THESIS

An empirical analysis of financial stress within South Africa and its apparent co-movement with financial stress emanating from Advanced and Emerging economies.

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DECLARATION

Except for references specifically indicated in the text, and such help as has been acknowledged, this thesis is wholly my own work and has not been submitted to any other University, Technikon or College for degree purposes.

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Abstract

The identification of financial stress, and an understanding of financial contagion on a global scale, is of critical importance to a South African economy that is becoming increasingly integrated into the global economy. The last decade has been characterised by periods of high economic growth, but also periods of significant financial instability culminating in global economic crises. This study examines the extent to which the South African financial system is exposed to distress abroad by identifying and measuring the co-movement of financial stress originating from within and outside South Africa.

The study can be separated into two sections: the identification of financial stress and the measurement of financial contagion. Using monthly data for the period 2000 to 2012, three indices were constructed for the emerging markets, advanced economies and South Africa using variance-equal weighting. The indices were tested for contagion using the Johansen and Jesulius (1990) multivariate cointegration approach supplemented with basic OLS architecture and Impulse Response analysis.

The results indicate the three constructed indices were highly accurate at identifying the intensity and timing of financial stress over the three regions respectively. It was found that the South African financial sector is highly susceptible to financial stress originating from advanced economies. The results obtained for financial stress emanating from emerging markets were not as conclusive and found to be insignificant.

Overall, it is clear that the methods employed to identify financial stress are highly accurate and that South Africa is highly susceptible to financial stress originating from abroad. It is clear that advanced economies have a greater ability to affect financial stress in South Africa via contagion. It must be noted that this does not conclude that South Africa is not affected by emerging market crises, but that these crises tend to affect South Africa through advanced economy channels as defined within this thesis.

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Acronyms

ADF	Augmented Dickey-Fuller
AEFSI	Advanced Economy FSI
AEG	Augmented Engle Granger
AIC	Akaike Information Criterion
BAEFSI	Balakrishnan Advanced Economy FSI
BCA	Bank Credit Analyst
BEMFSI	Balakrishnan Emerging Market FSI
BRIC	Brazil, Russia, India, China
BRICS	Brazil, Russia, India, China, South Africa
CDF	Cumulative Distribution Functions
CFNAI	Chicago Fed's National Activity Index
ECM	Error Correction Model
EG	Engle and Granger
EMFSI	Emerging Market FSI
EMS	European Monetary System
FDI	Foreign Direct Investment
FIH	Financial Instability Hypothesis
FPE	Final Prediction Error
FSI	Financial Stress Index
FX	Foreign Exchange
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
HQ	Hannan-Quinn information criterion
IMF	International Monetary Fund
KCFSI	Kansas City Financial Stress Index
LIBOR	London Interbank Overnight Rate
LR	Long Run
LTCM	Long Term Capital Management
OLS	Ordinary Least Squares
PP	Philips-Perron
SA	South Africa(n)
SAFSI	South African Financial Stress Index
SARB	South African Reserve Bank
SC	Schwarz information criterion
UK	United Kingdom

US	United States
USA	United States of America
VAR	Vector Autoregression
VE	Variance Equal
KCFSI	Kansas City Financial Stress Index
VECM	Vector Error Correction Model

CHAPTER ONE: INTRODUCTION

The turning points following expansions in economic activity are normally caused by turmoil within an economy, and these have recently been observed to originate with financial distress. The identification of financial stress, and an understanding of financial contagion on a global scale, are of critical importance to a South African economy that is becoming increasingly integrated into the global economy. This study is directed at identifying financial stress in South Africa and measuring its co-movement, through increasing levels of financial integration between advanced and emerging markets. Due to complications that arise with the linkages between emerging and advanced economies, the transmission of financial stress is not fully understood.

Interestingly, due to a mixture of historical, fundamental and circumstantial factors South Africa was not directly affected by the financial crisis of 2008 as much as other economies around the world. This meant that South African financial institutions were limited in their exposure to complex foreign financial products, as local banks were subject to fairly conservative financial regulations and maintained fairly stringent risk management practices (Bank for International Settlements, 2010: 371).

Illing and Liu (2006: 1) describe financial stress as the force exerted on economic agents by uncertainty and the changing expectations of loss that may occur in financial markets and institutions. Hakkio and Keeton (2009: 6) extend this description by identifying five behavioural and market characteristics that emerge during periods of financial stress. These are (i) the valuation of assets becomes difficult, (ii) investor behaviour becomes erratic, (iii) asymmetric information increases, (iv) investors' appetite for risk declines and (v) investors move away from illiquid assets. These characteristics tend to heighten financial stress through greater uncertainty and volatility within financial markets, and potentially result in a crisis that can spread to global markets.

Further to the identification of financial stress are the theories of financial contagion. Claessens and Forbes (2001: 22) define contagion as the spreading of market disturbance between different markets. Focusing specifically on financial markets, Dornbusch *et al*. (2000: 178) argue that, following an initial shock to a financial system, contagion may be described as the tracking of multiple markets together due to cross-market linkages that allow financial flows to move between markets. Most literature, according to Kaminsky and Reinhart (2001), focuses on trade links, capital market movements and the role that banks play in transmitting disturbance across borders. Glick and Rose (1998: 4) classify these transmission mechanisms into two broad categories: Firstly, macroeconomic channels whereby two countries with similar economic features transmit contagion between one another purely due to their macroeconomic similarities. Secondly, trade links act as a conduit for the transmission of financial stress as shocks permeate through the prices of imports and exports. A final channel is identified by Cardarelli *et al* (2009: 79), namely a financial channel via which stress is

transmitted through the financial system and, in particular, between banks. The volume of trading means that stress can be transmitted over a very short space of time.

Balakrishnan *et al* (2009: 5) show that a change in the volume of capital flows emanating from advanced economies during a crisis had a significant effect on emerging market economies; with relatively high foreign currency liabilities, emerging markets are at greater risk to fluctuations in exchange rates. Foreign branches of U.S. banks would have less access to their parent banks' balance sheet in times of tighter liquidity in the U.S., hindering credit extension for reasons not directly related to the local economy. The turmoil in advanced economies in 2007 affected many emerging market economies as financial stress caused a slowdown in capital flows while simultaneously widening sovereign debt yields, placing further pressure on foreign exchange markets and their financial systems (Balakrishnan *et al*, 2009: 3). More recently, the potential for sovereign default in various European countries has placed pressure on international banks to recapitalise and strengthen their positions.

Academic literature on financial and banking crises provides a large database of financial stress episodes. The problem with the majority of these studies is that hypotheses are formulated on the basis of unique historical events, highlighting the need for a general index or measure that can identify financial stress and its origins. Such Financial Stress Indices (FSIs) have been developed by Hakkio and Keeton (2009), Illing and Liu (2006), Balakrishnan *et al* (2009) and Cardarelli *et al* (2009), and all have been successful in signalling the most important crises. Balakrishnan *et al* (2009: 9) find that the subcomponents of their index accurately signal the type of crisis they are measuring. By identifying financial stress using market indicators, such as the Beta coefficient and stock market volatility in real time and in high frequency, the FSI does not suffer from the same drawbacks as those based in historical events, since stress can be gauged with the FSI. Thus, it is of the author's opinion, that identifying financial stress within South Africa and analysing the co-movement of financial stress, indicated by similar indices for emerging and advanced economies, will shed light on how the South African economy is affected by distress abroad.

Subsequently, the objectives of the study are twofold: Firstly, to identify financial stress in South Africa and a selection of advanced and emerging market economies using a financial stress index. Secondly, to investigate the relative strength and direction of financial contagion between advanced economies, emerging markets and South Africa.

The methodology used in this paper will be split into two sections: the identification of financial stress and the measurement of contagion. This study will identify financial stress using the methodologies developed by Illing and Liu (2006) and adapted by Balakrishnan *et al* (2009) and Cardarelli *et al* (2009). The indices are constructed from indicators taken from the banking sector, the securities sector and the foreign exchange sector. The choice of indicators will be limited to the availability of data and a preference for parsimony (Balakrishnan *et al*, 2009: 7). The indicators used are the beta of the banking sector, the spread of government debt, the spread of corporate debt, stock market

volatility and foreign exchange volatility. The aggregation of the indicators into an index, and the sub-indices into the final indices is based on variance-equal weighting, which gives equal importance to each variable. The countries used within the analysis are chosen based on their relative importance to South Africa, the size of their economies and data availability. The relative importance to South Africa is determined by analysing South Africa's largest trading partners. The countries chosen for the advanced economy index are Germany, the United States of America, France and Japan. The countries chosen for the emerging market index are Brazil, Russia, China and India.

The three constructed indices are then used to test for the co-movement of financial stress. OLS architecture and the multivariate Johansen cointegration analysis are used to investigate the short-run and long-run interaction between the emerging market index, advanced economy index and the South African index. The Johansen cointegration analysis is supplemented by impulse response analysis to gain further understanding of shock permeation on the South African index.

The study incorporates six chapters including the introduction. Chapters Two and Three study the leading theoretical and empirical literature surrounding the identification and contagion of financial stress. Chapter Four explains the methodologies used to answer the research the question and states the author's a priori expectations. Chapter Five presents and analyses the results of the empirical study. And finally, Chapter Six concludes the study and discusses possible areas of future research.

CHAPTER TWO: THEORETICAL ISSUES AND LITERATURE SURVEY

2.0 Introduction: Conceptualising Financial Stress

This chapter reviews the theoretical underpinnings of financial stress and financial contagion. In order to conceptualise financial stress, the chapter begins with an example of systemic stress and its effects on economic activity. Thereafter, the chapter is split into two sections. Section 2.1 discusses the key features of financial stress and positions why these key features could potentially cause stress to manifest within the economy and effect economic growth. Section 2.2 positions and explains the role of financial contagion. Within section 2.2, a brief discussion of the theoretical transmission mechanisms is discussed to highlight the channels with which financial contagion can be spread throughout an economy. The basic theories on financial contagion and the causes of financial contagion complete section 2.2, and section 2.3 concludes the chapter.

Financial stress initiated from advanced economies in 2007 and threw both emerging and advanced economies into economic turmoil. The collapse of the property market in the United States led to the collapse of the complex derivative markets related to the property market, leading to the near disintegration of the financial system in mature economies. A serious blow to confidence was dealt by the failure, in September 2008, of a prominent investment bank in the US which, through its activities and transactions, was directly and indirectly interconnected with numerous banks and other financial institutions in many parts of the world. This contraction immediately spread to developing countries due to high levels of financial integration and liberalisation (SARB, 2008: 34). Initially emerging economy stock markets crashed, and this was followed by a massive decline in bank lending and interruptions to credit channels. The financial stress, summarised and explicitly referred to above, caused a slowdown in capital flows while simultaneously widening sovereign debt placing significant pressure on the global financial system (Balakrishnan *et al*, 2009: 3).

The study of financial and banking crises is extensive and provides a large database of financial stress episodes. The problem with the majority of these studies is that these academic studies formulate hypotheses on historical events such as the erosion of bank capital or the disintegration of credit channels and apply the conclusions from these past events to a current crisis. The shortfalls of such actions are apparent as no two events are ever identical, thus the application of one crisis solution to another is never without a degree of error and is thus not well suited to measure financial stress and its diffusion. Balakrishnan *et al* (2009: 6) highlight these detractions with the following two reasons. Firstly, econometric techniques often use zero-one binary variables whereby a result is either a crisis or no crisis. A measure of this type provides no interim explanation for 'near misses' or the intensity of the crises and stress within the system. Secondly, studies of crisis generally identify sector specific

crises, such as currency crises, banking crises or debt crises, but pay very little attention to the stresses inherent in the system as a whole. The importance of this is paramount as the various sections of the financial system are progressively becoming more integrated and contagion within the financial system is progressively greater and efficient at creating system-wide crises (Balakrishnan *et al*, 2009: 6).

Illing and Liu (2006: 244) note that if financial stress is systemic, the real economy can be significantly influenced by changing economic behaviour. Therefore stress can be thought of as a by-product of financial loss, risk or uncertainly within the economy. Extending this thought process; financial stress can be explained as a continuous variable within a spectrum, where extreme values are called a crisis. Balakrishnan *et al* (2009: 6) believe financial stress is a system-wide contagion where financial stress is defined as "a period when the financial system is under strain and its ability to intermediate is impaired." Financial stress which may originate domestically or internationally subsequently shapes the demand and supply of funds, thus asset price volatility and stress may diffuse throughout the different segments of the financial system (Balakrishnan *et al*, 2009: 6).

2.1 Key Features of Financial Stress

Key features of financial stress and the manner with which they are explained vary substantially between authors. Balakrishnan *et al* (2009: 6) and Hakkio and Keeton (2009: 6) highlight that interruptions to the normal functioning of financial markets can differ to such a large degree that correlating and comparing two different episodes of financial stress can be futile and lead to incomplete results. Key phenomena, though, tend to be exhibited within the financial system during times of stress: the relative importance and influence of these phenomena varies between different episodes of financial stress but every episode of financial stress tends to exhibit at least one of the phenomena if not most of them (Hakkio and Keeton, 2009: 6). Following Hakkio and Keeton's argument, the key features of financial stress are highlighted below.

2.1.1 The Valuation of Assets

The uncertainty associated with the valuation of assets by lenders and investors is a common indicator of financial distress. The uncertainty of asset prices generally leads to greater volatility within their various markets and the economy as a whole (Hakkio and Keeton, 2009: 6). Cash flows generated from financial assets depend on future economic conditions, and as a result, with greater uncertainty inherent within the economy, lenders and investors become less sure about the discounted value of these cash flows (Hakkio and Keeton, 2009: 7).

Knightian theory can be indicative of this whereby risk is viewed as unknown and unmeasurable in which case the risk would be uncertain. If the distribution of the variable is known then the risk associated with the variable would be measurable (Bewley, 2002: 79). This places great pressure on asset prices where assets are relativity new and there is no historical data with which to analyse and

understand what may cause fluctuation in the asset's price. Hakkio and Keeton (2009: 7) touch on Knightian theory by explaining that uncertainty towards the behaviour of a new assets price will increase when losses are incurred on the asset for the first time. As the behaviour of the asset historically is not well known, investors would not be able to form a judgment on the behaviour of the assets returns. To expand this ideology further, if losses are incurred and cannot be explained or were not expected on an existing product, whether because of changing market dynamics or because the application of the asset has changed, the historical data used to predict the future behaviour of the asset becomes less relevant and the underlying principles behind Knightian theory apply as historical data could lead to inaccurate predictions.

Easley and O'Hara (2009: 3) use Knightian theory to explain how uncertainty within the market can play a distinctive role in influencing the behaviour of players within a previously existing market. Easley and O'Hara highlight that uncertainty within the market can cause players to not participate in trade and therefore overall trade volume declines. Furthermore when participation does occur, it is generally in the form of market players attempting to short their positions leading to a problem whereby everyone is either abstaining from the market or selling, potentially leading to large asset price shifts and low liquidity.

2.1.2 Increased Uncertainty about the Behaviour of Other Investors

Instability within the market at times is driven by investors making decisions that are not rational. A basic tenet of classical economic theory is that an agent makes investment decisions based on rational expectations (Scharfstein and Stein, 1990: 465). During times of crisis, the behaviour of investors becomes erratic which leads to the value of assets varying in an erratic manner (Hakkio and Keeton, 2009: 7). Keynes (1936: 140) likens professional investment to a competition whereby investors have to pick the six prettiest faces from a number of photographs, the winner being the person who picks the prettiest girl determined as the group's consensus. Keynes states that the idea is not to pick the prettiest girl according to your preferences but the prettiest girl you think the group will like the most. Allen *et al* (2006: 720) explain that understanding financial markets is as much an understanding about the products and structures within the market as it is an understanding about the behaviour of people within that market and how they react to different situations. Uncertainty within the market is exaggerated by the tendency of investors guessing about what other investors are doing, rather than making investing decisions with an educated backing; this inflates price instability further (Hakkio and Keeton, 2009: 8). An example of this irrational type of behaviour is herding, whereby for no apparent reason, an investor will make a decision based purely on the decisions that someone else has made, disregarding information that may not qualify the decision, even if the decision to follow is incorrect (Scharfstein and Stein, 1990: 465). A cycle of "follow the leader" can develop whereby no one is leading and everyone is following and the market breaks into irrational shifts and movements.

2.1.3 Asymmetric Information

Asymmetric Information is another common sign of financial stress and tends to occur when one party in a transaction does not know enough about the other party within the transaction to make accurate decisions about their dealings. The lack of information creates a problem before and after the transaction occurs within the financial system (Mishkin, 2004: 37). Adverse Selection is the problem created by asymmetric information before the transaction occurs. This is because the people who are likely to be borrowers are further the people who are most likely to default, i.e. they are high risk. The problem arises where not all people carry the same amount of risk and the lender has very little means to determine who carries the greater risk. Thus, borrowers with good credit risks may not get loans due to the lender's lack of available information to distinguish them from borrowers with bad credit risks (Mishkin, 2004: 37). Subsequently, moral hazard occurs after the transaction takes place. Moral hazard is the risk that the borrower might act in a manner that is undesirable from the point of view of the lender (Mishkin, 2004: 38). This increases the risk of default for the lender and in turn lowers the amount of loans the lender grants (Mishkin, 2004: 24). According to Hakkio and Keeton (2009: 9), asymmetries of information worsen during times of financial stress for two reasons. Firstly, the quality of borrowers and/or assets changes during times of crisis. Akerlof (1970: 489) highlights the idea of "lemons" whereby a lemon is a bad car (to adopt Akerlof's example), because when a consumer buys a new car, they do not know if that car is a good quality car or a lemon. The realisation of whether the car is of good or bad quality only occurs once the purchase has been made and the vehicle used for a period of time, thus an asymmetry of information has developed. The problem that occurs is that the prices of cars do not generally reflect their quality and there is no way for the buyer to discern the vehicle's quality without buying it. To compound this further, Akerlof (1970: 489) highlights that the reason for the seller trying to sell the vehicle is of further importance as one can ask: "Why is the car being sold if it is good quality?" Thus each party involved in the transaction cannot identify the true risk involved in the transaction due to asymmetries of information which exaggerate stress within the market.

Secondly, stress can be worsened when investors lose trust in the mechanisms provided to supply information i.e. credit ratings (Hakkio and Keeton, 2009: 9). Financial markets to this day react considerably to a change in a credit agency's rating on sovereigns and companies. But the ability of these companies to accurately predict the risk profile of a client is hard to determine as different companies use different means with which to rate clients. Thus, a company may be downgraded by one agency and not by another, not to mention that none of the major rating agencies correctly rated the financial sector before the financial crises in 2008. Once confidence is lost in such a tool, investors become uncertain about risk inherent in the system and may make bad investments; thus increasing asymmetric information and stress within markets (Hakkio and Keeton, 2009: 9).

2.1.4 Flight to Quality

A key feature of financial stress is a decrease in the willingness to hold risky financial assets. This shift away from risky assets towards safe assets widens the yield spread between assets of the same class and increases the cost of borrowing within the economy (Hakkio and Keeton, 2009: 9). Hakkio and Keeton attempt to explain this change in emphasis with an attempt to answer what could cause lenders and investors to change their risk appetites and hold different assets accordingly.

Minsky's Financial Instability Hypothesis (FIH) can be adopted in an attempt to explain this shift away from risky assets. The FIH attempts to account for the composition and structure of a crisis. The essence of the FIH lies in Minsky's belief that capitalist economies are inherently flawed and unstable because of the instability of the financial system. Minsky's focus, which is shared by much of modern financial macroeconomics, is accordingly on financial fundamentals at the microeconomic level (Keen, 2010: 6). As the economy advances through the business cycle, the behaviour of economic agents changes depending on current and future expectations at that point within the cycle. The actions of economic agents can be characterised by three general 'phases': the Hedging phase, where the economy is beginning to grow but actions are generally conservative due to recent losses; the speculative phase, where a euphoric economy develops whereby lenders and borrowers are extremely confident about future prospects and that their investments will succeed; and finally the Ponzi phase, which involves the considerable accumulation of debt in order to finance the trade of assets on a rising market (Keen, 2010: 6). In other words, agents believe that markets will continue to rise at a rapid rate and expand credit facilities to fund day-to-day operations in the hope that on the sale of assets, they will make a profit and be able to pay off their credit facilities i.e. they become over-leveraged.

Minsky's FIH derives distinctly from Keynes General Theory which is highlighted in Keynes's idea of 'animal sprits', and can clearly been seen as a backbone within the FIH (Keen, 1995: 607). Fundamentally Keynes and Minsky highlight how an economic agent's preference towards risk changes, and the role that the agent plays in manipulating the state of the economy, as the economy passed through various different phases.

This is a methodology of thinking that allows us to understand what could cause lenders and investors to become less willing to hold risky assets? The key idea is that of animal spirits, whereby emotions and illogical decisions lead to investors and lenders forgetting the bad times and just focusing on the good. This transition towards a Ponzi phase where eventually the economy collapses into a recession is due to bad credit decisions and poor investments from both lenders and borrowers and highlights the financial stress within the economy. But it is the signal of people who have realised that an eventual bust is imminent and in a supposedly rising market attempt to buy safe assets; such a shift in preferences causes lenders and investors to re-align their preferences with 'normal times' and demand higher rates of return on risky assets and lower rate of return on safe assets. This shift in preferences from risky to safe assets is known as the "flight to quality" (Hakkio and Keeton, 2009: 10).

2.1.5 Flight to Liquidity

A "flight to liquidity" is the final sign of financial stress inherent within the economy. The reason why investors seek liquidity in tough times is because an illiquid asset cannot be sold at short notice at a value close to its face value, and this can further be exaggerated if a secondary market for the asset is thin and underdeveloped or non-existent. An underdeveloped secondary market can additionally impede the market as a substantial sale can greatly affect the equilibrium price of the asset (Hakkio and Keeton, 2009: 10).

A flight to liquidity can occur with an unexpected increase in the demand for cash. An example of when this could occur is if a leveraged investor's holding becomes volatile and is required to liquidate assets in order to meet margin calls (Hakkio and Keeton, 2009: 10). In order to guard against the risks associated with illiquid assets in times of instability, investors will tend to hold a greater proportion of liquid assets to meet short term obligations (Hakkio and Keeton, 2009: 11).

A flight to liquidity can also occur if asymmetric information leads to the value of certain assets declining. In such a situation, players within the market will look at these assets as now being illiquid as these assets cannot be sold without investors making a substantial loss (Hakkio and Keeton, 2009: 11).

The definition of financial stress adopted for this thesis is a conglomeration of the definitions given by Balakrishnan *et al* and Illing and Liu. "An episode of financial stress is defined as a period when the financial system is under strain and its ability to intermediate is impaired" (Balakrishnan *et al*, 2009: 6) and "a force exerted on economic agents by uncertainty and changing expectations of loss in financial markets and institutions" (Illing and Liu, 2006: 244)

2.2 Contagion of Financial Stress

Dornbusch *et al* (2000: 178) state that contagion can be defined as the change in cross- market linkages after a shock to the financial system by either turmoil in an individual country, or a group of countries, whereby asset prices track each other across these various markets.

