Financial Contagion and the Transmission of the 2007 US Financial Crisis to South Africa

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In accordance with Rule G4.6.3, I hereby declare that the above mentioned dissertation is my own work and that it has not previously been submitted to another University or for another qualification.

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ABSTRACT

The topic of financial contagion has attracted increased attention in economic literature over the past three decades; in particular after the Asian crisis of 1997. This dissertation investigates financial contagion and its effects on South Africa after the 2007 global financial crisis.

In particular, it examines whether South Africa experienced contagion from the United States stock market to its own over the period 1 July 2007 to 1 April 2009 within the strict definition of contagion or otherwise: the fraction of exceedance events in the stock market that is left unexplained by its own covariates but is explained by the exceedance from another region. This is tested empirically with a binomial-nominal logistic model. In addition to this, various financial and trade transmission mechanisms are tested to empirically determine through which channels the crisis was propagated. The analysis makes use of quarterly data from January 2002 to April 2009, within an OLS framework, with a dummy variable differentiating the periods before and after the collapse of Lehman Brothers.

The findings suggest that contagion was in fact not present in this crisis, which speaks to market rationality and indicates that the South African stock market did in fact react rationally to a changing macroeconomic environment over this period. The transmission mechanism analyses indicate that there was a change in the interdependence relationship between the two stock markets following the crash of Lehman Brothers in September 2008. It is apparent that both trade and financial variables played significant roles in the propagation of this crisis.

**Keywords:** Financial contagion; Stock market; South Africa; Transmission mechanisms; Global financial crisis
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LIST OF ACRONYMS

ABSA – Amalgamated Banks of South Africa

ADF – Augmented Dickey Fuller

ARCH – Autoregressive Conditional Heteroskedasticity

ARM – Adjustable Rate Mortgage

ASI – All Share Index

BATS – Bond Automated Trading System

BESA – Bond Exchange of South Africa

BMA – Bond Market Association

BSD – Bank Supervisory Department

BTA – Bond Traders Association

CIA – Central Intelligence Agency

CPI – Consumer Price Index

CSD – Central Securities Depository

DCC – Determinate of the Change in the Covariance

EA – European Area

EEC – European Economic Community

EMEA – Europe, Middle East and Africa

EMP – Exchange Market Pressure

EVT – Extreme Value Theory

FDI – Foreign Direct Investment

FNB – First National Bank

FSB – Financial Services Board
GARCH – Generalised Autoregressive Conditional Heteroskedasticity

GDP – Gross Domestic Product

GEAR – Growth Employment and Redistribution Strategy

GSE – Government Sponsored Enterprise

IFC – International Finance Corporation

IFRS – International Financial Reporting Standards

IMF – International Monetary Fund

JET – Johannesburg Equities Trading

JSE – Johannesburg Stock Exchange

KPSS – Kwiatkowski-Phillips-Schmidt-Shin

LPM – Linear Probability Model

MERM – Multilateral Exchange Rate Model

OECD – Organisation for Economic Co-operation and Development

OLS – Ordinary Least Squares

OPEC – Organization of Petroleum Exporting Countries

PP – Phillips Perron

REM – Resilience Exchange Model

S&P – Standard and Poor

SABG – South African Business Guidebook

SARB – South African Reserve Bank

SARS – South African Revenue Service

SECA – Stock Exchange Control Act

US – United States of America
US GAPP – United States General Accepted Accounting Principles

UK – United Kingdom

UN – United Nations

VAR – Vector Autoregressive

VEC – Vector Error Correction

WEF – World Economic Forum
CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND AND PROBLEM STATEMENT

Following the seminal work of Grubel (1968) on the benefits of international diversification in an equity portfolio, the relationship between national stock markets has been analysed in a very thorough manner. Much of the work done in the early and late 1970’s such as Granger & Morgenstern (1970), Hilliard (1979), Lessard (1974), (1976); and Ripley (1973), Panton, Lessig & Joy (1976) confirmed that returns between national stock markets were correlated rather poorly; thus, further justifying the use of international diversification, instead of purely domestic diversification. (Eun & Shim 1989:241)

However, over the past three decades financial markets have become increasingly integrated, evidence of which can be seen through the increased institutional investment activity across national borders, an expansion of mergers and acquisitions financed by foreign national corporations and banks generally reallocating their financial risk from their balance sheets to security markets. This increased integration is largely what has contributed to the increase in country-specific market events, under specific conditions, to be transmitted to foreign financial markets (Boshoff 2006:2).

The possibility of transmission of crises internationally has a number of implications for the financial sector; implications which are reliant upon the probability and extent of a country being negatively impacted by a crisis in a foreign country. Optimal asset allocation, risk measurement, capital requirements and asset pricing are all areas of financial asset valuation which require the consideration of financial contagion (Horen, Jager,& Klaassen 2006:375).

