhere else for a higher return. This may subsequently result in investor panic, causing runs that result in the undercapitalisation of the financial sector and consequently producing systemic risk.

The tendency of emerging markets to provide higher interest rates raises investors' inclination to invest in those economies. An influx of capital increases the investment in the country, whether it is in the form of FDI or portfolio inflows. These investments result in the creation of jobs, contributing to the growth of the economy. The higher the interest rates, the higher the contentment of investors since they are receiving a market-related return and this in turn results in increased investments in the country. As mentioned above, a substantial decline in or volatile interest rates decreases investors' returns and sentiment to invest in a country, leading to a capital outflow. A significant outflow of capital reduces financial stability, increasing the possibility of systemic problems.

Lower interest rates (repo rate and prime rate) have substantial benefits, but are also accompanied by a number of negative consequences. Firstly, lower interest rates increase the ease with which credit is extended and if credit growth is too rapid, it may pose a threat to the stability of the financial system. Rapid credit growth and interest rates normally rise in crisis years and reliably tend to start increasing in the preceding year already (Hardy, 1998). This is confirmed by Eichengreen and Arteta (2000:57), finding that a one percentage point increase in the growth rate of domestic credit increases the possibility of financial problems the subsequent year with 0.056%. A lower interest rate also leads to an increased value of assets due to increased demand. This, in turn, can lay the foundation for credit and asset price booms, as evident prior to the 2007/2008 global financial crisis where real estate and housing prices rose substantially (Mohan, 2009:3). Secondly, lower interest rates may encourage investors to take excessive risks, in their search for a greater return. An extensive period of low interest rates may cause borrowers and lenders to undervalue the cost of debt as well as the possibility of higher future costs of repaying the debt.

Even though the rapid credit growth as a result of interest rates by itself pose little threat to the financial system (Borio & Lowe, 2002:11), the cumulative effects of rapid credit growth, increase in asset prices or investment booms – rather than these factors alone - may increase the likelihood of systemic problems.

3.2.4 Inflation

Inflation, measured by the consumer price index (CPI), is a significant factor when evaluating the stability of a country's financial sector. The inflation rate is an important factor that indirectly impacts financial stability as well as the quality of loan portfolios (Hoggarth *et al.,* 2005:21). A lower inflation rate is associated with a more stable macroeconomic environment and when considered in isolation, indicates a relatively low likelihood of systemic problems (Poghosyan & Cihak, 2011:176). High inflation deteriorates purchasing power, decreases institutions' efficiency (Triki *et al.*, 2016:194) and increases macroeconomic imbalances.

Although lower inflation is argued to be a sign of macroeconomic stability, it heightens the possibility of a financial crisis if there is an increase in inflation followed by a sharp reduction (Borio & Lowe, 2002:18). This increase in inflation followed by a sharp decline serves as a reliable and leading indicator of looming banking sector problems (Hardy, 1998).

Poghosyan and Cihak (2011:176) report that macroeconomic variables do have some degree of impact on the financial sector and the financial stability of a country, even though the impact might be quantitatively small. When considering the cumulative effect rather than the individual effect of the macroeconomic variables together with the high degree of economic integration, the impact on the financial sector's stability rises significantly and may produce systemic problems. A higher economic growth rate, low levels of unemployment followed by low interest rates and inflation contribute to increased macroeconomic and financial sector stability and could possibly result in lower systemic risk for South Africa.

In summarising the literature review on the determinants of systemic risk and recalling from Section 2.4.1, the King III Code reports that South Africa's financial institutions are fundamentally different from global financial institutions. Keeping this in mind, it follows that the individual factors that produce South Africa's systemic risk will also differ. Considering the highly complex nature of systemic risk, its various origins and the propensity to propagate between financial institutions, numerous variables were investigated. It should be noted that the analysis in this study is conducted using publicly available data, therefore the determinants of systemic risk identified in this study may not necessarily be the same as those reported by regulatory authorities such as Basel. The individual determinants discussed in this chapter are applicable to both developed and emerging markets, but are especially appropriate for the South African economy. Given South Africa's high degree of interconnectedness - not only in the South African financial market, but in global financial markets as well – both internal as well as external factors, such as the size of the financial institution and capital flows respectively, are expected to produce systemic risk. Keeping the state of developed economies in the global financial network in mind and also that emerging markets can grow easier due to the increased global investments and information efficiency of developed economies (Kim & Ryu, 2015:20), it follows that emerging markets are easily influenced by developed economies and not necessarily the other way around. It therefore makes sense that external factors, such as capital flows, should be significant determinants of systemic risk for the South African economy. Developed economies, such as the US and the UK, are mostly influenced by internal, firm-specific factors such as their size and level of capitalisation.

CHAPTER 4 METHODOLOGY AND DATA

4.1 Introduction

Chapter 2 explains in depth the concept of systemic risk and how it propagates through three main channels, namely: counterparty contagion, informational contagion and common shocks. In order for contagion and common shocks to occur, there must be a great degree of interconnectedness between financial institutions and countries. Increased interconnectedness results in an increased swiftness with which shocks transfer and contagion takes place. Chapter 2 outlines the structure and the role of the South African financial system and illustrated South Africa's current regulatory structure in detail. South Africa's banking sector used to be independently monitored by the SARB, while the non-banking sector was regulated by the Financial Services Board (FSB). Arnold *et al.* (2012:3125) emphasise that specific institutions need to monitor the implementation of regulations together with financial institutions' adherence to it. The Basel accords are implemented in order to regulate banks by ensuring that they have adequate capital to absorb unexpected losses that may have systemic consequences and are therefore discussed in detail. Since systemic risk results in the undercapitalisation of individual financial institutions or the entire financial sector, it is beneficial to know the causes thereof, hence the determinants are thoroughly disseminated in Chapter 3.

Given the numerous origins of systemic risk in the various financial institutions, a large amount of data is needed to identify the most significant determinants of systemic risk. Section 4.4 describes the various sources of the data, the properties of the data, how the data are transformed and the format in which they are reported. The work of Brownlees and Engle (2012), Laeven *et al.* (2014), Baselga-Pascual *et al.,* (2015) and Foggit (2016) are used as a basis for the choice of the inclusion of the independent variables. The statistically significant determinants of systemic risk in this study may differ from those reported by regulatory authorities, since publicly available data are used. The choice of independent variables are also limited due to data constraints. Given that the structure of the banking and non-banking sectors differ in developed, developing and emerging market economies, the determinants of systemic risk will also differ. A vast majority of studies mainly focus on developed economies and the banking sector. This study, however, includes variables that are not as often quoted in the literature for both emerging markets and the non-banking sector and include capital flows and profitability. Profitability is to the best of my knowledge introduced as a new variable for the non-banking sector.

A thorough description of the variables identified in the literature are reported in Section 3.1.1-3.2.4. The methodology followed in this study together with the several advantages of panel data are discussed in Section 4.2. This is followed by the specification of the model and the expected relationships between the dependent and various independent variables in Section 4.3. The discussion of the data as well as the banks and non-banks included in this study follow in Section 4.4 and Section 4.5 sets out the analysis, results and comparisons of systemic risk between the banking and non-banking sectors.

4.2 Modelling technique

Given that six banks for a time period of 15 years and seven non-banking financial institutions for a time period of 13 years are included in this study, panel data analysis serves as the most appropriate econometric technique. The reason for this being that panel data analysis considers both the time-series and cross-sectional dimension. The panel data analysis in Section 4.2.1 outlines the three methods that are commonly associated with panel data analysis, i.e. common constant, fixed effects and random effects method, followed by the panel unit root tests in Section 4.2.2 and panel cointegration tests in Section 4.2.3 in order to ensure that the regressions are not spurious. In this study, all of the aforementioned tests and analysis are conducted for both the banking and the non-banking sectors.

4.2.1 Panel data analysis

Panel data analysis combines both cross-sectional and time series data, allowing for the identification and measuring of effects that are only evident when these two series are combined (Baltagi, 2001:7). Repeated observations of enough cross-sections provide the study with the dynamics of change over a short time series (Yaffee, 2003:1). The combination of these series enhances the quantity and quality of the data in ways that would not be possible if only one of these dimensions was used (Gujarati, 2003:638). Panel data analysis provides regression analysis with both a spatial and temporal dimension (Yaffee, 2003:1). The spatial dimension comprises of the cross-sectional observation units, while the temporal dimension comprises of periodic observation units characterising the cross-sectional units over a particular time span. A panel data analysis is used in the estimation of the regression in order to deliver more informative and efficient results, while capturing the dynamic behaviour of the variables (Baltagi, 2001:6; Hsiao, 2007:4). Panel data models, by combining intra-individual dynamics and inter-individual differences, hold more advantages than cross-sectional and time-series data. Panel data increases the number of data points (Hsiao, 2007:3), resulting in more degrees of freedom and increased sample variety, improving the efficiency of the estimates (Hsiao, Mountain & Illman, 1995:325). Multicollinearity between the independent variables decreases with the use of panel data, while the impact of omitted variables can also be controlled (Hsiao, 2007:4). Panel data suggests that individuals, firms or countries are heterogeneous and therefore controls for individual heterogeneity (Klevmarken, 1989:525). Individual and cross-sectional heterogeneity is common in bank risk-taking, therefore it is valuable that panel data control for it (Jabra, Mighri & Mansouri, 2017:10). Since cross-sectional and time-series data do not control for individual heterogeneity, it risks delivering biased results, as opposed to panel data that provides more reliable and unbiased results.

Panel data regression comprises of three methods, namely the common constant or pooled ordinary least squares method, the fixed effects method and the random effects method (Yaffee, 2003:3). The common constant or pooled ordinary least squares method is the simplest method where the assumption is made that there are no differences between the data of the various cross-sectional dimensions (Asteriou & Hall, 2011:417). A common constant – referring to both the slope and intercept - therefore exists for the various cross-sections and is beneficial for analysing homogeneous cross-sections (Asteriou & Hall, 2011:417). The common constant method is unlikely to be a good fit, since the size of financial institutions and their profitability display some variation. In this study, the fixed effects and random effects method of estimation may be better, since the common constant method is restrictive.

The fixed effects method has a constant slope, but different intercepts for the cross-sectional units, i.e. assumes that the *i* denoting the individual financial institutions are fixed (Baltagi, 2001:12). The remainder of the disturbances are stochastic with a percentage independently and identically distributed (IID) (Baltagi, 2001:12). The constant is assumed to be specific to each cross-section, allowing each cross-section to have a different constant (Asteriou & Hall, 2011:418). Equation 4.1 illustrates the one-way fixed effects method (Asteriou & Hall, 2011:418):

$$\gamma it = \alpha + \beta' xit + eit, \tag{4.1}$$

Where:

$$eit \sim IN(0, \sigma 2) \tag{4.2}$$

In order to allow for different constants for each group in the cross-section, a dummy variable for each group must be included. The fixed effects method now includes dummy variables to account for heterogeneity across the cross-sectional dimension and can therefore be referred to the least squares dummy variables estimators. This method is not without its drawbacks. The fixed effects method may often have too many cross-sectional units of observation, requiring too many dummy variables for their specification and therefore decreasing the sufficient number of degrees of freedom to deliver adequate results (Asteriou & Hall, 2011:419). Although the error terms are assumed to be homogeneous and normally distributed, country-specific autocorrelation or heteroskedasticity over time could be present, affecting the estimation results (Yaffee, 2003:7).

According to Yaffee (2003:7), the biggest disadvantage of this method is that the error term and individual effects may be correlated.

It is also possible to extend the fixed effect method to a two-way fixed effect method by including a set of time dummies (Asteriou & Hall, 2011:419). This method has a further advantage of capturing any effects that are common across the entire panel, but vary over time. For example, when considering companies in a particular country, they may all be influenced by a common exchange rate, and therefore the time dummies will capture this effect. The fixed effect method is a basic, but valuable method to start from, however, traditionally estimations using panel data were only used for data sets with a very large *N* (Asteriou & Hall, 2011:419). In this case a simplifying assumption is occasionally made, giving rise to the random effects method.

The random effects method treats the constant for each cross-section as a random parameter, opposed to the fixed effects method treating it as a fixed parameter (Greene, 2003:146). Each cross-section's intercept is assumed to come from a common intercept *α* that does not change over time or cross-sections. An additional random variable Ɛ*i* is introduced that does not change over time, but does change over cross-sections (Baltagi, 2001:14). The random deviations that take place for each cross-section's intercept term from the common intercept term represented by *α* are therefore measured by the variable Ɛ*i*. This cross-sectional specific error term must be uncorrelated with the variables' error term (Yaffee, 2003:7). Since this variable is assumed to be random, it can help to avoid the loss in the degrees of freedom that may occur with a fixed effects method (Yaffee, 2003:7). Equation 4.3 illustrates the random effects model (Asteriou & Hall, 2011:420):

$$\gamma it = \alpha + \beta xit + \omega it, \qquad (4.3)$$

Where:

$$\omega it = \epsilon i + vit \quad and \quad \epsilon i \sim IN(0, \sigma 2) \qquad (4.4)$$

The ϵi terms capture the heterogeneity in the cross-sectional dimensions, while the xit terms represent the I x K vector of independent variables (Yaffee, 2003:7) The generalised least squares method is used instead of the ordinary least squares method and the α and β are estimated consistently (Asteriou & Hall, 2011:420). A noticeable disadvantage of the random effects method is that specific assumptions regarding the distribution of the random component need to be made. Furthermore, if the unobserved group-specific factors and the independent variables are correlated, the estimates will be biased and inconsistent. Nonetheless, the advantage is that this method has fewer parameters to estimate when compared to the fixed effects method, but also makes provision for including dummy variables (Asteriou & Hall, 2011:420). The random effects method can also be extended to a two-way random effects method, where the error term is uncorrelated with both the cross-sectional and time series component (Yaffee, 2003:8). Since these components are orthogonal, it allows the general error term to be broken down into temporal, cross-sectional and individual error components, illustrated by Equation 4.5:

$$eit = et + vi + \eta it \tag{4.5}$$

The component et is for all observations over time period t, the component vi represents the cross-section specific error, only affecting observations in that panel and $\eta\ it$ only affects the specific observation.

The fixed effects and random effects method differ since the former assumes that each cross-section differs in the intercept term, while the latter assumes that the cross-section differs in the error term. The fixed effects method would be a better model choice if the panel contains all of the existing cross-sectional data, i.e. balanced panel (Asteriou & Hall, 2011:420). On the other hand, the random effects method would be a better model choice if the panel contains fewer cross-sectional observations (Asteriou & Hall, 2011:420). The choice of the most suitable method therefore depends on the balance of the panel and the Hausman test is be conducted in order to choose between the two methods (Yaffee, 2003:10). The question is whether there is a significant correlation between the unobserved random effects and the regressors (Yaffee, 2003:10). The Hausman test then compares the random effects and the fixed effects under the null hypothesis of no correlation between the individual effects and other regressors in the model (Hausman, 1978:1268). If no significant correlation exists, the random effects model may be better and more parsimonious (Yaffee, 2003:10). Should a significant correlation exist, the random effects model would deliver inconsistent estimations and therefore the fixed effects model would be a better choice (Yaffee, 2003:10). Consequently, the random effects method will be used if the null hypothesis is not rejected, while the fixed effects method will be used if the null hypothesis is rejected. The options for the Hausman test is illustrated as follows:

H_0: both are consistent, but $\hat{\beta}^{FE}$ is inefficient.

H_1: $\hat{\beta}^{FE}$ is consistent and efficient, but $\hat{\beta}^{RE}$ is inconsistent.

When using data from different sources or time series are too short to conduct a separate time-series analysis, panel data may provide the only way to effectively analyse the data (Yaffee, 2003:13).

4.2.2 Panel unit root testing

More recent literature suggests that panel-based unit root tests have higher power than individual time series unit root tests. A panel unit root test is necessary in order to determine if the independent variables are stationary or non-stationary, since if non-stationary variables are regressed on one another, the results will be spurious. In stationary data, the shocks will be temporary and their effects may be eradicated over time as it returns to its long run mean values (Asteriou & Hall, 2011:335). Non-stationary data, on the other hand, will essentially contain permanent effects. Both the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF), initially created for unit root testing in time series data, have been extended to exhibit the presence of unit roots in panel data (Asteriou & Hall, 2011:442). The estimation procedure when dealing with panel data is more complex when compared to time series, since the degree of heterogeneity needs to be taken into account. All of the individuals in the panel may not have similar characteristics, i.e. being stationary or non-stationary (not cointegrated or cointegrated).

The basic panel data unit root theory considers if there are restrictions on the autoregressive process across cross-sections or series and therefore considers an AR(1) model (QMS, 2014:487). This basic model is displayed in Equation 4.6:

$$\gamma i,t = \rho i y i,t-1 + Xit\delta i + \epsilon it \qquad (4.6)$$

Where: i = 1, 2, 3 up to *N* cross-section units observed,

t = 1, 2, 3 up to T_i periods,

Xi,t = exogenous variables included in the model (including fixed effects or individual trends),

` ρi = autoregressive coefficients,

$\epsilon i,t$ = mutually independent idiosyncratic disturbances.

If: $|\rho i|$ < 1, yi is weakly (trend-) stationary, i.e. does not contain a unit root.

$|\rho i|$ = 1, yi is non-stationary, i.e. contains a unit root.

Two natural assumptions regarding ρi are made when testing for a unit root in panel data. First, $\rho i = \rho$ for all (i) units observed, suggesting that all cross-sections have common persistence parameters. Secondly, ρi differs between all cross-sections. The Levin, Lin and Chu (LLC), Breitung and Hadri tests all consider the first assumption, while the Im, Pesaran and Shin (IPS) and Fisher-ADF and Fisher-PP (PP) tests consider the second assumption.

When testing for common unit roots in panel data and assuming that ρi is the same across cross-sections, the Breitung (2000), Hadri (2000) and Levin, Lin and Chu (2002) tests can be used. The LLC and Breitung test both consider the basic ADF specification:

$$\Delta yit = \alpha yit - 1 + \sum_{j=1}^{pi} \beta i,j\, \Delta yit - j + X'it\delta + \epsilon it \qquad (4.7)$$

These tests both assume a null hypothesis of a unit root (in contrast to the Hadri test) and a common $\alpha = p - 1$. The lag order, however, differs across the cross-sections for different p_i (QMS, 2014:488). The null and alternative hypotheses are:

H_0: $\alpha = 0$, consisting of a unit root
H_1: $\alpha < 0$, does not consist of a unit root

The Hadri test is based on the residuals gained from the individual ordinary least squares (OLS) regressions of Yit on a constant or on a constant and a trend (QMS, 2014:490). Evidence suggests that in various scenarios, for example a small T, the panel unit root test experiences size distortion in the presence of autocorrelation when there is no unit root (Hlouskova & Wagner, 2006:111). The Hadri test may therefore generally over reject the null hypothesis of stationarity (no unit root) and contradict results obtained from alternative test statistics and should thus be interpreted with care.

The LLC test is considered to be an extension of the DF test and takes the following form:

$$\Delta Yit = \alpha i + \rho Yit - 1 + \sum_{k=1}^{n} \emptyset k \Delta Yit - k + \delta it + \theta t + uit \qquad (4.8)$$

This method in LLC provide estimates of α from proxies for ΔYit and Yit that are standardised, free of autocorrelation and free of deterministic components (QMS, 2014:488). This method also allows for both unit-specific (*i*) and time-specific (*t*) effects with the one stemming from αi and one from the θt (Asteriou & Hall, 2011:443). The LLC unit root test therefore allows for two-way fixed effects. The unit-specific (*i*) effects allow for heterogeneity, while the coefficient of the lagged Y_i is limited to being homogeneous (common) across all panel units. The null and alternative hypotheses of this test are:

H_0: $\rho = 0$, panel contains a unit root
H_1: $\rho < 0$, panel does not contain a unit root

The LLC test restricts ρ to being homogeneous across all units, constituting a major drawback of this test. When testing for an individual unit root, the IPS as well as the Fisher-ADF and Fisher-PP tests are used and combine the individual unit root tests in order to deliver panel-specific results (QMS, 2014:491). IPS improved the LLC test by allowing heterogeneity on ρ, the coefficient of the $Yi, t-1$ that varies across the cross-sections (Asteriou & Hall, 2011:444). IPS further proposes a testing method based on the average of the individual unit root test statistics. The IPS now allows for different estimations for each *i* unit, resulting in different lag lengths and residual variances (Asteriou & Hall, 2011:444). This improved model takes the following form:

$$\Delta Yit = \alpha i + \rho iYit - 1 + \sum_{k=1}^{n} \emptyset ik\Delta Yit - k + \delta it + uit \qquad (4.9)$$

The null and alternative hypotheses are now:

H_0: $\rho i = 0$, contains a unit root (for all *i*)
H_1: $\rho < 0$, does not contain a unit root (for at least one *i*)

These hypotheses are in contrast with the LLC test, since they assume that all series are stationary under the alternative hypothesis, while the alternative hypothesis of the IPS test assumes that only a fraction of the panel is stationary.

The IPS test is formulated with a restrictive assumption that T must be identical for all cross-sections and therefore requires a balanced panel in order to compute the $\bar{t}$-test statistic. The t-statistic is formed as a simple average of the individual ADF t-statistics for testing the null hypothesis of H_0: $\rho i = 0$, for all *i* and is denoted by t_{pi}:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} tpi \qquad (4.10)$$

The IPS test statistic requires the specification of both the number of lags and deterministic component for each cross-section ADF equation. Individual constants or individual constants and trends can be included.

The Fisher-ADF and Fisher-PP use the results of Fisher (1932) to derive tests that combine ρ-values from individual unit root tests, as proposed by Maddala and Wu (1999). For both Fisher tests, the exogenous variables in the test equations must be specified. In the Fisher tests, you may choose to include no exogenous variables, to include individual constants or to include individual constants and trends (QMS, 2014:493). For the Fisher test based on the ADF test statistics, the number of lags used in each cross-section ADF regression must be specified. An advantage of this test is that it does not require a balanced panel or identical lag lengths in the individual equations (Hlouskova & Wagner, 2006:96). A kernel-based sum-of-co-variances is specified as a method of estimation for the Fisher test based on the PP test statistics (QMS, 2014:493).

It would be useful to first summarise the characteristics of these tests and to then compare the various tests' advantages and shortcomings in order to comprehend and interpret the results in this study. Table 4.1 summarises the elementary characteristics of panel unit root tests for estimation in EViews™8:

Table 4.1: Summary of panel unit root tests

<table>
<tr><th colspan="2">Unit Root Test</th><th>Null hypothesis</th><th>Alternative hypothesis</th><th>Possible Deterministic Component</th><th>Autocorrelation Correction Method</th></tr>
<tr><td rowspan="3">Common Unit Root tests</td><td>Breitung (2000)</td><td>Unit root</td><td>No unit root</td><td>None, F, T</td><td>Lags</td></tr>
<tr><td>Hadri (2000)</td><td>No unit root</td><td>Unit root</td><td>F, T</td><td>Kernel</td></tr>
<tr><td>Levin and Lin (2002)</td><td>Unit root</td><td>No unit root</td><td>None, F, T</td><td>Lags</td></tr>
<tr><td rowspan="3">Individual Unit Root tests</td><td>Im, Pesaran and Shin (IPS)</td><td>Unit root</td><td>Some cross-sections have no unit root</td><td>F, T</td><td>Lags</td></tr>
<tr><td>Fisher-ADF</td><td>Unit root</td><td>Some cross-sections have no unit root</td><td>None, F, T</td><td>Lags</td></tr>
<tr><td>Fisher-PP</td><td>Unit root</td><td>Some cross-sections have no unit root</td><td>None, F, T</td><td>Kernel</td></tr>
<tr><td colspan="6">None - No exogenous variables; F - Fixed effects; and T - individual effect and individual trend</td></tr>
</table>

Source: QMS (2014:493)

Comparison between the various tests (Maddala & Wu, 1999:636):

- The LLC tests test a limiting hypothesis that is not really of practical interest.
- Although the IPS test is considered to be a generalisation of the LLC test, it is better regarded as a way to combine evidence from various independent unit root tests.
- The null hypothesis of the IPS and LLC test is the same, but the alternative hypothesis differs. The IPS test is based on the heterogeneity of the autoregressive parameter, in contrast with the LLC test based on the homogeneity of the autoregressive parameter and

heterogeneity in the autocorrelation structure of the error variances. The LLC tests are also based on pooled regressions and the IPS test, on the other hand, amounts to a combination of the various independent tests. The data in the LLC test are pooled, while there is no pooling of data in the IPS test. When comparing these two tests with one another, the LLC test is likely to do worse, since it uses the panel estimation method that is not effective if there is no need for pooling the data.