Financial contagion is a phenomenon that has affected the global economy increasingly over the last couple of decades. To emphasise with the use of recent examples: during 1997, financial turbulence hit many East Asian countries and then spread to many other parts of the world well into 1998. The result was massive capital market turbulence in many industrialised countries that affected the flow of capital to emerging markets, which eventually plunged them into recession. The effects of contagion were well known by this stage; in 1994 the "tequila effect" that was caused by the rapid devaluation of the Mexican peso in 1994, heavily affected many Latin American countries (Dornbusch *et al*, 2000: 178). More recently in 2007, the collapse of the property market in the United States led to the collapse of the complex derivative markets related to the property market, leading to the near disintegration of the financial system in mature economies. A serious blow to confidence within the

financial system was dealt by the failure, in September 2008, of a prominent investment bank in the US which, through its activities and transactions, was directly and indirectly interconnected with numerous banks and other financial institutions in many parts of the world. This contraction immediately spread to developing countries due to high levels of financial integration and liberalisation (SARB, 2008: 34).

Kaminsky *et al* (2003: 5) define contagion in a similar fashion to Dornbusch *et al* (2000) by stating that contagion is present when an episode or development has an immediate effect in multiple countries within a reasonable space of time. Claessens and Forbes (2001: 22) define contagion as the spreading of a measurable market disturbance between multiple counties. Contagion can affect the economy through many channels or co-movements such as exchange rates, stock prices, sovereign spreads and capital flows.

2.2.1 Traditional Transmission Mechanism

Before dealing with the theories of contagion and the underlying causes thereof, a discussion about the popular transmission mechanisms will enlighten the discussion further. In an ever increasing globalised economy, these transmission mechanisms can have far-reaching effects and provide a fundamental understanding that can be applied across national boundaries. These fundamental understandings are the aim of this section so that these fundamentals can be used to enhance the understanding of financial contagion. Monetary Transmission can be categorised into two broad categories: neoclassical channels and non-neoclassical channels (Boivin *et al*, 2010: 5).

Neoclassical channels are considered to be within perfect markets. These traditional channels are modelled around investment, consumption and international trade of the 20th century (Boivin *et al*, 2010: 5). Each of these channels differs around the perspective with which they are formed. For example, when monetary policy tightens and interest rates rise, the demand for credit, such as mortgages, declines. This lowers the demand for housing and general aggregate demand, which in turn reduces the value of housing and the level of wealth within the economy, i.e. reducing the general levels of investment within the economy (Boivin *et al*, 2010: 11). Consumption-based channels are a conduit whereby a stimulus of sorts changes the way in which consumers spend. Any change to consumer wealth or a change to preferences such as intertemporal substitution affect a consumer's profile and thus affect the performance of the economy as a whole (Boivin *et al*, 2010: 12).

Non-neoclassical channels, which many authors refer to as credit channels, arise due to imperfections within the market (Boivin *et al*, 2010: 15). These imperfections have their origins either from government intervention or from imperfections within the private markets, such as asymmetric information, that lead to markets not performing as expected. The three channels highlighted by Boivin *et al* are the effects on credit supply from government intervention, bank-based channels and balance sheet channels (Boivin *et al*, 2010: 15). The effects on credit supply via government occur when governments interfere in the market to force a certain initiative such as lowering inflation

(Boivin *et al*, 2010: 15), in other words, changing either the key interest rate or the level of fiscal stimulus, which can have far-reaching effects on the economy. Bank-based channels play a special role as loans from banks are not perfect substitutes for other sources. The appetite for risk that banks are willing to hold when issuing credit is directly influenced by the level of reserves and the key interest rate that central banks enforce on them. Furthermore, banks are well placed to minimise asymmetric information compared to other issuers of credit. Thus, the central bank can influence the level of credit extended via banks and thus indirectly affect the level of investment and consumer spending within the economy (Boivin *et al*, 2010: 16). A secondary channel that affects a bank's willingness to extend credit is the state of the bank's balance sheet. If the value of assets on a bank's balance sheet diminishes, the amount of capital diminishes. Due to capital requirements set by international accords, this will reduce the amount of credit that can be issued by the bank and indirectly affect the levels of investment within the economy (Boivin *et al*, 2010: 19). Finally, the balance sheet channel arises from the presence of asymmetric information within the credit market. As a result, lenders will be less willing to make loans which will lead to a reduction in spending and aggregate demand (Boivin *et al*, 2010: 20).

2.2.2 Theories of Contagion

Now that a theoretical foundation has been created about the transmission mechanisms that can influence the real economy, a discussion about contagion can commence using these fundamental principles. There are two broad categorisations of contagion between economies: spillovers and pure contagion. Spillovers result from the normal interdependence between two different market economies. Through this interdependence, shocks can be transmitted between two economies. Spillovers do not generally constitute contagion, but in times of crisis, may be construed as contagion (Dornbusch *et al*, 2000: 179). Pure contagion, on the other hand, involves a financial crisis whereby there is no observed change in macroeconomic or any economic fundamentals but is the sole result of a change in the behaviour of investors and economic agents. Dornbusch *et al* (2000: 179) simplify this definition by stating that the difference lies in the rationality of investors and economic agents. Similarly, referring to how contagion may transmit through emerging markets, Masson (1999b) proposes a taxonomy whereby a common cause to all countries involved is the reason for contagion, such as a change in US monetary policy (Monsoonal effects). This can occur through Macroeconomic linkages such as trade flows (Spillovers) or via pure contagion whereby there is no change in local macroeconomic policy yet contagion is highly prevalent.

Pure Contagion

Kaminsky *et al* (2003: 4) build their hypothesis of financial contagion around what they call the "Unholy Trinity", which attempts to explain why financial contagion occurs across some borders and not others. Firstly, contagion usually followed on the heels of a sudden increase of capital inflows and this shock could possibly cause the bursting of the capital flow bubble i.e. the "sudden stop problem".

Secondly, an announcement of the change in capital flows that set off the chain reactions was a surprise to financial markets, meaning that the stimulus to the economy was not expected and that rational expectations are thus impaired. Finally, a leveraged creditor has to be involved with the propagation of financial stress between countries, thus placing stress within the financial system. With the use of the unholy trinity, Kaminsky *et al* convey that financial linkages and investor behaviour figure most prominently in the theoretical discussions of financial contagion.

Irrationality: "Herding"

Kaminsky *et al* (2003: 5) explain an information cascade as a scenario whereby it is optimal for an individual to make a decision purely on the basis that another individual made the same decision without taking into account information that may state otherwise. The decisions of other players in the market can at times reflect important information that may not be apparent to the entire market. It is the presence of these types of information asymmetries that lead to irrational investor behaviour. According to Kaminsky *et al* (2003: 5), this can explain to some extent the irrational volatility that may be inherent within the market.

The irrationality of investors within the market is no new phenomenon. Again, using Minsky's Financial Instability Hypothesis, drawing heavily from Keynes "animal spirits", explains how investor behaviour can cause volatility within the economy and lead to herding behaviour. Minsky's FIH attempts to account for the composition and structure of a crisis, and to explain the dynamics of the business cycle. The essence of Minsky's FIH lies in the belief that capitalist economies are inherently flawed and unstable because of the instability of the financial systems. The hypothesis links to herding behaviour in that it is the frame of mind of the investor that heavily influences the "mood" of the economy (Keen, 1995: 611). This "frame of mind" is highly contagious and begins when an investor is in a hedging phase. Investors all have a high level of risk aversion and thus abstain from risky activities, but, as confidence within the economy increases, the behaviour of investors, and thus their actions, becomes ever more speculative. Investors begin to succeed at unprecedented levels and confidence within the economy begins to grow which leads to further speculative activities until the level of confidence within the economy reaches levels where Ponzi finance, spurred by the euphoric economy, characterises market behaviour. The change in mood between investors spreads as only positive feedback from investment accrues. It is this addictive behaviour that leads the economy to such a position that the level of risk has increased so high that the bubble bursts, leading to an economy wide slump in investor sentiment i.e. market player sentiments herd together (Keen, 1995: 611).

The similarity between Minsky's FIH and Keynes's "animal spirits" is evident as the idea is central to both theories. Keynes highlights that apart from the instability that is associated with speculation, it is human nature to make a large proportion of decisions based on a spur of the moment idea rather than a mathematical expectation (Dow and Dow, 1985: 46). The link between Minsky's euphoric economy

and the behaviour thereof, Keynes's animal instincts and the herding behaviour highlighted by Kaminsky *et al* (2003) is all based on the irrationality of economic agents.

Using a hypothesis coined by Goldstein *et al* (2000), the wakeup call hypothesis, Masson (1999a: 11) highlights that pure contagion can be apparent when a crisis abroad, without any significant links between the two countries, can highlight vulnerabilities within the financial system, even without these vulnerabilities coming to the fore. Masson uses the example of Thailand whereby the local banks and financial institutions were driven by the evils of crony capitalism. This revelation allowed the remainder of the world to realise that that the "Asian Miracle" was actually an "Asian Mirage".

Spillovers

Spillovers result from the traditional transmission mechanisms that exist between economies. These linkages allow for shocks to be transmitted whether they are of a financial or physical nature (Dornbusch *et al*, 2000: 179). Rijckeghem and Weder (1999: 3) simplify this definition by stating that spillovers result from real inter-linkages between affected countries. Various authors believe that spillovers may not technically be contagion as they are transmitted via identifiable channels. But as they normally occur during times of a crisis, and cannot necessarily be controlled or restricted, they may be expressed as contagion (Dornbusch *et al*, 2000: 179).

Eichengreen *et al* (1996: 37) set out to investigate two channels of contagion: trade links and macroeconomic similarities. Their results indicate that the effect of contagion operating through trade is stronger than that of contagion spreading as a result of two countries' macroeconomic similarities. Macroeconomic policies can tend towards financial contagion which has been shown by the effects that the tequila crisis had on countries such as Malaysia and Thailand, where trade links are all but non-existent. Glick and Rose (1998: 4) emphasise this, stating that a crisis may spread from the initial target country to another country if the two countries share various economic features.

Following on from Eichengreen *et al* (1996), Glick and Rose (1998: 2) set out to add to the literature on the contagion of a currency crisis, but more importantly, to emphasise the importance of trade links as means of spreading contagion. They emphasise this by stating that since trade patterns are negatively affected by distance, and thus countries tend to trade with those closest to them geographically, a currency crisis will tend to be regional (Glick and Rose, 1998: 5). A more indirect trade link is through competition in third markets whereby a crisis in one country, generally through a depreciation of its currency, affects other countries that export to that country (Rijckeghem and Weder, 1999: 4). Kaminsky *et al* (2003: 6) emphasise that trade linkages are often a voluntary means of contagion. The devaluation of a currency from a foreign country makes that country's goods more competitive internationally, thus the home country's goods become less competitive. In order to maintain the competitiveness of exports, trade competitors of the initial devaluation country, may be led to devalue their own currency to restore competitiveness. Although this explanation ignores

central bank intervention in maintenance of the currency, it does bring to the fore the effect of synchronised devaluations.

Financial market inter-linkages are a further means for contagion to manifest and generally take the form of shifts in investors' portfolios (Rijckeghem and Weder, 1999: 4). There are several mechanisms with which banking centres can cause cross border spillovers: if losses are being incurred in one country, banks will tend to sell off assets in other countries in order to restore their capital adequacy ratios. Most importantly, when banks are managing their risk portfolios, they will readjust their securities portfolio in various countries to maintain an acceptable level of risk (Rijckeghem and Weder, 1999: 5).

The underlying logic adopted by Rijckeghem and Weder (1999: 5) is that generally bank exposures in markets affected by a financial crisis are large and therefore banks have to rebalance their portfolios, absorb bad debts, manage illiquidity and eventually incur losses as a result. Thus an informal test of the common bank lender effect is to measure the losses that a bank incurs during a crisis. Rijckeghem and Weder (1999: 17) note that the bank lending channel had significant spillover effects during the Mexican and Russian currency crises.

The financial channel can also be utilised by investors required to make margin calls in time of low liquidity.

Another example, provided by Kaminsky *et al* (2003: 8), explains how market liquidity can lead to spillovers between assets classes and markets. In times of market stress, a highly leveraged investor may need to sell off assets to cover short term obligations. The chances are, due to the market disturbance, other investors are in a similar position. Thus a "lemons problem" may occur where assets may only be sold in a fire sale. Logically, investors will not want to sell the asset whose price has already collapsed, but another asset whose price has not collapsed in the attempt to reduce losses. In doing so, however, other asset prices fall as different classes of assets flood the market and the original disturbance spreads across markets.

2.2.3 Underlying Causes of Contagion

Contagion has its roots in macroeconomic shocks that fluctuate through trade links, competitive devaluations and financial links (Dornbusch *et al*, 2000: 180). But the cause of these shocks, and the reason why these shocks may or may not occur, has not been dealt with yet.

Dornbusch *et al* (2000: 180) highlight two major variations in the causes of contagion: fundamental causes and investors' behaviour.

Various studies have highlighted that certain common shocks can trigger markets around the world to change. A change in macroeconomic policy in an advanced economy, such as a change in US interest rates, can trigger a crisis in emerging markets. An example given by Dornbusch *et al* (2000: 180) is the strengthening of the US dollar between 1994 and 1995, which was an important factor in the export downturn in various parts of Asia thereafter.

As stated above, trade and financial links are major channels of contagion between countries (Glick and Rose, 1998; Rijckeghem and Weder, 1999; Kaminsky *et al*, 2003). But this is also a fundamental cause of contagion and thus crises. For example, Dornbusch *et al*. (2000: 180), note that if a specific country has a crisis within its local market that leads to a currency devaluation, it could be expected that trading partners be affected by declining asset prices, large changes in capital flows and may even become the target of speculative currency attacks as investors anticipate a decline in exports to the crisis country. This opens the door for strategic currency devaluations explained by Dornbusch *et al* as "games". The logical thought process for players in a game is to try and anticipate what the moves of other players may be; thus, to follow Dornbusch *el al.*'s example, if market players believe a currency crisis will lead to a game of competitive devaluation, they will sell off their securities to other markets and minimise exposure to where they believe they will incur losses (Dornbusch *et al*, 2000: 180). Thus, all the channels referred to above are both the medium through which contagion spreads and also the root cause for contagion to manifest.

Investors' Behaviour

The manner in which a crisis spreads depends on how integrated a market is in the global economy. The higher the level of integration, the higher the co-movement in asset prices and markets will be with the global equivalent. It should be highly evident then that the financial markets facilitate contagion rather than causing them. Thus all that is left to cause these disturbances, at the root, are the actions of players in the market (Dornbusch *et al*, 2000: 181). These behavioural characteristics can be explained following Dornbusch *et al* (2000: 183).

Information Asymmetries and Coordination Problems

Lack of information within the financial system leads investors to make decisions based on incomplete information. Thus, a crisis in one country may lead an investor to believe that the crisis may transfer to the local country, i.e. the explanation of countries with similar macroeconomic fundamentals holds true in this situation. Glick *et al* (1998: 4) emphasise this, stating that a crisis may spread from the initial target country to another country if the two countries share various economic features.

Multiple Equilibrium

Investor behaviour or expectations are a cause of contagion in economies of multiple equilibria. Contagion occurs in this context when a crisis in another country leads to other markets shifting to a worse position. The change in equilibria is due to a change in investor expectations, usually a mass change in an individual's wealth outlook. An example of this adopted by Dornbusch *et al* (2000: 184) is the scenario of a bank run: it is logical for an investor to hold money either at a bank or not, depending on the action of other depositors. Thus, if all other depositors are removing their holdings, and a good knowledge of fractional reserve banking is understood, the logical outcome is to remove

your holdings before it is impossible to do so. The consequence, though, may be the failure of a bank with far-reaching effects.

Changes in the Rules of the Game

Discussion over the Russian default in 1998 caused an increased concern that other countries may adopt similar unilateral policies regarding the treatment of foreign private creditors or that international financial bodies may not bail out these creditors as expected (Dornbusch *et al*, 2000: 185). These types of discussion cause changes in investors' perceptions of economic extremes and may change the way in which they view the 'rules of the game'. The changing of rules causes volatility within the market until consensus of expectations realigns at a new equilibrium (Dornbusch *et al*, 2000: 185).

Why Contagion occurs in some instances and not in others

Kaminsky *et al* (2003: 2) set out to explain why financial contagion across borders occurs in some cases and not in others. As stated above in the introduction, they build their hypothesis around what they term as the 'unholy trinity' to distinguish why financial contagion occurs at some times and not at others.

The Capital Flow Cycle

When volumes or surges of capital inflows into a country come to a stop in the wake of a crisis, usually in a violent manner, 'fast and furious' contagion generally follows. The inflow of capital is usually driven from the financial sector and is usually financed by short-term debt which means that investors are always having to plan the next rollover and are thus highly leveraged. In predictable times these rollovers can be planned and adjusted according to market conditions, but when capital flows are unpredictable and come to a standstill, leveraged debt and rollover periods become a serious concern for default (Kaminsky *et al*, 2003: 13).

Kaminsky *et al* (2003: 13) highlight that the capital flow cycle has played a significant role in determining whether the effects of a crisis have international ramifications.

Surprise Crises and Anticipated Catastrophes

The type of capital flow cycle represented above can have a high level of surprise associated with it compared to normal functioning times. Kaminsky *et al* (2003: 17) highlight the critical aspects by explaining a hypothetical situation whereby potentially affected countries have a common lender. If the common lender is taken by surprise when a crisis emanates, the lender does not have time to rebalance its portfolios and withdraw from the effected country and cannot limit the damage and reduce loss. Kaminsky *et al* (2003: 19) find in summary that anticipated crises are preceded by credit rating downgrades and widening interest rate spreads before the crisis, while in an unanticipated crisis the downgrading and widening of spreads occurs during the crisis.

Common Creditors

Kaminsky *et al* (2003: 3) conclude their discussion of the unholy trinity by stating that a common leveraged creditor was always involved in the propagation of financial contagion between markets in times a significant international economic turmoil.

2.4 Conclusion

This chapter explored the various theoretical ideologies of financial stress and financial contagion. The chapter began by positioning the idea of financial stress with an example of the recent credit crisis in 2007–09. The underlying danger of financial stress can be stressed through its intangible nature and the ability of financial stress to spread between economies.

The discussion that followed, on the key features of financial stress, highlighted five symptoms that are always present, wholly or individually, during times of crises: the uncertainty of the valuation of assets leads to volatility within markets as asset prices adjust rapidly; the uncertainty associated with the behaviour of other investors is a key feature during times of financial stress, as investors act in an un-rational manner and become unpredictable; asymmetric information becomes more prevalent as a lack of information impedes all stages of a transaction; investors tend to move towards safe assets with lower returns due to the unpredictability of more risky assets; and finally, investors tend to move to assets that are liquid allowing them the ability to change their portfolios quickly. These symptoms all indicate that financial stress can be transmitted or shifted between asset classes and economies, which led into the chapter's second discussion.

The discussion on financial contagion began with the distinction between neoclassical and non-neoclassical channels. The distinction is fundamentally simple in that neoclassical channels are considered within perfect markets and non-neoclassical are not. The section positioned the conduits with which financial stress can move between asset classes and economies and highlighted the theories of financial contagion. Pure contagion involves a financial crisis whereby there is no observed change in macroeconomic or any economic fundamentals but is the sole result of a change in the behaviour of investors and economic agents. Spillovers result from the normal interdependence between two different market economies. The chapter concluded with the underlying causes of contagion: fundamental issues such as the changing of the key interest rate could cause a crisis at home or another economy due to real linkages, and investors' behaviour and the actions of players within the market are the root cause of stress and its transmission within the global economy.

The next chapter reviews the empirical literature regarding financial stress and financial contagion.

CHAPTER THREE: EMPIRICAL LITERATURE REVIEW

3.1 Introduction

This chapter considers the empirical literature that discusses and tests financial stress and contagion. The chapter is divided into three sections. Section 3.2 discusses how various authors identify and measure financial stress. Section 3.3 studies empirical literature on financial contagion and is sub-divided into three sections. The first subsection is an introduction to financial contagion, the second subsection discusses financial linkages of contagion and the third subsection discusses non-specific financial channels. Section 3.4 concludes the chapter.

3.2 Financial Stress

Illing and Liu (2006: 243) developed an index of financial stress with the aspiration of formalising the concept of financial stress and evaluating how the index performs compared to well-known crises in Canada. While studies have devoted much attention to the identification and early warning indicators of crises, few have devoted attention to measuring the severity of crises. The BCA (Bank Credit Analyst) constructed a FSI for the United States and Bordo and Shwartz (2000) constructed a financial instability index. Illing and Liu (2006: 257), while modelling both the above FSIs for comparison, found that neither style captures a large number of stressful events that were highlighted by their survey, which was compiled from every Bank of Canada Annual report since 1977 and every Monetary Policy Report since 1995. Stressful events were highlighted if they had a significant impact on the Canadian financial system. Illing and Liu (2006: 257) did not find it surprising that both models were inaccurate at highlighting financial stress as the variables used in these models were cyclically driven rather than event driven.

In the construction of their index, Illing and Liu (2006: 250) highlight two important elements that need to be considered: the choice of variables and how they are weighted. The variables included were obtained from literature pertaining to the banking, foreign exchange, debt and equity markets while GARCH estimation techniques were used to extract volatility measures from pricing variables.

The first of the variables is the beta of the banking sector which is a measure of relative equity return and volatility of banking stock compared to the market, and can thus be used as an indicator for banking sector stress. An adjustment is made when the market is achieving high growth levels in order to normalise risk associated with the banking beta (Illing and Liu, 2006: 251). A hybrid volatility loss measure, CMAX calculation, is used to measure foreign exchange risk. To measure financial stress in the debt markets, Illing and Liu (2006: 252) determine the spread between risky and

risk free bonds as this is a function of expected loss. The bid offer spread of 90-day government Treasury Bonds is used to proxy market liquidity, and finally equity market stress is measured with the use of the CMAX calculation on stock market indexes.

Illing and Liu (2006: 255) use three different weighting methods in combining the different variables into one index, as the lack of a reference series with which to draw comparisons is not available. The different methods used were factor analyses, credit weights, variance-equal weights and transformations using credit default swaps. The results indicated that, apart from factor analyses, the other techniques produce very similar results when applied to the standard variables.

In comparison to the Bordo and BCA FSIs, Illing and Liu's FSI manages to capture 75–85% of stressful events highlighted whereas the other FSIs achieve far lower accuracy. The GARCH variables index and factor analyses index did not perform well, while the best performing index was the credit-weighted standard variable index which had the lowest number of type one and two errors. In fact, the credit-weighted standard variable index highlighted unknown periods of stress within the Canadian economy that were verified using the other techniques, which were not highlighted in any historical data (Illing and Liu, 2006: 261). It was concluded that the FSI could be used as a reference series for financial stability and could be adapted as an early warning system for a crisis if adapted using leading indicators.

Cardarelli *et al* (2009: 78) examined why some financial stress episodes lead to economic downturns. They identified episodes of financial turmoil in advanced economies using a FSI and propose an analytical framework to assess the impact of financial stress on the real economy. The FSI constructed by Cardarelli *et al* (2009: 80) identifies episodes of financial stress as extreme values within the FSI that is constructed using market data. The index was constructed using three sub-indices that were combined using variance-equal weighting. The three sub-indices have a similar composition to that of Illing and Liu's (2006) FSI whereby the sub-indices were split into banking, securities and foreign exchange indices. The banking sector index is compiled using the slope of the yield curve, the TED spread and the beta of the banking sector. The FX index was compiled by calculating the time varying volatility of monthly changes in the nominal effective exchange rate (GARCH (1, 1)). The securities index was constructed using corporate bond spreads measured as the difference between corporate bond yields minus that of long term government bonds, stock market returns and time varying stock market returns (GARCH (1, 1)) (Cardarelli *et al*, 2009: 81).