With reference to a country’s economy as a whole, if the benefit associated with financial market integration is supposedly economic growth, then the risk of contagion is the associated cost. As markets open up to foreign investors, theory suggests that exchange controls are relaxed with a subsequent increase in the vulnerability to sudden and large capital withdrawals. History has proven to us the dangers inherent in liquid capital markets. (Abrahamson & Collins 2004:1)

Although increased financial market integration and international diversification are relatively recent events, reports of financial contagion are by no means limited to the last
century. Schnabel & Shin (2004) argue that one of the first episodes of contagion struck the whole of Northern Europe in 1763. Many of the hotly debated topics over the last number of years; such as the role of highly leveraged institutions, liquidity drains in times of crisis, and the intertwining of credit risk and market risk were seemingly evident in 1763.

Regional episodes of contagion have also been prevalent in the past two decades with notable examples being the Mexican stock market crash of December 1994 which was subsequently seen to influence markets throughout Latin America (Forbes & Rigobon 2002:2223-2226). Also possibly more renowned, the Asian crisis of 1997/1998 which began in Thailand and spread throughout East Asia with little regard for country-specific fundamentals. Interestingly, the South African stock market fell by 14 percent over the same period. (Forbes 2000:1)

However, the 2007-2009 financial crisis is distinguishable from all others as, not only is it the most recent evidence of contagion according to some but, it was on a global scale which was previously unprecedented. Originating in the United States of America (US) sub-prime mortgage market, the crisis caused the failure of several banks in numerous countries around the world; including the US, United Kingdom (UK), Spain, Germany, Iceland, Ireland and Hungry among others. There were also contractions in the New York, London, Paris, Frankfurt, Mumbai, Singapore, Sydney, Hong Kong, Shanghai and Tokyo stock markets of over 30 percent for the year. (Pais & Stork 2010:1)

From the launch of South Africa’s democratisation process in 1990, the US has played an ever increasing role in the South African economy. Since 1994, the US has consistently been the largest foreign direct investor in South Africa, making up 40 percent of South Africa’s foreign direct investment (FDI) with an estimated 900 percent increase in US companies operating directly or indirectly in South Africa (International Relation and Cooperation: United States 2002).

If one continues to consider facts such as since 1994, the US has been the largest single country importer of South African goods and, on average, 160 000 (statistic from 2001) American tourists visit South Africa annually; the role the US plays in the South African economy is undeniable large (International Relation and Cooperation: United States 2002).

Although it has been said that the South African banking sector was, for the most part, shielded from the dangers of the US sub-prime mortgage market, the economy as a whole
was not able to withstand the negative impacts. May 2009, marked the official beginning of
the first recession in South Africa for 17 years with a -1.8 contraction in GDP in the fourth
quarter of 2008 and a -6.4 contraction in the first quarter of 2009. Following this, in the first
three quarters of 2009, the South African economy lost over 950 000 jobs. However, much of
this was anticipated after the stock market crash of 2008, which saw the Johannesburg Stock
Exchange (JSE) All Share Index, after experiencing an all-time high in May 2008, endure a
35 percent drop in prices by October 2008 (Stiftung 2009:1).

In response to the turmoil caused by the financial crisis, the South Africa government sought
to stimulate economic growth by earmarking R690 billion for public investment projects over
the three year period, 2009 to 2011. In absolute terms, South Africa’s stimulus package is the
largest in the region and would even rank fourth in the world. The South African Reserve
Bank (SARB) also followed suite, decreasing the interest rate from its high of 12 percent in
mid-2008 to below 6 percent by the end of 2010, in hopes of increase expenditure and
investment. (Afeikhena & Akinkugbe 2010:6 & 8)

However, much of the success of government intervention relies on the root cause of the
crisis. There are typically three possibilities as to how a shock can appear to spread between
countries: Firstly, pure coincidence – two countries just so happened to be hit by independent
shocks at the same time. Secondly, interdependence – which is commonly referred to as
“fundamental-based contagion”; will result in shocks, whether of a global or local nature, to
be transmitted across countries due to the real and financial linkages between them. Thirdly,
contagion - when a financial crisis cannot be linked to observed changes in the macro
economy or other fundamentals and is solely the result of the behaviour of individuals and
other financial agents, this is generally thought to be contagion (Pritskey 2000:7; Claessens,

The vast majority of papers written on the field of financial contagion are often informed by
one of two objectives. Firstly, they test whether contagion itself is present in the transmission
of a crisis. Distinctive policy and investment recommendations which can be drawn from this
research make it an imperative part of the literature.

Secondly and alternatively, tests are conducted on the channels through which a crisis is
transmitted into an economy; obviously important for its own unique policy and investment
conclusions. There is, however, a limited body of literature that attempts to encompass both
objectives in the hope of empirically studying both the presence of contagion and the
channels through which it is propagated. If conclusive policy recommendations and investment decisions are to be made, both of the following questions require answering: Did South Africa experience financial contagion or interdependence? And; what channels, if any, propagated the transmission of this contagion or interdependence?

1.2 OBJECTIVES

The broad objective of this paper is to study financial contagion in the recent global financial crisis and its influence on the South African economy. However, the specific objectives of the study shall be as follows:

- To examine whether South Africa experienced a case of financial contagion or simply interdependence, from the 2007 financial crisis that began in the United States (US).
- To determine by which channels, if any, the financial crisis was transmitted into the South African economy.
- To draw policy recommendations based on the outcomes of the research.