- The IPS test and Fisher tests can directly be compared, since both these tests aim to combine the significance of the different independent tests. An important element distinguishing these tests is that the IPS test is based on combining the test statistics, in contrast with the LLC test that combines the significance levels of the various tests.
- In terms of limitations, the Fisher test has very little and if the ADF test is used, the choice of lag length for any sample can be determined separately. Sample sizes may also vary according to the availability of data, since there is no restriction and it can be used in combination with any unit root test. The IPS test, however, may give problems if the time series' length differs across samples.
- All of the unit root tests can take care of heteroskedasticity and autocorrelation problems in the errors, but when the errors in the different samples are cross-correlated, none of these tests can effectively resolve this problem. However, this problem tends to be less severe with the Fisher test, when compared to the IPS and LLC test. For example, for high values of t (50-100) and smaller values of N (50-100), the Fisher test has small size distortions and comparable power. For medium values of t and high values of N, the Fisher test's size distortion is approximately the same as that of the IPS test.

Considering the aforementioned and comparing the Fisher, IPS and LLC tests, the Fisher test is more likely to deliver better results and is also the better model to use if the panel is only partially stationary.

The basic idea of Section 4.2.3 follows on the explanation of spurious regressions, showing that if two variables (or series) are non-stationary, the error can be represented as a combination of two cumulated error processes. These cumulated error processes are referred to as stochastic trends and are normally expected to combine in order to result in another non-stationary process (Asteriou & Hall, 2011:356). In the event that series X and Y are related, it is expected that they would move together, delivering a similar stochastic trend (Asteriou & Hall, 2011:356). When these series are put together, it may be possible to find a combination that eradicates the non-stationarity and the non-stationary time series is said to be cointegrated. Cointegration is a great way to discover the presence of economic structures. Cointegration testing is a predominant requirement for any regression working with non-stationary time series data. Considering the short time period for the non-banking sector and the intermediate time period for the banking sector, no cointegrated relationships are expected. Despite the fact that no cointegrated relationships are expected, cointegration tests will still be conducted.

4.2.3 Panel cointegration testing

Testing whether a series displays a cointegrating relationship or not is the next step after it has been determined whether unit roots are present in the series. The motivation for testing for cointegration stems from the need to investigate the problems with spurious regressions, which only exists in the presence of non-stationary series. Cointegration tests are a formal way of testing for two possible scenarios (Ateriou & Hall, 2011:447):

1. If $X_{i,t}$ and $Y_{i,t}$ are integrated of the same order and $u_{i,t}$, the residuals from regressing $Y_{i,t}$, to $X_{i,t}$ comprises of a stochastic trend
2. If $X_{i,t}$ and $Y_{i,t}$ are integrated of the same order, with the residuals, $u_{i,t}$, being stationary

In the first scenario, first differences are applied, while in the second scenario it can be concluded that the variables $X_{i,t}$ and $Y_{i,t}$, show a cointegrating relationship. In order to test for cointegration, it is important to make sure that all the variables are *a priori* integrated of the same order (Asteriou & Hall, 2011:447).

There are various tests available for panel cointegration of which the best known are based on the Engle-Granger (1987) test, namely the McCoskey and Kao (1998), Kao (1999) and Pedroni (2004) tests, while the Larsson, Lyhagen and Löthgren (2001) test is based on Johansen's maximum likelihood estimator (Asteriou & Hall, 2011:451). If the variables are cointegrated in a time series context, an error-correction model (ECM) exists. This analysis consists of a standard ADF test on the residuals under the null hypothesis of no cointegration or the alternative hypothesis where the variables are cointegrated. For an ADF statistic smaller that the critical value, the null hypothesis is rejected and the estimation of the ECM continues. The Engle-Granger test can be applied to either heterogeneous or homogeneous panels.

Both the Kao (1999) and Pedroni (2004) tests are an extension of the Engle-Granger (1987) residual-based cointegration test (Asteriou & Hall, 2011:448). The Engle-Granger cointegration test inspects the residuals of a spurious regression performed using variables integrated of order one, I(1). If the variables are cointegrated, the residuals would be I(0) and if not, they would be I(1) (QMS, 2014:864).

The Pedroni test allows for heterogeneous intercepts and trend coefficients for each cross-section, as well as for heterogeneity in the errors across different sections in the panel so that:

$$Yit = \alpha i + \delta i,t + \beta 1ix1i,t + \beta 2ix2i,t + \cdots + \beta MixMi,t + \epsilon i,t \qquad (4.11)$$

Where: t = 1 up to T;

i = 1 up to N;

m = 1 up to M;

y and x = are assumed to be integrated of order one, I(1); and

αi and δi = parameters indicating individual and trend effects (may be set to zero if preferred).

The null and alternative hypotheses under the Pedroni test are:

H_0: no cointegration, residuals $\epsilon i,t$ are I(1)
H_1: cointegration, residuals $\epsilon i,t$ are I(0)

The Pedroni panel cointegration test generates 11 different statistics with different size and power characteristics for various cross-sections and number of observations (QMS, 2014:865). The drawback of this test, however, is the limiting *a priori* assumption of a unique cointegrating vector (Asteriou & Hall, 2011:451). The Kao test follows a similar basic approach as the Pedroni tests, with the exception that it specifies cross-section specific intercepts and homogeneous coefficients on the first stage regressors (QMS, 2014:865). The null hypothesis is that there is no cointegration, with the alternative hypothesis that cointegration is present. The drawbacks of Kao's test are that homogeneous cointegrating vectors and AR coefficients are imposed, but it does not allow for numerous variables in the cointegrating vector (Asteriou & Hall, 2011:449). Another disadvantage is that the issue of identifying multiple cointegrating vectors, in the event that more than one cointegrating vector exists, are not addressed (Asteriou & Hall, 2011:449).

The Fisher-Johansen test is a combined individual test where the results of the individual independent tests are used (QMS, 2014:867). Maddala and Wu (1999:650) use the idea of Fisher (1932) and propose to combine the results of the individual Johansen tests obtained from individual cross-sections to obtain a test statistic for the full panel. The Fisher-Johansen test therefore pools the individual results of the Johansen test and can be conducted under five assumptions. The assumptions are: (i) no intercept or trend in the cointegrating equation (CE) of Vector Autoregressive (VAR) model; (ii) intercept in CE, but no intercept in VAR; (iii) intercept in

CE and VAR; (iv) intercept and trend in CE, no trend in VAR; and (v) intercept and trend in CE with a linear trend in VAR. The first and last assumption of the Fisher test is not entirely realistic. The first assumption specifies no intercept or trend in the long run model (CE) or short run model (VAR), but is unlikely to occur in practice. This is mainly since the intercept is needed to account for adjustments in the units of measurements in the variables (Asteriou & Hall, 2011:372). The fifth assumption assumes a quadratic trend in the CE and linear trend in the short run model. This model is therefore unrestricted and is difficult to interpret from an economics point of view. This is mainly since the variables are entered as logs and this model would therefore imply an ever-increasing or ever-decreasing rate of change (Asteriou & Hall, 2011:373). The null hypothesis for the Fisher-Johansen test is that the variables will have either none, at most one, at most two or more unit roots, depending on how many variables are being tested. This study uses the Kao, Pedroni, Fisher-Johansen and Johansen cointegration tests.

4.3 Model specification

The individual determinants of each bank and non-bank financial institution are investigated by using a panel regression model in order to identify the significant determinants as well as the magnitude of the effect that these individual determinants have on systemic risk. Taking into account the short time period, normal time series analysis will likely cause problems with the regression estimation. Panel data analysis eliminates this problem through an increased number of data points. However, stationarity and cointegration tests first need to be conducted on the data in order to ensure that the regressions are not spurious. In order to acknowledge the possible links between some of the firm-specific and macroeconomic variables, multicollinearity testing is conducted in Section 5.1 and 5.2 to deliver the specification least likely to suffer from multicollinearity. The cointegration testing also accounts for the potential of various structural relationships in a system of equations.

A panel regression model is used in this study since it is limited to six banks and 15 years per bank as well as seven non-banks and 13 years per non-banking financial institution. A limited number of observations may be a problem in a normal time series model. The primary aim of the regression model is to identify the significant determinants of systemic risk. SRISK is used as the dependent variable for the banking sector, but considering the significant data constraints for the non-banking sector, the LRMES replaces SRISK as the dependent variable for the non-banking sector. The LRMES is the expected percentage loss of a financial institution's equity value in the event that a crisis materializes and is an alternative measure of SRISK, given that it takes a longer time period (greater than six months) into account (Acharya, Brownlees, Engle, Farazmand & Richardson, 2013:70). Since this study utilises yearly data, this is an appropriate alternative measure. Given the very complex nature of systemic risk, its number of origins as well as the ease with which it spreads between financial institutions, various factors are investigated. The regression equation for banks is represented in the following form:

$$SRISK_{i,t} = \alpha i + \beta_1 Act_{i,t} + \beta_2 SIZE1_{i,t} + \beta_3 SIZE2_{i,t} + \beta_4 FLOW_{i,t} + \beta_5 LVG1_{i,t} + \beta_6 LVG2_{i,t} + \beta_7 PROF_{i,t} + \varepsilon_{i,t} \quad (4.12)$$

$$LRMES_{i,t} = \alpha i + \beta_1 Act_{i,t} + \beta_2 SIZE1_{i,t} + \beta_3 SIZE2_{i,t} + \beta_4 FLOW_{i,t} + \beta_5 LVG1_{i,t} + \beta_6 LVG2_{i,t} + \beta_7 PROF_{i,t} + \varepsilon_{i,t} \quad (4.13)$$

The regression equation for non-banks is represented in the following form:

$$LRMES_{i,t} = \alpha i + \beta_1 Act_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 PROF_{i,t} + \varepsilon_{i,t} \quad (4.14)$$

The variables in Equation 4.12 - 4.14 are based on the work of Baselga-Pascual *et al.* (2015:141), Brownlees and Engle (2012), Laeven *et al.* (2014:13) and Foggit (2016:177) and are represented as follows:

- α – Constant
- $Size1_{i,t}$ – size of the bank *i* at time *t,* measured using the logarithm of the total value of the firms' assets (López-Espinosa *et al.*, 2013:293)
- $Size2_{i,t}$ – the size of bank *i* at time *t,* measured as the logarithm of their market capitalisation
- $Size_{i,t}$ – the size of the non-banking financial institution *i* at time *t*, measured as the market capitalisation of the firm
- $LVG1_{i,t}$ – the leverage of bank *i* at time *t*, measured as the bank's total debt divided by its total equity
- $LVG2_{i,t}$ – the leverage of bank *i* at time *t*, measured as the sum of the total liabilities and market capitalisation divided by market capitalisation
- $PROF_{i,t}$ – the profitability of the bank and non-bank financial institution *i* at time *t,* measured using their ROA
- $ACTi_{,t}$ – activities of bank and non-bank financial institution *i* at time *t,* measured by the share of loans (proxied by gross loans) in total assets
- $FLOW_{i,t}$ – the capital inflows to South Africa proxied by the portfolio investment liabilities for South African banking sector

4.3.1 Expected relationship between the dependent and independent variables

Table 4.2: Expected relationships and construction of variables

	Notation	Banking Sector	Non-banking Sector	Formula	Data source	References*
Systemic Risk Index	SRISK	✔	✕		V-lab	Acharya, Engle and Richardson (2012) and Brownlees and Engle (2017)
Long-Run Marginal Expected Shortfall	LRMES	✔	✔		V-lab	Brownlees and Engle (2017)
Financial statement data						
Activities of the financial institution	Act	Negative	Negative	Share of loans in total assets	IRESS	Männasoo and Mayes (2009); Vodová (2015) and Foggit (2016)
Size of the bank measure 1	Size1	Positive	-	Natural log of total assets	IRESS	Baselga-Pascual *et al.* (2015); López-Espinosa *et al.* (2013); Foggit (2016); Varotto and Zhao (2017); Kamani (2019) and Brunnermeier *et al.* (2019)
Size of the bank measure 2	Size2	Positive	-	Natural log of market capitalisation	V-lab	Moreno (2013)
Size of the non-bank financial institution**	Size	-	Positive	Total market capitalisation	V-lab	Malkiel and Xu (1997)
Leverage of the bank measure 1**	LVG1	Positive	-	Debt to equity	IRESS	Goel, Chadha and Sharma (2015)
Leverage of the bank measure 2	LVG2	Positive	-	(Market capitalisation + Total liabilities)/Market capitalisation	IRESS and V-lab	Foggit (2016)
Profitability of the financial institution**	Prof	Negative	Negative	Return on assets	IRESS	Baselga-Pascual *et al* . (2015) and Varotto and Zhao (2018)
Market data						
Capital flows**	Flow	Negative	-	Portfolio investment liabilities	SARB	Foggit (2016)
* The references are only related to the computation of the explanatory variables and not the expected relationships. The discussion in order to arive at the expected relationship is reported in Chapter 3.1.1 - 3.2.4.						
** Variables are obtained directly from the respective databases. The remainder of the variables are calculated by the Author based on the displayed formulas.						

Source: Compiled by Author

SRISK and LRMES are used as dependent variables in regression equations for the banking sector, while due to data constraints only LRMES is used as the dependent variable for the non-banking sector. Subsequently, it follows that since the dependent variables for these two sectors differ, the expected relationship for the different sectors cannot be reported unless the same variable is used for both sectors. The discussion and influence of the individual determinants on systemic risk are reported in Section 3.1.1 – 3.2.4. The computation of the variables are based on both domestic and international literature and data are sourced from publicly available data.

4.4 Data

This study uses secondary data and the SRISK measure combines financial statement data with market data and economic indicators in order to produce values that may be more forward looking than financial statement data alone. The panel contains South African financial institutions from the banking and non-banking sectors with a market capitalisation greater than R10 billion and a range of R1 billion to R10 billion respectively as at the end of December 2017 (JSE, 2019b). The panel for the banking sector spans from 2003 to 2017, while the non-banking[11] sector panel spans from 2005 to 2017. This study uses a number of different data sources for a number of different bank and non-bank financial institutions. Section 4.4.1 outlines the financial statement data used, while Section 4.4.2 outlines the market data and economic indicators. Section 4.4.3 then sets out the banking and non-banking financial institutions included in this study, which are divided into subindustry groups based on their SIC codes. Subsequently it also explains how the banking and non-banking financial institutions were chosen for inclusion in this study.

4.4.1 Financial statement data

The majority of the financial statement data was acquired from IRESS Expert Dataset (INET BFA) with only the firm's market capitalisation being obtained from V-lab, all reported annually. The data for the banking sector cover the period 2003 to 2017, while the data for the non-banking sector cover the period 2005 to 2017. One South African bank's financial statements are dated for the year ended February, two for the year ended March, one for the year ended June and three[12] for the year ended December. One South African non-banking financial institution's financial statements are dated for the year ended March, two for June, one for September and four[13] for December. Although mention to this difference needs to be made, it is not expected to have a significant impact on the results.

4.4.2 Market data and economic indicators

The capital flow data into South Africa are acquired from the SARB. V-lab is used to obtain the SRISK and LRMES for the banking sector and LRMES for the non-banking sector as measures of systemic risk. V-lab data are reported in US Dollars (USD); therefore, the values are converted using the exchange rate[14] at the end of the specific year's reporting period in order to obtain the South African Rand (ZAR) value. V-lab data are reported as daily data, but since the financial statement data are reported as annual data, the data are converted[15] to yearly data. South Africa's inflation, interest, unemployment as well as economic growth rate for the period 2003 to 2017 for the banking and 2005 to 2017 for the non-banking sector are acquired from the SARB.

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[11] African Phoenix Investments (AXL) is an unbalanced panel with data constraints for 2015 and 2016.

[12] Absa Group Ltd's statements for 2003-2004 are dated for the year ended March, while 2005-2017 are dated for the year ended December.

[13] MMI Holdings Ltd's financial statements for 2003-2010 are dated for the year ended December, while the statements dated for 2011-2017's year end is in June.

[14] As provided by the SARB.

[15] Yearly averages of the daily data are obtained.

Both IRESS's and the SARB's financial reporting adheres to the International Financial Reporting Statements (IFRS) as well as the Basel requirements[16]. Due to this consistency in reporting standards, it is not expected that the use of different databases will negatively impact the results.

4.4.3 Bank and non-bank selection

Only listed banks and non-banks were considered for this study. Absa bank is listed on the JSE as Absa Group Limited (JSE, 2019b). V-lab refers to Absa as Barclays Africa Group Limited, while the IRESS Expert dataset refers to ABSA as Absa Group Limited. As mentioned in Section 2.6, Absa Group Limited was formerly known as Barclays Africa Group Limited for the period 2 August 2013 to 10 July 2018. Barclays reduced its shareholding in Barclays Africa Group Ltd to less than 50% and on 11 July 2018 the name changed to Absa Group Ltd. The remainder of this study will therefore refer to Absa Group Limited and not Barclays Africa Group Limited.

Six banks and seven non-banking financial institutions are included in this study, whereby the latter comprises of financial institutions included in the insurance sector (life and non-life insurance) as well as in the investment sector. Although it may be argued that other banking and non-banking financial institutions are relevant to this study, data availability was a limiting factor. Financial institutions included in the banking and non-banking sectors that did not have data available for the considered periods are eliminated from the analysis. Financial institutions are classified as large if they have a market capitalisation greater than R10 billion and small if their market capitalisation is less than R1 billion, leaving the R1 billion to R10 billion market capitalisation as medium sized (JSE, 2019a). Financial statement data are available for the six largest banking, six largest non-banking and one medium sized non-banking financial institutions. Bearing in mind that the size of the financial institution is a significant input for both the SRISK measure and the regression analysis, it can be argued that even if data were available for the other financial institutions, their results, given their relatively small size[17], would be insignificant by comparison. The selection of the banking and non-banking financial institutions for inclusion in this study is therefore based on both significance and data availability. The banking and non-banking financial institutions are listed in Tables 4.3 and 4.4 respectively.

[16] Basel I up to 31 December 2009, Basel II: 1 January 2008-31 December 2011, Basel 2.5: 1 January 2011–31 December 2012 and Basel III: 1 January 2013 onwards

[17] RMB Holdings Ltd is a large bank in SA with a market capitalisation of R107 967 062 113 on 31 December 2017, placing it in the top ten largest banks of SA. Due to data constraints, RMB Holdings could not be included in this study.

Table 4.3: South African banking institutions

Banks	JSE Ticker Code	Market capitalisation (millions)*	Market capitalisation (milions)**	Market capitalisation (millions)***
Absa Group Limited	ABG	R 117 615.62	R 135 631.60	R 118 270.00
FirstRand Limited	FSR	R 269 949.57	R 358 323.40	R 260 056.00
Investec Limited	INL	R 90 926.68	R 29 342.42	R 27 545.00
Standard Bank Group Limited	SBK	R 234 353.52	R 306 086.40	R 232 793.00
Capitec	CPI	R 88 857.96	R 96 254.90	R 88 035.00
Nedbank Group Limited	NED	R 103 267.90	R 124 849.70	R 120 282.00
Obtained from: *V-lab, year ended December 2017; ** JSE, year ended June 2018; *** IRESS, year ended December 2017.				

Source: Compiled by Author

Table 4.4: South African non-banking financial institutions

Non-Bank Financial Institutions	JSE Ticker Code	Market capitalisation (millions)*	Market capitalisation (millions)**	Market capitalisation (millions)***
Insurance sector				
Life insurance				
Discovery Limited	DSY	R 82 158.24	R 95 409.60	R 83 255.00
Liberty Holdings Limited	LBH	R 29 401.32	R 33 291.10	R 30 981.00
MMI Holdings Limited	MMI	R 31 498.51	R 32 760.00	R 36 043.00
Sanlam Limited	SLM	R 139 546.88	R 151 806.70	R 145 955.00
Non-life insurance				
Santam Limited	SNT	R 26 533.45	R 31 504.70	R 29 309.00
Investment sector				
African Phoenix Investments Limited	AXL	R 841.00	R 1 013.17	R 1 030.00
Hosken Consolidated Investments Limited	HCI	R 11 379.32	R 11 581.00	R 13 166.00
Obtained from: *V-lab, year ended December 2017; ** JSE, year ended June 2018; *** IRESS, year ended December 2017.				

Source: Compiled by Author

Mention of the different market capitalisation values needs to be made. These values are only to indicate the size of the financial institutions included in this study[18] and although it differs between V-lab, JSE and IRESS, these financial institutions' classification does not differ, i.e. small, medium or large. It is therefore not expected that this will negatively influence the results of this study.

[18] Only the market capitalisation data obtained from V-lab are used in the regressions.

4.5 SRISK

SRISK measures the expected capital shortfall of a financial institution conditional on a significant market decline[19] (Brownlees & Engle, 2017:1), i.e. the amount of capital that a financial institution would need in order to function normally and maintain an 8% capital to asset ratio as required by Basel III in the event that another financial crisis should realise (Engle, 2015:6). Acharya *et al.* (2012:59-60), Brownlees and Engle (2012:8) and Brownlees and Engle (2017:2) propose SRISK as a proxy measure of banks' systemic risk and measures the capital shortfall a bank is likely to experience when the market falls below a certain threshold. This is demonstrated by Equation 4.15:

$$SRISKi,t = kDi,t - (1-k).Ei,t\{1 - MESi,t + \frac{h}{t}(Ct + \frac{h}{t})\}, \quad (4.15)$$

Where:

- k is the total capital (Tier 1 capital plus Tier 2 capital) to risk-weighted asset ratio that banks are required to hold by the Basel Committee. The minimum global regulatory requirement is set at 8% (BCBS, 2011:12);
- Di,t is the book value of the bank's debt (total liabilities); and
- Ei,t is the market value of the bank's equity.