The index was then constructed for each of the 17 countries used in the sample and in total, 113 episodes of financial stress were identified over the last 30 years. The results indicated that 43 episodes were driven by banking distress, 50 episodes by the securities sector and 20 from the FX sector. It was also found that stress emanating from one sector eventually encompassed the other sectors, with particular emphasis on the banking sector, where one third of all the crises occurred when banks were either the leading contributor or the second most leading contributor (Cardarelli *et al*, 2009: 82).

Once these episodes of financial stress were identified, Cardarelli *et al* (2009: 82), set out to determine how many of these episodes were followed by an economic slowdown or recession and to determine if there was a difference between the type of stress preceding an economic downturn and the type of stress that preceded a period where there was no economic slowdown. In order to achieve this, Cardarelli *et al* (2009: 84) define economic downturns as an episode of financial stress that is followed by a recession within six quarters of the first recording of financial stress. The results indicated that of the 133 economic downturns, 29 were followed by economic slowdowns and a further 29 were followed by recessions while the remaining 55 episodes were not followed by a slowdown or recession according to their definitions. The results further indicated that the median time lag between the onset of financial stress and a slowdown or recession was about two quarters and that about half of the slowdowns or recessions occurred within the first quarter following financial stress (Cardarelli *et al*, 2009: 85). The results further indicate that about 60% of the episodes of financial stress that led to slowdowns or recessions were banking related and that these episodes tended to be deeper slowdowns or recessions than that associated with FX or security crises.

Cardarelli *et al* (2009: 94) conclude that financial stress is often a precursor to an economic downturn or recession. Financial stress is often stimulated by a rapid expansion of credit, inflationary housing prices, large borrowing by households and cooperates alike. But more specifically, when the financial cycle turns, as indicated by high levels on the FSI, the likelihood of a recession is greater depending on the extremity of the FSI. Furthermore, financial stress dominated by the banking sector is more likely to lead to deeper and longer downturns than that of the securities and FX markets (Cardarelli *et al*, 2009: 78).

Hakkio and Keeton (2009: 6) present a new index of financial stress, the Kansas City financial stress index (KCFSI). They stipulate that policy makers would gain significant benefit by having a single, comprehensive index whereby they would accurately be able gauge the state of the financial economy. The article explains how the components of the KCFSI capture key aspects of financial stress and show that extreme values of the KCFSI coincide with known times of financial stress.

Hakkio and Keeton (2009: 6) firstly highlight key features of financial stress that have previously been discussed within this thesis. In order for a variable to be included with the KCFSI, Hakkio and Keeton (2009: 11) hold that the variable must represent at least one of the five features that they believe indicate financial stress, as discussed earlier, namely increased uncertainly about the value of assets and the behaviour of other investors, increased asymmetric information, decreased willingness to hold risky assets and illiquid assets. These variables then had to reflect prices or yields available on financial markets and available on a monthly basis, and finally, each variable had to be available from 1990 onwards. These criteria led to the selection of 11 variables that were combined into the KCFSI and are as follows: 3-month LIBOR/ 3 month T-Bill spread, 2-year swap spread, off the run/ on the run treasury spread, Aaa/10 year government bond spread, high yield bond/Bbb spread, consumer ABS/5-year treasury spread, negative value of correlation between stock and treasury returns, implied

volatility of overall stock prices, idiosyncratic volatility of banking stock prices, and cross-section dispersion of bank stock returns. In order to compile these variables in one index, Hakkio and Keeton (2009: 18) use principle components to identify the co-movement of financial stress. In order to do this, the first step is to express each of these variables in the same units by subtracting the sample mean and then dividing the units by their standard deviation. The next step is to calculate the coefficients of these variables so that the index explains the maximum possible amount of total variation of all the variables (Hakkio and Keeton, 2009: 18). The coefficients are then scaled so that the standard deviation of the index equals one.

The results obtained by Hakkio and Keeton (2009: 18) indicate that 61.4% of the total variation of the 11 variables is captured by the index. But more importantly the index coincides with known periods of stress. Three periods in particular were highlighted by the KCFSI: the 1990–91 recessions in the US where the Iraqi invasion of Kuwait caused oil prices to spike, the period from 1998–2002 when the Russian Debt default crisis, LTCM bailout and the bursting of the dot-com bubble occurred, and the financial crises of 2008 until present.

The departure that Hakkio and Keeton (2009) make from preceding literature is that they attempt to create a link between financial stress and the real economy. In order to do this they compare the KCFSI to an index developed by the Chicago Fed's National Activity Index (CFNAI) (Hakkio and Keeton, 2009: 30) which combines various monthly economic activity indicators for employment, production and spending. The results indicate a very strong negative correlation with KCFSI and to very extreme proxies around times of financial turbulence.

Hakkio and Keeton (2009: 36) conclude that the results and accuracy of the KCFSI at highlighting financial stress and having a significant impact of real economic activity mean that the tool would have great rewards if adopted by the Federal Reserve. The tool would be very useful at identifying the correct time to change monetary policy as it can accurately be used as a leading indicator for business confidence and identifying financial stress.

3.3 Transmission and Contagion

Introduction

This section is split into two subsections: financial channels and multiple and non-financial channels, because of the volume of literature that focuses on testing specific channels. A problem arises in that there is little consensus as to the identification of different channels. For example Fratzscher (2002: 7) segregates authors who focus on financial interdependence, real interdependence and spillovers, while Illing and Liu (2006: 245) note that many authors focus on sector-specific crises such as currency crises or banking crises, and yet other authors focus on macroeconomic similarities and trade links. In this paper, this section has been split into literature that specifically investigates a financial linkage or

is financially focused while the second subsection focuses on all literature that investigates multiple channels that are not necessarily financial channel focused.

Financial Channels

Balakrishnan *et al* (2009: 1) study how financial stress is transmitted from advanced economies to emerging markets by using a new financial stress index for emerging economies. The financial stress index developed by Balakrishnan *et al* (2009) is based on the fundamentals on which Cardarelli *et al* (2009) built their FSI. The FSI constructed by Balakrishnan *et al* (2009: 7) is constructed with five variables which are aggregated into one index: the banking beta, stock market returns, time-varying stock market return volatility, sovereign debt spreads and the exchange market pressure index. These variables can be split into the three sub-indices highlighted by Cardarelli *et al* (2009): the banking, securities and exchange markets. The aggregate of all the indicators is compiled into the index based on variance-equal weighing. The availability of data among emerging markets played a large role in reducing the period for which the study could be conducted and the number of variables used in the index. Nonetheless, the index was constructed on monthly bases for 26 countries from 1997 until the publication of the paper in 2009 (Balakrishnan *et al*, 2009: 9).

The results indicate that the index performs well in comparison to other literature and in identifying the major periods of financial stress over the period. Furthermore, the sub-indices accurately identify the type of crisis (Balakrishnan *et al*, 2009: 9). The results indicate four systematic episodes of financial stress with all 17 countries being used. The first spike coincides with the Asian crisis in the last quarter of 1997. The second spike occurs towards the end of 1998 and predominately affects emerging markets subsequent to the Russian debt default and the bailout of LTCM which concluded with the Brazilian currency crisis. The third spike in the Emerging market FSI (EMFSI) was in 2000 around the period that the dot com bubble burst. And finally the fourth spike occurred in 2002 where the Argentineans defaulted on their debt repayment (Balakrishnan *et al*, 2009: 10). The index begins to capture the stress with the recent credit crisis with initial signs of stress being observed in Asia in the first quarter of 2008, and by 2009 all emerging market economies were showing significant increases in financial stress.

When analysing the advanced economy FSI and the EMFSI, Balakrishnan *et al* (2009: 11) note that there is clearly a presence of common factors in the transmission of financial stress. At the same time, country specific factors have also had an impact on the transmission pattern. The two indices show strong visual links where peaks and troughs occur at very similar points in time and intensity. The leading cause of common factors effecting economies has been the increasing financial integration that has occurred over the last couple of decades. Balakrishnan *et al* (2009: 12) highlight in particular that emerging market economies have grown significantly due to rising portfolio equity and direct investment which has increased the level of financial integration. Balakrishnan *et al* (2009: 12)

qualify this by stating that approximately 70% of countries have increased their gross external position by 70%, with various countries in Africa being the only exceptions.

In light of this, Balakrishnan *et al* (2009: 15) assess the respective roles of common and country-specific factors in the transmission of financial stress by undertaking three complementary exercises. Firstly, an estimation of a common time varying component in the emerging markets' FSI and its relationship to the advanced economy FSI. Secondly, a two-stage econometric analysis of monthly financial stress co-movements using a country by country approach. Thirdly, a panel data analysis of the underlying determinants of financial stress. The results indicate strongly that financial stress spreads quickly to emerging market economies. Financial linkages tend to be the most influential channel for the transmission of stress from advanced economies, with the bank lending channel being dominant. Countries with greater exposure to foreign debt tended to be further aggravated by stress in advanced economies compared to countries with less exposure (Balakrishnan *et al*, 2009: 25).

Duncan and Kabundi (2011: 2) set out to test the volatility transmission across domestic asset classes in South Africa; to the best of their knowledge, no other analysis of this type had been undertaken in a South African context. They investigated the volatility between South African currencies, equities and bonds on a daily basis between October 1996 and June 2010. The objective of the study was to characterise cross market linkages in asset pricing by estimating volatility spillovers with the use of indices. Accordingly, Duncan and Kabundi (2011: 2) define a volatility spillover as "the share total variability in one asset class attributable to volatility surprises in another asset class". Duncan and Kabundi (2011: 19) apply a generalised vector autoregressive model to estimate time aggregated and time varying daily volatility spillovers indices on South African currencies, equities and bonds. They find strong interaction volatility across all assets classes. In particular, Duncan and Kabundi (2011) find that equities are the primary source of spillovers to other assets classes but that currencies between 2011 and 2006 dominated volatility spillovers to a greater extent. Bonds, over the analysis period, are constant in their role as net receiver of volatility from the other two asset classes. Subsequently, volatility spillovers become more prevalent between asset classes during times of global and domestic financial unrest. Duncan and Kabundi (2011: 20) conclude, with reference to further research, to understand the synchronisation of volatility between emerging markets, advanced economies and South Africa.

Rijckeghem and Weder (1999: 1) present evidence that spillovers help explain the pattern of contagion, concentrating on the bank lending channel and ignoring other forms of players in the market such as hedge funds. To test the role of bank lending, Rijckeghem and Weder constructed panel data on capital flows to 30 emerging markets and constructed a measure for the competition of bank funds. The aim of the tests was to understand financial contagion through banking centres during currency crises in emerging markets in the latter part of the last century. To test the importance of the common bank lender channel, Rijckeghem and Weder (1999: 1) examine the relationship between bank exposure in the country where the crisis originated and bank flows to other emerging markets.

The ideology behind this test is that a bank will lower its exposure to other emerging markets if its exposure to the country of crisis origination is high. Rijckeghem and Weder (1999: 2) further undertook a "bank centre by bank centre" analysis with the analyses based on exchange rate pressure.

Rijckeghem and Weder (1999: 6) focused on three episodes of financial instability, in Mexico, Thailand and Russia. For each episode, two sets of regressions were run in order to test for a common lender effect. The first regression examined flow data disaggregated by banking sector while the second regression captured whether the country experienced a currency crisis due to a particular episode or general exchange market pressure. Rijckeghem and Weder (1999: 15) found that the results support the view that spillovers through the common bank lenders were important in the Thai crisis and to a lesser extent in the Mexican and Russian currency crises. The regression pertaining to the Thai crisis points to a large and statistically significant common lender effect. The regression results are not as robust for the Mexican or Russian crises but the common bank lender effect is sufficiently large and significant that the existence of such an effect cannot be ruled out (Rijckeghem and Weder, 1999: 18).

Eichengreen *et al* (1996: 1) are concerned with the fact that speculative attacks tend to be temporarily correlated between countries. Currency crises, particularly in the early 1990s, appear to be contagious from country to another. Eichengreen *et al* (1996: 19) set out to analyse the contagious nature of currency crises using quarterly data from twenty industrialised countries from 1959 to 1993, in an attempt to answer whether a currency crisis in one country is correlated to a currency crisis in another country at the same point in time. The underlying thesis would be that if both countries show a partial correlation, this may indicate the presence of contagion.

Although this may indicate the presence of contagion, Eichengreen *et al* (1996: 20) note that the possibility of a common shock has to be ruled out. To make the distinction, Eichengreen *et al* (1996: 21) constructed an index of exchange market pressure to determine when a speculative attack has occurred. A crisis occurs at an extreme value of the index. The index components were weighted to equalise their individual volatility so that one component did not dominate the index results. Using the index, Eichengreen *et al* (1996: 25) tested the hypothesis by estimating a binary probit model linking the dependent variable to the controls with maximum likelihood and including additional repressors to capture the effects of macroeconomic and political influence that may skew the results. Eichengreen *et al* (1996: 36) found that a speculative attack elsewhere in the world increased the odds of an attack on a domestic currency. A speculative attack abroad increased the chance of an attack locally by approximately 8%, but the methodology used does not have any proxy of the intensity of the attacks. Eichengreen *et al* (1996: 36) further highlight that the methodology does not narrow down the channel with which contagion is transmitted.

Duncan and Liu (2009: 1) proposed a new method for timing and highlighting the occurrence of a currency crisis. The methodology developed is based on the fact that currency crises tend to be short lived events and thus can be most accurately identified using frequent data observations. Thus Duncan

and Liu (2009: 1) use data in daily frequency to highlight currency crises in South Africa. The methodology adopts a two-step approach. The first step statistically tests the full set of possible structural change points in Rand volatility by implementing the iterative cumulative sum of squares algorithm developed by Inclan and Tiao (1994). The second step was to test for the significance and model the effects of these changes on the variance process. Duncan and Liu (2009: 12) found that by studying short term changes in volatility dynamics, it was possible to identify the start and end dates of crisis periods and that the SC-GARCH model was more precise then the Knedlik and Scheufele's MS model in identifying Rand crises.

Stating that there is a growing consensus that financial linkages are more likely playing a central role in the propagation of shocks across borders, Broner *et al* (2005: 204) investigated the trading behaviour of emerging market mutual funds and the role with which these financial linkages play in the transmission of shocks across international borders. Their research can be split into two segments. Firstly, a stylized model that facilitates in the interpretation of results was constructed, incorporating three main themes: investors hold heterogeneous beliefs and portfolios, investors care about their relative performance with other investors, and decisions made by portfolio managers affect stock prices (Broner *et al*, 2005: 205). Along these themes, an analysis on the effect of changes in investors' risk aversion would have on decisions and stock prices was undertaken. The analysis assumes that risk aversion is a function of past relative performance, and suggests that if relative past performance was weak, the investor would shift his portfolio towards the 'average' portfolio, selling assets in the overexposed country, and shifting these assets to underexposed countries (Broner *et al*, 2005: 205).

In the second part of their analysis, Broner *et al* (2005: 205) examine the gains and losses made by investors and the portfolio choices that led to either outcome. A time-varying index of financial interdependence was constructed to identify which regions may have been overexposed to funds. The index is used continuously to assess the transmission mechanisms with which shocks are transmitted, specifically at highlighted known times of crises.

Broner *et al* (2005: 206) found that when the returns of a particular fund are lower than other funds, exposures to this fund are reduced. When exposures to funds are adjusted, the financial independence index highlights the transmission mechanisms above and beyond trade linkages. The index further identifies a negative correlation between countries' stock market returns during a crisis and the level to which these countries shared overexposure at the inception of the crisis. Broner *et al* (2005) help explain conclusively why some countries are affected by a financial crisis abroad while others are not.

Kaminsky and Reinhart (2001: 74) focused on analysing how the Asian crisis spread in the latter part of 1997. Their investigation attempts to determine what the trade financial linkages were that resulted in the Thai economic woes having such far-reaching effects. The spread of contagion was analysed by constructing a series of vulnerability indexes that captured the various stresses that emanated from the Thai economy and spread through Asia.

The construction of the indexes incorporates the 'signals approach' which was used to assess the probability of a contagious currency crisis. The analysis incorporates data from 20 countries from 1970 to 1998. The composite index was constructed using a proxy index of currency crises, a proxy for contagion and a channel differentiator (Kaminsky and Reinhart, 2001: 80). The currency crisis index was constructed as a weighted average of exchange rates and reserve changes. In order to have a better idea of the channel of contagion, Kaminsky and Reinhart (2001: 81) group countries into clusters: countries that have high exposure to US banks, countries with high exposure to Japanese banks, European banks etc. By grouping countries in clusters, Kaminsky and Reinhart (2001) were able to identify where contagion was due to common bank lender effects. These clusters were then cross-examined to identify how each country would be exposed to the clusters by simply counting the number of common clusters through which a country is exposed to a source. The problem with this method is that it does not allow a relative rank of vulnerabilities as a simple count does not reflect the intensity of contagion but just a channel. Kaminsky and Reinhart (2001: 83) solved this by assigning weights to the index depending on the different financial and trade linkages. Finally a composite index was constructed using the above methodologies, to gauge the probability of a crisis conditioned on a signal approach from various economic fundamental indicators (Kaminsky and Reinhart, 2001: 85).

Kaminsky and Reinhart (2001: 74) conclude with several findings. Firstly, foreign banks played a large role in the transmission of stress by curtailing their exposure to distressed countries. The contagion vulnerability indices captured which countries were most likely to be affected by contagion but were not able to determine the severity of the contagion. Furthermore, the flows of contagion change drastically as the crises evolved. The agents of causality and interdependence are affected as different issues develop.

Multiple and Non-Financial Channels

Caramazza *et al* (2000: 3) empirically investigate the factors that render a country vulnerable to contagion by analysing the relevance of external, domestic and financial weaknesses as well as trade and financial linkages. An examination of the role of various indicators was undertaken to analyse how different countries were affected by currency pressures after a crises and compared these indicators to that of countries that were not affected by the crisis. To assess the characteristics of the countries that have been affected during the major crises of the 1990's, an index of speculative market pressure was constructed as a weighted average of monthly exchange rate changes and reserve changes for a group of 6 industrialised and emerging market economies. 16 countries were highlighted as having currency crises; 9 during the Mexican crisis, 10 during the Asian episode and 13 during the Russian crisis (Caramazza *et al*, 2000: 7).

Caramazza *et al* (2000: 17) follow up by investigating the importance of financial variables, the presence of linear effects and the role of institutional factors within the Asian, Mexican and Russian

crises with a focus on contagion. A panel probit regression with 41 countries during these three episodes was estimated. The results indicate that financial linkages and weaknesses play a significant role in explaining the spread of emerging market crises. Exchange rate regimes and capital controls are found not to have any impact on preventing the crisis from spreading (Caramazza *et al*, 2000: 35). This also indicates that these regional crises can be explained by economic factors and not by social factors such as "herding" Caramazza *et al* (2000: 35).

Fratzscher (2002: 6) implies that most empirical literature on financial crises focuses on country-specific macroeconomic factors and does not place enough emphasis on contagion. Subsequently the goal that Fratzscher (2002) attempts to achieve is to understand and add to the literature of how a crisis in one country can lead to a crisis in other countries. Therefore, to determine the difference between contagion and country specific fundamentals, a three-pronged strategy was adopted. Firstly a univariate Markov-switching model was used to analyse the extent to which exchange rate movements in emerging markets in the 1990s were explained by contagion and fundamentals separately. Secondly, to confirm these results, a more traditional panel data analysis was undertaken to investigate how robust the results of the Markov-switching model were, and finally, the predicative power of the model.

Analysing the extent to which exchange rate movements in emerging markets in the 1990s were explained by contagion and country specific fundamentals, the Markov-switching model reveals that country specific fundamentals mostly fail to capture the timing and severity of a crisis within individual countries. However, once contagion was included within the model, the explanatory power of the model was improved. The panel data analysis used to confirm the results obtained by the Markov-switching model, was undertaken for 24 emerging markets between 1989 and 1998. The key result obtained from the panel estimation was that contagion was a key driver behind exchange market movements with the financial channel the most prominent. The trade channel, although not as strong as the financial channel, was still significant (Fratzscher, 2002: 22). More specifically, contagion played a key role during the crisis periods between 1994–95 (Latin America) and 1997–98 (Asia) with major common bank lender effects. Finally, the full model developed by Fratzscher (2002) confirms that contagion variables are important in predicting the transmission of a crisis. The model was able not only to predict the rank of the severity of each country within the Asian crisis but also how severe the crisis would be. There were only two countries within Asia where the predictions were not accurate: Indonesia and Korea were underestimated. Fratzscher's results (2002) therefore suggest that contagion not only plays a significant role in the Asian and South American crises, but also is an important variable in predicting future stress.

Glick and Rose (1998: 5) undertook to demonstrate that, beyond macroeconomic and financial similarities, trade channels are important in the transmission of financial contagion. By focusing on currency crises across multiple countries, Glick and Rose (1998) attempted to determine why some countries are affected more than others during times of currency instability. Cross-sectional data was

gathered annually from 161 countries focusing on five different episodes of widespread currency instability: the breakdown of the Bretton Woods system (1971–2), the collapse of the Smithsonian agreement (1973), the EMS crisis (1992–4), the Mexican crisis (1994–5) and finally, the Asian crisis starting in 1997.

In order to perform their analysis Glick and Rose (1998: 7) split their methodology into three sections, measuring the currency crisis, the importance of trade between the country of origination and the 'victim', and the financial and macroeconomic control variables. To measure the currency crises, Glick and Rose (1998: 8) constructed a simple binary indicator regressand, which was in conjunction with other research, to determine crisis 'victims' and crisis 'originators'. The chi-squared test was also performed to determine the rationality of the crises. An index was constructed to quantify the degree to which the two countries (originator and victim) compete within third markets. This index was a weighted average of the importance of exports to the third country from the victim and originator, and was a measure of actual trade between the countries. Subsequently, Glick and Rose (1998: 10) tabulated the ranking of the top twenty trade competitors of the first 'victim'. And finally, a variety of macroeconomic controls were incorporated to account for the standard determinates of a currency crisis dictated by first and second generation models. In conclusion, Glick and Rose (1998: 18) found strong evidence that currency crises spread within a region, more specifically along trading lines, and that differing macroeconomic circumstances do not change the result. Fundamentally, Glick and Rose (1998) conclude that due to the proximity of regional partners and the trade patterns thereof, a country is highly susceptible to contagion from a currency attack along trading lines.

Forbes (2001: 1) addresses the debate as to whether trade linkages played a significant role in currency crises and economic instability in the 1990s. Forbes (2001) highlights, and subsequently tests, the role of three trade channels: a competitiveness effect, an income effect and a cheap import effect. Testing these channels was the paper's main goal which was tested by using trade flow data at the industry level, and thus was able to measure competition within third markets. Forbes (2001: 10) constructed a weighted index of exchange market pressure that incorporates a country's exchange rate, interest rate and reserve levels using data from 45 countries between 1994 and 1999. The index was thus able to highlight when a crisis occurred.