1.3 RELEVANCE AND JUSTIFICATION

There is a wide range of subject fields in economics and finance which are influenced by financial contagion. In economics, competent monetary and fiscal policy needs a thorough understanding of financial contagion and its influence on the South African economy if it is to prevent or minimize the impact of such future occurrences (Horen, Jager & Klaassen 2006:375). The policy implications associated with a crisis transmitted by contagion, compared to being transmitted by interdependence, are vastly different. If a crisis is driven by interdependence and the interlinked fundamentals, one cannot expect the crisis to dissipate until the fundamentals are altered. However, if a crisis is driven by contagion and the irrationality of investors, the priority of policy should be to soothe market sentiment and offer reassurance. Correct policy recommendations are completely reliant upon the correct diagnosis (Baig & Goldfajn 1999:194). Thus, this study will provide a backdrop from which South Africa’s policy response to the financial crisis can be analysed.

The regulation of financial markets needs to take into consideration the risks of contagion and how best to circumnavigate this potentially dangerous scenario. This can only be done once
there is a better understanding of what effects contagion and interdependence have on the South African economy and the channels through which they are able to have this effect. If factors unrelated to the fundamentals drove the crisis from the US to South Africa, one seriously needs to consider the benefits and hazards associated with foreign investment and how best to regulate this, so as to obtain the most beneficial outcome for the South African economy. Additionally, the knowledge of the channel/s through which contagion is propagated would allow regulators to design specific policies to overcome adverse effects of contagion in that channel and not create broad policies which may be unnecessary and burdensome for other sectors, and the economy as a whole. (Ilyina 2006:352)

For investors, the concept of contagion has the potential to influence a number of different subject fields which are considered before any investment decisions can be made; this would include: optimal asset allocation, risk measurement, capital requirements and asset pricing. The benefits of international diversification are completely dependent upon international financial market inter-linkages. The supposed benefits of international portfolio diversification for South African investors may fail to be delivered if cross country correlations of asset returns are significantly higher during crisis periods. This paper will be able to speak to that and in particular, to international diversification of South African equity portfolios in respect to the US. (Horen, Jager & Klaassen 2006:375)

Optimal asset allocation falls into both of the aforementioned groups as it is completely reliant upon the risk that the individual or firm is willing to gain exposure to. The probability of a country experiencing contagion and its role in systematic risk calculation is an imperative concept for all investors. This study will be able to speak specifically to the presence of contagion in South Africa resulting from the recent financial crisis. However, diversification also falls into this category due to the fact that if all the firm-specific risk cannot be diversified away, this increases the risk associated with all portfolios; thus changing the optimal asset allocation. Thus, this study will contribute to the ability of an investor to calculate systematic risk present in the South African market and as such, influence optimal asset allocation of investments in the country. (Horen, Jager & Klaassen 2006:375)
1.4 STRUCTURE OF DISSERTATION

The remainder of this dissertation is structured as follows: Chapter 2 gives a thorough background into the three most recent and widely recognised cases of contagion. This will be followed by an in-depth discussion on the Global Financial Crisis. Finally, an historical view will be taken on the major markets in South Africa and the impact the Global Financial Crisis had on them in relation to the historical trends. Chapter 3 begins with a brief introduction and discussion concerning the definition of contagion and the relevant considerations. This will be followed by a theoretical and empirical literature review, ending with a brief conclusion that will surmise the discussion of this chapter. Chapter 4 outlines the methodology which shall be used for the empirical analysis. The chapter contains three sections: Firstly, the methodological approach used to test for contagion is introduced. Secondly, the methodological approach used for testing the transmission channels through which contagion is propagated is explained. And, lastly, relevant data issues are discussed. In chapter 5, the actual empirical analysis is conducted, with the outcomes of the models being presented and discussed. Lastly, chapter 6 outlines conclusions and recommendation; where the dissertation in its entirety will be briefly considered with the ultimate policy and investment recommendations being elaborated upon.
CHAPTER TWO

CONTAGION AND THE SOUTH AFRICAN FINANCIAL MARKETS

2.1 INTRODUCTION

According to the Webster dictionary, contagion is “a disease that can be communicated rapidly through direct or indirect contact” (Bae, Karolyi & Stultz 2003:717). And although there are recordings of the phrase “contagion” being used in economic literature as far back as David Ricardo (1951:68) who attributed the panic leading to the suspension of convertibility in 1797 to “the contagion of the unfounded fears of the timid part of the community;” it was only in the 1990’s that the phrase truly gained wide spread recognition in economic literature (Kelly and Grada 2000:1110).

Before 1997, a Lexis-Nexis search for contagion finds hundreds of examples of the word in major American newspapers, almost none of which refer to the spread of international economic crises. This changed following the crisis which enveloped East Asia in 1997 and a Lexis-Nexis search of major newspapers since mid-1997 finds almost all references to contagion pertaining to the spread of international financial market turmoil. The term contagion has now become standard language in the vocabulary of both international economists and policy makers. (Claessens and Forbes 2004:1)

The chapter will now be divided into three distinct sections. Firstly, recent past cases of contagion shall be discussed, referring principally to the origin of the crisis and the resultant spread to other countries around the world. In particular, the Mexican “tequila” crisis of 1994/1995; the East Asian “flu” crisis of 1997/1998; and the Russian financial crisis of 1998 shall form the background discussion.