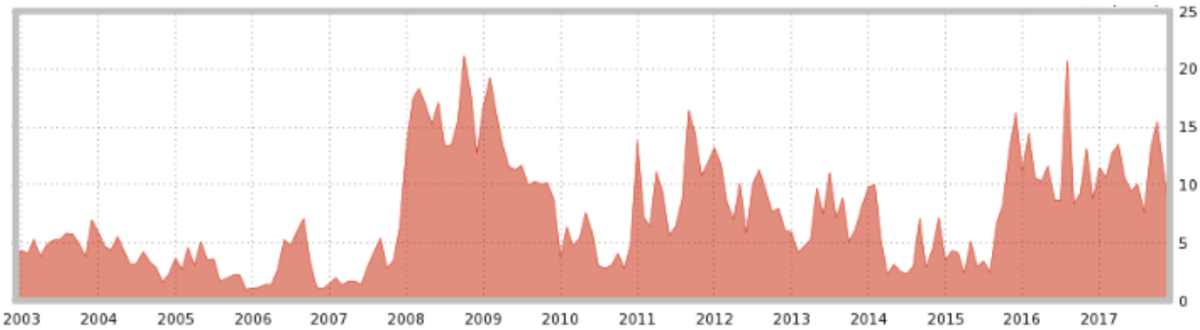
The SRISK (%) contribution measures the financial institution's percentage of the total financial sector capital shortfall and is an indication of how much the government would need to bail out the entire financial system during a crisis. This SRISK measure is deconstructed in this study in order to determine the contribution of each financial institution to the total financial sector SRISK and therefore the amount of capital the South African government would need to bail out the individual banks and non-bank financial institutions. Financial institutions with the greatest percentages of SRISK contribute the most to causing a crisis and are also the most vulnerable during a crisis. Negative SRISK values indicate that the financial institution has an excess capital, reflecting that they would have more than the required amount of capital during a crisis scenario.

The SRISK for the South African financial sector is discussed in Section 4.5.1, followed by the results for the banking and non-banking sector in Section 4.5.1.1 and 4.5.1.2 respectively. Section 4.5.2 assesses whether there are any corresponding trends in systemic risk between the banking and non-banking sectors.

[19] A significant market decline is defined as a 40% decline in the market.

4.5.1 South African financial sector

Figure 4.1: SRISK of the total South African financial sector (USD Billion)



Source: V-lab (2019)

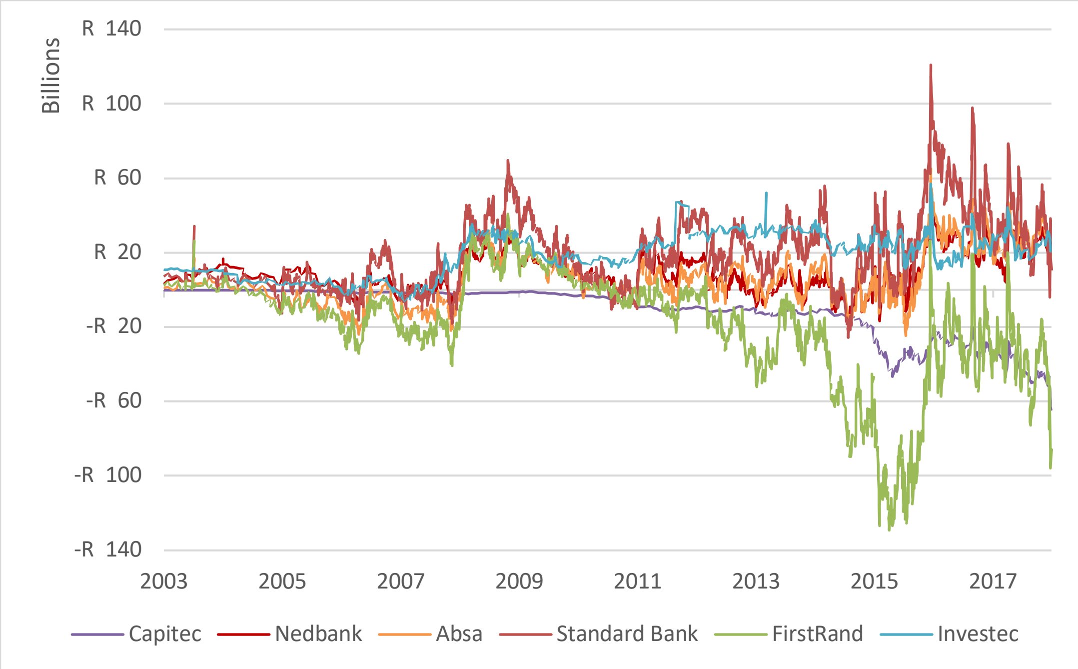
Following from the stock market crash in 2002, the aggregate levels of systemic risk in South Africa remained relatively low and exhibited little volatility, only for this steady decline to end with the financial crisis. From December 2007 to December 2009, the average capital shortfall of the entire South African financial sector is estimated to be close to 18 billion USD. The main contributor to this spike in the SRISK levels is the financial crisis of 2007/2008, which account for more than 30% of the aggregate SRISK for the period 2003 to 2017. In July 2007, South Africa's SRISK began to increase as the repercussions of the subprime crisis became more apparent. The effects of the crisis accelerated significantly in 2008 and the SRISK peaked at approximately 21 billion USD. During June 2009, the financial system's capitalisation started to improve and the aggregate SRISK started to decline. Although South Africa's financial sector was influenced by the 2007/2008 financial crisis, South Africa had a well-regulated financial sector and did not experience a banking crisis. South Africa's financial sector displayed an improvement, but the recovery was fairly sluggish. The South African financial system experienced another spike in the SRISK levels from January 2011 to January 2012. This spike was triggered by the European sovereign debt crisis of 2012 with spill-over effects to the South African financial sector. The initial conclusion drawn from these spikes in South Africa's SRISK is that it appears to spike during financial chaos in foreign countries. During 2014 there was a smaller spike in South Africa's SRISK levels triggered by African Bank being placed under curatorship as a result of poor management and liquidity problems. Another larger spike occurred at the end of 2016 with an average SRISK value of 14 billion USD, the largest since the 2007/2008 financial crisis. This spike may have been the result of the end of the super-commodity cycle and the severe drought, decreasing the supply side of commodities. Although the capitalisation of the financial sector started to improve at the end of 2017, the aggregate SRISK levels of the financial sector still looks weaker than in the early 2000s. From the above the conclusion can be drawn that the South

African financial sector is not only influenced by international factors, but national factors can also contribute to increasing systemic risk. The systemic importance of one financial institution therefore depends on both their properties as well as the properties of the entire financial network.

Figure A4.1, A4.2 and A4.3 in Annexure A display recent snapshots of the entire financial sector's aggregate statistics on SRISK/GDP, SRISK/Total Assets and SRISK/Market Capitalization respectively. The capital shortfall of Investec displayed in Figure A4.1, although small, is the greatest of the banking sector. The cost to bail Investec out would be approximately 0.43% of South Africa's GDP. MMI Holdings has a capital shortage of approximately 0.4% of GDP, making it the riskiest non-banking financial institution. Although the individual capital shortfalls are relatively small compared to South Africa's GDP, the aggregate cost of bailing out these financial institutions in a crisis would become enormous. In Figure A4.2, the ratio of SRISK to total assets is approximately 0.28%. Since the capital ratio of South African financial institutions is 8%, 0.28/8 of the financial institution's assets would need to be sold in order to cut the SRISK to 0%. The rapid selling of assets is likely to result in a fire sale of assets, substantially diminishing the institution's market value through the price impact of the sales. Financial institutions that are selling their assets such as mortgages and corporate loans will probably not issue new credit and such selling may therefore not result in a significant credit disruption. MMI Holdings' SRISK to total assets is approximately 0.26% and the same reasoning as above can be followed. Figure A4.3 indicates the new capital that would be needed by financial institutions in order to diminish their SRISK. Investec would need roughly 1.5% of its current market value, followed by MMI Holdings with 1.4% of new capital that needs to be raised. The stock market value of these institutions would need to increase with double of their SRISK/MC amount through selling new shares in order to eliminate the capital shortfall. When an increased volume of new shares needs to be sold, it is likely to lower the price substitutability, particularly if undertaken in a crisis. It is interesting to notice that Investec, followed by MMI Holdings, Nedbank and Absa are the riskiest for systemic risk when normalised by GDP, total assets and market capitalisation in the South African financial sector and that the order for all three measures remain the same.

4.5.1.1 Banking sector

Figure 4.2: SRISK of the South African banking sector



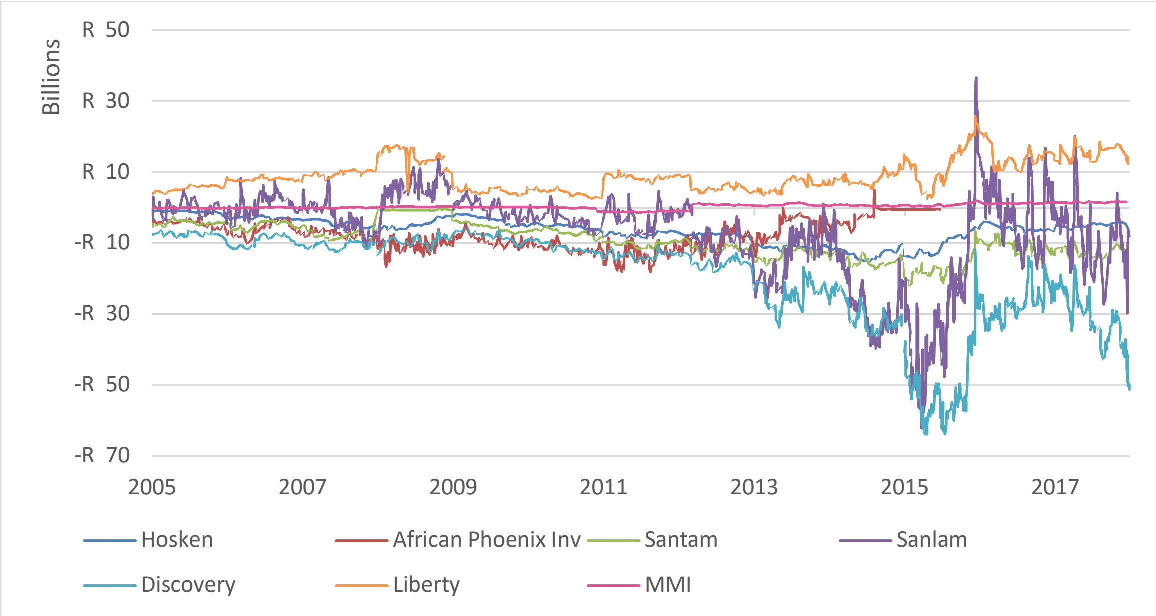
Source: Compiled by Author

Figure 4.2 illustrates the daily SRISK values of the individual banks in South Africa and displays high levels of volatility. For the largest part of 2003 to 2017, FirstRand Bank displayed the greatest capital surpluses, indicated by the negative SRISK values. Capitec, however, displayed capital surpluses for the entire period of 2003 to 2017, even during the 2007/2008 financial crisis. These negative SRISK values offset many of the positive SRISK values produced by the remainder of the banks when considering the total SRISK of the banking sector. All of the banks displayed an increase in their SRISK values during the financial crisis. Even though Capitec also saw a rise in its SRISK values, it still remained negative. Subsequently, the levels of SRISK in the banking sector decreased after the financial crisis, with Investec and Standard Bank displaying a steady upward trend for the rest of the sample period. During the European sovereign debt crisis of 2011 to 2012, each bank experienced a spike in their SRISK amounts, even though it was significantly less than in the previous crisis. During the course of 2003 to 2017, Standard Bank was responsible for the greatest contribution of SRISK during the financial crisis and also contributed the largest amount of SRISK overall. Capitec and FirstRand contributed the least to SRISK.

A conclusion that can be drawn from Figure 4.2 is that the South African banking sector's SRISK is generally fairly low, but during and following a crisis in a foreign country, the SRISK increases significantly. This is in line with the findings of Claessens and Ghosh (2013:92) who report that capital inflows and sudden capital outflows amplify business cycles in emerging markets and can generate systemic shocks, as discussed in Section 3.5. Capital flows are extremely volatile since investors withdraw their accumulated capital during a crisis, resulting in the undercapitalisation of banks (as indicated by the spikes in SRISK).

4.5.1.2 Non-banking sector

Figure 4.3: SRISK of the South African non-banking sector



Source: Compiled by Author

Figure 4.3 illustrates the SRISK amounts that the individual financial institutions in the non-banking sector contributed on a daily basis and displays some interesting characteristics. Discovery displayed the largest capital surpluses, indicated by the negative SRISK values for the entire period. With the exception of Liberty, all of the financial firms displayed capital surpluses for the majority of the period. The positive SRISK amounts produced by Liberty and occasionally by Sanlam are offset by much of the negative SRISK amounts that the rest of the non-financial institutions produced. During the 2007/2008 financial crisis the SRISK amounts produced by the institutions increased, although not by a significant amount. This trend continued until the beginning of 2013, where after all the institutions (with the exception of Liberty) displayed a significant decline in their SRISK amounts. The European sovereign debt crisis during 2011 to 2012 had no significant effect on the levels of SRISK in the non-banking sector.

From Figure 4.3 it is clear that the South African non-banking sector's SRISK is usually fairly low, with the majority of the firm's displaying capital surpluses. The little increase in SRISK during foreign crises is an indication that the non-banking sector is not as affected by global factors as the banking sector.

4.5.2 Comparisons between the banking and non-banking sectors

When comparing the SRISK of the banking to the non-banking sectors, it is clear that the non-banking sector displays less volatility than the banking sector. This is indicated by the rise in the banking sector's SRISK spikes during the 2007/2008 global financial crisis and the 2011/2012 European sovereign debt crisis, whilst the non-banking sector's SRISK did not increase significantly. The implication of this is that the non-banking sector is less vulnerable to foreign crises, since there is not a substantial rise in undercapitalisation of financial institutions during times of financial turmoil. Although the non-banking sector is much less volatile than the banking sector, a trend can be observed between these two sectors. Both sectors displayed an increase in SRISK values during 2007/2008 and during 2011/2012, albeit not of the same magnitude. The failure of African Bank in 2014 did not result in an increase in SRISK for the non-banking sector, indicating that the non-banking sector was not actually influenced by the failure of a bank. The reason for this phenomenon might be the swift intervention of the SARB in order to prevent negative spill-overs and limit contagion effects. The failure of this bank resulted in a slight increase in SRISK values of the banking sector, but this increase was not significantly more than with the European sovereign debt crisis of 2012. During 2015 the SRISK of both these sectors decreased, followed by an increase in 2016. The implications of these findings are that the banking sector is influenced by both external factors, such as international crises, as well as internal factors, such as the failure of another bank. In contrast to the banking sector, the non-banking sector is not as affected by external factors such as international crises or by internal factors that are not specific to the non-banking financial sector.

The conclusion can be drawn that both these sectors display a similar trend in their contribution to SRISK, although the non-banking sector contributes less than the banking sector. Systemic risk in the South African financial sector is closely related to times of increased instability and volatility and the banking sector becomes a progressively more relevant contributor to systemic risk during times of financial turmoil.

Figure 4.2 and 4.3 display the daily SRISK amounts of both the banking and the non-banking sectors. These figures clearly exhibit the volatility in both sectors, but since year-end accounting data are being used, the SRISK amounts as well as all other variables sourced from V-lab are converted to yearly data for the remainder of this paper. Figure A4.4 and A4.5 in Annexure A display the SRISK amounts of the yearly data for the banking and non-banking sectors respectively.

CHAPTER 5 EMPIRICAL RESULTS

Chapter 4 comprehensively details the empirical methodology that is used to study the individual determinants of systemic risk in the South African financial sector. Due to the complex nature of systemic risk, its propensity to spread between financial institutions and its numerous origins, a great amount of data are needed. Given the different structures of the banking and non-banking sectors, it is expected that the individual determinants differ between these sectors. As discussed in Section 4.2.1, a panel regression analysis is undertaken to overcome the problems associated with a shorter time period and also takes the assumed homogeneity of the financial sector into account. Section 5.1 focuses on the banking sector with its individual determinants as well as the magnitude of the effect, followed by Section 5.2 that report the individual determinants and magnitude of the effect for the non-banking sector. Section 5.3 compares and discusses the results and implications for the banking and non-banking sectors in order to provide insight into the phenomenon of systemic risk in the banking sector in contrast to the non-banking sector.

5.1 Banking sector

A great amount of variables is included for the banking sector in order to account for both bank-specific and country-specific factors associated with systemic risk. Table 5.1 and 5.2 present the descriptive statistics and correlation matrix respectively.

Table 5.1: Descriptive statistics for the banking sector

	SRISK	Bank Activities	Bank Size 1	Bank Size 2	Capital Inflows (Log)	Leverage 1	Leverage 2	Profitability
Mean	3.90 billion	1.202	1.91 trillion	91.90 billion	4.639	11.112	9.152	-4.701
Median	3.56 billion	1.238	761 billion	80.60 billion	5.059	11.363	8.123	-1.262
Maximum	55.20 billion	1.702	18 trillion	357 billion	5.445	22.443	65.081	0.636
Minimum	-89.40 billion	0.079	434 million	199 million	0.000	0.126	1.164	-64.705
Std. Dev.	21.20 billion	0.333	3.59 trillion	73.60 billion	1.298	4.769	8.774	12.168
Skewness	-1.151	-1.132	3.006	1.178	-3.061	-0.457	4.682	-3.944
Kurtosis	6.602	4.682	11.490	4.389	11.166	3.254	28.953	17.856
Jarque-Bera	68.527	29.818	405.881	28.049	390.603	3.371	2854.657	1060.924
Probability	0.000	0.000	0.000	0.000	0.000	0.185	0.000	0.000
Observations	90	90	90	90	90	90	90	90

Source: Compiled by Author

A basic investigation into the main determinants of systemic risk suggests that on average banks use a greater proportion of debt to assets as a form of leverage than the ratio of liabilities and market capitalisation to market capitalisation as a form of leverage. Similarly, banks are larger in size when considering their total assets as opposed to their market capitalization. A similar pattern holds for these variables' median values. Considering the bank's activities, the share that loans represent, on average, is a great proportion of the bank's total assets. The amount of systemic risk that banks produce in the financial sector ranges from a maximum of R55.17 billion to a minimum of R89.36 billion, with the negative minimum value indicating a capital surplus.

On average, banks display low levels of profitability, with the average amounting to -4.7%. This average profitability for the banking sector is very low and can be attributed to some outliers in the data. Capitec displayed the greatest outliers ranging between -64.71% and -30.52%. Figure A5.1 in Annexure A visually displays the banking sector's profitability. It is clear that the data is skewed to the left and this visual representation of the skewness is supported by the high kurtosis of 17.856. Banks' profitability ranges from a minimum ROA ratio of -64.71% to a maximum of 0.64%. The higher the profitability ratio of the bank, the better.

Table 5.2: Correlation matrix for the banking sector

	SRISK	Bank Activities	Bank Size 1	Bank Size 2	Capital Inflows (log)	Leverage 1	Leverage 2	Profitability
SRISK	1.000							
Bank Activities	-0.104	1.000						
Bank Size 1	0.347	0.457	1.000					
Bank Size 2	0.006	0.552	0.786	1.000				
Capital Inflows (log)	-0.214	0.014	0.084	0.178	1.000			
Leverage 1	0.238	0.524	0.628	0.378	-0.171	1.000		
Leverage 2	0.355	0.117	0.341	-0.030	-0.135	0.471	1.000	
Profitability	0.111	0.684	0.785	0.783	0.023	0.640	0.270	1.000

Source: Compiled by Author

The correlation matrix shows no instances of particularly high correlation (greater than 0.8) between the explanatory variables, but does however display three instances of correlation greater than 0.7. Although this degree of multicollinearity is not likely to impose severe problems in the regression, careful consideration is given to the variables displaying the collinearity. Given that bank size measure one shows two instances of correlation and that two measures of bank size exists bank size measure one will be removed in order to diminish the multicollinearity. Bank size measure two, although displaying one instance of correlation, will not be removed, since it is not expected that it will impose problems. Prior to performing the regression analysis, the variables must first be tested to determine their level of stationarity. Although we are ultimately concerned with the characterisation of the relationship between SRISK and the independent variables, it is necessary to focus on the behaviour of the individual series and whether or not they are subject to permanent changes in their level. This issue is known as the unit-root hypothesis and pose important implications for the final model choice as well as for drawing valid conclusions from the estimation procedures. This process is explained in Section 4.2.2. The capital inflows variable is logged with the intention of removing the influence of scale as well as increasing the probability of stationarity. Table 5.3 below provides the summary of the unit root tests.

Table 5.3: Summary of the unit roots for the banking sector

	SRISK	Bank Activities	Bank Size 1	Bank Size 2	Capital Inflows (log)	Leverage 1	Leverage 2	Profitability
LLC	I(1)***	I(0)***	I(0)***	I(0)***	I(0)***	I(1)***	I(0)***	I(0)***
IPS	I(1)***	I(1)***	I(0)**	I(0)**	I(0)***	I(1)***	I(0)***	I(0)***
Fisher-ADF	I(1)***	I(1)***	I(0)**	I(0)*	I(0)**	I(1)***	I(0)***	I(0)***
Fisher - PP	I(1)***	I(1)***	I(0)***	I(0)***	I(0)***	I(1)***	I(0)***	I(0)***
Hadri	N.S.***	N.S.***	N.S.***	N.S.***	N.S.*	N.S.***	S.***	N.S.***
Majority Consensus	I(1)	I(1)	I(0)	I(0)	I(0)	I(1)	I(0)	I(0)
N.S. indicates non-stationary; S. indicates stationary.								
***Significant at 1% level; **Significant at 5% level; and * Significant at 10% level.								

Source: Compiled by Author

A visual inspection indicated that there is no clear trend in the data. The unit root test results are therefore all presented for level and intercept with no trend. Breitung's unit root test is therefore not included, since it only considers both an intercept and trend. With the exception of the dependent variable, bank activities and leverage measure one, all of the explanatory variables are stationary. Considering that the majority of the independent variables are stationary, it is unnecessary to include them as exogenous variables when testing for a cointegrating relationship. Panel cointegration tests, i.e. Kao, Pedroni and Fisher-Johansen together with Johansen's cointegration test are conducted in order to determine if a cointegrating relationship exists between SRISK, bank activities and leverage measure one. If a cointegrating relationship exists, another model, such as the vector error-correction model (VECM) needs to be used, since it allows the use of non-stationary variables. Given that the data for the banking sector are yearly and are available for 15 years, the assumption is made that the inclusion of one lag would be the most suitable test specification (Wooldridge, 2015:577). When testing for the most appropriate lag length, all criteria indicate that one lag will be appropriate[20]. Table 5.4 presents a summary of the cointegration test results between all of the non-stationary variables, i.e. SRISK, bank activities and leverage measure one. Given that there are more stationary variables, I(0), than non-stationary variables, I(1), the amount of exogenous variables in the Johansen test would exceed the amount of endogenous variables, hence no I(0) variables were included in the Johansen test.

[20] The results of the tests that are not displayed in this section are presented in Annexure B.

Table 5.4: Summary of the cointegration test results

Cointegration test	Consensus*
Kao	No cointegration present
Pedroni	Mixed, mostly cointegration present
Fisher-Johansen	At most one according to the Eigen statistic
	Mixed, at most two according to the Trace statistic*
Johansen	Mixed, mostly no cointegration present
*On a 5% level of significance.	

Source: Compiled by Author

All of the cointegration tests were conducted using one lag. The use of automatic lag selection also confirmed the cointegration results. The first and last assumption of the Fisher-Johansen is not plausible in terms of economic theory (as discussed in Section 4.2.3) and was therefore not considered. Only model two, three and four were considered. Due to the mixed results of the cointegration tests, a VECM specifying only one cointegrating vector is estimated. As expected in Section 4.2.2, the VECM did not yield a negative and statistically significant adjustment coefficient, indicating that no long run relationship exists between SRISK and the independent variables. Given that there is no long run relationship, the Wald test is conducted to determine if the independent variables have a significant effect on SRISK in the short run. Both bank activities and leverage measure one indicate that the null hypothesis cannot be rejected, reflecting that there is no short run causality running from the independent variables to SRISK. Since there is no long run or short run relationship, the full results are only reported in Annexure B.