After highlighting when a crisis occurs, Forbes (2001: 13) estimated whether the three trade channels are significant channels of contagion. The dependent variable used within the regressions to determine the significance of the channels was stock market returns, and was used for several reasons: stock market data is accessible across many countries, stock market returns are measured at high frequency and can therefore pinpoint a crisis more accurately, and finally, stocks react to market conditions rapidly.

Forbes (2001: 43) finds that trade channels are highly significant vulnerabilities in the transmission of a crisis. More specifically the 'competitiveness' and 'income' channels played a large role in the transmission of a crisis whereas the 'cheap-import effect' had a significant impact in some markets

and not others. Forbes (2001: 43) elaborates that although trade channels contribute significantly towards contagion, it only accounts for about 25% of the result. Macroeconomic and financial channels must therefore also play a significant role. Forbes (2001) notes that what is more striking, is that the manner with which a country reacts to a crisis determines what trade channel becomes more significant. If a country responds by devaluing its currency, the competitiveness effect was negative and highly significant, and when a country's exchange rate remained constant, the competitiveness effect was not significant. When a country responded by raising interest rates, the income effect was highly negative and significant. When interest rates were held constant, the income effect was insignificant. Thus the manner with which a country responded to a crisis directly affected other countries by the direct exposure to trade channels.

3.4 Conclusion

This chapter started with a review of empirical literature pertaining to the identification and measurement of financial stress followed by literature on contagion of financial stress. In both cases, the studies incorporated most developed countries and emerging market countries given data availability.

In the identification of financial stress Illing and Liu (2006), Balakrishnan *et al* (2009), Hakkio and Keeton (2009) and Cardarelli *et al* (2009) all had success in identifying and measuring financial stress. All authors further stated that their indices were able to highlight most known times of crises but also periods that are not documented as stress periods. Balakrishnan *et al* (2009), Illing and Liu (2006) and Hakkio and Keeton (2009) conclude that the FSI could be used as a reference series for financial stability and could be adapted as an early warning system for a crisis if adapted using leading indicators. Cardarelli *et al* (2009: 82) extend their analysis after the identification of financial stress, and set out to determine how many of these episodes were followed by an economic slowdown or recession, and to determine if there was a difference between the types of stress preceding an economic downturn. In so doing, Cardarelli *et al* (2009: 94) find that financial stress is a precursor to an economic downturn or recession and that financial stress is often stimulated by a rapid expansion of credit, inflationary housing prices, and large borrowings by households and cooperates alike.

The contagion of financial stress over the last decade has become highly scrutinised due to multiple global crises that spread at unprecedented levels. Initial studies focused along trading lines as a means of spreading contagion. Forbes (2001) and Glick and Rose (1998) found that trade channels play a significant role in the spreading of financial stress. More specifically, Glick and Rose (1998) found that due to the proximity of regional trading partners, a country is highly susceptible to contagion from a currency attack, and therefore contagion, along trading lines. Forbes (2001) and Fratzscher (2002) agree that trade channels play a significant role, but state that financial channels play a larger role in transmitting contagion. Forbes (2001) notes that with trade channels, the manner with which a

country reacts to a crisis determines which trade channel becomes more prominent in transmitting stress.

Financial channels have become more relevant to the contagion of financial stress over the last two decades, as multiple crises have spread between countries that had very few trade links between them, particularly emerging markets. Forbes (2001) and Fratzscher (2002) determined that financial channels play the most significant role in transmitting contagion; while investigating trade channels. Subsequently, Balakrishnan *et al* (2009), Kaminsky and Reinhart (2001) and Rijckeghem & Weder (1999) all investigate which financial channel plays the largest role in the propagation of stress. In all cases the common bank lender effect was found to be the most significant channel. Rijckeghem and Weder (1999) explain that foreign banks in particular cut back their exposure to distressed countries in times of crises, leaving companies and countries alike with reduced credit lines to weather the crisis. Rijckeghem and Weder (1999) found that spillovers through common bank lenders were important in the Thai crisis in particular, but to a lesser extent in the Mexican and Russian currency crises, but still significant. With an emerging market focus, Caramazza *et al* (2000), Duncan and Liu (2009) and Balakrishnan *et al* (2009) indicate that financial linkages and weaknesses play a significant role in explaining the spread of emerging market crises and align their reasoning with that of Rijckeghem and Weder (1999) and Kaminsky and Reinhart (2001) that common bank lenders play the largest role. Form a South African perspective, Duncan and Liu (2009) highlight the interlinking volatility between asset classes and the affect that global shocks can have locally in South Africa.

The investigation of empirical literature has made it clear that contagion of financial stress can originate from a plethora of events, from any region and through multiple channels. The evidence indicates that global movement of capital, particularly with the use of common bank lenders, can have significant effects on the global economy.

The next chapter sets out the analytical framework that is used to provide answers to the objectives of the study.

CHAPTER FOUR: METHODOLOGY AND DATA

4.0 Introduction

This chapter sets out to explain the framework that is used to achieve the objectives set out in chapter 1. As noted in chapter 1, the study sets out to identify financial stress in South Africa, emerging markets and advanced economies and to test the significance of co-movement of financial stress between South Africa and these markets. Empirical studies, such as Balakrishnan *et al* (2009), Cardarelli *et al* (2009), Illing and Liu (2006), Chinzara (2008: 29) and Junkin (2011: 40) identify the methodology within which this study will work. This study will identify financial stress using the methodologies developed by Illing and Liu (2006). To test for the long run co-movement of financial stress, the study will adopt well-known econometric techniques such as the Johansen and Engle and Granger cointegration techniques, impulse response analysis and OLS to understand the causal relationships between the stress indices.

The chapter is structured as follows: Section 4.1 discusses the methodology used to construct the stress indices and includes a section discussing the variables used within the indices and the weighting methodology. Section 4.2 discusses the methods used to test for co-movement between the indices. Section 4.3 discusses the author's a priori expectations, and finally section 4.4 concludes the chapter.

4.1 Construction of the Indices

The financial stress indices constructed in this paper are based on the methodologies used by Balakrishnan *et al* (2009) which were built on the methodologies used by Cardarelli *et al* (2009) which in turn were derived from the methodologies used by Illing and Liu (2006) and Hakkio and Keeton (2009). Illing and Liu (2006) developed a financial stress index for Canada which Cardarelli *et al* (2009) built on to construct an index for a collection of advanced economies. Subsequently, Balakrishnan *et al* (2009) developed financial stress indices for advanced and emerging economies. This paper will construct indices for a collection of advanced and emerging economies and an index of financial stress for South Africa.

Variables used within the Index

The indices are constructed from indicators taken from the banking sector, the securities sector and the foreign exchange sector. The choice of indicators was limited to the availability of data and a preference for parsimony (Balakrishnan *et al*, 2009: 7).

The indicators used in all of the indices are as follows:

- The Beta of the banking sector; which is the correlation between the total returns of the banking sector stock index and the overall stock market index / systemic risk proxy

(Cardarelli *et al*, 2009: 80). In line with the Capital Asset Pricing model, a beta of greater than one indicates that banking stocks move more than proportionally with the overall stock market index i.e. are relatively risky. A beta greater than one would indicate a greater likelihood of a banking crisis (Balakrishnan *et al*, 2009: 8). Accordingly, in periods where financial stress is prevalent, this indicator would indicate an unusually large drop of banking sector stock prices relative to the market.

$$\beta = \frac{cov(r, m)}{var(m)}$$

Equation 4.1

Where r and m represent the year-over-year banking and market returns respectively, computed over a 12-month rolling average.

- The TED spread: 3-month LIBOR minus short term government bonds which captures the premium banks charge one another over treasury bill rates and is a proxy for counterparty risk (Cardarelli *et al*, 2009: 80).
- Stock decline, which is calculated as the stock market index in the previous period minus the stock market index in the current period divided by the stock market index in the previous period captures sharp volatility in equity markets (Cardarelli *et al*, 2009: 95).
- CMAX calculation to determine volatility within the foreign exchange market and equity market. A depreciation of a currency, or drop in equity prices represents a loss to the asset holders. Thus unexpected volatility increases uncertainty within the market. The CMAX calculation is a hybrid volatility loss measure used commonly in literature (Illing and Liu, 2006: 252).

$$CMAX_t = \frac{X_t}{\max[\in (x_{t-j} \,|j = 0,1, \dots, t)]}$$

Equation 4.2

- The slope of the yield curve, measured as the difference between short-term and long-term government bonds (Cardarelli *et al*, 2009: 80). The spread between short- and long-term bonds indicates the level of risk within the market as banks generate income by intermediating deposits into longer-term asset, thus when there is a negative sloping yield curve, bank profitability is seriously jeopardized (Cardarelli *et al*, 2009: 80).

In the case of advanced economies and South Africa, due to data availability and maturity of the financial systems, corporate bond spreads are added to the indices as a proxy for level of risk associated with corporate debt and are calculated as the difference between corporate bond yields minus long-term government bond yields (Cardarelli *et al*, 2009: 95).

In the case of Brazil, due to a lack of data availability and market maturity, the slope of the yield curve is omitted from the index.

Weighting and Aggregation of the variables: Index Specification

The aggregation of the indicators into an index and the sub-indices into the final indices is based on variance-equal weighting (Balakrishnan *et al*, 2009: 8). Variance-equal weighting generates an index that gives equal importance to each variable. The variables are assumed to be normally distributed and this entails that the mean of a series is subtracted from each variable before it is divided by its standard deviation (Illing and Liu, 2006: 255).

Illing and Liu (2006: 258) consider multiple methods of combining variables into a single index and the weighting methods used. They test factor analysis, credit weighting, variance-equal weighting and transformation using CDFs. Furthermore, they test each approach using various standard and refined measures and using GARCH techniques (Illing and Liu, 2006: 255). Many studies have found that asset-price-series over time exhibit changes in variance which tend to be serially correlated. Typically in the literature, stock price and exchange rate volatility are modelled using GARCH techniques (Illing and Liu, 2006: 254).

Illing and Liu (2006: 257) evaluate which aggregation and weighting method, and which variables, most accurately identify a crisis. They test this by using type one and type two errors to determine the accuracy of an index identifying a crisis. Type one errors are the probability of failing to signal a crisis, and type two errors are the probability of falsely signalling a crisis.

Illing and Liu (2006: 257) find that most of the standard and refined measures (used in this paper) capture 75–85% of all stressful events highlighted by their survey. Indices that included GARCH variables did not perform as well as the standard and refined measures as they indicated large amounts of type one errors (Illing and Liu, 2006: 258). Furthermore, variance-equal weighting, as used by Cardarelli *et al* (2009) and Balakrishnan *et al* (2009), was (marginally) the second best weighting method after credit weighting. Credit weighting is not feasible for use within this study due to multiple economies being used.

$$SAFSI\ (\text{AEFSI})(\text{EMFSI}) = \beta_1\,\text{X}(\beta) + \beta_2\text{X}(TED) + \beta_3\text{X}(CMAXe) + \beta_4\text{X}(CMAXfx) + \beta_5\text{X}(Slope\ of\ yield\ curve) + \beta_6\text{X}(Corporate\ debt) + \beta_7\text{X}(Stock\ decline)$$

Equation 4.3

Selection of Data and Countries

The countries used within the analysis were chosen based on their relative importance to South Africa, the size of their economies and data availability. The relative importance to South Africa was determined by analysing South Africa's largest trading partners. According to the CIA World Fact

Book (2012: 1), South Africa's largest export partners (excluding Africa) in 2011 were China, Germany, the USA, Japan, India and the UK and largest import partners (excluding Africa) were China, Germany, Saudi Arabia, Iran, Japan and the UK. Taking data availability and the relative size of each economy into account, the countries used for the advanced economy index are the USA, Germany, France and Japan, and for the emerging market index Brazil, India, China and Russia.

All data was obtained from Thompson DataStream 2007 except for Corporate Bond yields for the USA, Germany and France which were obtained from the Federal Reserve Bank of St. Louis (2012), the Deutsche Bundesbank (2012) and Bloomberg DataStream 2012 respectively.

For all the advanced economies and South Africa, data was gathered between January 1995 and October 2012 in monthly frequency. For emerging market economies, data was gathered between May 2000 and October 2012 in monthly frequency.

4.2 Testing for Contagion

Testing for Stationarity and the Cointegration Framework

A time series process is said to be covariance stationary if its mean and variance are constant and independent of time (Baltagi, 2008: 356). Brooks (2008: 318) defines a stationary series as one that has a constant mean, variance and auto-variances for each given lag. There are multiple reasons why it is important for a series to be stationary. If a series is non-stationary, its behaviour and properties can be erratic, non-stationary data can lead to spurious regression and, finally, if the data is not stationary, it can be proved that standard assumptions for asymptotic analysis will not be valid (Brooks, 2008: 320). The standard OLS framework requires that each series be integrated of order zero, otherwise the possibility of spurious regression may occur (Gujarati, 2005:496). However, it is possible for a combination of individual I(1) series to be I(0). Cointegration occurs when a linear combination of a set of variables is stationary. A condition for such a scenario is that the series must be integrated at an order greater than zero or at least have a deterministic trend (Brooks, 2008: 326).

This study tests for stationarity by performing two unit root tests: the Augmented Dickey-Fuller Unit root test and the Phillips-Perron Unit root test. Both techniques are well recognised in econometric literature and for that reason do not warrant explanation. The two most commonly used methods for testing for cointegration are the Engle and Granger (Engle and Granger, 1987) and the Johansen Cointegration approach (Johansen and Jesulius, 1990). The Engle and Granger (EG) technique has lost popularity as it fails to identify multiple cointegrating vectors and does not accommodate for the possibility of simultaneity in the causal relationship among variables. These problems can be solved by the Johansen approach which assumes that all the variables within the estimation are endogenous. Thus it is possible to run a weak exogeneity test to distinguish between truly endogenous variables on which the identified cointegrating vectors will be normalised. Thus, this study, due to relatively few variables within the estimation, will use both the Engle and Granger technique and Johansen to check

for cointegration as set out by Olalere (2007), Hancocks (2010), Chinzara (2008) and Junkin (2011). Johansen's approach will be used to identify if there is more than one cointegrating vector and a more comprehensive analysis of the causal relationship between the variables.

Using Johansen (1988) and following Chinzara (2008: 29) and Junkin (2011: 40), the approach applies a VAR model that assumes the errors are white noise and is specified as follows:

$$\Delta X_t = \prod X_{t-1} + \sum_{t=1}^{k} \Gamma_{i\Delta X_{t-1}} + pz_t + \epsilon_{kt}$$

Equation 4.5

where X_t is a vector of the I(1) indices, ΔX_{t-1} are all I(0), Γ_i are n x n coefficient matrices, ϵ_{kt} are normally and independently distributed, $\prod X_{t-1}$gives the number of cointegrating vectors, z_t is a vector of deterministic variables and k is a finite autoregressive lag. If$\prod = r$, then r possible stationary variables exist and n x r matrices of α and β such that

$$\prod X_{t-1} = \alpha\beta^1$$

Equation 4.6

where α = speed of adjustment and β = is a matrix of long run coefficients.

By using the two likelihood ratio test statistics provided by Johansen (1988), the rank of the matrix $\prod$ and the number of cointegrating relations can be determined. These are the trace statistic (λ_{trace}) and the maximum eigenvalue test (λ_{max}) where

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \log(1 - \hat{\lambda}_i)$$

Equation 4.7

$$\lambda_{max} = -Tlog(1 - \hat{\lambda}_{r+1})$$

Equation 4.8

where r is the number of cointegrating vectors under the null hypothesis and $\hat{\lambda}_i$ is the estimated value of the i^{th} ordered eigenvalue for equation 4.4. The λ_{trace} statistic is a test where the null hypothesis is "that the number of cointegrating vectors is less than or equal to r". The λ_{max} individually tests each eigenvalue and has the null hypothesis that the number of cointegrating vectors is r against the alternative that states r+1 (Brooks, 2008: 352).

Subsequently, a set of variables that individually may be non-stationary may be cointegrated if it can be proved that linear combinations of these variables are together stationary. In the context of this study, if it is proven that one or more of the financial stress indices are non-stationary, but are cointegrated with only one cointegrating vector, one would be able to test the relationship using OLS

techniques with the use of the VECM (Vector error correction model). The VECM framework allows for short-run adjustment dynamics while restricting the long-run behaviour of the endogenous variables allowing for the convergence on their cointegrating relationship.

Impulse Response analysis

Impulse response analysis traces out the responsiveness of the dependent variables within the VAR to shocks to each of the variables (Brooks, 2008: 300). Thus for each variable from each equation dealt with separately, a shock is applied to the error term and the resulting effects upon the VAR system are recorded over time. Provided that the system is stable, the shock should eventually dissipate. It is important that all variables are stationary within the analysis. This study uses the Cholesky decomposition estimation criterion and the indices will be othorgonolized accordingly.

4.3 *A priori* Expectations

Undertaking an analysis of Chapters two and three identifies the multiple channels and the type of stress that can be transmitted from outside South Africa. But Chapters two and three also allude to the fact that financial stress can emanate from within South Africa itself. South Africa has a recent history of political unrest, highlighted by the ending of apartheid in the early 1990s, but also more recently the violent strikes that have spread across the economy in 2012. Contradictory to an African and emerging market economy, South Africa has one of the most mature financial systems in the world. This is important as financial contagion between mature economies can occur with ease due to the level of financial integration. Kaminsky and Reinhart (2001: 74) show how these financial linkages played a large role in the spreading contagion in the Asian crisis, while Fratzscher (2002) showed that the financial channel played the most significant role in the spread of the currency crisis that ensued.

Thus it is the view of the author that financial stress within South Africa is significantly affected by both advanced economy and emerging market contagion, and that the constructed South African financial stress index will indicate a mixture of advanced and emerging market crises. It is the view of the author that the results will be in line with the results obtained by Balakrishnan *et al* (2009: 25) "that financial stress tends to spread rapidly to emerging market economies and with a high pass through" and "financial linkages appear to be a key conduit of transmission". The author believes that, due to the maturity of the South African financial system and its integration into the global economy (possibly more so than most emerging markets), but also the disadvantage of being prone to the risk-off/risk-on attitude that effects emerging markets in times of stress, the South African financial stress index may show greater volatility than most other countries, and the emerging and advanced economy indices.

It is under these expectations that the model, to be estimated using OLS techniques, will be estimated as follows:

$$SAFSI_t = AEFSI_t + EMFSI_t + \varepsilon_t$$

Equation 4.9

Subsequent to this estimation, it is expected that both the AEFSI and EMFSI will be positively correlated with the SAFSI in line with the results obtained by Balakrishnan *et al* (2009).

4.4 Conclusions

This chapter has discussed the chronological order with which the analysis will address the objectives set out in chapter 1. This entails the identification and co-movement of financial stress between South Africa, emerging markets and advanced economies. Firstly, the methods used to identify stress were highlighted, followed by the weighting technique. Following this, the methods used to measure the co-movement of stress were discussed, notably Augmented Dickey Fuller and Phillips-Perron stationarity tests, Johansen and EG cointegration techniques, impulse response analysis and standard OLS architecture. Finally the author's a priori expectations were discussed. The analytical framework having been set out, the next chapter will analyse the specified models.

CHAPTER FIVE: EMPIRICAL RESULTS

5.0 Introduction

The goals of the research were identified in chapter one to emphasise the research question under evaluation. The goals for this research are twofold. Firstly, to identify financial stress in South Africa and a selection of advanced and emerging market economies using a financial stress index. Secondly, after identifying financial stress across these geographies, the study will investigate the relative strength and direction of financial contagion between advanced economies, emerging market economies and South Africa. Chapters Two and Three discussed the theoretical and empirical issues pertaining to the field of research while Chapter four explained the methodologies to be used to achieve the goals of the research.

The remainder of this chapter is laid out as follows: section 5.1 investigates and measures financial stress within South Africa, emerging markets and advanced economies. It also compares the constructed indices to well-known times of financial stress highlighted by the literature and other indices. Section 5.2 investigates the contagion of financial stress by measuring the co-movement of financial stress between the three constructed indices. Within the analysis, multiple techniques will be adopted for completeness and accuracy: basic OLS architecture coupled with Augmented Engle-Granger cointegration techniques and Johansen's cointegration analysis. Section 5.3 concludes the chapter.

5.1 Identification of Financial Stress

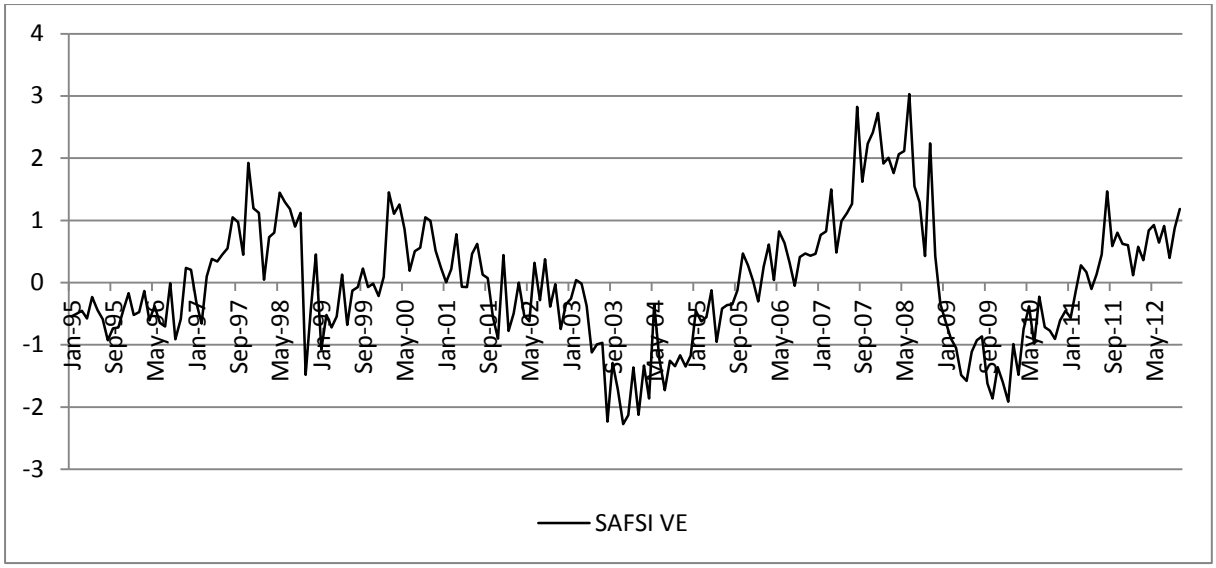
The primary goal of the financial stress index (FSI) is to identify financial stress within a given economy. This entails that the index needs to identify the intensity of stress and the period within which the stress occurs. Illing and Liu (2006: 259) note that interpreting an FSI can be tricky as there is very little literature that identifies 'financial stress' in this manner. As mentioned in Chapter Four, the FSI was constructed using variance-equal weighting. Subsequently, as the mean of every series has been removed and made equal to zero, and the variance of all datasets is equal, the indices are comparable. Intuitively, the greater the value represented within the index, the greater the intensity of financial stress within the economy. A further advantage of this technique, highlighted by Illing and Liu (2006: 260), is that historical events and cross-country comparisons can be made. Thus, a stressful event can be compared to a historical event, or an event in another country, as the stress level is being measured as a deviation from its historical mean.