Secondly, an in depth examination of the global financial crisis of 2007/2008 shall take place. The origins of the crisis shall be deliberated from three different macroeconomic schools of thought, namely: the Keynesian school; the Monetarist school; and the Austrian school. From this a brief discussion on the disagreements that each school has with one another, regarding the origins of crisis shall take place; from which a synopsis will be drawn on the three

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1 The exception to this being a few articles written referring to the spread of an economic crisis through Latin American countries following the Mexican peso crisis of 1994. (Claessens and Forbes 2004:1)
different schools of thought. To conclude this section, a discussion on the role of the crash of Lehman Brothers in September 2008 will take place and the various global effects this incident appeared to pre-empt.

The last section will take the form of an overview of various South African financial markets. Specifically, the stock exchange, bond exchange, exchange rate, banking market, mineral commodity market and the trade market shall form the central themes for the section and are individually given their own unique subdivision. A historical account of each of these markets begins their discussion, moving forward through time until the effects of the global financial crisis of 2007/2008 is elaborated upon, functioning as the closing remarks about the individual markets.

2.2 CONTAGION IN THE 1990’s

Historically there are a number of examples of contagion occurring before the 1990’s. Commonly cited are the Latin America’s debt crises, which were started by Peru’s default in 1826, and the international financial crisis of 1873. Going further back, there was a contagion dimension to the Tulip Mania of the 1630’s and the Mississippi and South Sea Bubbles of 1719-1720². Regardless, the study of contagion only truly began to gain widespread popularity in the 1990’s with the Mexican crisis of 1994/1995, the East Asian crisis of 1997, and the Russian crisis of 1997/1998. (Kaminsky et al. 2003: 52)

2.2.1 The Mexican “Tequila” crisis, 1994-1995

The first widely recognised episode of contagion to occur in the 1990’s is said to have its starting point on Monday, 20 December 1994, when Mexico made the first official announcements that it was widening the trading band for the peso. This follows President Zedillo taking office on 1 December 1994 and assuring financial markets that the Mexican government would continue to support its currency at 3.4 pesos to one US dollar. By the end of Tuesday, 21 December 1994, the peso had dropped 12.7 percent against the US dollar. Two days later, the Mexican government abandoned all attempts to peg the currency within a

²For detailed accounts of these episodes of contagion and more, refer to Bordo and Eichengreen (1999), Bordo and Murshid (2000), Kindleberger (1977) and, Neal & Weidenmier (2002). (Kaminsky et al. 2003: 52).
trading range, resulting in a further 15 percent devaluation. (Buttimer and Swidler 1998:191-192)

Although December 1994 is marked as the period in which the Mexican economy truly began to unravel, signs of weakness were present well before this. In early 1994, the prospects for the Mexican economy looked promising: there was a budget surplus, a respectable privatization policy, increasing capital inflows and a declining budget deficit. Several important factors lead to this rapid and sizable decent: political unrest in the Mexican state of Chiapas and the assassination of a presidential candidate both impacted negatively on investor confidence regarding the stability of the Mexican government. Furthermore, a significant amount of short-term debt was replaced with “tesebonos”- securities convertible to US dollars at maturity – which investors considered a troubling sign regarding the confidence in the peso (Dibooglu Gleason, Mathur & Singh. 2002:21)

Additionally, inflation had begun to run out of control, with investors fearing hyperinflation by December 1994. The Mexican government’s foreign reserves had decreased from $30 billion in 1993 to $5 billion by December 1994. This is on the back of export growth which had deteriorated sharply and thus a current account deficit that had risen significantly. Perhaps most significantly, the government did not seem to recognise that the depletion in foreign reserves was also largely due to a long-term decrease in demand for Mexican assets by foreign investors. Thus, when the decision to devalue the currency was made, they failed to anticipate the extent and speed at which the stock market would react. (Dibooglu et al. 2002:21)

However, it would be overly jaundiced not to mention a commonly cited external factor which attributed to the Mexican crisis. Calvo & Mendoza (1994) warned two years prior to the crisis that, “the importance of external factors suggests that reversal of those conditions may lead to future capital outflow.” This refers to the US interest rates that fell from highs in 1989 of 9.5 percent to 3 percent in 1992. This was followed by a move of US capital to Mexico in the hope of reaping greater returns. However, in 1994 the Federal Reserve raised interest rates seven times to 6 percent. As Calvo et al. (1994) suggested, this came with a mass exodus of capital which had flowed so steadily to Mexico over the previous four years (Maskooki 2002:161).

Irrespective of the cause, fears quickly began to build that a major economic crisis in Mexico would spread throughout Latin America. On the 12th of January 1995, the US government
began to consider a support package to stabilize the peso. Ultimately, a $20 billion package was approved and made available through the US Treasury’s Exchange Stabilization Fund (Dibooglu et al. 2002:22). The US, however, was not alone as the International Monetary Fund (IMF) also stepped in to support what was essentially a Mexican bailout. Stanley Fischer, deputy managing director at the time, rationalized the IMF’s contribution in this way, “Of course, there was another justification: contagion effects. They were there and they were substantial” (Bae et al. 2003:717).