Due to the majority of the variables being stationary and bank activities and leverage measure one not displaying a long run cointegrating or short run relationship with the dependent variable, a panel regression model with fixed effects and random effects can be estimated, illustrated in Table 5.5 below. Recalling the theory discussed in Section 4.2.2, a linear combination of non-stationary variables that are integrated of the same order result in a stationary series and will therefore not lead to a spurious regression. Given that neither a long run nor a short run relationship exists, the non-stationary variables can be differenced to achieve stationarity. This allows for the estimation of a fixed effects model specifying the differenced SRISK as the dependent variable with all of the independent variables. Significant drawbacks of the fixed effects method are that cross-sectional heteroskedasticity could be present and that the error terms may be correlated with the individual effects, affecting the estimation results (Yaffee, 2013:7). In the presence of heteroskedasticity, OLS estimators are no longer BLUE (Asteriou & Hall, 2011:113).

The OLS does not, in other words, provide estimates with the smallest variance and are therefore inefficient (Asteriou & Hall, 2011:113). The variances of the estimators are underestimated and result in increased *t*- and *F*-statistics, resulting in the rejection of the null hypothesis when it should not be rejected (Asteriou & Hall, 2011:113). However, the OLS estimators are still unbiased and consistent, since none of the explanatory variables are correlated with the error term. In addition to this, standard errors are biased, resulting in biased test statistics and confidence intervals. If the standard errors are biased, they are no longer identically and independently distributed. In order to deal with this, robust standard errors could be used. The fixed effects method is therefore estimated with the White cross-sectional method, delivering robust standard errors and improved p-values. The use of this method does not change the coefficient estimates, but alters the standard errors and significance tests. This test therefore assumes that errors are cross-sectional correlated and robust to cross-sectional correlation and heteroskedasticity. This robust coefficient regression is illustrated in Table 5.5 below.

Table 5.5: Panel regression model with fixed effects for the banking sector

Variable	Coefficient	Standard Error	t-Statistic	Probability
d(Bank Activities)	-7048.491	3274.986	-2.152	0.035
Bank Size 2	8313.816	6507.143	1.278	0.206
Capital Inflows (log)	-5827.843	298.559	-19.520	0.000
d(Leverage 1)	962.847	816.693	1.179	0.242
Leverage 2	494.707	106.292	4.654	0.000
Profitability	-342.125	178.671	-1.915	0.060
Constant	-17717.330	30732.290	-0.577	0.566
Adjusted R-squared		0.227		

Source: Compiled by Author

The redundant fixed effects likelihood ratio test is conducted to determine whether the fixed effects are redundant or not and it is concluded that they are redundant. This results in the common constant method being preferred over the fixed effects method and suggests that there are no differences among the various cross-sections (banks). However, this instance is quite restrictive and the appropriateness of a random effects method also needs to be considered. This first requires the estimation of a random effects model. Given that the current fixed effects model contains an equal number of independent variables and cross-sections, it would not be possible to estimate a random effects model. The two differenced variables, bank activities and leverage measure one display the highest probabilities and are henceforth left out. The removal of these variables now allows for the estimation of a random effects model between differenced SRISK and the various independent variables. Recalling the theory in Section 4.2.1, it is important that the cross-sectional specific error term is uncorrelated with the variables' error term in the random effects model. If the error terms are correlated, then the estimates will be biased and inconsistent. Subsequently, this requires the random effects model to also be estimated with the White cross-sectional robust coefficient method, since this test is robust to cross-sectional correlation and heteroskedasticity. The robust results are illustrated below in Table 5.6.

Table 5.6: Panel regression model with random effects for the banking sector

Variable	Coefficient	Standard Error	t-Statistic	Probability
Bank Size 2	6642.355	6287.466	1.056	0.294
Capital Inflows (log)	-5667.136	272.074	-20.829	0.000
Leverage 2	460.821	130.100	3.542	0.001
Profitability	-315.814	192.361	-1.642	0.105
Constant	-10455.150	29328.820	-0.356	0.722
Adjusted R-squared		0.266		

Source: Compiled by Author

Bank size measure two and the profitability measure display probabilities of 29.4% and 10.5% respectively. These two variables are only significant at 30% and 11%. While these variables are not statistically significant, the profitability measure is close to the 10% level of significance. This indicates that there are signs that profitability has an effect on the change in SRISK. Profitability displayed the expected sign, with the implication that it could be significant if included in a larger panel. However, these variables are not significant in this panel and are therefore not included in the final random effects regression model.

The estimation of a random effects model with the White cross-sectional robust coefficients does not allow for the performance of a Hausman test. The illustrated results are robust coefficients and there is no correlation amongst the error terms or heteroskedasticity present. Subsequently, considering the aforementioned negative consequences of heteroskedasticity, it is more important to conduct this test than the Hausman test and it is thus not problematic that the Hausman test could not be conducted.

Following from the random effects model, the regression equation for the South African banking sector takes the form:

$$\Delta SRISK_{i,t} = \alpha + \beta_1 Cap\_FLOW_{i,t} + \beta_2 LVG2_{i,t} + \beta_3 SIZE2_{i,t} + \beta_4 PROF_{i,t} + \varepsilon_{i,t} \quad (5.1)$$

The results presented in Table 5.6 indicate that both bank-specific as well as country-specific factors contribute to producing SRISK in the South African banking sector. Given that the structures of the banking and non-banking sectors differ, the individual determinants are not necessarily the same for the non-banking financial sector. For the South African banking sector, banks' leverage as well as the capital flows into South Africa are the most significant determinants. As expected, an increase in the leverage ratio will result in an increased change in SRISK. This implies that the higher a bank's leverage ratio, the more it contributes to the change in SRISK and vice versa. The capital inflows measure displays the expected inverse relationship with SRISK. This inverse relationship implies that an increase in capital inflows decreases the amount of SRISK in the South African banking sector, while a reversal of these flows may increase the SRISK by the same amount. Considering that the log of capital flows was used, its effect should be interpreted in percentages, hence a one percentage increase may result in an R5.7 billion decrease in SRISK. Given the volatility of these flows combined with South Africa's dependence on capital flows to fund the current account, the manifestation of a crisis could result in a swift reversal of these funds, subsequently leaving the banking sector undercapitalised and increasing the systemic risk.

Comparing the results presented above to traditional literature on determinants of systemic risk, it is interesting to see that systemic risk in the banking sector of an emerging market manifests differently than in developed markets. For example, bank-specific factors such as their size is not the main driver of systemic risk (opposed to the US; Foggit (2016)), but country-specific factors such as capital flows is one of the most significant drivers.

In order to determine if the systemic risk measure, i.e. SRISK or LRMES has a significant influence on banks' and non-banks' significant determinants, both measures are used in regression analysis. For the sake of consistency and possible test for robustness, a regression equation comprising LRMES as the dependent variable is estimated for the banking sector. However, given that SRISK delivered better results and is a more common measure of systemic risk, the results for the LRMES regression is only displayed in Annexure C. Data constraints were a significant problem for the non-banking sector, hence a regression analysis only comprising LRMES is estimated.

5.2 Non-banking sector

Due to data constraints, fewer variables are used for the non-banking sector regression model, simplifying the initial data examination. Table 5.7 and 5.8 present the descriptive statistics and correlation matrix respectively.

Table 5.7: Descriptive statistics for the non-banking sector

	LRMES	Activities	Size	Profitability
Mean	0.393	0.561	31.80 billion	2.859
Median	0.406	0.595	20.30 billion	0.932
Maximum	0.583	1.608	181 billion	19.730
Minimum	0.253	0.011	841 million	-17.898
Std. Dev.	0.078	0.400	33 billion	6.962
Skewness	0.132	0.340	2.382	0.392
Kurtosis	2.692	2.364	9.080	3.113
Jarque-Bera	0.605	3.179	218.764	2.299
Probability	0.739	0.204	0.000	0.317
Observations	88	88	88	88

Source: Compiled by Author

A basic analysis of the main determinants of systemic risk in the non-banking sector suggests that, on average, the share that the financial institution's loans represent is a small proportion of their assets, indicating more involvement in market-based activities. However, NBFIs are more profitable than banks with ROA ranging from a minimum of -17.90% to a maximum of 19.73% while averaging on 2.86% per NBFI. The average size of NBFIs is R31.8 billion proxied by their market capitalization. The size of NBFIs ranges from a minimum of R841 million to a maximum of R 181 billion. On average, the expected percentage that NBFIs may lose in equity are 39.3% and ranges from a minimum of 25.3 % to a maximum of 58.3%, should a crisis occur.

Table 5.8: Correlation matrix for the non-banking sector

	LRMES	Activities	Size	Profitability
LRMES	1			
Activities	0.084	1		
Size	0.530	-0.116	1	
Profitability	-0.689	-0.376	-0.241	1

Source: Compiled by Author

The correlation matrix does not indicate any instances of high collinearity (greater than 0.8) and these low levels of collinearity will therefore not result in problems in the estimation process. Once again, the variables must first be tested for their order of integration prior to proceeding with the regression analysis. Again, the visual inspection of the data indicate no sign of a clear trend, therefore the unit roots are only presented for level and intercept. Breitung's unit root test is therefore not included. The unit root test results are summarised in Table 5.9 below.

Table 5.9: Summary of the unit roots for the non-banking sector

	LRMES	Activities	Size	Profitability
LLC	I(1)***	I(1)***	I(1)***	I(0)***
IPS	I(1)***	I(1)**	I(1)*	I(0)***
Fisher-ADF	I(1)***	I(1)**	I(1)**	I(0)***
Fisher - PP	I(1)***	I(1)***	I(1)***	I(0)***
Hadri	N.S.***	N.S.***	N.S.***	N.S.***
Majority Consensus	I(1)	I(1)	I(1)	I(0)
N.S. indicates non-stationary; S. indicates stationary.				
***Significant at 1% level; **Significant at 5% level; and * Significant at 10% level.				

Source: Compiled by Author

Considering that the majority of the variables are non-stationary, it is necessary to test for a cointegrating relationship, since various combinations of these series may reveal a long run relationship (Jawaid, Qadri & Ali, 2011:135). If a cointegrating relationship is found, an error-correction model will be used, since it allows the use of non-stationary variables. Prior to conducting the various cointegration tests, it is important to first determine the appropriate lag length.

The appropriate lag length criteria indicated that one lag should be included (based on the Schwarz information criterion) and that seven lags should be included (based on the Akaike and Hannan-Quinn information criterion). The choice of the lag length is based on this criterion, since it is the strictest. This test was initially conducted with the one lag, as well as with the inclusion of further lags up to seven. However, if too many lags are included, it results in a loss of degrees of freedom and statistically insignificant coefficients. Considering the short time period, including a large amount of lags may result in a great loss of degrees of freedom and as mentioned in Section 5.1, one lag would be appropriate. Hence, only one lag will be included throughout these tests. Table 5.10 presents the summary of the various cointegration test results.

Table 5.10: Summary of the cointegration test results for the non-banking sector

Cointegration test	Consensus*
Kao	Cointegration present
Pedroni	Mixed, mostly no cointegration present
Fisher-Johansen	Mixed, mostly 2 cointegrating relationships present
Johansen	Mixed, mostly 1 cointegrating relationship present
*On a 5% level of significance.	

Source: Compiled by Author

The Kao (1999) panel unit root test indicates that cointegration is present. The Pedroni (2004) panel unit root test produces mixed results of cointegration. With a null hypothesis of no cointegration, it cannot be rejected under the assumption of an individual intercept and trend or no intercept or trend. The null hypothesis of the assumption of an individual intercept can be rejected, indicating the presence of cointegration. Given that the majority of the assumptions cannot be rejected, it is concluded that no cointegration is present. The Pedroni test accounts for the limitations imposed by the Kao (1999) panel unit root test, i.e. homogeneous autoregressive coefficients. Similar to the Pedroni test, the Kao test also has a null hypothesis of no cointegration. Fisher-Johansen takes another approach and pools all of the individual Johansen test results, providing a system-based cointegration test for the entire panel. This test can be conducted under five assumptions and deliver mixed results. Recalling the theory discussed in Section 4.2.3, the first and last assumption of the Fisher-Johansen test is not plausible in terms of economic theory. Since model one and five are not plausible in terms of economic theory, only model two, three and four were considered, reaching a consensus that two cointegrating relationships are present. The Kao, Pedoni and Fisher-Johansen tests do not allow for the inclusion of exogenous variables and therefore the Johansen cointegration test was conducted, with the profitability of the financial institutions as an exogenous variable. The Johansen test is conducted under all five assumptions and provides both the Trace statistic as well as the Max-Eigen statistic. The Trace and Max-Eigen statistic deliver mixed results, but given that the Trace statistic considers all of the smallest Eigen value statistics (Serletis & King, 1997:48) it is a more stringent statistic. Burke and Hunter (2005:104) recommend using the Trace statistic if these two statistics provide conflicting results. The Trace statistic is therefore used to formulate the consensus, with the consensus being that cointegration is present.

Recalling the theory in Section 4.2.3 regarding cointegration testing, if a series contains a unit root and are all integrated of the same, order i.e. I(1) or I(2), then cointegration testing is an overriding requirement for any economic model using non-stationary data. In the presence of a cointegrating relationship between the two series, the use of this series would not result in a spurious regression (Asteriou & Hall, 2011:356). The Kao, Pedroni, Fisher-Johansen and Johansen tests delivered mixed results with the Fisher-Johansen indicating that there are two cointegrating relationships present and the Johansen indicating one cointegrating relationship. The middle way is chosen and it is concluded that there is one cointegrating relationship present. Due to the presence of cointegration, a VECM is conducted with the inclusion of one lag and one cointegrating relationship. This VECM includes profitability, I(0), as an exogenous variable, since it does not form part of the long run relationship, but can play a significant role in the short-term. Table 5.11 presents the results of the VECM.

Table 5.11: Vector Error Correction Model results for the non-banking sector

Cointegrating Equation	Cointegrating Equation 1
LRMES (-1)	1.000
Activities (-1)	0.124
	-0.044
	[2.81410]
Size (-1)	-1.04E-06
	-5.00E-07
	[-2.08694]
Constant	-0.427
Error Correction	
Cointegrating Equation 1:	
d(LRMES)	-0.255206
	-0.07094
	[-3.59760]
d(Activities)	-1.196111
	-0.57575
	[-2.07748]
d(Size)	23023.05
	-26234.7
	[0.87758]
Adjusted R-squared	0.22
Standard Errors in ( ) and t-Statistics in [ ].	

Source: Compiled by Author

A long run cointegrating relationship exists between a financial institution's systemic risk and their activities and size, contrary to expected (as discussed in Section 4.2.2). The VECM lags both the dependent and independent variables once. The adjustment coefficient (error correction term) of -0.2552 is both negative and statistically significant on a 1% level of significance, indicating that this model converges swiftly to the equilibrium value, with 25.52% of the adjustment taking place per annum. Considering the correct sign and significance of the error correction term, it can be concluded with certainty that there is a long run relationship between LRMES, activities and size. Table 5.12 reports the short run relationships between LRMES and the various independent variables, with profitability included as an exogenous variable.

Table 5.12: Summary of the short run relationships

Variables	Coefficient	Standard Error	t-Statistic	Probability
d(LRMES)	-0.255	0.071	-3.598	0.001
d(activities)	-0.011	0.019	-0.584	0.561
d(size)	5.91E-07	3.54E-07	1.669	0.100
Constant	0.012	0.005	2.188	0.032
Profitability	-0.002	0.001	-2.516	0.014
Adjusted R-squared		0.221		
Durbin-Watson statistic		1.841		

Source: Compiled by Author

All the variables display the expected relationship. The above estimates show that any change in the activities that a financial institution undertakes has an insignificant effect on the change in systemic risk in the short run. In contrast, a change in the size of the financial institution (on a 10% level of significance) together with the profitability of the financial institution have respectively a significant positive and negative effect on the change in the non-banking sector's level of systemic risk in the short run. An increase in the size of the financial institution will in the short run result in an increased contribution to systemic risk and vice versa, whilst an increase in their profitability will result in a decreased contribution to systemic risk and vice versa. The implications are that as firms grow larger, they produce more systemic risk. Likewise, as firms' profitability grows, they contribute less to systemic risk. The Wald test delivered similar results and similar conclusions can be drawn and is reported in Annexure B.

Following from the VECM, the final regression equation for the South African non-banking sector for the long run and the short run respectively takes the form:

$$\Delta LRMES_{i,t} = \alpha + \beta_1 \Delta SIZE_{i,t} + \beta_2 \Delta ACT_{i,t} + \varepsilon_{i,t} \quad (5.2)$$

$$\Delta LRMES_{i,t} = \alpha + \beta_1 \Delta SIZE_{i,t} + \beta_2 \Delta PROF_{i,t} + \varepsilon_{i,t} \quad (5.3)$$

The results obtained in Table 5.11 and Table 5.12 indicate that only firm-specific factors contribute to producing systemic risk in the South African non-banking sector. For the non-banking sector, the size and activities of the financial institution has a long run cointegrating relationship with systemic risk, whilst both size and profitability influence systemic risk in the short run.

It is also important to review the diagnostics and consider the goodness of the model as a whole. The full results are provided in Annexure B. As mentioned before, the cointegration tests were initially all conducted with the inclusion of one lag up to seven lags. Given that the inclusion of too many lags results in a loss in degrees of freedom and that the results of the VECM delivered similar results despite the lag length, only one lag was included. With the inclusion of one lag, the null hypothesis of no serial correlation cannot be rejected, concluding that this model does not suffer from serial correlation. When testing for the normality of the residuals, it can be deduced that the overall residuals of this model are not normally distributed, since the null of normally distributed residuals can be rejected. Only the residuals of the dependent variable are normally distributed, while the independent variables' residuals are not normally distributed. This model suffers from the presence of heteroskedasticity since the null hypothesis of homoskedasticity could be rejected at a 1% level of significance. Considering the low adjusted R-squared value of 22%, this model only describes 22% of the variation in systemic risk. This is fairly low, but it is necessary to keep in mind that data constraints were a significant problem for the non-banking industry and few conventional determinants could be used. The problems of heteroskedasticity and not normally distributed residuals could perhaps be resolved if the panel is larger.

The profitability of financial institutions are not often quoted in the literature as a significant determinant of systemic risk – even for the banking sector - and has to my knowledge not been identified as a determinant of systemic risk in the non-banking sector. The identification of a financial institution's profitability as a short run determinant when using LRMES as an alternative measure for systemic risk represents a new contribution to this field.

5.3 Comparisons and implications

As expected, the results indicate that systemic risk manifests differently in the banking and non-banking financial sectors. The reason for this being that the structure and the core activities of the financial institutions are different. The manifestation of systemic risk in the banking sector is the result of both firm-specific and country-specific factors, in contrast to the non-banking sector that is only influenced by firm-specific factors. The results illustrate that the systemic risk produced by individual banks increases as their leverage ratio – firm-specific – increases and was expected.

The higher the leverage ratio of the bank, the more systemic risk it would produce. An increased leverage ratio is the result of increased liabilities. If the total liabilities increase, an increase in market capitalisation will not offset this increase in liabilities (*ceteris paribus*). But, if the total liabilities remain the same, an increase in market capitalisation lowers the leverage ratio (*ceteris paribus*). A decrease in market capitalisation actually raises the firm's leverage ratio (*ceteris paribus*). Engle, Jondeau and Rockinger (2015:170) ascribe this to market capitalisation eroding rapidly if a crisis should occur, thereby leaving the bank undercapitalised. High market capitalisation might give the banking sector a false sense of financial security. In this form, the only way to actually decrease the leverage ratio is to decrease the bank's total liabilities. It can therefore be concluded that a higher leverage ratio is a significant firm-specific determinant of systemic risk for the South African banking sector. Considering country-specific factors, the capital inflows into South Africa is a significant determinant of systemic risk. This variable displayed the expected negative sign, indicating that an inflow of capital decreases systemic risk and a swift withdrawal of these funds during crisis periods increases the systemic risk. This is in line with the findings of Claessens and Ghosh (2013:92) that capital flows are one of the primary causes of systemic risk in emerging markets. Various banks displayed an increase in systemic risk following the stock market crash in 2002 and the global financial crisis of 2007/2008, which might be explained by the volatile capital inflows. Keeping in mind that South Africa's current account is financed through capital inflows and that capital flows are extremely volatile, it makes sense. Although the banking sector is not dependent on capital flows, capital flows are intermediated through the banking sector and therefore influence credit growth and indirectly financial fragility. A rapid withdrawal of these flows can therefore have systemic consequences. The regulatory implication of this is that South Africa's banking sector should constantly prepare for a possible systemic crisis, since an outflow of capital and the realisation of a systemic crisis is possible if there is no change in the country's economic fundamentals or bank characteristics. Country-specific factors such as domestic interest rates and credit ratings also affect capital inflows and consideration should therefore be given to these factors as well when analysing the impact of capital flows on systemic risk.

In contrast to the banking sector, the non-banking sector only displayed firm-specific factors to be significant determinants of systemic risk. The non-banking sector displayed a significant positive and negative relationship respectively with the size and the profitability of the financial institution in the short run. As expected, an increase in the size of the financial institution will result in a rise in its contribution to systemic risk in the short run. This might be since larger financial institutions engage in complex activities and in the event of failure, smaller institutions won't be able to replicate their activities, hence increasing their systemic risk. As expected, an increase in the individual firm's profitability will also result in a decreased contribution to systemic risk and vice versa. The explanation for this is that firms that effectively utilise their assets are able to yield a higher return on their assets, increasing their profits and funds to meet their short-term responsibilities and decreasing their propensity to be undercapitalised, lowering their systemic risk. The size and activities of non-banking financial institutions display a long run cointegrating relationship with systemic risk, indicating that these variables move together and influence systemic risk in the long-run.

The nature of the relationship between the banking and non-banking sectors differs. Contrary to expected, the non-banking sector displays a long run cointegrating relationship between LRMES, the firm's size and activities, whilst the banking sector does not display a cointegrating relationship between systemic risk and any of the independent variables. The implication of this is that the variables in the banking sector do not move together in the long run and that activities and leverage measure two do not have an impact on systemic risk in the long run, whilst systemic risk in the non-banking sector moves together with the size and activities of the financial institution in the long run.

Based on the aforementioned results, the best way for the banking sector to diminish its systemic risk would be to decrease the leverage of individual banks. An improvement in various bank characteristics might also result in a decreased contribution to systemic risk. Macroeconomic fundamentals that affect capital inflows should also be given increased consideration, due to the extreme volatility of capital flows in an emerging market. For the non-banking sector, the most effective way to decrease systemic risk is to decrease the size of the financial institution (i.e. market equity) and to increase its level of profitability in the short run. In the long run, an increase in the firm's activities (i.e. a lower share of market-based activities[21]) and decrease in their size (i.e. market capitalization) can decrease their contribution to systemic risk. For each sector individually, the determinants were different. The banking sector's contribution to systemic risk is influenced by both firm-specific and country-specific factors, in contrast to the non-banking sector that is only impacted by firm-specific factors.

[21] As discussed in Section 3.1.2.

CHAPTER 6 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

Systemic risk, although it has always been present, used to receive little attention and was arguably one of the least understood risks. This, however, changed after the global financial crisis of 2007/2008 and is now one of the most feared risks. This renewed interest in systemic risk considers that the concept of systemic risk was initially associated with bank runs, but this concept can now be applied more broadly to shocks that propagate to the rest of the financial sector, i.e. OTC derivatives market, consumer finance and repurchase agreements. The understanding of systemic risk together with the need to effectively mitigate it evolved as the world's financial system evolved. Although systemic risk is one of the most feared and is seen as one of the most important risks, a clear-cut definition seems remarkably elusive. A general definition refers to the risk that a highly interconnected financial institution collapses, propagating the negative externalities to the aggregate financial sector, resulting in an entire financial system collapse. A problem that arises when identifying systemic risk lies in its manifestation, since it manifests differently within different economies. As mentioned in Section 5.1, both SRISK and LRMES were used as measures of systemic risk for the banking sector, while due to data constraints only LRMES was used for the non-banking sector. The LRMES measure for the banking sector did not yield satisfactory results[22] and is therefore reported and discussed in Annexure C.