The first step of interpreting the FSIs is to validate the accuracy with which they highlight well-known times of crises. Each FSI constructed will be compared to the literature, government reports and the FSIs constructed by Illing and Liu (2006), Balakrishnan *et al* (2009) and Cardarelli *et al*

(2009). Once each FSI is validated, a discussion can ensue about the levels of stress and its correlation to other FSIs.

5.1.1 FSI: South Africa

Figure 1: The South African Financial Stress Index

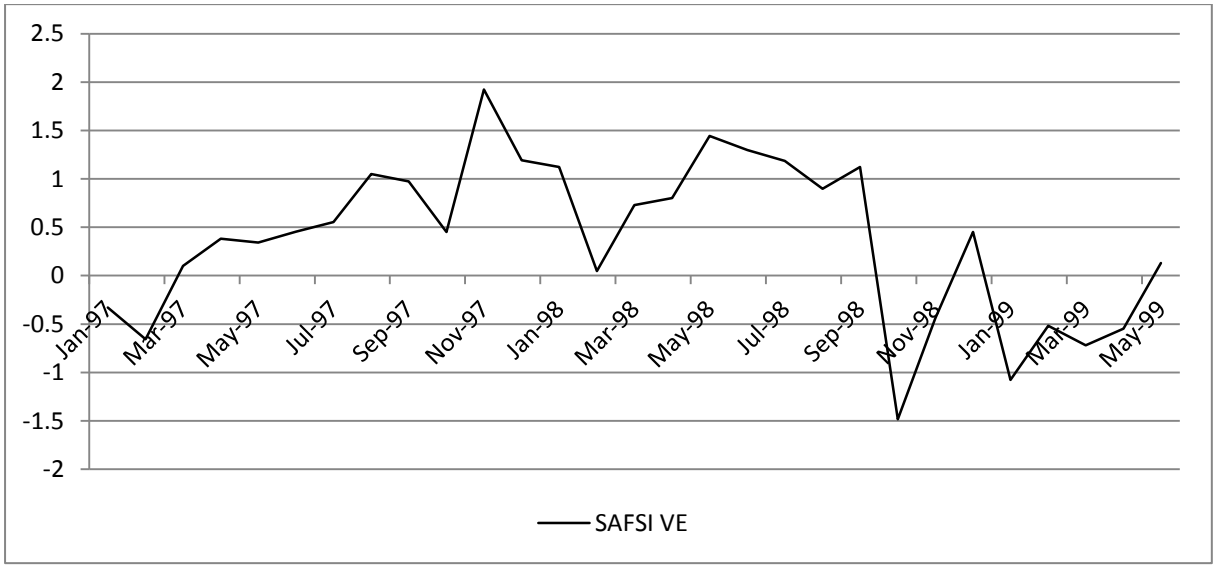


The South African (SA) FSI was constructed using monthly data from January 1995 until October 2012 at a monthly frequency. Illing and Liu (2006), Balakrishnan *et al* (2009: 6) and Cardarelli *et al* (2009) do not specifically construct a FSI for SA, even though it is included in their analyses. Therefore, South African Reserve Bank Annual Reports will be used to highlight times of financial stress within South Africa, and these periods will be compared to those highlighted by the SAFSI.

A visual analysis of the SAFSI highlights four distinct periods of financial stress. The first period of stress is captured between the first quarter of 1997 until the final quarter of 1998. This period of stress peaked at just above 1.92 standard deviation points above its mean: the second highest peak during analysed period. The second period of stress is captured between January 2000 and September 2001 with a peak of 1.45 standard deviation points above its mean: the third highest peak during the period. The longest, and most severe, period of stress, peaking at 3.03 standard deviation points above its mean, was recorded between January 2006 and December 2008. The final, period of stress started in January 2011 and remained positive until October 2012, and was the least severe of the analysed period.

Period from Q1 1997 to Q4 2008

Figure 2: SAFSI January 1997 – May 1999



The South African Reserve Bank (1997: 6) note that as early as the second half of 1995, there were signs of weaker economic growth, and that these indications intensified into 1996. Declining real gross domestic expenditure was the driving force behind the presumption that the business cycle had reached its peak and was entering a downward phase. Concurrently, real consumption expenditure by the government expanded in the latter part of 1996 and into the first half of 1997 in an attempt to stave off lower economic growth. The SAFSI, shown in Figure 1, although negative during this time frame, indicates an upward trend in financial stress as economic conditions in South Africa began to waver. The South African Reserve Bank (1998: 6) elaborate further, that during this period, economic growth was weak and employment in the formal sector had declined to its lowest level in 20 years.

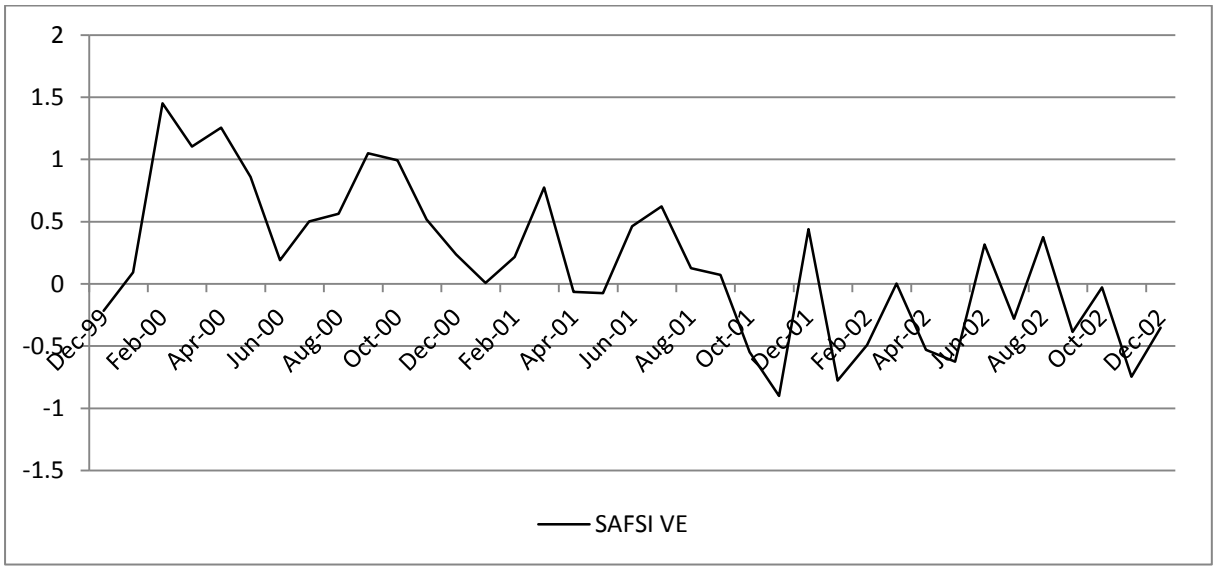
In the second half of 1997 severe strains in Asian financial markets developed (South African Reserve Bank, 1997: 6). By May 1998, and the second round of financial turbulence in Asia, the South African economy had been severely affected by the turbulence in Asia, and monetary conditions tightened considerably while the reserve bank increased supply of foreign currency: the nominal effective exchange rate fell by 20% during the first seven months of 1998. Over the same period, credit extension by the private sector increased rapidly, despite interest rates being at relatively high levels. Between 10 June 1998 and 13 July 1998, private banks increased the prime overdraft rate by 6 percentage points to 24%. The securities market was also affected: non-resident investor sentiment declined rapidly as fear of emerging market contagion spread through the developed world. Asset prices, interest rates and bond yields suffered as a result and volatility within the financial sector increased dramatically. From May 1998 onwards, market sentiment was bearish and yields on long-term government bonds moved significantly higher and steepened an already negative yield curve (South African Reserve Bank, 1997: 8).

An analysis of the SAFSI during the period (Figure 2) reveals very similar results. Between April 1997 and October 1998, the SAFSI remains positive and at high levels above its mean. The strains in Asia towards the second half of 1997 are clearly represented and by May 1998, financial stress had peaked, but remained high until October 1998: the same period that the Rand depreciated, risk premiums increased, private sector debt increased and FDI reversed.

By the end of 1998, there were signs that the turmoil in Asia had subsided and the crisis was over. Economic output in Asia was increasing, and demand from the remainder of the world had responded accordingly. During the 4th quarter of 1998 and into 1999, gross domestic savings rates improved, gross domestic production improved and formal sector employment improved. More importantly, foreign sentiment towards South Africa improved remarkably and FDI flows increased, which led to a meaningful increase in international reserves (South African Reserve Bank, 1999: 6). The SAFSI once again shows the recovery after the Asian crisis in 1998: financial stress in the later parts of 1998 declined significantly and remained negative until the beginning of 2000.

Period from 2000 to 2002

Figure 3: SAFSI December 1999 – December 2002



A strong recovery ensued in 1999 after the Asian crisis in 1997/1998. The IMF and other economic organisations revised economic outlooks in a positive manner. From a South African perspective, the outlook for the country's largest trading partner, Europe, was very positive and the pace of economic activity in Asia was increasing (South African Reserve Bank, 2000: 1).

At the beginning of 2000, economic growth in South Africa began to subside with the issue being highlighted by government as lethargic aggregate supply. Analysis of the South African economy during this period reveals certain imbalances, and employment in the formal sectors continued to decline through 1999 and 2000. During the same period, spurred on by improving global demand and supply restrictions, oil prices increased rapidly, and by the beginning of 2000, affected food and general inflationary pressures in South Africa increased. Stress was amplified in the first half of 2000

by a wide current account deficit and an abrupt stop to capital inflows in the beginning of 2000. In fact, the South African Reserve Bank (2000: 3) highlights a net capital outflow during the first two quarters of 2000. Private bank credit extension during the first half of 2000 was constrained due to worries of high inflation despite the easing of monetary policies. The negative sentiment developing in South Africa during the period led to bond yields widening in the first four months of 2000 and it was not until May 2000 that confidence started returning to the market. In parallel with the bond market, equities faltered in the same period as confidence waned, but as with the bond market, confidence returned around May 2000 (South African Reserve Bank, 2000: 4).

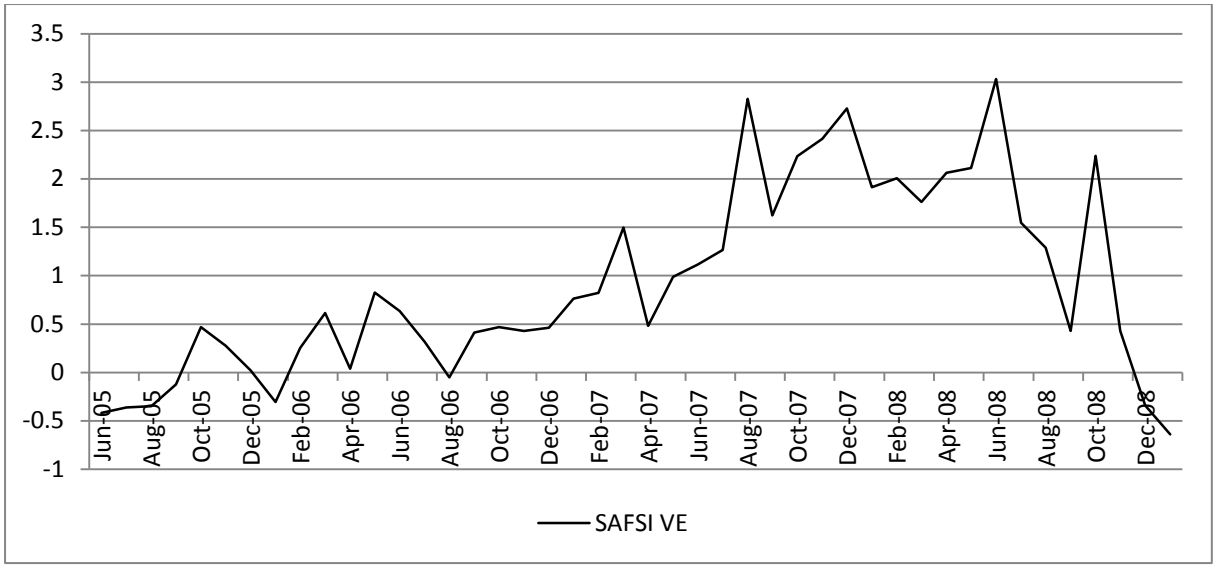
Towards the second half of 2000, the most significant development was the sudden reversal in the global outlook, most prominently from the USA. The slowing of the US economy, most notably in the electronics and computer industries, was not staved off by monetary policy easing in the developed world (South African Reserve Bank, 2001: 1). The weaker global conditions started to affect the South African economy towards the end of 2000 with economic growth declining by 2.5%. The major issues that were affecting global markets leading into the second half of 2001, most notability in the USA, were the inherent imbalance between aggregate supply and demand, the sustainability of capital inflows and the relative strength of the US dollar to other major currencies (South African Reserve Bank, 2001: 1). Combined with the September 11 2001 attacks in the USA, global consensus aligned to the fact that there was a decline in economic activity and governments around the world began to embark on expansionary measures. Due to a trend of rand depreciation from 1998, the South African economy helped to cushion the effect of the global slowdown in 2001 and into 2002. Duncan and Liu (2009: 12) in their analysis of currency crises in South Africa highlight a period of significant foreign currency turbulence between December 2001 and January 2002 where the rand experienced significant depreciation. Nonetheless, domestic demand showed great resilience while government and private consumption expenditure increased at an impressive rate in the latter parts of 2001 and 2002 (South African Reserve Bank, 2001: 2).

The SAFSI captures a significant portion of stress within the period the state of the South African economy during this period, most notably, the first half of 2000. During this period, the negative sentiment surrounding the South African economy led to widening spreads in bond markets and equity market volatility in the first 5 months of the year. The index clearly highlights this volatility in the exact period. During the second half of 2000 and into 2001, the South African economy was very resilient to deteriorating global sentiment, but due to a weaker rand, the economy remained reasonably shielded. The SAFSI highlights the declining strain on the economy with a downward trend with very few notable spikes in financial stress. The index further captures the period where government and private consumption expenditure increased at an impressive rate in the latter parts of 2001 and 2002 by indicating negligible financial stress. Furthermore, the currency crisis highlighted by Duncan and Liu (2009: 12) between December 2001 and January 2002 is captured in the

corresponding period by the index, but not as significant as that highlighted by Duncan and Liu (2009) due to multiple other indicators included in the SAFSI that will have had a dampening effect.

Period from mid-2005 to January 2009

Figure 4: SAFSI July 2005 – December 2008



In the 18 months prior to 2005, the global economy expanded briskly with minimal levels of financial stress (South African Reserve Bank, 2001: 1). The minor stress inherent within the economy during this period was the general trend of widening current account deficits, the on-going war in the Middle East and the increasing interest rates during the period (South African Reserve Bank, 2005: 1). The SAFSI captures this period of high economic growth with minimal financial stress.

The sustained upswing, now becoming South Africa's largest in known history, was maintained into 2006, with a temporary reduction in growth in the second half of 2005 due to poor results from the mining sector. The increasingly large stress that was developing within the South African economy into 2006 was the current account deficit, which in the beginning of 2006 was more than 6% of GDP (South African Reserve Bank, 2006: 2). The South African economy had two major boosts of foreign investor confidence when two large South African companies were bought and this characterised the South African equity market in the beginning of 2006. However, in May 2006, investor sentiment turned away from emerging markets and resulted in a decline in FDI, a drop in equity markets and widening spreads in the bond markets together with a substantial depreciation in the rand in the second week of May (South African Reserve Bank, 2006: 2).

The inherent risks developing in the global economy throughout 2005 and 2006 remained and intensified into 2007. The volatility in emerging markets in May 2006 highlighted the changing global sentiment into a risk-off attitude. Larger economies globally started having significant economic issues. In February 2007, a decline in the Chinese stock markets led to a correction in multiple global

markets. In August 2007, the ever-increasing risk associated with the sub-prime sector in the USA was becoming more apparent: this led to a loss in confidence and a reduction in liquidity globally, resulting in a decline in global stock markets. In the first half of 2007, it was announced that the South African current account deficit had widened to 6.5%, the highest it had been since 1975 (South African Reserve Bank, 2007: 3).

In 2008, the implosion of the sub-prime crisis in the USA led to a global credit market crisis and a severe reduction in economic activity. Issues started developing in the financial sector as liquidity in the interbank markets dried up and confidence between counterparties evaporated. Adding further stress, commodity price increases over the previous four years resulted in global inflation, particularly food inflation (South African Reserve Bank, 2008: 29). In South Africa, the longest business cycle upswing in history ended in November 2007, and combined with electricity supply issues in the first couple months of 2008, the economy lost momentum (South African Reserve Bank, 2009: 33). The resulting turmoil from abroad, exacerbated by electricity issues and concerns about the current account deficit, resulted in significant Rand volatility and depreciation in the first few months of 2008 (South African Reserve Bank, 2008: 30). The crisis spread to all parts of the South African economy with equity markets retreating and bond yields widening.

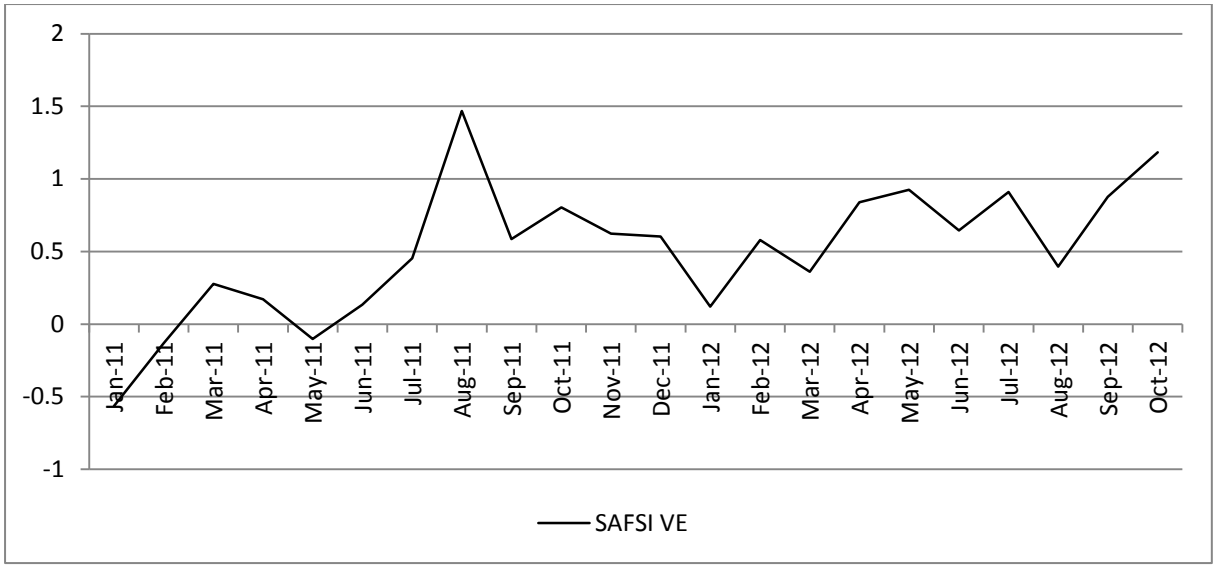
In the latter part of 2008, after gaining control of inflationary pressures within South Africa, the Monetary Policy Committee started lowering the Repo Rate in December 2008 and did so for most of 2009 until the rate was at 5% (South African Reserve Bank, 2009: 36).

The SAFSI shows a number of distinct peaks during the period July 2005 to November 2008, and an upward trend in financial stress starting in September 2005 until the May 2008 turning point. The only spike in 2005 was recorded in October and was not substantial, and could be attributed to mining sector results and the widening of the current account deficit. In 2006, the risk aversion away from emerging markets in May, highlighted by the South African Reserve Bank (2006: 2) was clearly captured, reaching 0.82 standard deviation points above the mean. From August 2006 onwards, financial stress increased substantially according to the SAFSI. The correction in stock markets globally, caused by Chinese equities, was clearly captured with the SAFSI recording a peak of 1.49 standard deviation points in the corresponding month. The second highest peak in the SAFSI was recorded in August 2007 and coincides with the apparent stress emanating from the USA, highlighted by the South African Reserve Bank (2007: 3). The SAFSI remained at sustained high levels until June 2008 where it peaked at 3.03 standard deviation points. The sustained stress corresponds to the global turmoil originating from the USA, the electricity issues within South Africa, the widening current account deficit, the retreat of equity markets, the widening yield spreads of bond markets, inflationary pressures and rand volatility highlighted in the period by the South African Reserve Bank (2008). The final peak during the period in October 2008 was the recording of the collapse of a prominent bank in the USA in September 2008 (South African Reserve Bank, 2008: 34). The subsequent decline in

financial stress after this point and into 2009 coincides with the easing on monetary policy from December 2008 onwards and as inflationary pressures subsided.

Period from January 2011 until the present day

Figure 5: SAFSI January 2011 until present



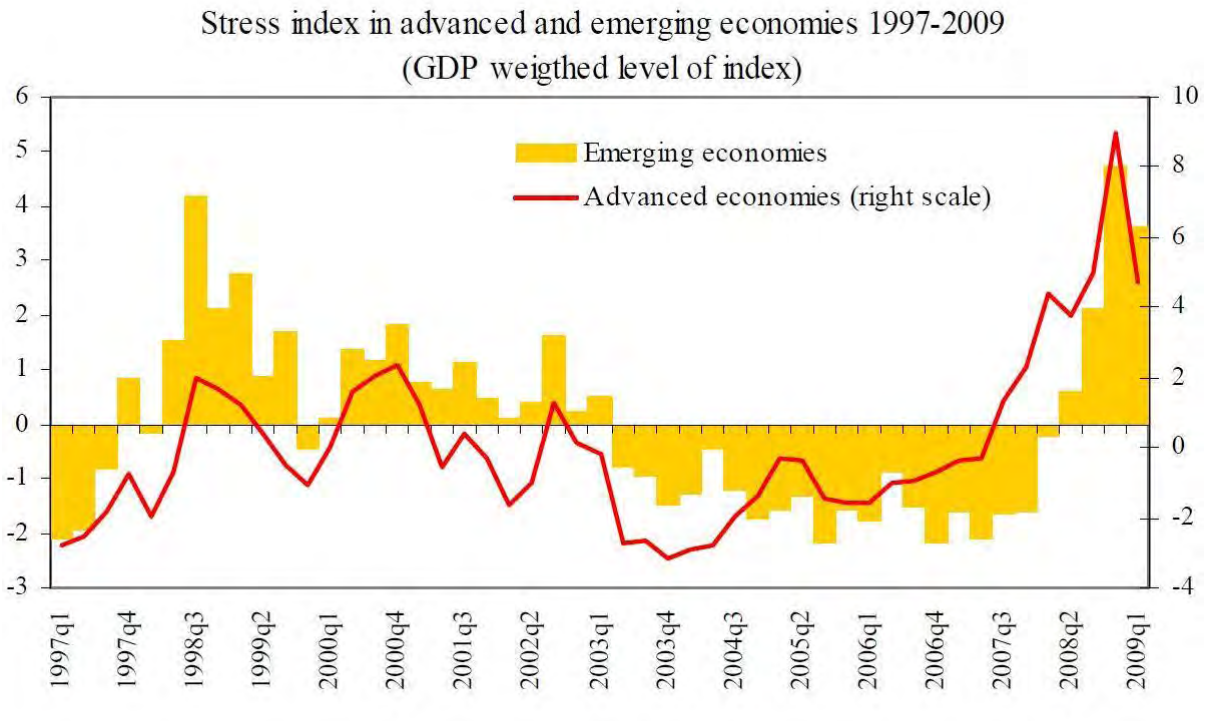
Post the 2008–2009 peaks in financial stress and the global economic meltdown, governments around the world in one form or another embarked on aggressive stimulatory monetary and fiscal policies. Subsequently, the escalation of government debt triggered concerns about fiscal stability and structural weaknesses (South African Reserve Bank, 2010a: 1). Developing economies recovered at a far greater pace than developed economies, primarily driven from demand originating from India and China. Subsequently, commodity prices were bolstered and many commodity-driven economies resumed economic growth. South Africa followed a hybrid trend between advanced and developing economies whereby growth was not as great as developing countries but more than advanced economies (South African Reserve Bank, 2010a: 2). The South African economy, particularly the durable goods sectors, was bolstered by the 2010 Soccer World Cup.