Regardless of these packages put forward by the US, IMF and other countries, contagion did arguably occur, with Argentina and Brazil hit hardest. Argentina similarly had a pegged currency to the US dollar. On 28 December 1994, the Argentinean central bank sold $353 million of reserves (the largest amount since the monetary board had been established). In the following three months, the Argentinean central bank sold more than one third of its foreign exchange reserves. Bond prices fell 36 percent whilst between December 19, 1994, and March 8, 1995, Argentina’s stock market index plummeted 50 percent. (Ganapolsky & Schmukler 1998:2)

The Brazilian financial markets were hit similarly hard with the stock market falling 16.4 percent between 20 and 27 December 1994. Beyond this, Brazil experienced massive withdrawals of debt, outflows of capital and rises in interest rates. At the height of the crisis the Brazilian government reduced or eliminated existing taxes on foreign purchase of stocks and bonds in the hopes of stimulating capital inflows. (Calvo & Reinhart 1996:1-4)

2.2.2 The East Asian “Flu” crisis, 1997

The next significant case of contagion took place in East Asia, 1997. Specifically, 2 July 1997 is quoted by many as being the official start of what is now one of the most famed cases of contagion in economic literature. The significance of this date is associated with the devaluation of the Thai Baht which had been pegged to the US dollar. In the aftermath of this devaluation, increased pressure was placed on currencies throughout the region, resulting in the unravelling of the Malaysian and Indonesian managed currencies. As the crisis became full-blown, massive foreign exchange and stock market turmoil spread through the entire region, culminating in the collapse of the Korean won (Baig and Goldfajn 1999:167). A currency crisis was in full motion by December 1997 with Indonesia, Korea, Malaysia and
the Philippines hardest hit, with their currencies having depreciated by about 75 percent (on average) (Kaminsky, Reinhart & Vegh. 2003:51).

Krugman (1998) importantly points out that economists had raised concerns about the region from one to two years before the devaluation of Thailand’s Baht. Current account deficits were high enough to elicit a currency crisis, which would have resulted in a slowdown of economic growth. However, none of these predictions got close to anticipating the magnitude and severity the real crisis would have (Khan, Islam & Ahmed 2005:170).

The prevailing view in economic literature for the cause of this contagious event is as follows: Starting in the early 1990’s, the Asian countries began a build-up of short-term external debt. Domestic Asian banks borrowing, mainly in US dollars, increased as a result of low US interest rates. Although in an expeditiously growing economy this does not present any imminent concerns, the situation in the Asian economies was very different. Sustained depreciation of the Japanese Yen vis-à-vis the US dollar, beginning in the summer of 1995, was a significant external factor contributing to the pressure experienced by the Asian markets. As exports began to plunge and the current account deficit began to balloon, economic growth slowed down and the exchange rate appeared to be overvalued. With this, speculators stepped in and began an assault on the Thai Baht, forcing the government to devalue and float the currency (Khan, Islam & Ahmed 2005:171; Baig & Goldfajn 1999:169).

This in turn raised the value of short-term debt, leading to the failure of heavily indebted banks and the bankruptcy of many Thai companies. Combining this with the burst of a stock market bubble and an asset price tumble; it all ultimately culminated in shock waves being sent throughout the economy and the region (which is argued to have already been in a financial frail position) (Khan, Islam & Ahmed 2005:171).

As foreign exchange reserves rapidly diminished in the affected Asian countries, foreign creditors reacted through mass withdrawals of capital. Major credit rating agencies also began downgrading these affected countries, leading to further credit withdrawals. With many of the Asian countries already under significant pressure due to them running significant current account deficits, this magnitude of capital withdrawal became too much and brought about the eventual devaluation of the currencies (Khan, Islam & Ahmed 2005:172).
There were a number of other factors which played a role in the crises which need to be noted briefly. Indonesia and Korea had massive amounts of external debt which was mostly invested in unproductive assets. Malaysia had a problem of excessively risky investments. And on the political front, almost none of the Asian economies which were greatly affected by the crisis had much stability. Thailand’s government was run by a coalition of politicians which had little concern for the solvency of its financial institutions or the welfare of the middle class. The Suharto government proved ill-equipped to deal with the crises unfolding around them and resisted any change in regulation or policy to the Indonesian economy. A newly elected government in Korea was undergoing transitional changes. Further, the Malaysian Prime Minister made a number of inflammatory comments which only aggravated an already worsening situation (Khan, Islam & Ahmed 2005:172).

Thus the prevailing view is that the Asian crisis was primarily sparked by weak financial systems, only to be transmitted later via panic. Alternatively, theories for the cause of the East Asian crisis vary from fundamental linkages via trade and financial channels, to herd behaviour which was first illustrated by Calvo & Reinhart (1996) and then applied to the following years crisis, to Masson’s (1999) multiple equilibrium framework and to Goldstein’s (1998) wake-up call hypothesis. Although it is tempting to go into greater detail of the application of these theories in the East Asian crisis, the topic of theoretical discussion shall be left for the next chapter.