During the global financial crisis, systemic risk manifested in the US due to large, highly leveraged banks undertaking multifaceted activities that resulted in undercapitalisation. Attributable to the high degree of interconnectedness between financial institutions, systemic risk swiftly transferred between these institutions. Taking the increased globalisation into account, systemic risk not only rapidly propagated between US' financial institutions, but also spread to other countries. Although none of the emerging markets' economic fundamentals changed, they were still affected by a crisis in another country. Emerging markets were affected belatedly and differently than developed markets, primarily due to contagion. Although South Africa did not experience a banking crisis, it was still affected, illustrating the universal effect that significantly large levels of systemic risk could have.

Systemic risk in emerging markets mainly occurs as a result of the financial sector's pro-cyclicality as well as the volatility of capital flows. These factors build up during an economic expansion, but can reverse rapidly if a crisis should occur or during an economic contraction. A regression

[22] The LRMES resulted in a 2.4% adjusted R-squared compared to SRISK's 26.6%, the latter indicating a better model.

analysis was used to identify the determinants of systemic risk for the banking and non-banking sector respectively. All variables were based on literature that illustrates how systemic risk manifests differently in developed and emerging markets as well as how emerging markets are affected differently than developed markets. Capital inflows and the leverage ratio[23] were found to be significant for the banking sector, whilst the size and activities of the non-banking financial institutions were found to respectively have a significant positive and negative relationship with systemic risk in the long run, with both size and profitability having a significant positive and negative relationship respectively with systemic risk in the short run. In the non-banking sector's model, any deviation from the long run equilibrium is corrected at a speed of 25.52% per annum in the non-banking sector.

Regulatory measures prior to the global financial crisis were not effectively constructed to protect countries against a widespread, low-probability event of a systemic nature. This became evident when the negative externalities spilled over to other economies and most economies had to improve their regulatory structures after the global financial crisis. The UK implemented a set of banking regulations and the US implemented the Dodd-Frank act to enhance the regulation of financial services, both as an aftermath of the global financial crisis. South Africa used to follow a silo approach prior to the global financial crisis, but this approach displayed various shortcomings. One of its greatest flaws was that market conduct regulation was not part of either the SARB's or other regulators' regulatory responsibility. The global financial crisis of 2007-2008 stressed the need for a macroprudential approach to financial regulation, since macroeconomic risks, i.e. asset bubbles and large degree of interconnectedness, may be overlooked by microprudential regulators. Although South Africa's financial sector was not severely harmed, the National Treasury (2011:13) still investigated the need for an all-inclusive macroprudential approach to financial regulation. South Africa's transformation from the silo approach to a Twin Peaks approach on 1 April 2018 was therefore not as a repercussion of the global financial crisis, but primarily occurred in order to ensure a safer financial sector through macroprudential regulation. The choice of regulatory structure depends on the individual characteristics of an individual country and the development of their financial system, there is therefore no agreement on which regulatory structure is best. It should also be important for regulators to be mindful of the amount of systemic risk that may be present in an economy, as well as the distinctive origins of this risk in various economies and financial sectors.

The majority of the systemic risk quantification methods currently assume that systemic risk manifests similarly in different financial sectors and are not developed to suit the inherent

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[23] Measured as the (total liabilities + market capitalization)/ market capitalization

individual characteristics of different countries or financial sectors. This study, however, identifies determinants of systemic risk for the banking and non-banking sectors. This study does not identify determinants for the South African financial sector as a whole, but identifies individual determinants for the banking and non-banking sectors respectively. As a result, regulators would not only have the knowledge about the amount of systemic risk present in the aggregate financial sector or the amount that the banking and non-banking sectors contributes to the overall financial sector, but also which individual characteristics within the banking and non-banking sectors contribute to systemic risk. The profitability of a financial institution was also introduced as a new variable for the non-banking sector. The identification of this new variable provides improved detail into the unique characteristics of the non-banking sector in order to effectively prepare for and mitigate the effects of systemic risk. As a result of this new variable, regulators can expand their base in order to make more informed decisions for the respective financial sector.

6.2 Conclusions and recommendations

The aggregate financial sector displayed increased amounts of systemic risk during the global financial crisis of 2007-2008 as well as the European sovereign debt crisis of 2012. Although the levels of systemic risk declined after both crises, the recovery remained sluggish for the entire sample period, as indicated by Figure 4.1. These spikes in SRISK indicate that the aggregate South African financial sector is vulnerable to foreign factors, especially to crises.

The total contribution of the six banks to the banking sector's systemic risk decreased following the global financial crisis of 2007/2008, as illustrated by Figure 4.2. This might be an indication of the soundness of the South African banking system as well as the success of the implemented regulatory measures such as Basel III in addressing systemic risk. The smallest of the six sample banks were also the smallest contributor to systemic risk, displaying only capital surpluses, even during the financial crisis. Standard Bank, one of the largest banks (by total assets), displayed the highest contribution to SRISK, with levels of systemic risk at the end of the sample period that were greater than during the foreign crises. The European sovereign debt crisis of 2012 also resulted in an increase in all of the sample bank's SRISK contribution, but it was significantly lower than with the global financial crisis. These spikes in SRISK during crises periods may be an indication that South Africa's banking sector relies greatly on external influences, irrespective of the country's macroeconomic fundamentals.

When considering the size of the banks in Section 4.5.1.1, their contribution to systemic risk was roughly in line with their size, i.e. large banks produced more systemic risk (with the exception of FirstRand), whilst smaller banks produced less systemic risk (with the exception of Investec). This supports the findings of Beck *et al.* (2006:1583), Brownlees and Engle (2012:9), Laeven *et al.*

(2014:3) and Alber (2015:118). A possible reason may be that larger banks provide liquidity to smaller banks and they rely on economies of scale and scope. If larger banks fail, their activities cannot be taken over by smaller banks, resulting in the undercapitalization of the financial sector. The size of banks was, however, not a significant determinant in the regression analysis. The regression analysis shows that capital inflows is a significant determinant of systemic risk of the South African banking sector, supporting the idea that South Africa's banking sector is greatly dependent on external factors. As mentioned in Section 2.6, the great reliance on capital flows combined with a large degree of interconnectedness in the banking sector create potential areas of concern. The degree of leverage of the bank is also a highly significant determinant, with the implication that the higher the level of leverage, the higher the bank's contribution to systemic risk. This indicates that South Africa's banking sector is not only reliant on external factors, but that bank-specific factors also influence banks' systemic risk levels.

The regulatory implications of these results differ for the two financial sectors. For the banking sector, it appears that although size was not a significant determinant in the regression, there is still a rough positive relationship between the size of the bank and its contribution to systemic risk, as mentioned earlier and illustrated in Section 4.5.1.1. The SARB developed an indicator-based approach based on Basel's in order to identify D-SIBs. The SARB doubled the weighting assigned to the size of a bank to 40%, illustrating that they perceive size to significantly influence whether a bank is classified as a systemically important bank or not. This also illustrates that although size was not a significant determinant in the regression, it is still perceived by the SARB to increase the susceptibility of the banking sector to a financial crisis. The levels of systemic risk also increased during times of international crises. A failure of one of these banks is therefore likely to harm the South African banking sector and result in a financial crisis. Basel III, currently implemented in South Africa, addresses systemic risk and the size of financial institutions. It was expected that the implementation of Basel III would decrease the systemic risk contributions of banks even more, but this is not the case. It may however take some time before these regulations effectively decrease systemic risk, partially since these regulations are phased in and the year for final implementation was repeatedly extended to 31 March 2019.

Based on the results of this study, the leverage of a bank is an important determinant. Basel III implemented a non-risk based leverage ratio as an attempt to capture the effects of off-balance leverage. The theoretical implication of this is a possible deleveraging process that could have led to the disruption of the aggregate financial sector, but has now been controlled. A leverage ratio to cap excessive credit growth of banks is important and the collateral should be adjusted to reduce the leverage growth in the banking sector. Given that leverage is a highly significant determinant of systemic risk, it would be of importance to re-examine the regulations relating to the leverage of a bank in order to improve it even more. Regarding the capital inflows, regulators need to consider the various factors such as interest rates and credit ratings that drive capital flows to ensure a stable banking sector. As evident throughout this study, the banking sector is affected by both country-specific as well as firm-specific factors. The implication of this is that banks should comply with both individual banking regulations, i.e. Basel, as well as corporate governance regulations promoting ethical behaviour, i.e. King III. Subsequently, banks should also ensure that they are adequately capitalised to diminish any consequences of financial turmoil that might originate in another country and spill over to South Africa.

Current regulatory measures do not take this into account when addressing systemic risk and therefore the realisation of large capital outflows is likely to result in a domestic financial crisis. Regulatory bodies should therefore consider and forecast events that may result in capital outflows as a counteractive measure. If capital outflows can be forecasted, banks can ensure to keep an increased amount of capital for the prescribed period or until the regulators deem the economic environment safe and stable. The implementation of this additional capital flow buffer can mimic the countercyclical buffer, where the stimulating events can be regulator-specified events. The required capital flow levels can be determined by using worst-case scenario analysis to safeguard banks by ensuring that they are adequately capitalised during financial troubles, protecting them against systemic consequences.

The case for the non-banking sector provides an interesting comparison. As illustrated by Figure 4.3, the non-banking financial institutions displayed lower levels of systemic risk, in contrast to the high levels of the banking sector. For the majority of the sample period, all of the financial institutions, with the exception of Liberty and occasionally Sanlam, displayed capital surpluses. The levels of systemic risk did not experience a significant increase during the 2007-2008 global financial crisis, hence following from the crisis the systemic risk levels did decrease, although not substantially. The European sovereign debt crisis of 2012 did not result in major spikes in systemic risk either. The implication of this is that South Africa’s non-banking financial sector is not as influenced by external factors as the banking sector. Although the non-banking sector is less volatile than the banking sector, a trend in their SRISK contribution can be observed. This is since both sectors displayed an increase in their SRISK amounts during the 2007/2008 global financial crisis and the European sovereign debt crisis, albeit not to the same extent. As discussed in Section 4.5.2, the non-banking sector was not influenced by the failure of African Bank, although this might have been due to the rapid intervention of the SARB to mitigate contagion effects.

Contrary to expected, the VECM indicated the existence of a significant long run relationship between the size and activities of the non-banking financial institutions with systemic risk. A significant positive and negative short run relationship exists between the size and the profitability of the financial institutions with systemic risk respectively. The results furthermore indicated that the profitability of the financial institution is more effective than the size of the financial institution for the non-banking sector in the short run. Contrastingly, the systemic risk that the non-banking sector produces is as a result of firm-specific factors, as opposed to the banking sector.

Given that the structure and the systemic risk determinants for the non-banking sector are different compared to the banking sector, the regulatory implications will also differ. Profitability displayed a highly significant relationship with systemic risk for the non-banking sector over the short term. Although this study demonstrated that higher profitability decreases systemic risk over the short term, it should be interpreted with care. The reckless chasing of short-term "artificial" profits poses a significant risk for the non-banking sector. This was proved during the global financial crisis of 2007-2008 and although the crisis did not originate in the non-banking sector, it remains important to adequately regulate the profits of a financial institution. Profits arising from unreasonably high fees may be seen as excessive and instead of resulting in a stable non-banking financial sector, instead decrease financial stability. Regulatory bodies should ensure that salary and bonus incentives are not structured towards short-term, risky profits, since this will only encourage industry behaviour that is tilted towards short-term, risky investments that may leave this sector undercapitalised.

The size of the financial institution also significantly influences the institution's contribution to systemic risk in the short and long run. As explained by Engle *et al.* (2015:170), a crisis in the market may cause a rapid decline in the firm's market capitalisation, leaving the firm undercapitalised and unable to meet their short-term demands. Although the amount of SRISK that firms contribute based on their size is relatively small, a significant positive relationship exists between the size and systemic risk in the short and long run. Hence, regulations that address the size of financial institutions should be re-examined. South Africa's current regulation, i.e. Basel III, does address the size of financial institutions, but it may take some time before these regulations effectively lower systemic risk. Large financial institutions should be encouraged to hold higher than expected capital levels in order to decrease their propensity to contribute to a systemic crisis. The difficulty here is to determine at what point the costs associated with increased capital ratios start to prevail, since capital is now more expensive and results in less efficient financial intermediation.

Given that systemic risk is an externality that can occur in two dimensions (Section 2.1), i.e. the cross-sectional and the time dimension, it would be appropriate to give broad policy recommendations for these dimensions as well. Recalling from Section 2.2, the structure of the financial system, i.e. linkages and common exposures, influences how it reacts to and how it amplifies shocks in the cross-sectional dimension, whereas the time dimension considers the build-up of risks over time and how it interacts with the macroeconomic cycle. The following policies could address system-wide interconnectedness:

- Improved infrastructure: More resilient market structures might be a primary way to diminish systemic risk created by large, interconnected financial institutions. Central counterparties (CCP) could be implemented to substitute the network of bilateral exposures. These CCPs mimic organised exchanges, where it interposes itself between two sides of a transaction by becoming the buyer to every seller and by becoming the seller to every buyer. This increases the liquidity in the market and diminishes contagion effects. Default risk is also diminished, since each participant will be required to hold a margin account prior to entering a transaction. This margin could be determined by the volatility of the market: the higher the volatility, the more money is required to keep in the margin account. Subsequently, the channelling of transactions through a CCP improves the collection and propagation of information, effectively allowing market participants and regulatory authorities to monitor the concentration of individual exposures and linkages that they create.
- Taxation: Large financial institutions could be taxed, since their size and interconnectedness could be seen as a negative externality. However, this might give rise to further questions about who will be paying the tax, customers or shareholders. The higher capital and liquidity standards imposed by Basel III deal with the size of the financial institution, although the taxation imposed on the firm’s size could be considered in the future.
- Insurance: Large financial institutions should be required to buy private insurance to hedge against possible losses resulting from systemic crises. This should reduce institutions’ moral hazard and excessive contribution to systemic risk.

Policies when dealing with the time dimension:

- Capital and liquidity buffers: The implementation of capital and liquidity buffers is the most obvious policy. Basel III effectively increased the capital and liquidity buffers, however, as the interconnectedness between financial institutions increase, it could be beneficial increasing these buffers.

- Sector-specific buffers: Given that some sectors are more volatile than other, the risk of providing funds to these sectors is significantly higher. Restrictions can be imposed on certain sectors, following the example of Asian countries where restrictions on mortgage lending are imposed whenever significant concerns regarding a housing bubble arises. Differential risk weighting can be used with the capital and countercyclical buffers where the pace of growth to specific sectors can be controlled.

V-lab's indicators of systemic risk were used in this study while previous studies on the determinants of systemic risk calculated their own measure of SRISK. If the determinants identified in this study differ from the ones identified in previous studies, it can potentially be ascribed to the different sources of these measures. Considering that previous studies only focused on SRISK for the banking sector, but not for the non-banking sector, only the results obtained for the banking sector can potentially be compared. The leverage measure as well as capital flows were found to be significant determinants of SRISK, in line with the findings of Foggit (2016). The implication of the latter being that it does not matter for the banking sector whether V-lab's SRISK measure or own calculations of SRISK are used, given that similar results are obtained.

Taking into account the different results for the banking and the non-banking sectors, the final conclusion made from this study is that the measurement and regulation of systemic risk should not be done on only one level, but rather on multiple levels and policy coordination should be regarded as essential. Systemic risk manifests differently in different economies and sectors and since systemic risk is an inherent part of any financial sector, its elimination is unlikely. The focus on measuring and regulating systemic risk should therefore be on its origin. The level of systemic risk present in a financial sector should continuously be monitored and forecasted, according to various aspects. It is also imperative to determine if systemic risk is likely to transfer to another market and if so, to which and how many markets. The identification of the individual characteristics that contribute to systemic risk within each sector should also be determined. The identification of these characteristics in this study serves as a foundation on which further studies can be built upon to measure the individual determinants for the banking and non-banking sectors.

South Africa's financial sector is held to high standards of corporate governance and risk management. Although large levels of systemic risk are not an inherent part of the South African financial sector, a high degree of interconnectedness and large levels of concentration combined with the identified factors in Section 5.1 and Section 5.2 may increase the financial sector's susceptibility to systemic crises. Ultimately, it should be accepted that all financial systems will experience financial instability at one point or another. However, previous crises such as the stock market crash of 2002, the global financial crisis of 2007/2008 and the European sovereign debt crisis of 2012 taught us many lessons about the characteristics of the global financial system that has made it vulnerable to a system-wide failure. The development of new measurement tools to monitor systemic risk and identification of more determinants of systemic risk will play an imperative part in predicting and preventing future crises.

6.3 Suggestions for future studies

As explained in Chapter 1, the banking sector is dominated by the five largest banks and the insurance sector is dominated by the four largest insurers. The same degree of interconnectedness is also evident throughout the rest of the financial sector. These financial institutions all have a history of doing business with one another, hence the failure of one large financial institution could spill over to other institutions and disrupt the entire financial sector. Since the problems of systemic risk stem from the interactions between financial institutions and the complex nature of the financial system, it is beneficial to have a central counterparty that facilitates counterparty lending. The SARB acts as the central counterparty providing the settlement of interbank obligations through the South African Multiple Option Settlement (SAMOS) system. The SARB facilitates this function in order to minimise possible systemic risk emanating from the settlement default of one or more banks. Even though the SARB facilitates this function, the high degree of interconnectedness between South Africa's financial institutions should be investigated in detail in the near future.

An adequate definition for systemic risk should be identified. This definition should both consider the structure of the specific economy (or sector) and how systemic risk manifests in the particular economy (or sector). This study shows that systemic risk manifests differently in different economies (or sectors) and it would therefore be appropriate if individualised definitions could be given to the particular economy (or sector) that considers both the country-specific as well as firm-specific factors. Following from these individual definitions, it would be easier to quantify systemic risk and implement regulatory measures to diminish this risk.

Keeping in mind that the level of systemic risk in the banking sector increased during foreign crises, it would be beneficial to develop a capital flows classification system where capital flows from foreign countries are labelled as "safe" or "risky". Capital flows from countries experiencing domestic difficulties or other emerging market economies could be labelled as "risky", whilst capital flows from a stable or developed economy could be labelled as "safe". These classifications could be based on the specific country's credit rating where banks need to keep a higher capital flow buffer for riskier ratings and a lower capital buffer for safer ratings. Although Basel III phased in a systemically important bank capital requirement, it is suggested that the systemic risk buffer is re-evaluated to potentially increase the charge. This systemic risk buffer should be applied to all financial institutions, not only to SIFIs. SIFIs should, however, receive a higher charge. Based on the results of this study, the buffer for deposit-taking institutions should be significantly higher than for non-deposit-taking institutions and it should be even higher for deposit-taking SIFIs. This capital buffer should also be imposed on financial institutions at a group level as well as at the parent company level.

Even though the great differences in market capitalisation did not yield problems for this study, it is proposed that these differences are accounted for in future research. Financial institutions could use their own calculated value to their own advantage and this value may not always reflect their true market capitalisation. Given that the market capitalisation (proxy for size) of non-banking financial institutions is a significantly important determinant in both the short and long run, the over- or under-calculated value could possibly produce systemic consequences. Regulators could potentially establish a fixed definition for measuring a firm’s market capitalisation to which all financial institutions should adhere.

Given the unique structure of the South African banking and non-banking sectors and that both firm-specific as well as country-specific factors produce systemic risk, it should be of importance to identify all possible crisis periods and not only large, international crises. Financial institutions’ reaction to these crises should also be monitored in order to effectively mitigate systemic risk. With the high degree of interconnectedness in the South African financial sector, small crises could potentially produce systemic risk, increasing the need for increased identification of potential crisis periods.

Finally, capital flows is the only significant country-specific systemic risk determinant for the South African financial sector and South Africa is reliant on these volatile flows to fund the current account. Even though the banking sector is not reliant on these flows, these flows are intermediated through the banking sector and a swift reversal them increases banks’ financial fragility and could potentially leave them undercapitalised. Therefore, internal factors affecting capital flows, such as credit ratings and domestic interest rates, should be investigated. The reasoning behind this is that if an interest rate cut or credit rating downgrade is expected, banks can prepare for a possible outflow of capital that may leave the financial sector undercapitalised, resulting in systemic risk. This should not only be applicable to the banking sector, but to the entire financial sector. Financial institutions can therefore increase their capital reserves in advance, ensuring the stability of the financial sector.