In March 2011, a devastating tsunami severely destroyed much of the Japanese economy. The significant impact on the global economy was the disruption to global supply chains (South African Reserve Bank, 2011: 1). Concurrently, the sovereign debt crisis in the EU was intensifying and a risk-off attitude developed in the global economy. The rand depreciated substantially in the second part of 2011 and again in 2012 due to capital outflows. In the early parts of 2012, the 'Arab Spring' disrupted multiple oil-producing countries, driving the price of oil as high as $125 a barrel. The South African economy was also experiencing high levels of turmoil with two rounds of illegal strike action stymieing the economy: strike action in the platinum sector in the first and second quarter of 2012 (South African Reserve Bank, 2012: 2), and the second round of strike action which developed in August and continues until the present day.

The SAFSI captures this stress successfully. The tsunami in Japan is captured with a spike in the SAFSI in March 2011. The EU sovereign debt crisis and the rand depreciation in the third quarter of 2011 are captured spiking in August 2011. In 2012, the strike action around South Africa intensifies but is clearly shown with the striking at Impala Platinum in February and March leading to rand volatility. But furthermore, the strike action starting at Lonmin, Marikana, in August 2012 led to significant volatility in the rand but also capital outflows from the economy in general. The spike in the SAFSI from August 2012 onwards captures the inherent stress within the South African economy.

Comparison of SAFSI to other indices

Figure 6: Taken from Balakrishnan *et al* (2009: 43)



None of Illing and Liu (2006), Balakrishnan *et al* (2009) or Cardarelli *et al* (2009) published a FSI for South Africa, although Balakrishnan *et al* (2009) included South African data within their emerging market index. Thus, no direct comparison can be made between these authors' indices and the index created within this thesis. Nonetheless, an approximation of the SAFSI's validity can be gained by comparing it to the emerging market index constructed by Balakrishnan *et al* (2009). Furthermore, Illing and Liu (2006: 263) highlight stressful events that affected the Canadian economy between 1981 and 2001. Not all events highlighted will be comparable to the SAFSI, but they will provide a proxy with which a comparison can be made.

The index constructed by Balakrishnan *et al* (2009) starts in the first quarter on 1997 and ends in the first quarter of 2009 (Figure 6). Figure 6 also shows an overlay of the advanced economy and emerging economy indices constructed by Balakrishnan *et al* (2009). The four periods of stress highlighted by the SAFSI were between the first quarter of 1997 until the final quarter of 1998,

between January 2000 and September 2001, between January 2006 and December 2008, and between January 2011 and October 2012.

Comparing these periods to the index constructed by Balakrishnan *et al* (2009) (BEMFSI), the SAFSI results are very favourable. The BEMFSI shows three periods of stress: the first period corresponds to the Asian crisis and started in the fourth quarter of 1997 until the third quarter of 1999. The SAFSI shows stress in a very similar period commencing three quarters prior to the BEMFSI and concluding 3 quarters prior to the BEMFSI. The magnitude of stress between the two indices also compares favourably, with both indices representing stress proportionately to other periods of stress. The second period of financial stress on the BEMFSI was captured between the first quarter of 2000 and was sustained at low levels until the third quarter of 2003. Once again, the SAFSI mimics the stress levels of the BEMFSI over a nearly identical period. The final period of stress captured by the BEMFSI was from the second quarter of 2008 onwards. The SAFSI, on the other hand, registers financial stress some two years prior to this date. Nonetheless, both indices show a similar trend at peak at very similar levels. The extreme peaks captured by the two indices roughly correspond to the mid to latter parts of 2008 and begin to subside into 2009.

Illing and Liu (2006: 263) highlight certain events that caused financial stress within the Canadian economy. Many of these events can be seen on the SAFSI in Figure 1. Firstly, in October 1997, the Asian crisis caused headlines with the devaluation of the Thai Baht which caused further devaluation in Malaysia, Indonesia, South Korea and the Philippines: in October 97, the SAFSI spikes to under 2 standard deviation points. Between August and September 1998, the Russian LTCM crisis engulfed emerging markets. Once again, in a similar period ending in October 1998, the SAFSI spikes substantially. A final series of events highlighted by Illing and Liu (2006: 263) is captured by the SAFSI: in 2000 the bursting of the dot-com bubble in the USA, the devaluation of the Turkish lire in 2001, the Argentinean bond crisis in 2001 and the 9/11 terrorist attacks in the USA. Over the same period, the SAFSI spikes numerous times, but continues a downwards trend until the end of 2004.

5.1.2 The Emerging Market FSI

Figure 7: The Emerging Market FSI

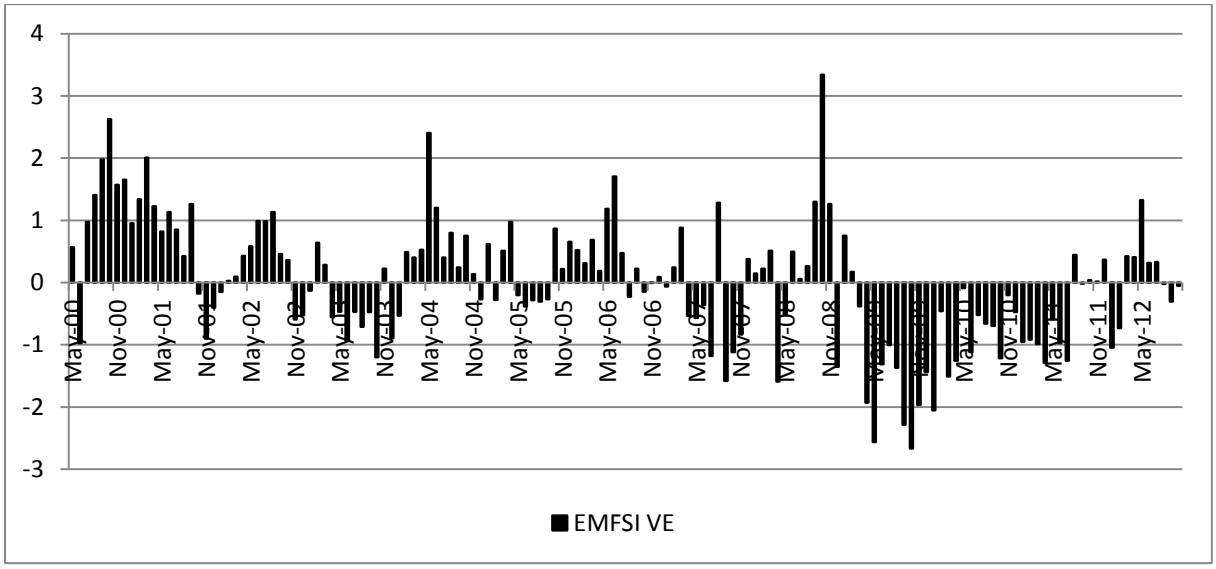


Figure 7 represents the FSI for emerging markets comprising financial stress indices from China, Brazil, India and Russia (BRICS excluding South Africa). In a similar manner to the investigation carried out for the validity of the South African FSI, the EMFSI will be compared to known periods of stress, and other FSIs such as the ones constructed by Illing and Liu (2006), Balakrishnan *et al* (2009) and Cardarelli *et al* (2009).

An initial visual analysis shows that the trend line of financial stress in emerging markets is far more volatile than, and not as distinctive as, that of the SAFSI and the BEMFSI. The BAEFSI is constructed using 26 countries whereas the EMFSI is constructed using four countries from the BRIC regions, thus financial stress using the EMFSI is far more concentrated than that of the BEMFSI. None the less, the two indices share similar peaks and troughs.

The first similarity between the two indices is during the post-2000 period where the bursting of the dot-com bubble in the USA, the devaluation of the Turkish lire in 2001, the Argentinean bond crisis in 2001 and the 9/11 terrorist attacks in the USA occurred. During this period, the EMFSI shows a positive but declining trend until the beginning of 2003 when it turns negative until January 2004. The BEMFSI shows a near identical trend and intensity level over the same period.

From the second quarter of 2003 until the first quarter of 2008 the BEMFSI captures very low levels of financial stress, and until the fourth quarter of 2006, the trend is downwards. This is in stark contrast to the EMFSI which between the first quarter of 2004 and the first quarter of 2007 shows much higher levels of financial stress with a positive trend, similar to that of the SAFSI during the same period. Analysis into the discrepancy reveals events that could affect certain markets more severely than others. The EMFSI shows a positive spike in financial stress from the first quarter of 2004 until June 2006. During this period, the South African Reserve Bank (2005: 1) states that crude

oil prices more than doubled which resulted in higher levels of inflation in most countries. In May 2006 the EMFSI shows a significant spike in financial stress that is not captured on the BEMFSI. The South African Reserve Bank (2006: 2) highlights that in May 2006 international investor sentiment negatively affected emerging markets causing securities and equities to decline and bond yields to widen.

By the first quarter of 2008, the EMFSI starts to show an upward trend in financial stress and in October 2008 spikes at 3.3 standard deviation points above its mean, the highest recorded over the period. This corresponds with the BEMFSI which shows an upward trend in financial stress from the first quarter of 2008, peaking at its highest value in the third quarter of 2008.

5.1.3 The Advanced economy FSI

Figure 8: The Advanced Economy FSI

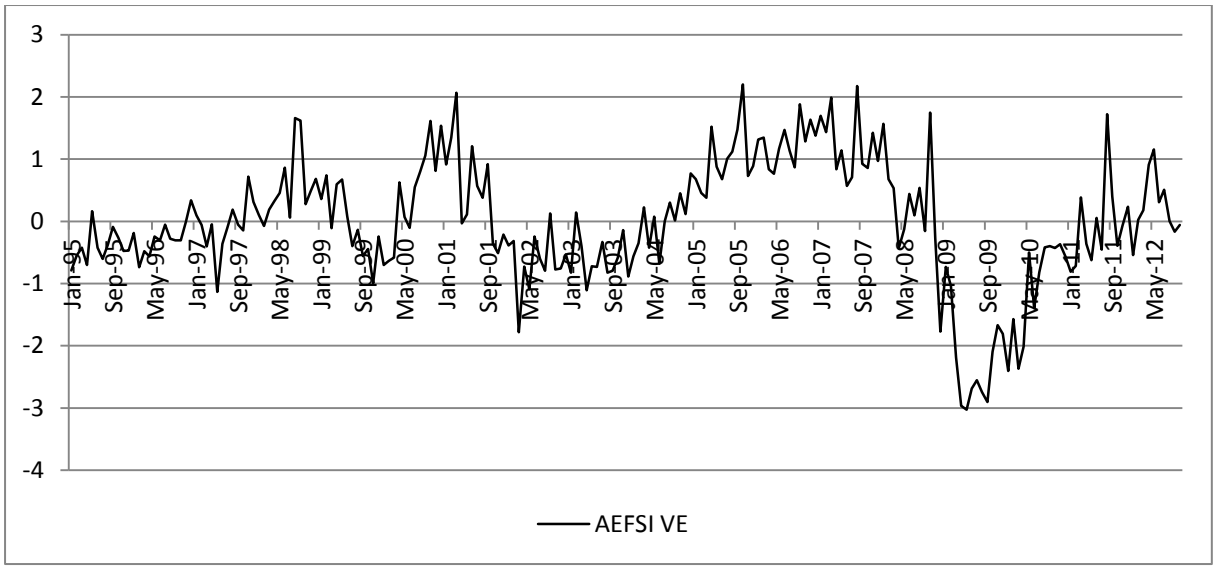


Figure 8 represents the FSI for advanced economies comprising the United States of America, Germany, Japan and France. As discussed previously, the AEFSI (advanced economy financial stress index) will be compared to other indices and known times of financial stress to check its validity. An initial visual comparison to the advanced economy financial stress index constructed by Balakrishnan *et al* (2009) (BAEFSI), shows that the two indices capture very similar periods of financial stress.

Both indices peak during the Asian and Russian crises in 1998 and 1999. Both peak for a second time between 2000 and the end of 2002 where the bursting of the dot-com bubble in the USA, the devaluation of the Turkish lire in 2001, the Argentinean bond crisis in 2001 and the 911 terrorist attacks in the USA occurred. And finally, both indices capture a substantial build-up in financial stress leading up to the sub-prime crises in the United States.

The major turning points in the trend of financial stress between the two indices correspond. The first major turning point on the BAEFSI occurs in the third quarter of 2008, and on the AEFSI, the first

major turning point occurs in August and September 1998. This trend continues: the BAEFSI peaks in the final quarter of 2000 and the AEFSI peaks in January 2001, a minor peak in the BAEFSI occurs in the third quarter of 2002 and the AEFSI has two minor peaks in the months following September 2002. From the third and fourth quarters of 2003, both indices start trending upwards towards the sub-prime and global financial crisis. Minor differences become apparent when comparing the trends from this point onwards. The AEFSI, although matching the trend, captures multiple peaks between September 2005 and October 2008 whereas the BAEFSI is far more linear.

Analysing the Annual Report of the Board of Governors of the Federal Reserve System (2005: 24), the stress captured by the AEFSI is warranted. The strains on US markets in 2005 included increases in key interest rates to manage inflation that was driven by sharply rising commodity prices. Furthermore, the extension of credit within the USA was increasing at a rapid pace to both business and households. Credit extension within the USA continued to increase across most sectors well into 2006, with household credit extension outstripping the growth in disposable income (Board of Governors of the Federal Reserve System, 2006: 26). The Deutsche Bundesbank (2006: 14) mimics the Federal Reserve and states that the rise in commodity prices placed many economies under inflationary pressures, and subsequently, moving into 2006, interest rates were increased to cool economies around the world.

The AEFSI remains at high levels until October 2008, when the near collapse of a large bank in the USA caused one final spike in the AEFSI. In the latter parts of 2008, both indices decline rapidly moving into the first quarter of 2009.

5.2 The Contagion of Financial Stress

Table 1: Basic Data Description

	AEFSI	SAFSI	EMFSI
Observations	214	214	150
Mean	0	0	0
Median	-0.05	-0.04	0.03
Maximum	2.20	3.03	3.34
Minimum	-3.03	-2.27	-2.66
Variance	1	1	1
Kurtosis	0.79	0.22	0.61
Skewness	-0.47	0.33	1.48
Correlation to SAFSI	57%	100%	35%
Source: Thompson DataStream (2012) and author's estimates using EViews 7			

5.2.1 Stationarity Tests

Following from Chapter 4, which indicated that the Augmented Dickey-Fuller (ADF) and Phillips-Perron tests would be performed, the three series were tested. A quick graphical analysis of the indices indicated that they are all time-varying and with an intercept. The indices over the entire period have a mean of 0 and a standard deviation of 1 due to the variance-equal weighting methodology adopted. For this reason, the assumption of "intercept" was used as the series will always revert to a zero mean in the long run, and therefore no long-run trend. For the Augmented Dickey-Fuller tests, due to the data having a monthly frequency, the maximum lag length was 12 lags using the Schwarz Information Criterion. For the Phillips-Perron tests, the spectral estimation method was set to the Bartlett kernel using the Newey-West Bandwidth. The results of both tests are shown below.

Table 2: ADF and Phillips-Perron unit root tests (Intercept)

Variable	ADF Level	ADF 1st Difference	PP Level	PP 1st Difference	Order of Integration
SAFSI	-2.11(0.2421)	19.12(0.0000)*	3.15(0.0249)	20.04(0.0000)*	I(1)
AEFSI	-1.93(0.3151)	13.72(0.0000)*	3.44(0.0110)	-20.32(0.000)*	I(1)
EMFSI	5.83(0.0000)*		5.79(0.000)*		I(0)

Notes:

The MacKinnon (1996) ADF 1% critical value = -3.48 and the Phillips Perron 1% critical value = -3.48

* denotes rejection of the Null Hypothesis (p-values in parenthesis)

Source: Thompson DataStream (2012) and author's estimates using EViews 7

The results indicated that the SAFSI and AEFSI are stationary at first difference: i.e. they do not contain a unit root at I(1), while the EMFSI is stationary at level terms: i.e. does not contain a unit root. In both tests, the null hypothesis is that the series contains a unit root. Therefore, in order to determine the order of integration for each index, it had to be shown that the absolute value of the calculated t-statistic was greater than the absolute value of critical statistic (-3.47) for each test. It was noted in the previous chapter that if one non-stationary series is regressed on another, the results may be spurious. However, the results will not be spurious if it is proved that the variables within the regression are cointegrated - i.e. linear combinations of the variables are stationary.

5.2.2 Testing for Cointegration

Due to the number of variables being tested, this analysis has tested for cointegration using two methodologies; only one cointegrating vector is likely. This will allow for OLS methodologies to be adopted after incorporating an error correction mechanism. Concurrently, the relationship between the indices will be tested using the Johansen methodology which is preferred in the literature.

Augmented Engle Granger test for Cointegration

In order for the Augmented Engle-Granger test to be run, the residuals of the following regression had to be obtained:

$$SAFSI_t = AEFSI_t + EMFSI_t + U_t$$

Equation 5.1

The first step in obtaining the residuals is to estimate Equation 5.1 using OLS techniques. The results indicate that the relationship between the SAFSI and the AEFSI is positive. The SAFSI and EMFSI are, contrary to expectations, negatively related. This relationship is not significant, while that with the AEFSI is significant at the 1% level. These results can be seen in the table below.

Table 3: OLS Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000000	0.062735	0.000000	1.000000
AEFSI	0.659263	0.080542	8.185291	0.000000
EMFSI	-0.021274	0.080542	-0.26413	0.792047
R-squared	0.417580	Mean dependent var		
Adjusted R-squared	0.409656	S.D. dependent var		
S.E. of regression	0.768338	Akaike info criterion		
Sum squared resid	86.780518	Schwarz criterion		
Log likelihood	-171.79679	Hannan-Quinn criter.		
F-statistic	52.697680	Durbin-Watson stat		

Consequently, the EMFSI is omitted from the analysis with Equation 5.2 used to obtain the residual series.

$$SAFSI_t = AEFSI_t + U_t$$

Equation 5.2

The residual series generated is then tested for stationarity using the ADF test statistic. The residuals were tested using the "no intercept or trend" specification with a maximum lag length of 12 months using the Schwarz Information Criterion.

Table 4: AEG Cointegration Test

Variable	ADF Level	Order of Integration
RESIDFORAEG	-2.46(0.0139)	I(0)
Engle-Granger critical tau value at 5% level = -1.94		
* denotes rejection of the Null Hypothesis (p-values in parenthesis)		
Source: Thompson DataStream (2012) and author's estimates using EViews 7		

The results indicate that, at the 5% level, the null hypothesis of non-stationary can be rejected: i.e. the residuals do not have a unit root. Therefore, according to the AEG cointegration test, the SAFSI and AEFSI are cointegrated and the original regression is not spurious.

Johansen Cointegration Analysis

As noted in Chapter Four, the Johansen's cointegration analysis was followed as set out by Olalere (2007), Hancocks (2010), Chinzara (2008) and Junkin (2011). The analysis is carried out to determine the number of cointegrating vectors among the specification and to investigate the long-run relationship between the SAFSI and AEFSI. This was done by specifying a VAR for the SAFSI and AEFSI. Hall (1991: 318) notes that the Johansen cointegration approach requires that an appropriate lag order and deterministic assumption for the VAR order be specified. If the lag order chosen is too low, the likelihood of serial correlation increases, and if the lag order is too high, small sample problems may develop. Furthermore, empirical studies have found that the chosen Johansen test statistics are sensitive to the lag order chosen. Following Junkin (2011: 52), various information criteria will be used to determine the optimal lag order. Due to the number of criteria, and the conflicting results which they will obtain, a range of lags will be highlighted. Cointegration is then sequentially tested from the smallest lag until meaningful cointegration results are obtained. If no meaningful results are obtained within the range of lag orders, the conclusion that there is no long-run relationship between the variables will be accepted. As the data is monthly, 12 lags will be selected as the maximum lag length as it is expected that a resulting shock to one of the indices will return back to long-run equilibrium within this time period. The results are shown below.

Table 5: Lag length selection

Lag Criterion	FSI Model
LR	5
FPE	3
AIC	3
SC	2
HQ	3

Notes:

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

The lag lengths highlighted varied depending on the statistic. The HQ statistic selected a lag length of 2. The AIC, SC and FPE statistics selected 3 lags and the LR statistic selected 5 lags. As stated above, due to the conflicting lag lengths, we start the cointegration analysis using the smallest selected VAR lag and then increase the lag until the results show acceptable residual diagnostic checks.

In the test for cointegration, all results were tested for serial correlation and were found to be robust. Johansen (1998) provides two likelihood tests statistics used in the analysis: the trace statistic and the maximum eigenvalue statistic. The table below represents the results. Testing the FSI model, it was found that using 5 lags yielded appropriate results. Using deterministic assumption 3, that is "intercept with no trend" allowing for a deterministic assumption, the trace statistic highlighted one cointegrating vector and was significant at the 5% level while the max eigenvalue statistic did not highlight a cointegrating vector; the models have thus been estimated according to the trace statistic. Examining Figures 10 through 12 in the Appendix, assumption three is best suited as the variance-equal weighting methodology adopted to construct the indices requires that the long-run mean be equal to zero. This means that in the long run, no trend will be apparent as the series will always adjust back to a zero mean. However, in the indices, it is evident that a trend line over the sample period may imply a minor deterministic trend, and thus assumption three allows for a deterministic assumption.

Table 6: Cointegration Test Results

FSI Model	Statistic	Prob**	5% critical Value
Trace	9.854172	0.00017	3.841466
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values			

In order to identify the true cointegrating vectors, the VECM model was estimated. The results are shown in Table 7 overleaf.