### 2.2.3 Russian crisis, 1998

After six years of economic reform in Russia, limited success had been experienced through privatization and macroeconomic stabilization. Yet, in August 1998, after recording its first year of economic growth since the fall of the Soviet Union, Russia was forced to default on its sovereign debt, devalue the ruble and declare a suspension of payments by commercial banks to foreign creditors. This was obviously not completely by surprise and there had been a number of indications hinting towards weakness and pending disaster in the Russian economy (Chiodo & Owyang 2002:9-11).

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3 Not only was it recording economic growth: inflation had decreased from 131 percent in 1995, to 22 percent in 1996, to 11 percent in 1997; a trade surplus was moving towards balance between exports and imports; relations with the West were beginning to improve; and oil was selling at $23 per barrel – a high price by recent standards (fuel made up more than 45 percent of Russian export commodities in 1997) (Chiodo & Owyang 2002:9-12).
The year 1998 brought with it growing debt payments where early credits from the IMF were due. Policymakers estimated that the Gross Domestic Product (GDP) had to grow by 2 percent in 1998 to compensate for the debt growth. Unfortunately, events would begin to unfold that would further strain the Russian economy; instead of growth, real GDP declined by 4.9 percent in 1998. (Chiodo & Owyang 2002:12)

To make the matter of government debt repayments worse, tax legislation had proven to be a point of serious concern as mass fraud and numerous loopholes prevented government collections. Thus, in February 1998, new tax legislation was passed but even then, some crucial areas to improve federal revenues were ignored. (Chiodo & Owyang 2002:12)

There was also growing discontent in government ranks reaching a boiling point on March 23, 1998, when President Yeltsin abruptly fired his entire government, including Prime Minister Viktor Chernomyrdin. And in a move that would prove to further challenge investor confidence, Yeltsin appointed 35-year-old Sergei Kiriyenko, who had been in government for less than a year, to take over as Prime Minister. (Chiodo & Owyang 2002:12)

As investor confidence steadily declined, Russian bond yields swelled to 47 percent by 18 May 1998. To further exacerbate an already difficult position, speculative attacks had begun on the ruble with $1 billion of foreign reserves being used to defend the currency in two days around the same time. Oil prices were plummeting, reaching $11 per barrel; less than half their level a year earlier. And it had become widespread knowledge that $3 billion in loans to Russian corporations were due in September 1998. (Chiodo & Owyang 2002:12)

Through January to August 1998, the Russian stock market had lost more than 75 percent of its value. August 13, 1998 brought with it the default of Russian sovereign debt, and it was only four days later that it was announced that the ruble would be floated. (Chiodo & Owyang 2002:13)

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4 Over the same period, President Yeltsin also made public threats to dissolve parliament (Chiodo & Owyang 2002:12).

5 One can read Chiodo & Owyang (2002:9-13) for further examples of government failures in the lead up to the eventual crisis.

6 It had previously been a pegged rate to the US dollar.
Following the demise of the Russian economy, as one would expect, many of the former Soviet Union states\(^7\) suffered massive economic hardship ranging from significant currency devaluations, to retractions in economic growth, exports and imports. They were, however, not the only countries to experience a windfall from this crisis with even the US Dow Jones Industrial Average falling 11.5 percent in three days at the end of August. Possibly the most publicised impact of the Russian crisis in economic literature was that on Brazil. What makes this noteworthy and unique in literature is that it is one of the few contemporary examples were a crisis was transmitted across countries which have very few interlinked fundamentals and are for all intents and purposes, on the opposite ends of the world. Ultimately the Brazilian real was floated in February 1999; with many arguing this was a direct consequence of the Russian crisis. (Baig & Goldfajn 2000:3)

To give a brief background, in July of 1994 Brazil adopted a crawling peg exchange rate policy in the hopes of stabilizing inflation. However, the impact of the Russian crisis on the Brazilian exchange rate was particularly severe with an excess demand for dollars in the foreign exchange rate market being $11.8 and $18.9 billion in the months of August and September respectively. Sustained speculation\(^8\) resulted in the central bank deciding to devalue the real by 8 percent in January, and eventual deciding to float the Brazilian real on 1 February 1999. (Baig & Goldfajn 2000:3)

With the floating of the real came fears that inflation would wipe out the gains of the new exchange rate policy. In February, inflation reached 4 percent on some indicators (from around 2.5 percent previously). The authorities reacted swiftly however, with high interest rates (they reached an annual rate of 50 percent at one point) and a new policy of an inflation targeting regime which was successful in keeping inflation to negligible levels. (Kaminsky et al. 2003:52-54)

These high interest rates, however, only sped up the fall of asset prices, reducing the collateral backing existing loans, increasing the rate and risk of bankruptcy; and placing large burdens on the entire financial system. What proved to be the final blow was when the governor of the Minas Gerais province called for a debt moratorium and said they would not be servicing the $15 billion debt owed to the federal government for a period of ninety days.