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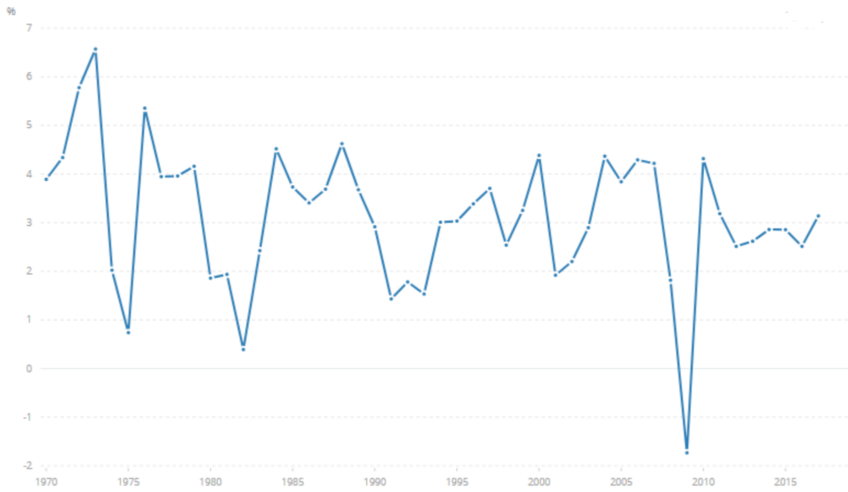
ANNEXURES

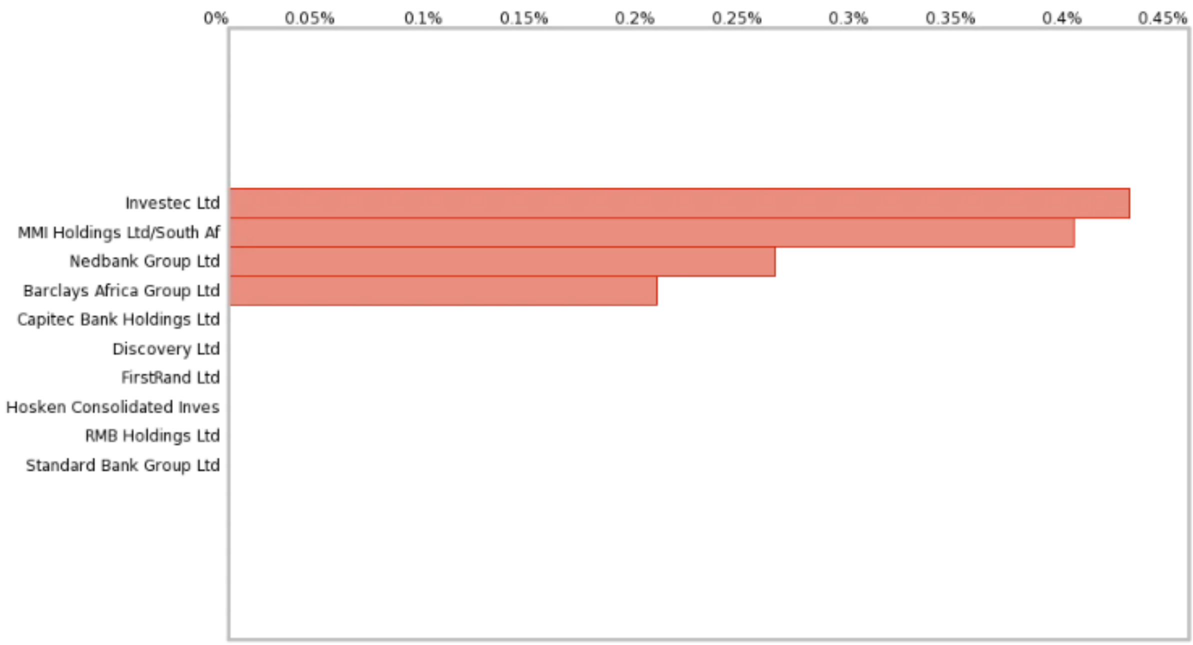
ANNEXURE A

Figure A 1.1: Global GDP growth (annual %) for the period 1970-2017



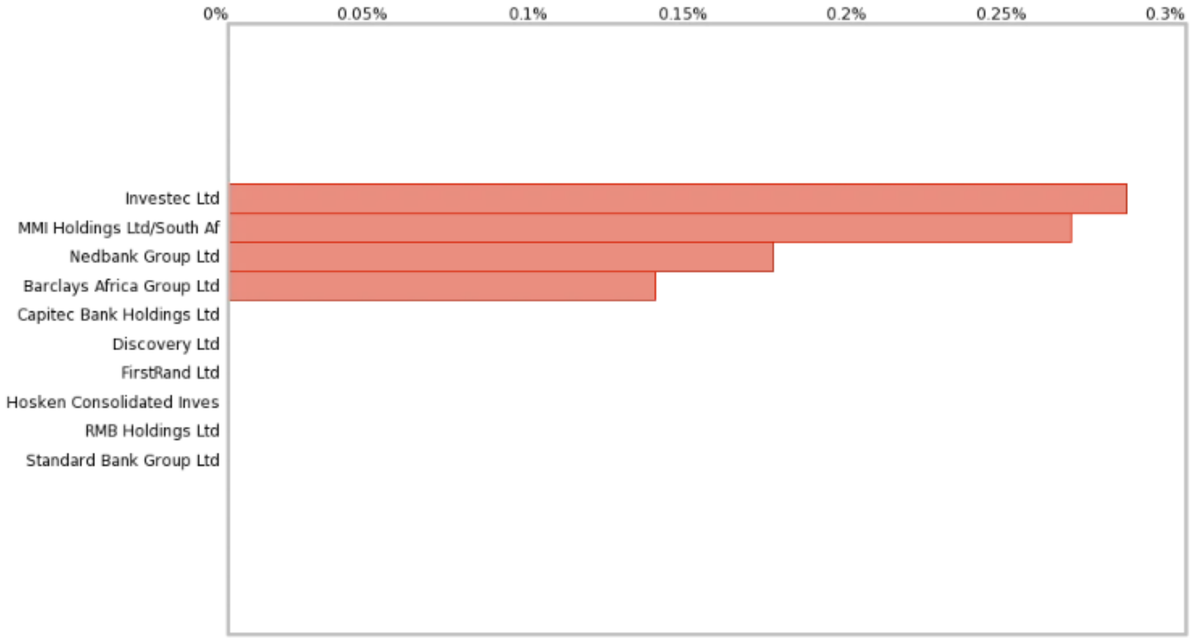
Source: World Bank (2019)

Figure A 4.1 : SRISK/GDP for South Africa on December 2017



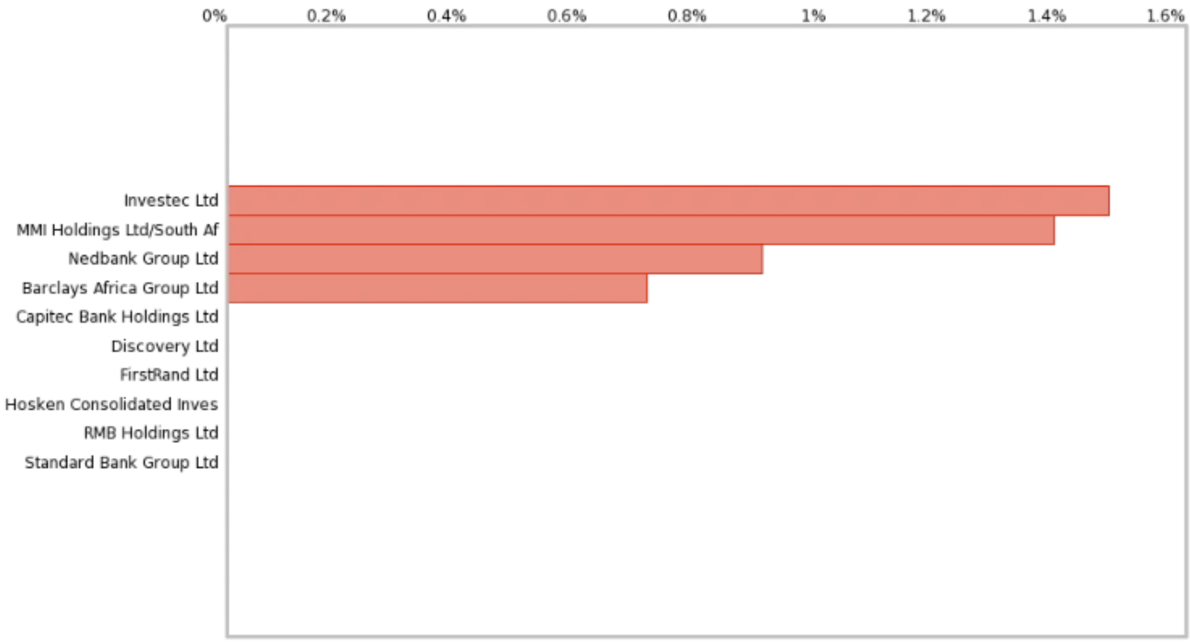
Source: Vlab (2019)

Figure A 4.2 : SRISK/Total Assets for South Africa on December 2017



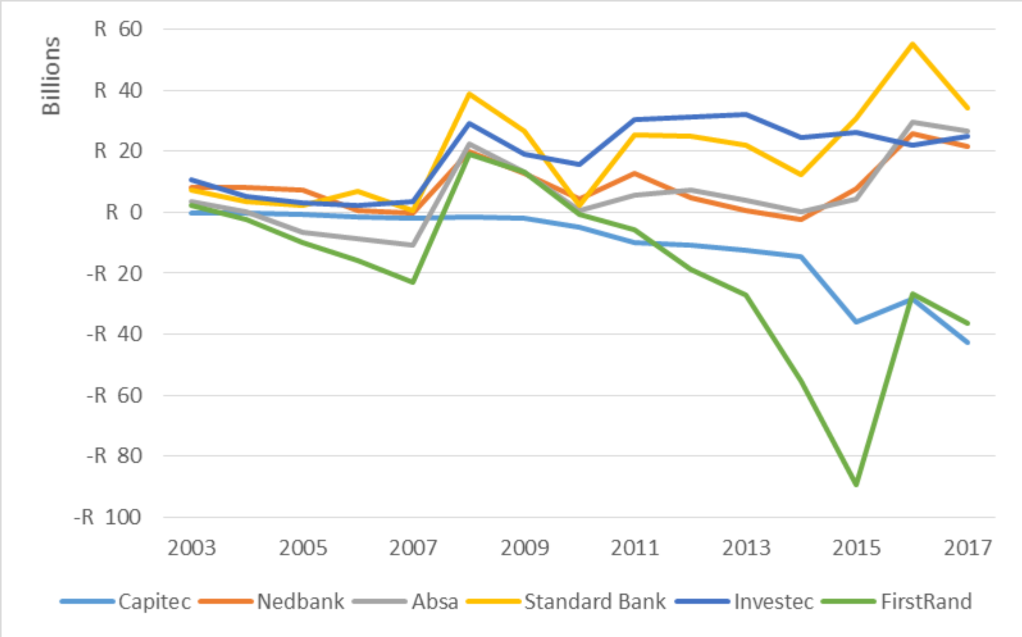
Source: Vlab (2019)

Figure A 4.3 : SRISK/Market Capitalization for South Africa on December 2017



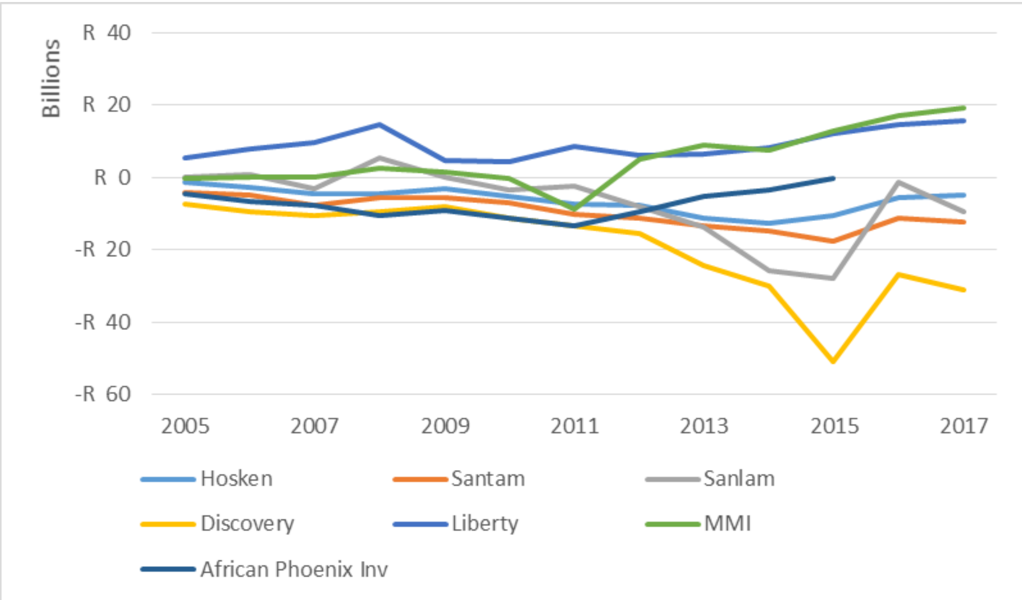
Source: Vlab (2019)

Figure A 4.4 : SRISK (yearly) of the South African banking sector



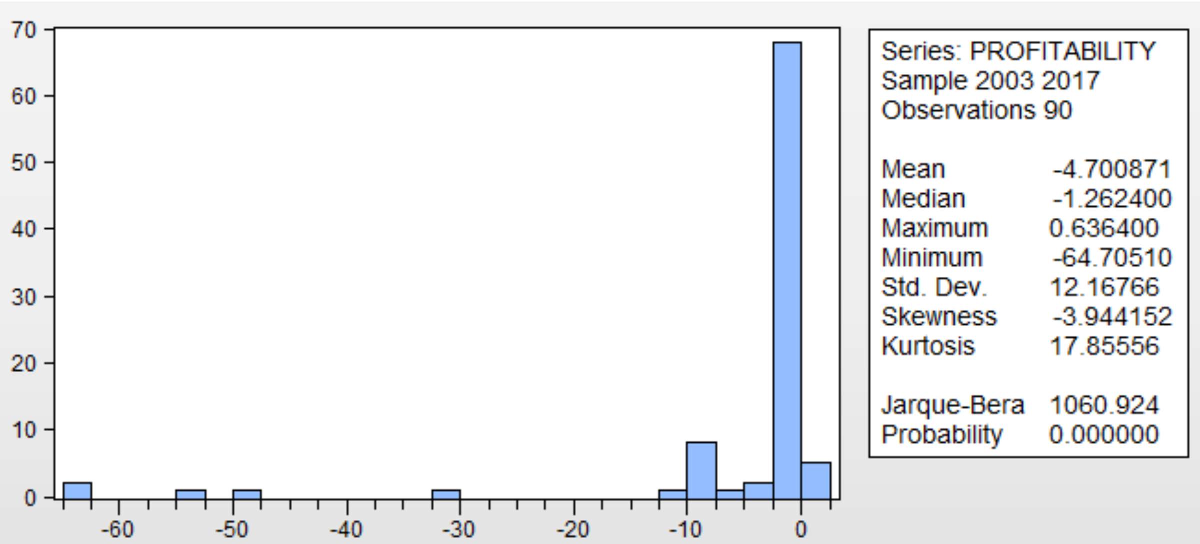
Source: Compiled by Author

Figure A 4.5 : SRISK (yearly) of the South African non-banking sector



Source: Compiled by Author

Figure A7: Banking sector profitability



Source: EViews™ 8

ANNEXURE B

BANKING SECTOR – EVIEWS RESULTS

Unit root test results[24]

Panel unit root test: Summary				
Series: SRISK				
Date: 09/11/19 Time: 12:03				
Sample: 2003 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	0.2262	0.5895	6	78
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.4150	0.6609	6	78
ADF - Fisher Chi-square	12.6610	0.3942	6	78
PP - Fisher Chi-square	10.3305	0.5870	6	84
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

[24] The results are only shown for level, and not for first differences.

Null Hypothesis: Stationarity			
Series: SRISK			
Date: 09/11/19 Time: 11:46			
Sample: 2003 2017			
Exogenous variables: Individual effects			
Newey-West automatic bandwidth selection and Bartlett kernel			
Total (balanced) observations: 90			
Cross-sections included: 6			
Method		Statistic	Prob.**
Hadri Z-stat		4.1679	0
Heteroscedastic Consistent Z-stat		4.2136	0

* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.

** Probabilities are computed assuming asympotic normality

Intermediate results on SRISK

Cross-section	LM	Variance HAC	Bandwidth	Obs
Capitec (CPI)	0.5323	3.96E+08	2	15
Nedbank (NED)	0.1665	80648883	2	15
Absa (ABG)	0.5106	1.37E+08	0	15
Standard Bank (SBK)	0.5224	3.34E+08	1	15
FirstRand (FSR)	0.3655	1.38E+09	2	15
Investec (INL)	0.4413	2.46E+08	2	15

Panel unit root test: Summary				
Series: BANK_ACTIVITIES				
Date: 09/11/19 Time: 11:50				
Sample: 2003 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.7208	0.0033	6	78
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.0608	0.1444	6	78
ADF - Fisher Chi-square	16.4030	0.1735	6	78
PP - Fisher Chi-square	16.3778	0.1745	6	84

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Null Hypothesis: Stationarity			
Series: BANK_ACTIVITIES			
Date: 09/11/19 Time: 11:51			
Sample: 2003 2017			
Exogenous variables: Individual effects			
Newey-West automatic bandwidth selection and Bartlett kernel			
Total (balanced) observations: 90			
Cross-sections included: 6			
Method		Statistic	Prob.**
Hadri Z-stat		4.4734	0
Heteroscedastic Consistent Z-stat		2.1078	0.0175

* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.

** Probabilities are computed assuming asympotic normality

Intermediate results on BANK_ACTIVITIES

Cross-section	LM	Variance HAC	Bandwidth	Obs
Capitec (CPI)	0.5432	0.4894	2	15
Nedbank (NED)	0.4485	0.2663	2	15
Absa (ABG)	0.2283	0.0310	2	15
Standard Bank (SBK)	0.2582	0.0274	1	15
FirstRand (FSR)	0.1690	0.1151	2	15
Investec (INL)	0.1224	0.0349	0	15

Panel unit root test: Summary				
Series: BANK_SIZE_1				
Date: 09/11/19 Time: 11:52				
Sample: 2003 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.4575	0.0000	6	78
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.0087	0.0223	6	78
ADF - Fisher Chi-square	22.0484	0.0370	6	78
PP - Fisher Chi-square	29.5836	0.0032	6	84
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity				
Series: BANK_SIZE_1				
Date: 09/11/19 Time: 11:54				
Sample: 2003 2017				
Exogenous variables: Individual effects				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total (balanced) observations: 90				
Cross-sections included: 6				
Method			Statistic	Prob.**
Hadri Z-stat			6.3960	0
Heteroscedastic Consistent Z-stat			6.5084	0
* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.				
** Probabilities are computed assuming asympotic normality				
Intermediate results on BANK_SIZE_1				
Cross-section	LM	Variance HAC	Bandwidth	Obs
Capitec (CPI)	0.5935	1.5242	2	15
Nedbank (NED)	0.5973	0.0673	2	15
Absa (ABG)	0.5691	0.0874	2	15
Standard Bank (SBK)	0.5610	0.0737	2	15
FirstRand (FSR)	0.5568	0.0486	2	15
Investec (INL)	0.4986	1.0776	2	15

Panel unit root test: Summary				
Series: BANK_SIZE_2				
Date: 09/11/19 Time: 11:55				
Sample: 2003 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.6226	0.0001	6	78
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.7367	0.0412	6	78
ADF - Fisher Chi-square	20.6661	0.0555	6	78
PP - Fisher Chi-square	40.7674	0.0001	6	84
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity				
Series: BANK_SIZE_2				
Date: 09/11/19 Time: 11:55				
Sample: 2003 2017				
Exogenous variables: Individual effects				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total (balanced) observations: 90				
Cross-sections included: 6				
Method			Statistic	Prob.**
Hadri Z-stat			6.8727	0
Heteroscedastic Consistent Z-stat			6.4083	0
* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.				
** Probabilities are computed assuming asympotic normality				
Intermediate results on BANK_SIZE_2				
Cross-section	LM	Variance HAC	Bandwidth	Obs
Capitec (CPI)	0.6085	1.4544	2	15
Nedbank (NED)	0.5496	0.1480	2	15
Absa (ABG)	0.5363	0.1229	2	15
Standard Bank (SBK)	0.5592	0.1190	2	15
FirstRand (FSR)	0.5601	0.1595	2	15
Investec (INL)	0.5264	0.2732	2	15

Panel unit root test: Summary				
Series: CAPITAL_FLOWS_LOG				
Date: 09/11/19 Time: 11:56				
Sample: 2003 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.7899	0.0000	6	78
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.2950	0.0109	6	78
ADF - Fisher Chi-square	23.5125	0.0237	6	78
PP - Fisher Chi-square	47.5414	0.0000	6	84
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity				
Series: CAPITAL_FLOWS_LOG				
Date: 09/11/19 Time: 11:57				
Sample: 2003 2017				
Exogenous variables: Individual effects				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total (balanced) observations: 90				
Cross-sections included: 6				
Method			Statistic	Prob.**
Hadri Z-stat			1.5372	0.0621
Heteroscedastic Consistent Z-stat			1.5372	0.0621
* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.				
** Probabilities are computed assuming asympotic normality				
Intermediate results on CAPITAL_FLOWS_LOG				
Cross-section	LM	Variance HAC	Bandwidth	Obs
Capitec (CPI)	0.2602	1.4462	2	15
Nedbank (NED)	0.2602	1.4462	2	15
Absa (ABG)	0.2602	1.4462	2	15
Standard Bank (SBK)	0.2602	1.4462	2	15
FirstRand (FSR)	0.2602	1.4462	2	15
Investec (INL)	0.2602	1.4462	2	15

Panel unit root test: Summary				
Series: LEVERAGE_1				
Date: 09/11/19 Time: 11:57				
Sample: 2003 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-0.6741	0.2501	6	78
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.8502	0.8024	6	78
ADF - Fisher Chi-square	5.4831	0.9399	6	78
PP - Fisher Chi-square	15.3130	0.2248	6	84
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity				
Series: LEVERAGE_1				
Date: 09/11/19 Time: 11:58				
Sample: 2003 2017				
Exogenous variables: Individual effects				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total (balanced) observations: 90				
Cross-sections included: 6				
Method			Statistic	Prob.**
Hadri Z-stat			6.1190	0
Heteroscedastic Consistent Z-stat			5.5781	0
* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.				
** Probabilities are computed assuming asympotic normality				
Intermediate results on LEVERAGE_1				
Cross-section	LM	Variance HAC	Bandwidth	Obs
Capitec (CPI)	0.5031	5.2399	2	15
Nedbank (NED)	0.5829	18.4682	2	15
Absa (ABG)	0.5433	10.6831	2	15
Standard Bank (SBK)	0.5159	28.7474	2	15
FirstRand (FSR)	0.3283	3.4367	2	15
Investec (INL)	0.5633	29.8315	2	15

Panel unit root test: Summary				
Series: LEVERAGE_2_				
Date: 09/11/19 Time: 11:59				
Sample: 2003 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.5193	0.0059	6	78
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.6464	0.0001	6	78
ADF - Fisher Chi-square	35.8483	0.0003	6	78
PP - Fisher Chi-square	63.9886	0.0000	6	84
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity			
Series: LEVERAGE_2_			
Date: 09/11/19 Time: 12:00			
Sample: 2003 2017			
Exogenous variables: Individual effects			
Newey-West automatic bandwidth selection and Bartlett kernel			
Total (balanced) observations: 90			
Cross-sections included: 6			
Method		Statistic	Prob.**
Hadri Z-stat		0.4575	0.3237
Heteroscedastic Consistent Z-stat		2.8180	0.0024

* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.

** Probabilities are computed assuming asympotic normality

Intermediate results on LEVERAGE_2_

Cross-section	LM	Variance HAC	Bandwidth	Obs
Capitec (CPI)	0.3681	0.2949	2	15
Nedbank (NED)	0.5297	4.8933	0	15
Absa (ABG)	0.2086	3.6112	3	15
Standard Bank (SBK)	0.3268	2.7194	3	15
FirstRand (FSR)	0.4154	9.7507	2	15
Investec (INL)	0.1803	299.9601	1	15

Panel unit root test: Summary				
Series: PROFITABILITY				
Date: 09/11/19 Time: 12:01				
Sample: 2003 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.9457	0.0000	6	78
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.3083	0.0005	6	78
ADF - Fisher Chi-square	33.3146	0.0009	6	78
PP - Fisher Chi-square	27.1139	0.0074	6	84

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Null Hypothesis: Stationarity			
Series: PROFITABILITY			
Date: 09/11/19 Time: 12:01			
Sample: 2003 2017			
Exogenous variables: Individual effects			
Newey-West automatic bandwidth selection and Bartlett kernel			
Total (balanced) observations: 90			
Cross-sections included: 6			
Method		Statistic	Prob.**
Hadri Z-stat		5.0543	0
Heteroscedastic Consistent Z-stat		2.1978	0.014

* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.