Table 7: VECM results

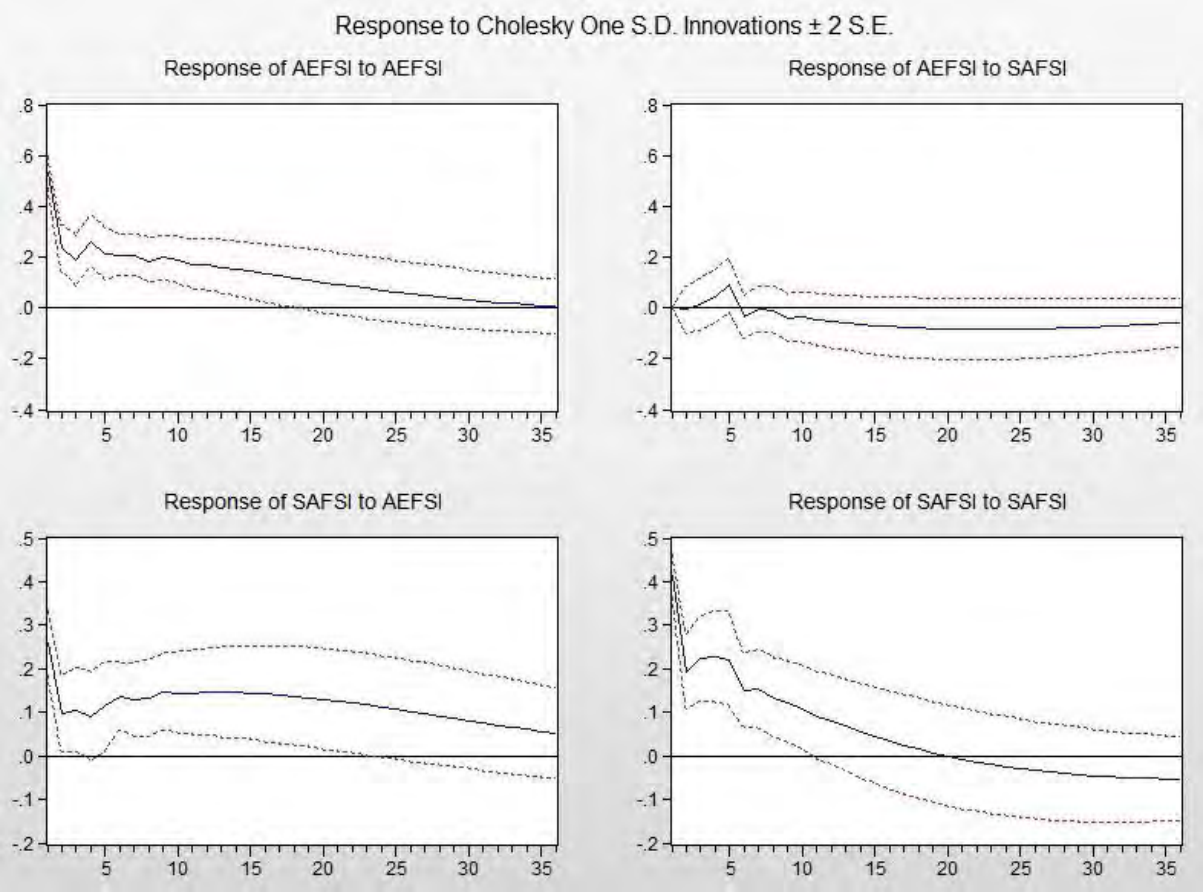
Vector Error Correction Estimates Sample (adjusted): 2000M08 2012M10 Included observations: 147 after adjustments Standard errors in ( ) & t-statistics in [ ]	
Cointegrating Eq:	CointEq1
SAFSI(-1)	1
AEFSI(-1)	-0.491244
	0.24458
	[-2.00852]
C	0.023814
Error Correction:	D(SAFSI)
CointEq1	-0.182652
	-0.05962
	[-3.06343]

Before these results can be accepted, the ECM (error correction model) coefficients need to be validated, and the residuals need to be checked for autocorrelation. The ECM coefficients are required to be negative and significant. From the above table, the ECM coefficient (CointEq1) is negative and is significant at the 1% level. The ECM coefficient implies that the SAFSI adjusts back to its long-run equilibrium relationship with the AEFSI when there is a shock to the short-run equilibrium. More specifically, the SAFSI adjusts back to long-run equilibrium at a rate of 18% per month, given a shock to its short-run equilibrium. Generally speaking, the SAFSI will return to long-run equilibrium with the AEFSI within 5 months of a shock to its short-run equilibrium. Testing for auto correlation, using the LM test on the residuals of the VECM series, at five lags, we fail to reject the null hypothesis of no autocorrelation.

Impulse Response Analysis

The impulse response function was estimated using the Cholesky approach and the results are shown in Table 8 below. The impulse response function is used to examine the signs and persistence of short-run shocks to the SAFSI by the AEFSI. Significantly, in the results obtained, the sign of the response corresponds to that obtained by the VECM. The response of the SAFSI to a shock in the AEFSI is positive. After an initial shock, the response declines sharply and flattens in a declining fashion over time.

Table 8: Impulse Response



5.2.3 Error correction with OLS estimation

The error correction mechanism allows for the testing of the cointegrated variables using OLS techniques. These techniques will be used to supplement the results obtained from the Johansen analysis above. Table 2 indicated the residual series was stationary, therefore cointegrated. This indicates a stable long-run relationship between the variables and possibly short-run disequilibrium. The ECM corrects for this short-run disequilibrium by incorporating a lagged residual series to tie the short-run behaviour of the dependent variable to its long-run value. The results of the estimation are shown below.

Table 9: ECM OLS estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000116857	0.036684464	-0.003185465	0.997462715
AEFSI	0.637939932	0.03668612	17.38913606	2.14E-37
RESIDFORAEG02(-1)	0.814008773	0.048350362	16.83562935	5.06E-36
R-squared	0.802524092	Mean dependent var		-0.005845998
Adjusted R-squared	0.799818943	S.D. dependent var		1.000797564
S.E. of regression	0.447772821	Akaike info criterion		1.250867295
Sum squared resid	29.27307284	Schwarz criterion		1.311349435
Log likelihood	-90.18961345	Hannan-Quinn criter.		1.275440188
F-statistic	296.6653475	Durbin-Watson stat		2.537520304

The ECM OLS estimation concurs with the results obtained from the Johansen analysis. The relationship between the SAFSI and the AEFSI is positive and significant at the 1% level. The R^2 statistic is less than the Durbin-Watson statistic, suggesting that the regression is not spurious. The R^2 statistic measures the goodness of fit for a multiple regression model. With an adjusted R^2 squared of approximately 80%, this suggests that roughly 80% of the variation in the SAFSI is explained by the variation in the AEFSI. Finally, the F-statistic is significant at the 1% level indicating that, as a whole, the regression results are significant.

5.2.4 Contagion analysis of the SAFSI

The value of understanding stress within the South African economy, and highlighting its cause, will assist decision makers in South Africa to maximise economic growth. Chapter 1 highlights the importance of such tools. The following section discusses the results obtained and the implications of financial contagion for South Africa.

The above analysis of financial contagion adopted two methodologies to test the relationship. The reasons for this are simple: the pre-testing requirements for OLS estimation are limited in determining more than one cointegrating vector. Furthermore, the Johansen cointegration analysis is preferred in the literature and has been used successfully in the identification of multiple cointegrating vectors.

Performing stationarity tests on the three indices indicated that the two of the series were stationary at first difference while the EMFSI was stationary at level terms. Furthermore, an estimation of the three indices using OLS techniques revealed that the EMFSI had a negative but insignificant relationship with the SAFSI. This could have impacted the remainder of the analysis if it was to be included, and as such, the EMFSI was excluded from the cointegration and subsequent ECM OLS analysis.

This is contrary to *a priori* expectations and the theoretical literature; the EMFSI was expected to have a positive and significant relationship with the SAFSI. The South African Reserve Bank (2006) noted on multiple occasions how emerging market distress affected South Africa i.e. 1997–1998, and the Russian and Asian crises. Although the channels of such stress and the causality of the stress have not been examined from a South African perspective, the result tends to contradict the literature. A possible theory that may explain such a scenario is that emerging market distress may affect South Africa through advanced economy financial linkages. Kaminsky *et al* (2003: 4) highlight within their Unholy Trinity that investor sentiment may have a large effect in the spreading of contagion. Thus, as some emerging markets are experiencing distress, advanced economies adopt a risk-off attitude across all emerging markets, and hence, cause distress among other emerging markets that were not directly affected by the distress. This resulting behaviour through advanced economy linkages may have a greater impact on the South African economy than the stress emanating directly from emerging market linkages.

At this point in the analysis, it was evident that the possibility of cointegration was likely as the SAFSI and AEFSI were I(1). In order to test for cointegration, the AEG cointegration technique was undertaken and the results indicated that the variables were cointegrated and as a series were stationary. Thus under OLS architecture, the error correction model could be run with the resulting regression being tested to obtain results that could be analysed to determine the contagious relationship between the SAFSI and the AEFSI.

To supplement the AEG cointegration analysis, the Johansen cointegration analysis was performed. The results of the Johansen cointegration analysis were in line with those obtained from the AEG technique. Initial testing revealed that trace statistic highlighted one cointegrating vector that was significant at the 5% level. This validates the results obtained by the AEG test as the result indicates one cointegrating vector. In order to identify the relationship between the true cointegrating vectors, the VECM model was estimated. In order for the results to be valid the ECM coefficients were validated and found to be significant at the 1% level, and the residuals were checked for autocorrelation. The ECM coefficient indicates that given a shock to its short-run equilibrium, the SAFSI adjusts back to its long-run equilibrium relationship with the AEFSI at a rate of 18% per month. Furthermore, the SAFSI was found to have a positively correlated relationship with the AEFSI that is significant at the 1% level. Thus, financial stress emanating from advanced economies has a significant positive relationship on financial stress within South Africa.

The results obtained from the VECM under the Johansen cointegration analysis prompted further investigation into the relationship between the stress indices. Impulse response analysis indicated that the relationship obtained by the VECM analysis was indeed correct. A positive correlation to the AEFSI was obtained.

Finally, OLS techniques were used to estimate the SAFSI against the AEFSI. This was possible as the Johansen cointegration analysis identified only one cointegrating vector, thus validating the results obtained by the AEG cointegration tests. That is, there is a long-run cointegrating relationship between the SAFSI and AEFSI, disproving the possibility of spurious regression. Once again, the results obtained showed a positive correlation between the SAFSI and the AEFSI. The results are significant at the 1% level and indicate that the AEFSI explains 80% of the variation of a 1 standard deviation shock to the SAFSI. Contrary to *a priori* expectations and those indicated by the theoretical literature, the correlation between the SAFSI and the EMFSI is negative, but under OLS architecture, the relationship is found to be insignificant.

5.3 Conclusion

The chapter constructed financial stress indices for a group of countries representing emerging markets, advanced economies and an index for South Africa, with the intention of analysing the co-movement of stress between the regions. The chapter commenced with the identification of financial

stress in South Africa. The index captured stress within the economy adequately and highlighted most major periods of financial turmoil. South African Reserve Bank Economic Reports were studied to highlight periods where the South African economy manifested financial stress. On an annual basis, these reports highlight events that were applicable and known to have somehow affected the economy. The SAFSI did well to highlight most events and was accurate in identifying the time period within which an event occurred and the intensity of each event. The same can be said of the EMFSI and AEFSI. Both indices captured all major events and were compared to other indices constructed. Some deviation was highlighted between the indices which can be attributed to the sample of countries selected. It was noted that all three indices seem to trend together during times of high global stress.

The second half of the analysis tested for the co-movement of financial stress between the three indices with a focus on South Africa. The three indices were tested for stationarity with the SAFSI and AEFSI found to be stationary at first difference while the EMFSI was stationary in level terms. Due to the characteristics of the data, the analysis adopted two methodologies to test for cointegration and subsequently the co-movement between the FSI's. Firstly, within the OLS architecture, it was discovered the EMFSI was, against *a priori* expectations, insignificant and thus was not included in the analysis going forward. Subsequently, the Augmented Engle-Granger cointegration test was performed and it was found that the SAFSI and AEFSI were cointegrated, and therefore not spurious. To supplement the basic OLS architecture and to gain additional credibility, the Johansen Cointegration analysis was undertaken as the literature has shown a preference for this methodology. The results indicated that there was one cointegrating vector, validating the results obtained by the AEG. The ECM coefficient indicates that given a shock to its short-run equilibrium the SAFSI adjusts back to its long-run equilibrium relationship with the AEFSI at a rate of 18% per month. Furthermore, the Johansen analysis indicated that the SAFSI is positively correlated to the AEFSI. Further investigation by undertaking an impulse response analysis generally concurred with the above results. Finally, under OLS architecture and incorporating the error correction methodology stipulated by AEG, the results obtained by the Johansen analysis were confirmed; a significant positive relationship exists between the SAFSI and AEFSI.

Having concluded the analysis, the following chapter concludes the study and highlights areas for further research.

CHAPTER SIX: CONCLUSION

6.0 Summary of the Study and Conclusion

This study identified financial stress in South Africa and tested for the co-movement of financial stress originating from advanced and emerging economies. This was done to accurately gauge the distress within the South African economy at any point in time, and to understand where the stress may originate from. Subsequently, the goals of the research were to identify financial stress in South Africa and a selection of advanced and emerging market economies using a financial stress index and to investigate the relative strength and direction of financial contagion between advanced economies, emerging market economies and South Africa.

The first step in the study was to investigate the theoretical underpinnings of financial stress and the contagion of financial stress. Chapter 2 investigated these underpinnings by looking at financial stress and contagion in two sections. The chapter started by positioning financial stress and discussing the key features which in some form are always present during a crisis: uncertainty of the valuation of assets which leads to volatility within markets as asset prices adjust rapidly; uncertainty associated with the behaviour of other investors which is a key feature during times of financial stress, as investors act in an irrational manner and become unpredictable; asymmetric information which becomes more prevalent as a lack of information impedes all stages of a transaction; the tendency of investors to move towards safe assets with lower returns due to the unpredictability of more risky assets; and finally, the tendency of investors to move to assets that are liquid, allowing them the ability to change their portfolios quickly.

The discussion of financial contagion began with the distinction between neoclassical and non-neoclassical channels. The section positioned the conduits with which financial stress can move between asset classes and economies by highlighting the theories of financial contagion. Pure contagion involves a financial crisis where there is no observed change in macroeconomic or any economic fundamentals but the crisis is the sole result of a change in the behaviour of investors and economic agents. Spillovers result from the normal interdependence between two different market economies. Finally, the chapter concluded with a discussion on the two root causes of contagion: fundamental changes to an economy and changes in investor behaviour.

Chapter 3 discussed the empirical literature in the same structure as Chapter 2: firstly literature studying financial stress and secondly financial contagion. By constructing financial stress indices, significant success in the identification and measurement of financial stress from a vast array of economies was obtained. Empirical literature on financial contagion focuses on the transmission mechanisms with which distress permeates throughout the global economy. It was apparent that there is no consensus as to the definition of these channels. Nonetheless, financial channels were found be

the most significant channel in the promulgation of financial contagion, and to a lesser extent the trade channel.

In order to address the aims of the research, multiple econometric techniques were used in the identification financial stress and contagion. The FSI's were constructed using various financial indicators and compiled into an index using variance-equal weighting. The FSI's accurately identified the magnitude and timing of well-known events. The co-movement of stress was analysed using the Augmented Dickey-Fuller and Phillips-Perron stationarity tests, Johansen and EG cointegration techniques, impulse response analysis and standard OLS architecture. Two of the three FSI's were found to be stationary at I(1) and one at I(0) and thus tests for cointegration were undertaken to examine the long-run relationship between the three FSI's. In the ensuing analysis, it was discovered that the EMFSI had an insignificant relationship with the SAFSI and was subsequently removed from the analysis going forward. The Johansen analysis noted that there was only one cointegrating vector and that the SAFSI adjusts back to its long-run equilibrium relationship with the AEFSI at a rate of 18% per month, given a shock to its short-run equilibrium. The Johansen and impulse response analysis indicated that the SAFSI is positively correlated to the AEFSI. Finally, as the Johansen analysis identified only one cointegrating vector, the study could be supplemented using basic OLS architecture. Performing the Augmented Engle-Granger cointegration analysis, it was found that that the SAFSI and AEFSI were cointegrated, and therefore not spurious. Under OLS architecture, the results obtained by the Johansen analysis were confirmed; there is a significant positive relationship between the SAFSI and AEFSI.

Overall, the framework adopted to identify financial stress within South Africa, emerging markets and advanced economies was accurate at identifying distress. The results indicate that the South African financial sector is at more risk to distress in advanced economies than in emerging markets. The Johansen analysis, impulse response analysis and the OLS regression all indicated a significant positive correlation between the SAFSI and AEFSI, with the exception of the OLS regression found the SAFSI and EMFSI coefficient to be negative but insignificant. This result is contradictory as it is apparent from other literature, and even the SAFSI constructed within this analysis, that South Africa has been affected significantly by emerging market crises. It is believed that, due to the maturity of the financial system in South Africa, and its integration into the global financial system which is dominated by advanced economies, these emerging market crises are being 'transmitted' through advanced economy linkages despite the origins being emerging market based. Thus, in the framework of this research, the contagion would be realised through an advanced economy channel. The results indicate clearly that the South African financial sector is highly reactive to advanced economy stress.

6.1 Areas for further research

As mentioned above, the correlation between the SAFSI and EMFSI warrants further research. It has been evident in the literature, and even indicated within this study, that South Africa has been affected

by emerging market crises. The framework adopted in this study is agnostic about the root cause of financial distress but pays attention as to where the South African economy is most vulnerable. These channels clearly originate from advanced economies due to the apparent synergy with the South African financial system. Further analysis into the permutation of financial stress originating from emerging economies through advanced economies and on to South Africa would significantly improve the ability of regulators to form a reaction.

The analysis could be supplemented by incorporating a country-specific analysis instead of grouping countries into one index, as done in this research. This would indicate to which specific countries the South African economy is correlated. Furthermore, this would improve the accuracy of the FSI's as country-specific variables could be used, while an improved weighting method (credit aggregates) could be used.

Finally, other African economies could be incorporated into the analysis, depending on data availability. The causal correlation between South Africa and the African continent could yield valuable information into the state of the broader African economy and its economic stability going forward.