\(^7\) Such as Belarus, Estonia, Lithuania, Kazakhstan and Moldova

\(^8\) Driven by “country re-evaluation” according to Baig & Goldfajn (2000) – a theory of contagion which shall be discussed in the next chapter.
Following this, credit agencies began downgrading Brazil’s sovereign debt, further raising credit costs and creating even tighter credit conditions for the entire economy. Ultimately the economy sunk into near recession by the first quarter of 1999. (Kaminsky et al. 2003:52-54)

Surprisingly, however, this crisis did not lead to the contagion throughout Latin America which was feared. Together with Argentina’s default and abandonment of the Convertibility Plan in December 2001 and Turkey’s devaluation of the lira on 22 February 2002, there are a group of crises in the early 2000’s which did not precede any immediate international repercussions. Given that all three countries are relatively large emerging markets, one might expect that these crises might result in contagious episodes as bad, if not worse than those seen in the 1990s. However, financial markets paid little attention to these events despite the fact that they would have very real and fundamental consequences. For example, with the sharp devaluation of the Brazilian real in 1999 (by 70 percent between January and the end of February 1999), the Argentinean peso was clearly overvalued as Brazil was Argentina’s largest trading partner (Kaminsky et al. 2003:52).

The remainder of the 2000’s went without any new or significant crises to study which would add to the body of research which had been done up until this point. However, 2007 would bring with it, the most significant global economic crisis since the end of world war two.

2.3 THE GLOBAL FINANCIAL CRISIS, 2007/2008

The financial crisis of 2007 resulted in the greatest global recession in history, with the only possible exception being the Great Depression of the 1930s. Greenspan (2011:202), former US central bank chairman said that, “the bankruptcy of Lehman Brothers in September 2008 precipitated, what in retrospect, is likely to be judged the most virulent global financial crisis ever.”

This section shall give a broad overview of the crisis; and be divided into three main subsections discussing respectively the origins of the financial crisis, the crash of Lehman Brothers and the effects this US crisis had around the world with particular reference to the effects on South Africa.
2.3.1 Theoretical Explanations of the Origins and Cause of the Global Financial Crisis

It is important to be aware of what is essentially a fact throughout economic literature; there are almost always a number of different theoretical arguments to explain a single phenomenon. As the focus of this dissertation is on the 2007 financial crisis, it is essential that an in depth discussion occur on the crisis and the differing theoretical arguments. Namely, the theoretical arguments will be limited to three macroeconomic schools of thought: Keynesian, Austrian and Monetarist.

Fundamentally, however, all three schools of thought agree on a sequence of events. To briefly outline this sequence of events, they all argue that there was a housing price expansion which resulted in large profits in sub-prime mortgage securities. This lead to increased demand for these sub-prime mortgages but ultimately, they became overvalued with the failure of analysts to calculate the correct valuation for risk in these securities. The eventual burst, of what had become a housing price bubble; lead to extreme and rapid loses, both in the securities and those who had invested directly in the housing market. This amongst other tangential events culminated in an evaporation of real wealth both for investors and investment holding companies, which was seen to infect the entire economy through a sudden evaporation of liquidity. Greenspan (2011:202) said that, “the evaporation of the global supply of short-term credits within hours or days of the Lehman failure is, I believe, without historical precedent.” (Greenspan 2011:202-206)

All things considered, chief economist for the IMF, Oliver Blanchard estimated that loses experienced on the US sub-prime loans and securitization was $250 billion as of October 2007. He went further and estimated that loses on output between 2008 and 2015 would be $4,7 trillion and the decrease in the world’s stock markets between July 2007 and November 2008 to be about $26,4 trillion (Calitz 2009:5).

Keynesian School

Thirwall (1993) suggested there were ‘six central propositions to Keynes’s vision’, which he stated as being: Firstly, the proposition that output and employment are determined in the product market, not the labour market. Secondly, involuntary unemployment exists and requires intervention to sustainable reduce it. Thirdly, an increase in savings does not result in an equivalent increase in investments. Fourthly, a monetary economy is fundamentally
different to a barter economy. Fifthly, the quantity theory holds only under full employment, with a constant velocity of circulation, whilst cost push forces cause inflation long before this point is reached. Lastly, capitalist economies are driven by the animal spirits of entrepreneurs, which determine the decision to invest. Ultimately, Keynes would have you believe that every recession is as a result of a diminishing demand, driven by these animal spirits of entrepreneurs (Thirwall 1993:335-337).

The Keynesian school is of the opinion that the 2008 financial crisis was in the making as early as 1990. With much of the third world taking advantage of their cheap labour, combined with access to first world technology; exports from these countries grew exponentially. As such, employment and income grew. However, with this rapid growth, consumption failed to grow as significantly. As a consequence, a rapid increase in savings occurred with the savings rate soaring from 24 percent of nominal GDP in 1999 to 34 percent by 2007. Investment was not as quick to grow, and with investment elsewhere in the world failing to demand this increase supply of available funds, the result was a pronounced fall from 2000 to 2005 in global long term interest rates. Equity and real estate capitalization were inescapably arbitraged lower by the fall in the global long term interest rates and accordingly; asset prices, particularly housing price were moved significantly higher (Greenspan 2011:202-204).

With this rapid surge of profitability in the housing market, the securitization of sub-prime loans became similarly increasingly popular and profitable – which ultimately resulted in a simultaneous asset price bubble occurring in housing prices, mortgaged backed securities and equities. It is at this point that Keynesian explanation is purposefully halted - as the Austrian and Monetarist explanations shall similarly be halted - as it is simply in the formation of the asset price bubble which the various schools of thought differ. The bursting of the asset price bubble and the resultant consequences are less a part of theoretical debate and simply, facts – facts which shall be discussed in the “synopsis”, 2.3.2 and 2.3.3 sections.