** Probabilities are computed assuming asympotic normality

Intermediate results on PROFITABILITY

Cross-section	LM	Variance HAC	Bandwidth	Obs
Capitec (CPI)	0.4745	1144.8270	2	15
Nedbank (NED)	0.3417	0.1924	0	15
Absa (ABG)	0.3011	0.1704	2	15
Standard Bank (SBK)	0.4006	0.6597	2	15
FirstRand (FSR)	0.1604	0.2078	4	15
Investec (INL)	0.1243	0.3375	1	15

Lag length criteria

VAR Lag Order Selection Criteria						
Endogenous variables: SRISK BANK_ACTIVITIES LEVERAGE_1						
Exogenous variables: C						
Date: 09/11/19 Time: 12:14						
Sample: 2003 2017						
Included observations: 48						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-663.3518	NA	2.29E+08	27.7647	27.8816	27.8089
1	-556.9707	195.0320*	3971454.*	23.7071*	24.17491*	23.8838*
2	-551.4093	9.5007	4606774	23.8504	24.6690	24.1598
3	-544.5430	10.8716	5097350	23.9393	25.1088	24.3813
4	-541.9758	3.7439	6819323	24.2073	25.7277	24.7819
5	-537.0490	6.5691	8392512	24.3770	26.2482	25.0842
6	-525.9424	13.4205	8144260	24.2893	26.5113	25.1290
7	-512.6550	14.3947	7408865	24.1106	26.6835	25.0829
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Cointegration test results[25]

Kao Residual Cointegration Test				
Series: SRISK BANK_ACTIVITIES LEVERAGE_1				
Date: 09/11/19 Time: 12:15				
Sample: 2003 2017				
Included observations: 90				
Null Hypothesis: No cointegration				
Trend assumption: No deterministic trend				
User-specified lag length: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
			t-Statistic	Prob.
ADF			0.0867	0.4655
Residual variance			2.12E+08	
HAC variance			71370235	

Pedroni Residual Cointegration Test					
Series: SRISK BANK_ACTIVITIES LEVERAGE_1					
Date: 09/11/19 Time: 12:16					
Sample: 2003 2017					
Included observations: 90					
Cross-sections included: 6					
Null Hypothesis: No cointegration					
Trend assumption: No deterministic trend					
User-specified lag length: 1					
Newey-West automatic bandwidth selection and Bartlett kernel					
Alternative hypothesis: common AR coefs. (within-dimension)					
		Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic		-1.2526	0.8948	-1.1540	0.8757
Panel rho-Statistic		0.5733	0.7168	0.4788	0.6839
Panel PP-Statistic		-1.8222	0.0342	-1.4863	0.0686
Panel ADF-Statistic		-2.3975	0.0083	-2.4061	0.0081
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		1.6334	0.9488		
Group PP-Statistic		-1.5621	0.0591		
Group ADF-Statistic		-1.7555	0.0396		

25 The automatic and user specified lag selection delivered similar results, hence only the latter are displayed here.

Pedroni Residual Cointegration Test					
Series: SRISK BANK_ACTIVITIES LEVERAGE_1					
Date: 09/11/19 Time: 12:16					
Sample: 2003 2017					
Included observations: 90					
Cross-sections included: 6					
Null Hypothesis: No cointegration					
Trend assumption: Deterministic intercept and trend					
User-specified lag length: 1					
Newey-West automatic bandwidth selection and Bartlett kernel					
Alternative hypothesis: common AR coefs. (within-dimension)					
		Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic		-2.3442	0.9905	-2.3285	0.9901
Panel rho-Statistic		1.5616	0.9408	1.4771	0.9302
Panel PP-Statistic		-5.2241	0.0000	-4.8755	0.0000
Panel ADF-Statistic		-4.6557	0.0000	-4.5202	0.0000
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		1.8610	0.9686		
Group PP-Statistic		-6.5416	0.0000		
Group ADF-Statistic		-3.2342	0.0006		

Pedroni Residual Cointegration Test					
Series: SRISK BANK_ACTIVITIES LEVERAGE_1					
Date: 09/11/19 Time: 12:17					
Sample: 2003 2017					
Included observations: 90					
Cross-sections included: 6					
Null Hypothesis: No cointegration					
Trend assumption: No deterministic intercept or trend					
User-specified lag length: 1					
Newey-West automatic bandwidth selection and Bartlett kernel					
Alternative hypothesis: common AR coefs. (within-dimension)					
		Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic		-0.2982	0.6172	-0.2060	0.5816
Panel rho-Statistic		-0.6316	0.2638	-0.5847	0.2794
Panel PP-Statistic		-2.2740	0.0115	-1.9955	0.0230
Panel ADF-Statistic		-2.4366	0.0074	-2.4112	0.0080
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		0.8893	0.8131		
Group PP-Statistic		-1.9813	0.0238		
Group ADF-Statistic		-2.2811	0.0113		

Johansen Fisher Panel Cointegration Test				
Series: SRISK BANK_ACTIVITIES LEVERAGE_1				
Date: 09/11/19 Time: 12:19				
Sample: 2003 2017				
Included observations: 90				
Trend assumption: No deterministic trend				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	42.2800	0.0000	41.8000	0.0000
At most 1	12.3800	0.4153	12.8800	0.3779
At most 2	6.9630	0.8600	6.9630	0.8600
* Probabilities are computed using asymptotic Chi-square distribution.				

Johansen Fisher Panel Cointegration Test				
Series: SRISK BANK_ACTIVITIES LEVERAGE_1				
Date: 09/11/19 Time: 12:20				
Sample: 2003 2017				
Included observations: 90				
Trend assumption: No deterministic trend (restricted constant)				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	Fisher Stat.*	Prob.	Fisher Stat.*	Prob.
No. of CE(s)	(from trace test)		(from max-eigen test)	
None	52.6600	0.0000	45.0100	0.0000
At most 1	21.6300	0.0419	19.1700	0.0846
At most 2	12.4200	0.4129	12.4200	0.4129

Johansen Fisher Panel Cointegration Test				
Series: SRISK BANK_ACTIVITIES LEVERAGE_1				
Date: 09/11/19 Time: 12:20				
Sample: 2003 2017				
Included observations: 90				
Trend assumption: Linear deterministic trend				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	Fisher Stat.*	Prob.	Fisher Stat.*	Prob.
No. of CE(s)	(from trace test)		(from max-eigen test)	
None	49.7800	0.0000	39.5200	0.0001
At most 1	22.6000	0.0313	20.6600	0.0556
At most 2	18.9500	0.0896	18.9500	0.0896
* Probabilities are computed using asymptotic Chi-square distribution.				

Johansen Fisher Panel Cointegration Test				
Series: SRISK BANK_ACTIVITIES LEVERAGE_1				
Date: 09/11/19 Time: 12:20				
Sample: 2003 2017				
Included observations: 90				
Trend assumption: Linear deterministic trend (restricted)				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	Fisher Stat.*	Prob.	Fisher Stat.*	Prob.
No. of CE(s)	(from trace test)		(from max-eigen test)	
None	58.4500	0.0000	52.9100	0.0000
At most 1	18.6500	0.0974	17.7700	0.1229
At most 2	9.5720	0.6535	9.5720	0.6535
* Probabilities are computed using asymptotic Chi-square distribution.				

Johansen Fisher Panel Cointegration Test					
Series: SRISK BANK_ACTIVITIES LEVERAGE_1					
Date: 09/11/19 Time: 12:21					
Sample: 2003 2017					
Included observations: 90					
Trend assumption: Quadratic deterministic trend					
Lags interval (in first differences): 1 1					
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)					
Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.	
					Quadratic
None	74.4500	0.0000	55.2800	0.0000	Intercept
At most 1	32.2300	0.0013	23.3100	0.0252	Trend
At most 2	33.2500	0.0009	33.2500	0.0009	0.0000
					0.0000
* Probabilities are computed using asymptotic Chi-square distribution.					

Date: 09/11/19 Time: 12:23				
Sample: 2003 2017				
Included observations: 78				
Series: SRISK BANK_ACTIVITIES LEVERAGE_1				
Lags interval: 1 to 1				
Selected (0.05 level*) Number of Cointegrating Relations by Model				
Data Trend:	None	None	Linear	Linear
Test Type	No Intercept, No Trend	Intercept, No Trend	Intercept, No Trend	Intercept, Trend
Trace	0	1	0	0
Max-Eig	0	0	0	0
*Critical values based on MacKinnon-Haug-Michelis (1999)				

Vector Error Correction Model results

Vector Error Correction Estimates			
Date: 09/13/19 Time: 11:18			
Sample (adjusted): 2005 2017			
Included observations: 78 after adjustments			
Standard errors in ( ) & t-statistics in [ ]			
Cointegrating Eq:	CointEq1		
SRISK(-1)	1		
BANK_ACTIVITIES(-1)	140550.3000		
	-48246.7000		
	[2.9131]		
LEVERAGE_1(-1)	2472.0640		
	-3425.0500		
	[0.7217]		
C	-200630.5000		
Error Correction:	D(SRISK)	D(BANK_ACTIVITIES)	D(LEVERAGE_1)
CointEq1	0.0079	-1.35E-06	-6.70E-06
	-0.0324	-4.00E-07	-2.60E-06
	[0.2432]	[-3.4158]	[-2.5789]
D(SRISK(-1))	-0.2352	9.77E-07	-1.47E-05
	-0.1182	-1.40E-06	-9.50E-06
	[-1.9909]	[0.6752]	[-1.5456]
D(BANK_ACTIVITIES(-1))	-4966.9970	-0.0765	0.3581
	-8740.2800	-0.1070	-0.7014
	[-0.5682]	[-0.7154]	[0.5105]
D(LEVERAGE_1(-1))	1841.0920	0.0130	-0.1681
	-1195.1300	-0.0146	-0.0959
	[1.5404]	[0.8906]	[-1.7523]
C	988.5010	0.0113	-0.3578
	-1757.9700	-0.0215	-0.1411
	[0.5623]	[0.5237]	[-2.5361]
R-squared	0.0760	0.1748	0.1542
Adj. R-squared	0.0254	0.1296	0.1079
Sum sq. resids	1.65E+10	2.4673	106.0369
S.E. equation	15019.0400	0.1838	1.2052
F-statistic	1.5011	3.8654	3.3277
Log likelihood	-858.2253	24.0128	-122.6533
Akaike AIC	22.1340	-0.4875	3.2732
Schwarz SC	22.2851	-0.3364	3.4242
Mean dependent	172.1764	0.0068	-0.3048
S.D. dependent	15213.2600	0.1971	1.2760
Determinant resid covariance (dof adj.)		10915453	
Determinant resid covariance		8948012	
Log likelihood		-956.3024	
Akaike information criterion		24.9821	
Schwarz criterion		25.5260	

Dependent Variable: D(SRISK)
Method: Panel Least Squares
Date: 09/25/19 Time: 11:22
Sample (adjusted): 2005 2017
Periods included: 13
Cross-sections included: 6
Total panel (balanced) observations: 78
D(SRISK) = C(1)*(SRISK(-1) + 140550.25974*BANK_ACTIVITIES(-1) + 2472.06392533*LEVERAGE_1(-1) - 200630.525261) + C(2)*D(SRISK(-1)) + C(3)*D(BANK_ACTIVITIES(-1)) + C(4)*D(LEVERAGE_1(-1)) + C(5)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.007879	0.032386	0.243275	0.8085
C(2)	-0.235247	0.118158	-1.990958	0.0502
C(3)	-4966.997	8740.283	-0.568288	0.5716
C(4)	1841.092	1195.133	1.540492	0.1278
C(5)	988.501	1757.972	0.562296	0.5756

R-squared	0.076	Mean dependent var		172.1764
Adjusted R-squared	0.02537	S.D. dependent var		15213.26
S.E. of regression	15019.04	Akaike info criterion		22.13398
Sum squared resid	1.65E+10	Schwarz criterion		22.28505
Log likelihood	-858.2253	Hannan-Quinn criter.		22.19446
F-statistic	1.501076	Durbin-Watson stat		2.22649
Prob(F-statistic)	0.210782			

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	-0.568288	73	0.5716
F-statistic	0.322951	(1, 73)	0.5716
Chi-square	0.322951	1	0.5698

Null Hypothesis: C(3)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3)	-4966.997	8740.283

Restrictions are linear in coefficients.

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	1.540492	73	0.1278
F-statistic	2.373115	(1, 73)	0.1278
Chi-square	2.373115	1	0.1234

Null Hypothesis: C(4)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	1841.092	1195.133

Restrictions are linear in coefficients.

Fixed and Random effects estimation

Dependent Variable: DSRISK				
Method: Panel Least Squares				
Date: 09/19/19 Time: 12:25				
Sample (adjusted): 2004 2017				
Periods included: 14				
Cross-sections included: 6				
Total panel (balanced) observations: 84				
White cross-section standard errors & covariance (no d.f. correction)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DBANK_ACTIVITIES	-7048.491	3274.986	-2.152	0.035
BANK_SIZE_2	8313.816	6507.143	1.278	0.206
CAPITAL_FLOWS_LOG	-5827.843	298.559	-19.520	0.000
DLEVERAGE_1	962.847	816.693	1.179	0.242
LEVERAGE_2	494.707	106.292	4.654	0.000
PROFITABILITY	-342.125	178.671	-1.915	0.060
C	-17717.330	30732.290	-0.577	0.566
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.329	Mean dependent var		-40.011
Adjusted R-squared	0.227	S.D. dependent var		14683.960
S.E. of regression	12911.680	Akaike info criterion		21.901
Sum squared resid	1.20E+10	Schwarz criterion		22.248
Log likelihood	-907.851	Hannan-Quinn criter.		22.041
F-statistic	3.214	Durbin-Watson stat		2.508
Prob(F-statistic)	0.001			

Redundant Fixed Effects Tests			
Equation: Untitled			
Test cross-section fixed effects			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	0.272	(5,72)	0.927
Cross-section Chi-square	1.569	5	0.905

Dependent Variable: DSRISK				
Method: Panel EGLS (Cross-section random effects)				
Date: 09/19/19 Time: 12:56				
Sample (adjusted): 2004 2017				
Periods included: 14				
Cross-sections included: 6				
Total panel (balanced) observations: 84				
Swamy and Arora estimator of component variances				
White cross-section standard errors & covariance (no d.f. correction)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
BANK_SIZE_2	6642.355	6287.466	1.056	0.294
CAPITAL_FLOWS_LOG	-5667.136	272.074	-20.829	0.000
LEVERAGE_2	460.821	130.100	3.542	0.001
PROFITABILITY	-315.814	192.361	-1.642	0.105
C	-10455.150	29328.820	-0.356	0.722
Effects Specification				
			S.D.	Rho
Cross-section random			0.00	0.00
Idiosyncratic random			12877.140	1.000
Weighted Statistics				
R-squared	0.302	Mean dependent var		-40.011
Adjusted R-squared	0.266	S.D. dependent var		14683.960
S.E. of regression	12577.690	Sum squared resid		1.25E+10
F-statistic	8.532	Durbin-Watson stat		2.462
Prob(F-statistic)	0.000			
Unweighted Statistics				
R-squared	0.302	Mean dependent var		-40.011
Sum squared resid	1.25E+10	Durbin-Watson stat		2.462

NON-BANKING SECTOR – EVIEWS RESULTS

Unit root test results[26]

Panel unit root test: Summary				
Series: LRMES				
Date: 09/12/19 Time: 09:42				
Sample: 2005 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.1785	0.8807	7	74
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.0657	0.8567	7	74
ADF - Fisher Chi-square	8.4885	0.8624	7	74
PP - Fisher Chi-square	7.7249	0.9032	7	81
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity				
Series: LRMES				
Date: 09/12/19 Time: 09:43				
Sample: 2005 2017				
Exogenous variables: Individual effects				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total number of observations: 88				
Cross-sections included: 7				
Method			Statistic	Prob.**
Hadri Z-stat			4.9683	0
Heteroscedastic Consistent Z-stat			4.6547	0
* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.				
** Probabilities are computed assuming asympotic normality				
Intermediate results on LRMES				
Cross-section	LM	Variance HAC	Bandwidth	Obs
Hosken Cons Inv (HCI)	0.3664	0.0024	2	13
Santam (SNT)	0.3403	0.0048	2	13
Sanlam (SLM)	0.3868	0.0055	2	13
Discovery (DSY)	0.5302	0.0127	2	13
Liberty Holdings (LBH)	0.4377	0.0013	0	13
MMI Holdings (MMI)	0.4411	0.0046	1	13
African Phoenix Investments (AXL)	0.5000	0.0002	9	10

[26] The results are only shown for level, and not for first differences.

Panel unit root test: Summary				
Series: ACTIVITIES				
Date: 09/12/19 Time: 09:45				
Sample: 2005 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	0.0556	0.5222	7	74
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.1107	0.4559	7	74
ADF - Fisher Chi-square	15.0358	0.3757	7	74
PP - Fisher Chi-square	12.6852	0.5515	7	81
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity				
Series: ACTIVITIES				
Date: 09/12/19 Time: 09:45				
Sample: 2005 2017				
Exogenous variables: Individual effects				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total number of observations: 88				
Cross-sections included: 7				
Method			Statistic	Prob.**
Hadri Z-stat			3.8844	0.0001
Heteroscedastic Consistent Z-stat			2.2601	0.0119
* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.				
** Probabilities are computed assuming asympotic normality				
Intermediate results on ACTIVITIES				
Cross-section	LM	Variance HAC	Bandwidth	Obs
Hosken Cons Inv (HCI)	0.1328	0.0442	1	13
Santam (SNT)	0.1986	0.0059	5	13
Sanlam (SLM)	0.3771	0.3902	2	13
Discovery (DSY)	0.1747	0.0510	0	13
Liberty Holdings (LBH)	0.4691	0.4345	2	13
MMI Holdings (MMI)	0.4697	0.3072	2	13
African Phoenix Investments (AXL)	0.2360	0.2396	0	10

Panel unit root test: Summary				
Series: SIZE				
Date: 09/12/19 Time: 09:47				
Sample: 2005 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-0.6533	0.2568	7	74
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.3571	0.6395	7	74
ADF - Fisher Chi-square	10.5378	0.7219	7	74
PP - Fisher Chi-square	8.7985	0.8437	7	81
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity				
Series: SIZE				
Date: 09/12/19 Time: 09:47				
Sample: 2005 2017				
Exogenous variables: Individual effects				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total number of observations: 88				
Cross-sections included: 7				
Method			Statistic	Prob.**
Hadri Z-stat			4.8233	0.0000
Heteroscedastic Consistent Z-stat			3.2812	0.0005
* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.				
** Probabilities are computed assuming asympotic normality				
Intermediate results on SIZE				
Cross-section	LM	Variance HAC	Bandwidth	Obs
Hosken Cons Inv (HCI)	0.2498	174451.8000	1	13
Santam (SNT)	0.3696	347218.6000	2	13
Sanlam (SLM)	0.4722	13138058	2	13
Discovery (DSY)	0.5082	7049712	2	13
Liberty Holdings (LBH)	0.3525	1493945	2	13
MMI Holdings (MMI)	0.3663	3430715	2	13
African Phoenix Investments (AXL)	0.1422	1696683	1	10

Panel unit root test: Summary				
Series: PROFITABILITY				
Date: 09/12/19 Time: 09:49				
Sample: 2005 2017				
Exogenous variables: Individual effects				
User-specified lags: 1				
Newey-West automatic bandwidth selection and Bartlett kernel				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.7495	0.0001	7	74
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.4733	0.0067	7	74
ADF - Fisher Chi-square	33.7422	0.0022	7	74
PP - Fisher Chi-square	36.5360	0.0009	7	81
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

Null Hypothesis: Stationarity				
Series: PROFITABILITY				
Date: 09/12/19 Time: 09:50				
Sample: 2005 2017				
Exogenous variables: Individual effects				
Newey-West automatic bandwidth selection and Bartlett kernel				
Total number of observations: 88				
Cross-sections included: 7				
Method			Statistic	Prob.**
Hadri Z-stat			3.4143	0.0003
Heteroscedastic Consistent Z-stat			2.9243	0.0017
: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the				
** Probabilities are computed assuming asympotic normality				
Intermediate results on PROFITABILITY				
Cross-section	LM	Variance HAC	Bandwidth	Obs
Hosken Cons Inv (HCI)	0.0771	27.3748	2	13
Santam (SNT)	0.4283	6.6166	7	13
Sanlam (SLM)	0.4668	5.4514	2	13
Discovery (DSY)	0.5263	41.2955	2	13
Liberty Holdings (LBH)	0.0783	1.2196	1	13
MMI Holdings (MMI)	0.2433	2.9099	0	13
African Phoenix Investments (AXL)	0.5000	3.1685	9	10

Lag length criteria

VAR Lag Order Selection Criteria						
Endogenous variables: LRMES ACTIVITIES SIZE						
Exogenous variables: C PROFITABILITY						
Date: 09/12/19 Time: 09:54						
Sample: 2005 2017						
Included observations: 39						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-431.4152	NA	1108133	22.4316	22.6875	22.5234
1	-372.7622	102.2667	87192.0900	19.8852	20.5250*	20.1148
2	-365.3329	11.8107	95785.9800	19.9658	20.9895	20.3331
3	-344.2365	30.2923	53049.4500	19.3455	20.7531	19.8505
4	-337.2359	8.9752	61992.2700	19.4480	21.2395	20.0908
5	-328.3755	9.9963	68122.6400	19.4552	21.6306	20.2357
6	-316.1029	11.9579	65911.6300	19.2873	21.8467	20.2056
7	-291.8871	19.8693*	36996.46*	18.5070*	21.4503	19.5630*
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Cointegration test results[27]

Kao Residual Cointegration Test			
Series: LRMES ACTIVITIES SIZE			
Date: 09/12/19 Time: 09:55			
Sample: 2005 2017			
Included observations: 88			
Null Hypothesis: No cointegration			
Trend assumption: No deterministic trend			
User-specified lag length: 1			
Newey-West automatic bandwidth selection and Bartlett kernel			
		t-Statistic	Prob.
ADF		-1.9717	0.0243
Residual variance		0.0016	
HAC variance		0.0015	

Pedroni Residual Cointegration Test					
Series: LRMES ACTIVITIES SIZE					
Date: 09/12/19 Time: 09:56					
Sample: 2005 2017					
Included observations: 88					
Cross-sections included: 7					
Null Hypothesis: No cointegration					
Trend assumption: No deterministic trend					
User-specified lag length: 1					
Newey-West automatic bandwidth selection and Bartlett kernel					
Alternative hypothesis: common AR coefs. (within-dimension)					
		Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic		0.3851	0.3501	-0.4732	0.6820
Panel rho-Statistic		0.1113	0.5443	-0.0146	0.4942
Panel PP-Statistic		-2.7672	0.0028	-3.7378	0.0001
Panel ADF-Statistic		-2.3332	0.0098	-2.3960	0.0083
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		1.3790	0.9160		
Group PP-Statistic		-3.3415	0.0004		
Group ADF-Statistic		-1.8630	0.0312		

Pedroni Residual Cointegration Test					
Series: LRMES ACTIVITIES SIZE					
Date: 09/12/19 Time: 09:57					
Sample: 2005 2017					
Included observations: 88					
Cross-sections included: 7					
Null Hypothesis: No cointegration					
Trend assumption: Deterministic intercept and trend					
User-specified lag length: 1					
Newey-West automatic bandwidth selection and Bartlett kernel					
Alternative hypothesis: common AR coefs. (within-dimension)					
		Statistic	Prob.	eighted Statis	Prob.
Panel v-Statistic		-0.4215	0.6633	-1.8407	0.9672
Panel rho-Statistic		0.9632	0.8323	1.0069	0.8430
Panel PP-Statistic		-3.9001	0.0000	-5.6948	0.0000
Panel ADF-Statistic		-1.4550	0.0728	-1.9073	0.0282
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		1.9932	0.9769		
Group PP-Statistic		-6.0994	0.0000		
Group ADF-Statistic		-0.6590	0.2550		

[27] The automatic and user specified lag selection delivered similar results, hence only the latter are displayed here.