Appendix

Financial Stress Indices

Figure 9: Financial Stress Indices

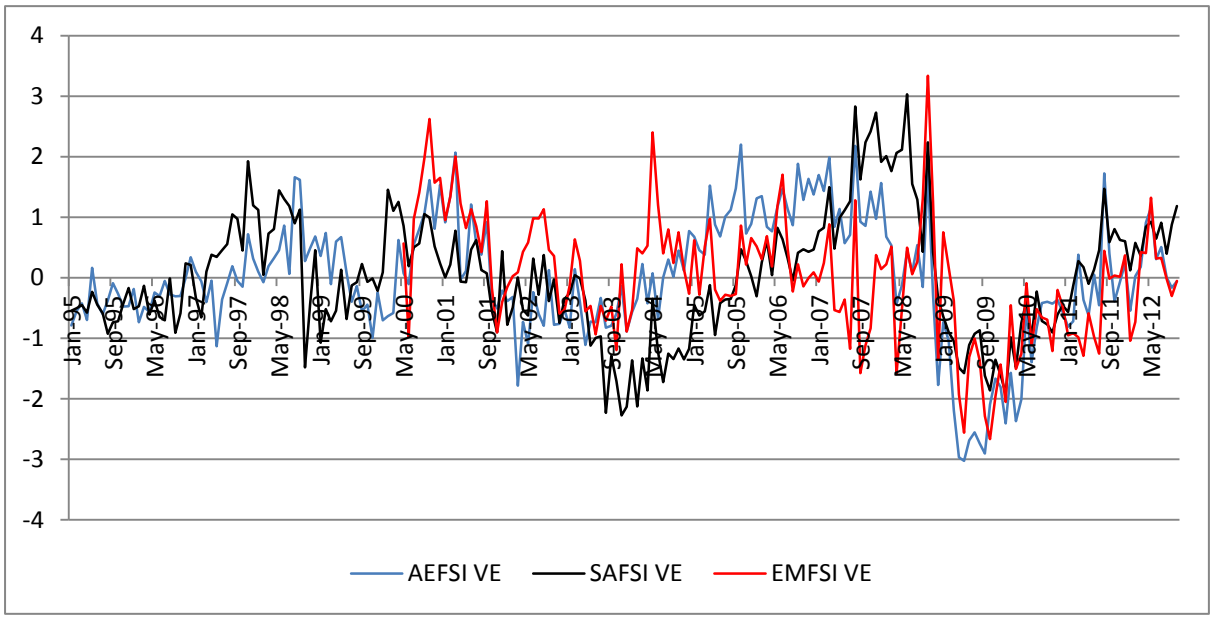


Figure 10: SAFSI with Trend Line

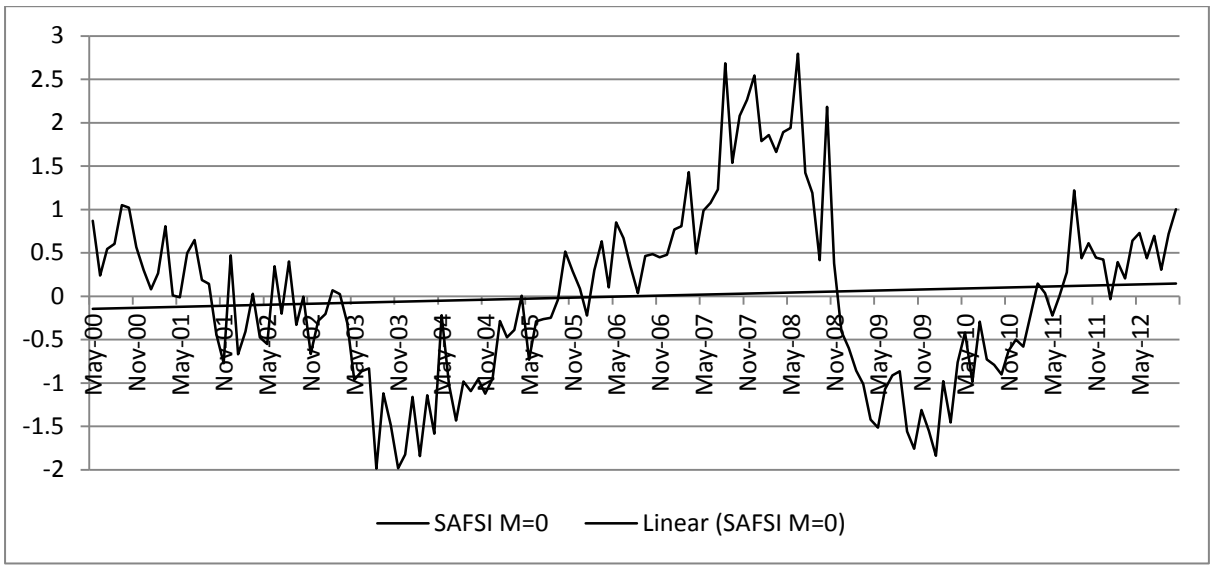


Figure 11: EMFSI with Trend Line

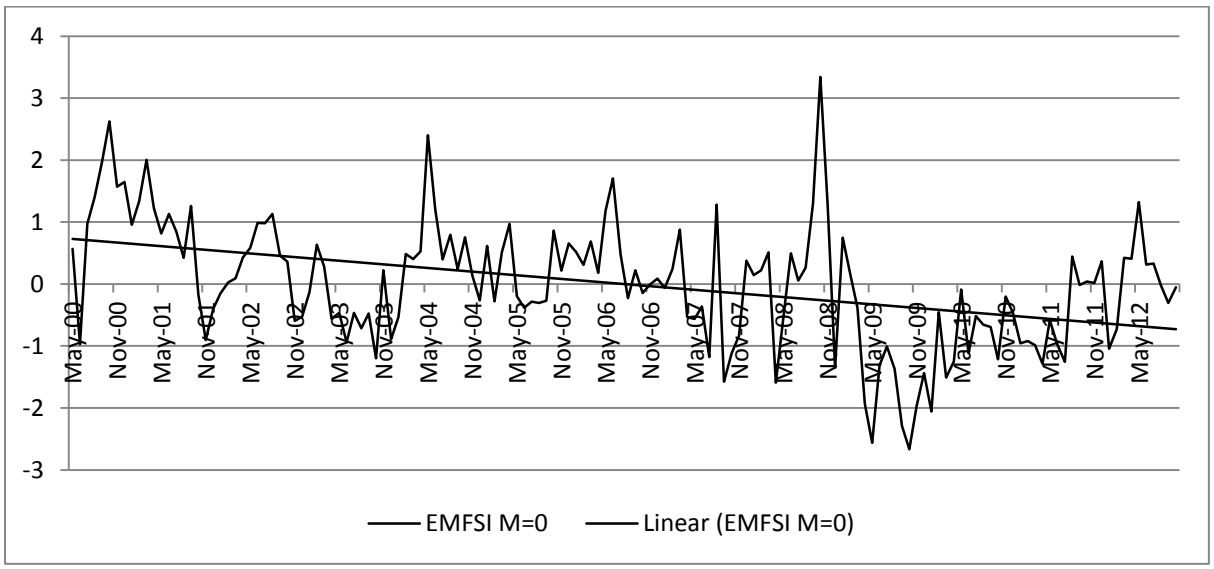


Figure 12: AEFSI with Trend Line

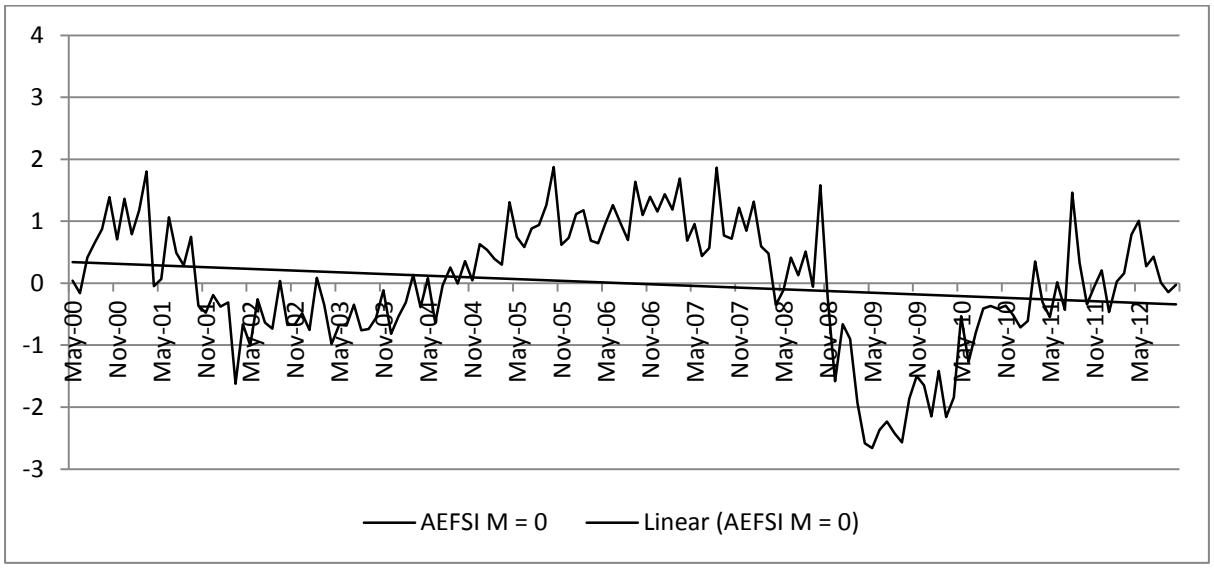


Table 10: FSIs 1995–1999

	AEFSI VE	SAFSI VE	EMFSI VE		AEFSI VE	SAFSI VE	EMFSI VE
Jan-95	-0.78668835	-0.54550711		Jun-97	-0.362965371	0.453603782	
Feb-95	-0.54627388	-0.50171716		Jul-97	-0.092810111	0.551979465	
Mar-95	-0.42377819	-0.45156106		Aug-97	0.189820385	1.048778384	
Apr-95	-0.70026706	-0.57724118		Sep-97	-0.051302996	0.974022768	
May-95	0.16301202	-0.23208017		Oct-97	-0.147270663	0.449613766	
Jun-95	-0.42615222	-0.44389690		Nov-97	0.719776808	1.922544582	
Jul-95	-0.60266077	-0.58795835		Dec-97	0.314081376	1.191813534	
Aug-95	-0.37828096	-0.92799126		Jan-98	0.100017527	1.121870292	
Sep-95	-0.09193191	-0.73387529		Feb-98	-0.076457557	0.047879505	
Oct-95	-0.26380997	-0.71819039		Mar-98	0.190270834	0.727948972	
Nov-95	-0.47575287	-0.43252538		Apr-98	0.32380632	0.801576928	
Dec-95	-0.47051377	-0.17169409		May-98	0.456322885	1.44387896	
Jan-96	-0.18578839	-0.52156295		Jun-98	0.86090471	1.29860729	
Feb-96	-0.73678960	-0.47285352		Jul-98	0.062078392	1.185325095	
Mar-96	-0.48098292	-0.13200815		Aug-98	1.658213901	0.898257196	
Apr-96	-0.56435941	-0.60699790		Sep-98	1.618584541	1.123591947	
May-96	-0.24642638	-0.37536654		Oct-98	0.27323979	-1.48316416	
Jun-96	-0.30395333	-0.65002363		Nov-98	0.485351591	-0.441425612	
Jul-96	-0.05224773	-0.70461600		Dec-98	0.680701403	0.451949815	
Aug-96	-0.27838402	-0.01034114		Jan-99	0.36004476	-1.076958484	
Sep-96	-0.30649258	-0.90989578		Feb-99	0.738701916	-0.518971447	
Oct-96	-0.30433261	-0.58713203		Mar-99	-0.107901853	-0.721412654	
Nov-96	-0.00870159	0.23879218		Apr-99	0.594267988	-0.54788417	
Dec-96	0.33498393	0.20806622		May-99	0.672958399	0.128991981	
Jan-97	0.09778713	-0.32898036		Jun-99	0.078805089	-0.681230353	
Feb-97	-0.05735960	-0.65714881		Jul-99	-0.396427205	-0.127998773	
Mar-97	-0.40188586	0.09970408		Aug-99	-0.137092916	-0.073119057	
Apr-97	-0.04997073	0.38197947		Sep-99	-0.556687654	0.225475327	
May-97	-1.13397942	0.34035365		Oct-99	-0.442945092	-0.071368244	

Table 11: FSIs 1999–2004

	AEFSI VE	SAFSI VE	EMFSI VE		AEFSI VE	SAFSI VE	EMFSI VE
Nov-99	-0.992865631	-0.014042659		Apr-02	-0.72879896	-0.530292785	0.429213211
Dec-99	-0.243879367	-0.21717766		May-02	-1.092134495	-0.625250728	0.582083915
Jan-00	-0.703713347	0.09158582		Jun-02	-0.241405771	0.316518547	0.98539669
Feb-00	-0.633852186	1.45118705		Jul-02	-0.596772583	-0.281296028	0.979998449
Mar-00	-0.582302722	1.104686356		Aug-02	-0.79525328	0.376593215	1.131363105
Apr-00	0.624181208	1.254820856		Sep-02	0.128071446	-0.386652597	0.459393076
May-00	0.070754201	0.857932964	0.567271997	Oct-02	-0.776168698	-0.0281298	0.360972105
Jun-00	-0.105174044	0.190276235	-0.972299928	Nov-02	-0.760791257	-0.74675188	-0.592446119
Jul-00	0.549878759	0.502651431	0.970580697	Dec-02	-0.531108346	-0.352030508	-0.527386584
Aug-00	0.80181136	0.563036927	1.405389256	Jan-03	-0.824238533	-0.256287212	-0.127549657
Sep-00	1.059454258	1.049237525	1.973301497	Feb-03	0.13985092	0.041885607	0.635362161
Oct-00	1.614774952	0.992746438	2.623357467	Mar-03	-0.403630452	-0.013664318	0.280237116
Nov-00	0.810371677	0.515910757	1.5698408	Apr-03	-1.110616975	-0.375296927	-0.556129594
Dec-00	1.534934591	0.237206171	1.649030187	May-03	-0.723568589	-1.121020795	-0.466678206
Jan-01	0.914826939	0.006526029	0.952473656	Jun-03	-0.734642106	-0.995029697	-0.938583144
Feb-01	1.347167812	0.215041438	1.337785126	Jul-03	-0.332122884	-0.968002613	-0.466692273
Mar-01	2.065308275	0.774384049	2.005778436	Aug-03	-0.826167142	-2.232338047	-0.711859617
Apr-01	-0.031305966	-0.064652497	1.224319841	Sep-03	-0.793139729	-1.291338684	-0.475110554
May-01	0.110485744	-0.074151923	0.816807758	Oct-03	-0.591138039	-1.710631992	-1.198121408
Jun-01	1.207821367	0.463043099	1.129648776	Nov-03	-0.140564429	-2.27323154	0.223226309
Jul-01	0.568808209	0.621363987	0.848607069	Dec-03	-0.888065483	-2.129764545	-0.890714773
Aug-01	0.379764271	0.126255908	0.422661478	Jan-04	-0.565301113	-1.363683588	-0.531034566
Sep-01	0.919118062	0.072259028	1.260544521	Feb-04	-0.349745441	-2.126241696	0.486407045
Oct-01	-0.358824959	-0.549241993	-0.176557595	Mar-04	0.225528594	-1.334663259	0.401197053
Nov-01	-0.510547127	-0.901509156	-0.903075226	Apr-04	-0.426394199	-1.860339553	0.526807614
Dec-01	-0.210591827	0.440362789	-0.40392344	May-04	0.07443367	-0.347903122	2.402789116
Jan-02	-0.38683977	-0.77751525	-0.151817346	Jun-04	-0.678695229	-1.227108766	1.200361336
Feb-02	-0.316018073	-0.492344167	0.025848676	Jul-04	0.004820163	-1.726838255	0.399541886
Mar-02	-1.782387575	0.002323103	0.091522512	Aug-04	0.30081588	-1.256441739	0.796368776

Table 12: FSIs 2004–2009

	AEFSI VE	SAFSI VE	EMFSI VE		AEFSI VE	SAFSI VE	EMFSI VE
Sep-04	0.014264667	-1.34372221	0.241214621	Feb-07	1.433145151	0.822145028	0.242139412
Oct-04	0.448666509	-1.169126067	0.750947836	Mar-07	1.986530461	1.496858873	0.880041292
Nov-04	0.116617829	-1.349989429	0.13510427	Apr-07	0.838705057	0.481665289	-0.533847941
Dec-04	0.768762059	-1.172518137	-0.266234716	May-07	1.138812399	0.988896383	-0.564624803
Jan-05	0.677470096	-0.451315547	0.615481969	Jun-07	0.570169426	1.115791088	-0.361929238
Feb-05	0.455663296	-0.623693276	-0.280309642	Jul-07	0.709530712	1.264922383	-1.177232084
Mar-05	0.37725077	-0.558030565	0.511362762	Aug-07	2.175592528	2.826116315	1.279416715
Apr-05	1.521343125	-0.122954833	0.971952184	Sep-07	0.924061915	1.62217109	-1.578156356
May-05	0.876613226	-0.949840124	-0.198514443	Oct-07	0.85525309	2.234408789	-1.114807301
Jun-05	0.679251182	-0.418456809	-0.382583889	Nov-07	1.422415497	2.414897012	-0.834533661
Jul-05	1.006783779	-0.359903104	-0.282873485	Dec-07	0.971757157	2.728508451	0.377015495
Aug-05	1.120011366	-0.349742267	-0.304895828	Jan-08	1.566746329	1.913374547	0.143952117
Sep-05	1.476883635	-0.122416534	-0.269741587	Feb-08	0.67860646	2.007552059	0.223424294
Oct-05	2.199013785	0.468162848	0.863665641	Mar-08	0.531855138	1.760766257	0.510784467
Nov-05	0.730780951	0.275891429	0.218414858	Apr-08	-0.433858301	2.062449642	-1.59051233
Dec-05	0.885775846	0.023677656	0.653645141	May-08	-0.123206848	2.112224816	-0.515165219
Jan-06	1.31320442	-0.305952647	0.517560416	Jun-08	0.438994862	3.03202836	0.494495481
Feb-06	1.345510505	0.254990108	0.306958544	Jul-08	0.096694353	1.54674391	0.057382123
Mar-06	0.837748637	0.61455437	0.686471397	Aug-08	0.53783855	1.290040945	0.261175037
Apr-06	0.76652159	0.039931295	0.182663	Sep-08	-0.155244916	0.428692626	1.29844175
May-06	1.16758002	0.824352387	1.184098697	Oct-08	1.746064025	2.238647839	3.338983968
Jun-06	1.468967383	0.63526004	1.703939533	Nov-08	-0.274634345	0.427509816	1.261006991
Jul-06	1.132809671	0.317300083	0.472717118	Dec-08	-1.771996932	-0.342967871	-1.350847355
Aug-06	0.868302884	-0.051064339	-0.227925215	Jan-09	-0.734014808	-0.639460109	0.748646983
Sep-06	1.882308694	0.413285445	0.22111626	Feb-09	-1.042897245	-0.902092525	0.168492416
Oct-06	1.28530996	0.470297568	-0.144931508	Mar-09	-2.189505644	-1.050196221	-0.381442511
Nov-06	1.631669767	0.429986593	-0.005180271	Apr-09	-2.966395653	-1.48781293	-1.931194021
Dec-06	1.37499439	0.463481355	0.088096154	May-09	-3.025071656	-1.577768694	-2.561768414
Jan-07	1.69600693	0.763852759	-0.063718755	Jun-09	-2.688296589	-1.111515455	-1.31353228

Table 13: FSIs 2009–2012

	AEFSI VE	SAFSI VE	EMFSI VE
Jul-09	-2.555070851	-0.92535602	-1.005582793
Aug-09	-2.742816097	-0.866907537	-1.370623673
Sep-09	-2.905067979	-1.620378087	-2.286676748
Oct-09	-2.096560841	-1.861409624	-2.664689992
Nov-09	-1.667561306	-1.35717529	-1.965529935
Dec-09	-1.805932838	-1.601785121	-1.435577414
Jan-10	-2.406966419	-1.915902691	-2.05490142
Feb-10	-1.569539467	-0.985708858	-0.457671485
Mar-10	-2.371041347	-1.48050517	-1.506950332
Apr-10	-2.012079272	-0.747834593	-1.253232679
May-10	-0.500086367	-0.380604513	-0.088719543
Jun-10	-1.398508899	-0.982733423	-1.114378235
Jul-10	-0.818773147	-0.228564145	-0.519443561
Aug-10	-0.41691539	-0.714535229	-0.657564981
Sep-10	-0.399850535	-0.771487409	-0.692367491
Oct-10	-0.429434524	-0.905754104	-1.213791775
Nov-10	-0.367142149	-0.607065966	-0.201283819
Dec-10	-0.565494188	-0.454039517	-0.472539715
Jan-11	-0.812151527	-0.566512146	-0.954421505
Feb-11	-0.71764387	-0.133319433	-0.918037465
Mar-11	0.381537214	0.276044255	-0.987093703
Apr-11	-0.364753045	0.171659007	-1.288824728
May-11	-0.623639926	-0.102858632	-0.585966891
Jun-11	0.053841211	0.132742409	-0.974196269
Jul-11	-0.455742111	0.454032493	-1.25625059
Aug-11	1.723669663	1.46790458	0.441993242
Sep-11	0.400231356	0.585743494	-0.01671131
Oct-11	-0.394761529	0.804679747	0.038381687
Nov-11	-0.068238232	0.623506265	0.014934284
Dec-11	0.236251788	0.603684485	0.367499536
Jan-12	-0.543750618	0.119522282	-1.04404935
Feb-12	0.025580151	0.577896723	-0.731352508
Mar-12	0.180544214	0.361140146	0.421297651
Apr-12	0.907787645	0.839231282	0.407832558
May-12	1.156039443	0.924893907	1.321347164
Jun-12	0.305225718	0.644065009	0.314041014
Jul-12	0.508392852	0.909605488	0.329419328
Aug-12	0.004987441	0.395819408	-0.022364586
Sep-12	-0.165979507	0.876031764	-0.304186897
Oct-12	-0.060646051	1.182462557	-0.051579847

Lag length Criteria

Table 14: Lag Length Criteria

Exogenous variables: C
Sample: 2000M05 2012M10
Included observations: 138

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-357.6852117	NA	0.62944	5.212829	5.255253	5.230069
1	-202.5653564	303.4954	0.070436	3.022686	3.149958	3.074406
2	-184.1063952	35.58032	0.057123	2.813136	3.025256*	2.899336
3	-176.5789459	14.29124	0.054282*	2.762014*	3.058981	2.882694*
4	-175.0311896	2.893631	0.056257	2.797553	3.179369	2.952714
5	-169.4042386	10.35685*	0.054963	2.773974	3.240638	2.963615
6	-165.5790459	6.929697	0.055126	2.776508	3.328019	3.000629
7	-162.385304	5.693192	0.055808	2.788193	3.424552	3.046794
8	-158.8910232	6.127652	0.056263	2.795522	3.51673	3.088603
9	-154.5636716	7.463114	0.056053	2.790778	3.596833	3.118339
10	-153.6966558	1.470157	0.05873	2.836183	3.727087	3.198224
11	-152.3817553	2.191501	0.061153	2.875098	3.850849	3.271619
12	-148.3902343	6.536839	0.061271	2.875221	3.93582	3.306222

* 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

Trace/ Eigenvalue Result

Table 15: Trace/ Eigenvalue

Sample (adjusted): 2000M11 2012M10
Included observations: 144 after adjustments
Trend assumption: Linear deterministic trend
Series: SAFSI AEFSI
Lags interval (in first differences): 1 to 5

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.068822411	20.12213037	15.49471288	0.009322369
At most 1 *	0.066142804	9.854171635	3.841465501	0.001692934

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.068822411	10.26795874	14.26460015	0.194922571
At most 1 *	0.066142804	9.854171635	3.841465501	0.001692934

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

SAFSI	AEFSI
-1.470364543	0.722308133
0.38893946	-1.352963847

Unrestricted Adjustment Coefficients (alpha):

D(SAFSI)	0.124222116	-0.023377814
D(AEFSI)	0.092510275	0.096483641

1 Cointegrating Equation Log likelihood -178.5789069

Normalized cointegrating coefficients (standard error in parentheses

SAFSI	AEFSI
1	-0.491244254
	0.244580626

Adjustment coefficients (standard error in parentheses)

D(SAFSI)	-0.182651795
	0.059623337
D(AEFSI)	-0.136023828
	0.064820401

Cointegrating Vectors

Table 16: Cointegrating Vectors

Sample: 2000M05 2012M10
Included observations: 144
Series: SAFSI AEFSI
Lags interval: 1 to 5

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	2	2	2	1	2
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or	No Intercept	Intercept	Intercept	Intercept	Intercept
No. of CEs	No Trend	No Trend	No Trend	Trend	Trend

Log Likelihood by Rank (rows) and Model (columns)

0	-183.7998543	-183.7998543	-183.7128863	-183.7128863	-183.289694
1	-178.6858473	-178.6529547	-178.5789069	-175.2209349	-175.1752579
2	-173.7662518	-173.6518211	-173.6518211	-170.2227455	-170.2227455

Akaike Information Criteria by Rank (rows) and Model (columns)

0	2.830554	2.830554	2.857123	2.857123	2.879024
1	2.815081	2.828513	2.841374	2.808624	2.821879
2	2.802309*	2.828498	2.828498	2.808649	2.808649

Schwarz Criteria by Rank (rows) and Model (columns)

0	3.243028*	3.243028*	3.310845	3.310845	3.373992
1	3.31005	3.344106	3.37759	3.365464	3.399342
2	3.379773	3.447209	3.447209	3.468608	3.468608

VECM

Table 17: VECM

SAFSI(-1)	1	
AEFSI(-1)	-0.491244254	
	0.244580626	
	[-2.00852]	
C	0.023814295	
Error Correction:	D(SAFSI)	D(AEFSI)
CointEq1	-0.182651795	-0.136023828
	0.059623337	0.064820401
	[-3.06343]	[-2.09847]
R-squared	0.277549088	0.329018304
Adj. R-squared	0.217344846	0.273103163
Sum sq. resids	31.25495963	36.94109907
S.E. equation	0.486600449	0.529014944
F-statistic	4.610125069	5.884243452
Log likelihood	-94.33741238	-106.3719716
Akaike AIC	1.476908505	1.644055161
Schwarz SC	1.724392947	1.891539602
Mean dependent	-0.000127938	-0.00983706
S.D. dependent	0.550031144	0.620485377
Determinant resid covariance (dof adj.)		0.048729593
Determinant resid covariance		0.040946394
Log likelihood		-178.5789069
Akaike information criterion		2.841373707
Schwarz criterion		3.377589998

Serial Autocorrelation LM-Test

Table 18: Lm-Test

VEC Residual Serial Correlation LM Tests		
Null Hypothesis: no serial correlation at lag order h		
Sample: 2000M05 2012M10		
Included observations: 145		
Lags	LM-Stat	Prob
1	2.728561	0.604226
2	8.680604	0.069598
3	5.68739	0.223742
4	5.138942	0.273336
5	3.74462	0.441669
6	5.190572	0.268297
7	2.511651	0.642551
8	7.25891	0.122822
9	5.467929	0.242563
10	1.860183	0.761455
11	0.814028	0.936558
12	4.300268	0.366892
Probs from chi-square with 4 df.		

OLS Regression

Table 19: OLS Regression

Dependent Variable: SAFSI				
Method: Least Squares				
Sample (adjusted): 2000M06 2012M10				
Included observations: 149 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000116857	0.036684464	-0.003185465	0.997462715
AEFSI	0.637939932	0.03668612	17.38913606	2.14E-37
RESIDFORAEG02(-1)	0.814008773	0.048350362	16.83562935	5.06E-36
R-squared	0.802524092	Mean dependent var		-0.005845998
Adjusted R-squared	0.799818943	S.D. dependent var		1.000797564
S.E. of regression	0.447772821	Akaike info criterion		1.250867295
Sum squared resid	29.27307284	Schwarz criterion		1.311349435
Log likelihood	-90.18961345	Hannan-Quinn criter.		1.275440188
F-statistic	296.6653475	Durbin-Watson stat		2.537520304

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