Pedroni Residual Cointegration Test					
Series: LRMES ACTIVITIES SIZE					
Date: 09/12/19 Time: 09:57					
Sample: 2005 2017					
Included observations: 88					
Cross-sections included: 7					
Null Hypothesis: No cointegration					
Trend assumption: No deterministic intercept or trend					
User-specified lag length: 1					
Newey-West automatic bandwidth selection and Bartlett kernel					
Alternative hypothesis: common AR coefs. (within-dimension)					
		Statistic	Prob.	eighted Statis	Prob.
Panel v-Statistic		-1.7151	0.9568	-1.8366	0.9669
Panel rho-Statistic		-0.1933	0.4234	0.0301	0.5120
Panel PP-Statistic		-0.8230	0.2053	-0.1667	0.4338
Panel ADF-Statistic		-0.7509	0.2264	-0.1988	0.4212
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		1.1337	0.8715		
Group PP-Statistic		-0.8639	0.1938		
Group ADF-Statistic		-1.3121	0.0947		

Johansen Fisher Panel Cointegration Test				
Series: LRMES ACTIVITIES SIZE				
Date: 09/12/19 Time: 09:59				
Sample: 2005 2017				
Included observations: 88				
Trend assumption: No deterministic trend				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	61.5900	0.0000	58.5600	0.0000
At most 1	19.0200	0.0880	18.5600	0.0996
At most 2	10.2300	0.5961	10.2300	0.5961
* Probabilities are computed using asymptotic Chi-square distribution.				

Johansen Fisher Panel Cointegration Test				
Series: LRMES ACTIVITIES SIZE				
Date: 09/12/19 Time: 10:00				
Sample: 2005 2017				
Included observations: 88				
Trend assumption: No deterministic trend (restricted constant)				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	Fisher Stat.*	Prob.	Fisher Stat.*	Prob.
No. of CE(s)	(from trace test)		(from max-eigen test)	
None	115.4000	0.0000	85.5900	0.0000
At most 1	34.3800	0.0006	30.9400	0.0020
At most 2	15.3700	0.2221	15.3700	0.2221
* Probabilities are computed using asymptotic Chi-square distribution.				

Johansen Fisher Panel Cointegration Test				
Series: LRMES ACTIVITIES SIZE				
Date: 09/12/19 Time: 10:00				
Sample: 2005 2017				
Included observations: 88				
Trend assumption: Linear deterministic trend				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	Fisher Stat.*	Prob.	Fisher Stat.*	Prob.
No. of CE(s)	(from trace test)		(from max-eigen test)	
None	96.4400	0.0000	77.3000	0.0000
At most 1	35.7500	0.0004	32.9800	0.0010
At most 2	19.5000	0.0771	19.5000	0.0771
* Probabilities are computed using asymptotic Chi-square distribution.				

Johansen Fisher Panel Cointegration Test				
Series: LRMES ACTIVITIES SIZE				
Date: 09/12/19 Time: 10:00				
Sample: 2005 2017				
Included observations: 88				
Trend assumption: Linear deterministic trend (restricted)				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	Fisher Stat.*	Prob.	Fisher Stat.*	Prob.
No. of CE(s)	(from trace test)		(from max-eigen test)	
None	206.8000	0.0000	162.0000	0.0000
At most 1	38.9600	0.0001	30.7200	0.0022
At most 2	19.7600	0.0717	19.7600	0.0717
* Probabilities are computed using asymptotic Chi-square distribution.				

Johansen Fisher Panel Cointegration Test				
Series: LRMES ACTIVITIES SIZE				
Date: 09/12/19 Time: 10:00				
Sample: 2005 2017				
Included observations: 88				
Trend assumption: Quadratic deterministic trend				
Lags interval (in first differences): 1 1				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	191.2000	0.0000	155.7000	0.0000
At most 1	51.4200	0.0000	33.8400	0.0007
At most 2	47.5500	0.0000	47.5500	0.0000
* Probabilities are computed using asymptotic Chi-square distribution.				

Johansen Cointegration Test Summary					
Date: 09/12/19 Time: 10:01					
Sample: 2005 2017					
Included observations: 74					
Series: LRMES ACTIVITIES SIZE					
Exogenous series: PROFITABILITY					
Warning: Rank Test critical values derived assuming no exogenous series					
Lags interval: 1 to 1					
Selected (0.05 level*) Number of Cointegrating Relations by Model					
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept, No Trend	Intercept, No Trend	Intercept, No Trend	Intercept, Trend	Intercept, Trend
Trace	1	1	1	0	1
Max-Eig	1	0	0	0	1
*Critical values based on MacKinnon-Haug-Michelis (1999)					

Vector Error Correction Model results

Vector Error Correction Estimates			
Date: 09/12/19 Time: 10:02			
Sample (adjusted): 2007 2017			
Included observations: 74 after adjustments			
Standard errors in ( ) & t-statistics in [ ]			
Cointegrating Eq:	CointEq1		
LRMES(-1)	1		
ACTIVITIES(-1)	0.1243		
	-0.0442		
	[2.8141]		
SIZE(-1)	-1.04E-06		
	-5.00E-07		
	[-2.0869]		
C	-0.4269		
Error Correction:	D(LRMES)	D(ACTIVITIES)	D(SIZE)
CointEq1	-0.2552	-1.1961	23023.0500
	-0.0709	-0.5758	-26234.7000
	[-3.5976]	[-2.0774]	[0.8775]
D(LRMES(-1))	-0.0162	1.6997	-19459.4900
	-0.1109	-0.9000	-41011.2000
	[-0.1460]	[1.8884]	[-0.4744]
D(ACTIVITIES(-1))	-0.0109	-0.0368	9351.7060
	-0.0186	-0.1511	-6882.8700
	[-0.5840]	[-0.2439]	[1.3586]
D(SIZE(-1))	5.91E-07	-2.88E-06	-0.0765
	-3.50E-07	-2.90E-06	-0.1310
	[1.6688]	[-1.0013]	[-0.5834]
C	0.0116	-0.0348	3136.0340
	-0.0053	-0.0430	-1961.2800
	[2.1876]	[-0.8087]	[1.5989]
PROFITABILITY	-0.0023	-0.0083	156.5247
	-0.0009	-0.0075	-340.8660
	[-2.5155]	[-1.1036]	[0.4592]
R-squared	0.2741	0.1349	0.0753
Adj. R-squared	0.2207	0.0713	0.0073
Sum sq. resids	0.0887	5.8408	1.21E+10
S.E. equation	0.0361	0.2931	13354.3400
F-statistic	5.1351	2.1202	1.1072
Log likelihood	143.8956	-11.0512	-804.8430
Akaike AIC	-3.7269	0.4608	21.9147
Schwarz SC	-3.5401	0.6477	22.1015
Mean dependent	0.0075	-0.0514	2947.6280
S.D. dependent	0.0409	0.3041	13403.2700
Determinant resid covariance (dof adj.)		18980.7600	
Determinant resid covariance		14728.0500	
Log likelihood		-670.1122	
Akaike information criterion		18.6787	
Schwarz criterion		19.3326	

Dependent Variable: D(LRMES)				
Method: Panel Least Squares				
Date: 09/12/19 Time: 10:03				
Sample (adjusted): 2007 2017				
Periods included: 11				
Cross-sections included: 7				
Total panel (unbalanced) observations: 74				
D(LRMES) = C(1)*(LRMES(-1) + 0.124275716492*ACTIVITIES(-1) -1.04331404601E-06*SIZE(-1) - 0.426852876166) + C(2)*D(LRMES(-1)) + C(3)*D(ACTIVITIES(-1)) + C(4)*D(SIZE(-1)) + C(5) + C(6)*PROFITABILITY				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.255	0.071	-3.598	0.001
C(2)	-0.016	0.111	-0.146	0.884
C(3)	-0.011	0.019	-0.584	0.561
C(4)	0.000	0.000	1.669	0.100
C(5)	0.012	0.005	2.188	0.032
C(6)	-0.002	0.001	-2.516	0.014
R-squared	0.274	Mean dependent var		0.008
Adjusted R-squared	0.221	S.D. dependent var		0.041
S.E. of regression	0.036	Akaike info criterion		-3.727
Sum squared resid	0.089	Schwarz criterion		-3.540
Log likelihood	143.896	Hannan-Quinn criter.		-3.652
F-statistic	5.135	Durbin-Watson stat		1.841
Prob(F-statistic)	0.000			

Wald Test:			
Equation: Untitled			
Test Statistic	Value	df	Probability
t-statistic	-0.584065	68	0.5611
F-statistic	0.341132	(1, 68)	0.5611
Chi-square	0.341132	1	0.5592
Null Hypothesis: C(3) = 0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(3)		-0.01087	0.018611
Restrictions are linear in coefficients.			

Wald Test:			
Equation: Untitled			
Test Statistic	Value	df	Probability
t-statistic	1.668821	68	0.0998
F-statistic	2.784962	(1, 68)	0.0998
Chi-square	2.784962	1	0.0952
Null Hypothesis: C(4) = 0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(4)		5.91E-07	3.54E-07
Restrictions are linear in coefficients.			

Wald Test:			
Equation: Untitled			
Test Statistic	Value	df	Probability
t-statistic	-2.515585	68	0.0143
F-statistic	6.32817	(1, 68)	0.0143
Chi-square	6.32817	1	0.0119
Null Hypothesis: C(6) = 0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(6)		-0.002319	0.000922
Restrictions are linear in coefficients.			

Diagnostic tests

VEC Residual Serial Correlation LM Tests		
Null Hypothesis: no serial correlation at lag order h		
Date: 09/14/19 Time: 16:11		
Sample: 2005 2017		
Included observations: 74		
Lags	LM-Stat	Prob
1	7.791356	0.5553
Probs from chi-square with 9 df.		

VEC Residual Normality Tests				
Orthogonalization: Cholesky (Lutkepohl)				
Null Hypothesis: residuals are multivariate normal				
Date: 09/14/19 Time: 16:17				
Sample: 2005 2017				
Included observations: 74				
Component	Skewness	Chi-sq	df	Prob.
1	-0.209397	0.540778	1	0.4621
2	-1.365614	23.00046	1	0
3	0.506381	3.162535	1	0.0753
Joint		26.70378	3	0
Component	Kurtosis	Chi-sq	df	Prob.
1	3.287737	0.255277	1	0.6134
2	7.108004	52.0334	1	0
3	5.798557	24.14842	1	0
Joint		76.4371	3	0
Component	Jarque-Bera	df	Prob.	
1	0.796056	2	0.6716	
2	75.03386	2	0	
3	27.31096	2	0	
Joint	103.1409	6	0	

VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)					
Date: 09/14/19 Time: 16:18					
Sample: 2005 2017					
Included observations: 74					
Joint test:					
Chi-sq	df	Prob.			
122.2809	60	0			
Individual components:					
Dependent	R-squared	F(10,63)	Prob.	Chi-sq(10)	Prob.
res1*res1	0.176253	1.347975	0.2255	13.04269	0.2213
res2*res2	0.356023	3.482952	0.0011	26.34567	0.0033
res3*res3	0.46064	5.38052	0	34.08739	0.0002
res2*res1	0.090486	0.626775	0.7854	6.695955	0.7538
res3*res1	0.361236	3.562802	0.0009	26.73149	0.0029
res3*res2	0.286308	2.527335	0.0126	21.18678	0.0198

ANNEXURE C

In order to be consistent throughout this study, a regression analysis for the banking sector is done with LRMES as the dependent variable. A great amount of variables is included for the banking sector in order to account for both bank-specific and country-specific factors associated with systemic risk. Table C5.1 and C5.2 display the descriptive statistics and correlation matrix respectively.

Table C13: Descriptive statistics for the banking sector

	LRMES	Bank Activities	Bank Size 1	Bank Size 2	Capital Inflows (log)	Leverage 1	Leverage 2	Profitability
Mean	0.426	1.202	1.91 trillion	91.90 billion	4.639	11.112	9.152	-4.701
Median	0.424	1.238	761 billion	80.60 billion	5.059	11.363	8.123	-1.262
Maximum	0.590	1.702	18 trillion	357 billion	5.445	22.443	65.081	0.636
Minimum	0.290	0.079	434 million	199 million	0.000	0.126	1.164	-64.705
Std. Dev.	0.071	0.333	3.59 trillion	73.60 billion	1.298	4.769	8.774	12.168
Skewness	0.318	-1.132	3.006	1.178	-3.061	-0.457	4.682	-3.944
Kurtosis	2.646	4.682	11.490	4.389	11.166	3.254	28.953	17.856
Jarque-Bera	1.993	29.818	405.881	28.049	390.603	3.371	2854.657	1060.924
Probability	0.369	0.000	0.000	0.000	0.000	0.185	0.000	0.000
Observations	90	90	90	90	90	90	90	90

Source: Compiled by Author

A basic investigation into the main determinants suggest that banks are, on average, larger in size when considering their total assets as opposed to their market capitalization. A similar trend can be observed in the bank's leverage, where the proportion of debt to assets that banks use are greater than the ratio of liabilities and market capitalization to market capitalization as a form of leverage. These variables' median values display a similar pattern. Considering the bank's activities, the share that loans represent, on average, is a great proportion of the bank's total assets. On average, banks display low levels of profitability, with the average reaching -4.7%. Banks' profitability ranges from a minimum ROA ratio of -64.71% to a maximum of 0.64%. The expected percentage of losses in banks' equity - should a crisis occur - ranges from a maximum of 59% to a minimum of 29%.

Table C14: Correlation matrix for the banking sector

	LRMES	Bank Activities	Bank Size 1	Bank Size 2	Capital Inflows (log)	Leverage 1	Leverage 2	Profitability
LRMES	1.000							
Bank Activities	0.213	1.000						
Bank Size 1	0.517	-0.049	1.000					
Bank Size 2	0.696	0.457	0.572	1.000				
Capital Inflows (log)	0.227	0.014	0.074	0.084	1.000			
Leverage 1	0.250	0.524	0.102	0.628	-0.171	1.000		
Leverage 2	0.131	0.117	0.205	0.341	-0.135	0.471	1.000	
Profitability	0.444	0.684	0.179	0.785	0.023	0.640	0.270	1.000

Source: Compiled by Author

The correlation matrix indicates no instances of particularly high correlation (greater than 0.8) between the explanatory variables, but does however indicate one instance of collinearity greater than 0.7. Although this degree of collinearity is not likely to impose severe problems, careful consideration is given to this variable displaying the collinearity. Given that an alternative measure for bank size exists, bank size measure two will be removed in order to diminish the multicollinearity. Prior to performing the regression analysis, it is imperative to first test the variables' level of stationarity. It is necessary to determine their stationarity in order to determine if an individual series is subject to permanent changes in their level. This concept is known as the unit-root hypothesis and pose important implications for the final model choice and to enable the drawing of valid conclusions from the estimation procedure, and is discussed in Section 4.2.2. As mentioned in Section 5.1, the capital inflows variable is logged in order to remove the influence of scale and to increase the probability of stationarity. Table C5.3 below present a summary of the unit root tests.

Table C15: Summary of the unit roots for the banking sector

	LRMES	Bank Activities	Bank Size 1	Bank Size 2	Capital Inflows (log)	Leverage 1	Leverage 2	Profitability
LLC	I(1)***	I(0)***	I(0)***	I(0)***	I(0)***	I(1)***	I(0)***	I(0)***
IPS	I(1)***	I(1)***	I(0)**	I(0)**	I(0)***	I(1)***	I(0)***	I(0)***
Fisher-ADF	I(1)***	I(1)***	I(0)**	I(0)*	I(0)**	I(1)***	I(0)***	I(0)***
Fisher - PP	I(1)***	I(1)***	I(0)***	I(0)***	I(0)***	I(1)***	I(0)***	I(0)***
Hadri	N.S.***	N.S.***	N.S.***	N.S.***	N.S.*	N.S.***	S.***	N.S.***
Majority Consensus	I(1)	I(1)	I(0)	I(0)	I(0)	I(1)	I(0)	I(0)

N.S. indicates non-stationary; S. indicates stationary.
***Significant at 1% level; **Significant at 5% level; and * Significant at 10% level.

Source: Compiled by Author

After visually inspecting the data it follows that there is no clear trend in the data, hence the unit roots are all reported for level and intercept with no trend. Considering that Breitung's unit root test only considers both an intercept and trend, these test results are not included. With the exception of the dependent variable, bank activities and leverage measure one, all of the independent variables are stationary. Kao, Pedroni, Fisher-Johansen and Johansen's cointegration tests are conducted to determine if a cointegrating relationship exists between LRMES, bank activities and leverage measure one. Considering that the majority of the independent variables are stationary, i.e. I(0), it is unnecessary to include them as exogenous variables when testing for a cointegrating relationship. As mentioned in Section 5.1, a VECM will be estimated if the cointegration tests indicate a possible cointegrating relationship. The lag length criteria indicates the most appropriate lag length to be one, and this is supported by Wooldridge (2015:577), considering the shorter time period and annual data. Table C5.4 below presents a summary of the cointegration test results between LRMES, bank activities and leverage measure one.

Table C16: Summary of the cointegration test results

Cointegration test	Consensus*
Kao	No cointegration present
Pedroni	Mixed, mostly no cointegration present
Fisher-Johansen	Mixed, at most two cointegrating relationships present
Johansen	Mixed, mostly no cointegration present
*On a 5% level of significance.	

Source: Compiled by Author

All of the cointegration tests were conducted using one lag and the use of the automatic lag selection confirmed the cointegration test results. As discussed in Section 4.2.3, the first and last assumption of the Fisher-Johansen is not plausible in terms of economic theory and was therefore not considered. As expected in Section 4.2.2, the majority of the results indicated that no cointegration is present, subsequently allowing for the estimation of a panel regression model with fixed and random effects. In order to allow for this estimation, all of the variables need to be stationary and therefore the non-stationary variables are differenced once to achieve stationarity. This allows for the estimation of a fixed and random effects model with the differenced LRMES as the dependent variable. Considering the drawbacks of the fixed effects method and the subsequent negative consequences of heteroskedasticity – as discussed in Section 5.1 – the fixed effects method is estimated with the White cross-sectional method. This test assumes that errors are cross-sectional correlated and is robust to cross-sectional correlation and heteroskedasticity. Table C5.5 below present the robust coefficient regression.

Table C17: Panel regression model with fixed effects for the banking sector

Variable	Coefficient	Standard Error	t-Statistic	Probability
d(Bank Activities)	0.033	0.021	1.600	0.114
Bank Size 2	-0.006	0.026	-0.223	0.825
Capital Inflows (log)	0.003	0.001	2.411	0.019
d(Leverage 1)	0.004	0.003	1.719	0.090
Leverage 2	0.000	0.000	0.506	0.615
Profitability	0.001	0.001	0.816	0.417
Constant	0.028	0.122	0.228	0.820
Adjusted R-squared		-0.060		

Source: Compiled by Author

The redundant fixed effects likelihood ratio test is conducted in order to determine if the fixed effects are redundant or not with the conclusion that it is indeed redundant. The implication of this being that the common constant method is preferred over the fixed effects method and suggests that there are no differences between the various cross-sections, i.e. banks. This method is quite restrictive and therefore the appropriateness of this method should be considered, requiring the estimation of a random effects method. Given that the fixed effects method contains an equal number of cross-sections and explanatory variables, it would not be possible to estimate a random effects method. Subsequently, the removal of the variables with the highest probabilities i.e. bank size measure two and leverage measure two allow for the estimation of a random effects method between the differenced LRMES and the remainder of the explanatory variables. Recalling the importance that the cross-sectional specific error term is uncorrelated with the variables' error term – discussed in Section 4.2.1 - , this method also needs to be estimated with the White cross-sectional robust coefficient method. Subsequently, the results illustrated in Table C5.6 below is robust to cross-sectional correlation and heteroskedasticity.

Table C18: Panel regression model with random effects for the banking sector

Variable	Coefficient	Standard Error	t-Statistic	Probability
d(Bank Activities)	0.033	0.022	1.529	0.130
Capital Inflows (log)	0.003	0.002	1.410	0.162
d(Leverage 1)	0.004	0.002	1.758	0.083
Profitability	0.001	0.000	1.627	0.108
Constant	0.004	0.005	0.752	0.455
Adjusted R-squared		0.024		

Source: Compiled by Author

Capital inflows, the differenced form of bank activities and profitability display probabilities of 16.2%, 13% and 10.8% respectively. These variables are only significant at 20%, 15% and 11% respectively. Although these variables are not statistically significant, the profitability measure is close to the 10% level of significance. The implication of this being that there may be signs that profitability can influence the change in a bank's LRMES and that it could be significant if included in a larger panel. Given that these variables are not significant in this panel, it is not included in the final random effects regression equation. Only the change in a bank's leverage ratio influences the change in a bank's LRMES, on a 10% level of significance.

The random effects estimation with the White cross-sectional robust coefficients does not allow for the performance of a Hausman test. The results illustrated above are robust coefficients with no heteroskedasticity present or correlation amongst the error terms. Subsequently, keeping in mind the negative consequences of heteroskedasticity, it is more important to conduct this test than the Hausman test and it is thus not problematic that the Hausman test could not be conducted.

Following from the random effects method, the final regression equation for the South African banking sector's LRMES takes the form:

$$\Delta LRMES_{i,\mathrm{t}} = \alpha + \beta_1 \Delta LVG1_{i,t} + \varepsilon_{\mathrm{i,t}} \quad \text{(C5.1)}$$

The results displayed in Table C5.6 indicate that only the change in the bank's leverage, i.e. a bank-specific factor influences the change in systemic risk in the banking sector when using

LRMES as a proxy for systemic risk. As expected, an increase in the bank's leverage ratio will result in an increase in their systemic risk contribution. This implies that the greater the change in a bank's leverage ratio, the greater the change in their systemic risk contribution and vice versa.

LIST OF ACRONYMS

ABIL	African Bank Investments Limited
ADF	Augmented Dickey-Fuller
AIG	American Insurance Group
BCBS	Basel Committee on Banking Supervision
BIS	Bank of International Settlements
CDS	Credit Default Swaps
CE	Cointegrating Equation
CLF	Committed Liquidity Facility
CPI	Consumer Price Index
CSD	Central Securities Depository
D-SIB	Domestic Systemically Important Banks
DBSA	Development Bank of Southern Africa
DF	Dickey-Fuller
DFI	Development Finance Institutions
DTI	Department of Trade and Industry
EAD	Exposure At Default
ECM	Error-Correction Model
ETF	Exchange Traded Fund
FAIS	Financial Advisory and Intermediary Services Act
FDI	Foreign direct investment
FSA	Financial Services Authority

FSB	Financial Services Board
FSCA	Financial Sector Conduct Authority
FSRA	Financial Sector Regulation Act
G-10	Group of Ten
G-20	Group of 20
G-SIB	Global Systemically Important Bank
G-SII	Global Systemically Important Insurers
GDP	Gross Domestic Product
IDC	Industrial Development Corporation
IID	Independently and Identically Distributed
IMF	International Monetary Fund
IODSA	Institute of Directors in Southern Africa
IPS	Im, Pesaran and Shin
IRB	Internal ratings-based
JSE	Johannesburg Stock Exchange
KING III	Third King Report on Governance for South Africa
Land Bank	Land and Agricultural Development Bank of South Africa
LCR	Liquidity Coverage Ratio
LGD	Loss-Given-Default
LLC	Levin, Lin and Chu
LRMES	Long Run Marginal Expected Shortfall
LSE	London Stock Exchange
NBFI	Non-banking financial institution

NBNI	Non-bank, Non-insurers
NCA	National Credit Advisor
NCR	National Credit Regulator
NPL	Non-Performing Loans
NSFR	Net Stable Funding Ratio
OTC	Over-the-Counter
PA	Prudential Authority
PD	Probability of Default
ROA	Return on Assets
RODR	Rand Overnight Deposit Rate
ROE	Return on Equity
RWA	Risk-weighted Assets
SABOR	South African Benchmark Overnight Rate
SAMOS	The South African Multiple Option Settlement System
SARB	The South African Reserve Bank
SARS	South African Revenue Services
SIFI	Systemic important financial institutions
SRISK	Systemic Risk Index
UK	United Kingdom
US	United States
V-Lab	New York University Stern Volatility Laboratory
VAR	Vector Autoregressive