Austrian School

The Austrian school on the other hand believe that poor monetary policy is to blame for the housing price bubble, but before any part of the Austrians schools business cycle can be explained or illustrated, an important element of the theory needs to be discussed. The
Austrians believe the market for loanable funds is where the interest rate is determined. The interest rate essentially brings the individual’s preference to save into equilibrium with firms’ willingness to invest, producing what is referred to as the ‘natural rate of interest’. The individual’s willingness to save is thought to stem from the individuals time preference for consumption. Larger real savings, stemming from the desire of individuals to improve future consumption, results in lower interest rates; or vice versa (note that if real savings have increased, real consumption must have decreased). The rate of interest consequently sends important messages to producers about the future consumption plans of these consumers. Lower interest rates will send the signal that more output needs to be produced as future demand is expected to be greater, or vice versa. Lower interest rates as such, induce changes in the capital structure of the economy, with investment moving out of short-term production processes as the immediate demand has decreased; and into long-term production processes which require current investment if they are to meet future demand (Horwitz 2010:98).

Accordingly, the boom phase of the Austrian business cycle is said to begin when the central banks supplies more money than the public is willing to hold at that given price level. Even though there has been no noticeable increase in savings from the public, banks will be able to supply greater quantities of loans as this excess supply of money by the central bank finds its way into the banking system. The increase in supply of loanable funds drives interest rates lower to find a new equilibrium point where a greater quantity of borrowing occurs. As touched on previously, the lower interest rates signal to producers that future consumption will be greater. Subsequently this results in changes to the capital structure whereby the long-term production process receives greater investment (Horwitz 2010:99).

At this point it is important to realize that because the individual’s time preference for consumption has not changed, current consumption has not decreased. In actual fact, the lower interest rates induce individuals to save less and consume more as they are receiving lower returns on their savings. Current demand has essentially increased. Short term production processes now require greater investment to satisfy this increased current demand. This is essentially where the problem arises. Had the increase in loanable funds been financed by genuine savings, the lower interest rates would have signalled the correct information to producers about the public’s intentions. However, when the increase in loanable funds is as a result of the expansion in money supply rather than a change in the public’s time preference of consumption, the tight relationship between the public time preference and the interest rate is broken (Horwitz 2010:99).
With this incorrect interest rate, essentially a double disequilibrium is created whereby there is too great a demand for loanable funds and too small a supply. This pulls the economy in opposite directions with consumers demanding more consumable goods and investors demanding more loanable funds. Their combined effect is the movement of the economy beyond a sustainable level of output. However, the economy is able to produce beyond this sustainable level only on a temporary basis. The economy is able to produce at this point for any number, or a combination, of reasons: additional members of the household may be induced into working due to the favourable labour market conditions; people work overtime; others delay retirement or forgo vacations, etc. (Snowdon & Vane 2005:507)

However, the increasingly binding resource constraint eventually catches up with the economy. With the increased investment in both the short-term and long-term production processes, middle-term production processes suffer relative declines as investment is taken out of it to satisfy the demand in the other two sectors of the production process. Before the long-term production processes are able to come to full fruition, the under-maintained middle-term production processes impinge negatively on the consumable output. The absolute or relative decline in consumable output is referred to as “forced savings” in Austrian literature. This “forced saving” is but one aspect of the so called bust. The increasingly binding resource constraints force the prices of inputs in the short-term production process upwards and similarly consumables; and the rate of interest rises as businesses compete for the fast evaporating supply of loanable funds. (Snowdon & Vane 2005:507)

Now, an additional part of the Austrian theory is that both labour and capital are heterogeneous, in contrast to the neoclassical school (which is not discussed in this paper). As such, not all capital and labour from one industry can simply be transferred to another when no longer required. The bust, resulting in labour and capital being abandoned cannot result in all capital and labour simply being redeployed into other sectors of the economy as they are designed for a specific purpose or have a limited skill set for a distinct industry. The bust is consequently associated with longer periods of unemployment than other schools would theorize, as labour requires the learning of different skill sets and capital is simply gone unused as it cannot be redeployed in other sectors (Horwitz 2010:98-100).

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9 Typically Austrians will describe this with a production possibilities frontier, with consumption on the y-axis and investment on the x-axis.
The Austrians argue that the Federal Reserve’s lowering of interest rates from 6 percent in 2001 to 1 percent by 2004 was an artificial rate reduction in the sense that consumer’s time preferences between present and future consumption had not been reduced to that extent during that time period. Essentially, monetary disequilibrium occurred. The fall in the interest rates was not initiated by a change in household consumption and savings plans; hence the flow of funds for debt finance did not reflect a decrease in the so-called natural rate of interest (Prychitko 2009:214).

Now in the Austrian theory, credit expansions have a specific impact at different times in different sectors of the economy, such that the relative prices of both consumer and producer goods will change (as eluded to earlier, a drop in interest rates will result in greater investment in long-term processes or vice versa). Hence, firms with different interest rates sensitivities are seen to adjust present value and cost calculations differently when interest rates change (Prychitko 2009:214-215).

Let us see how this applies to the current crisis. According to Prychitko (2009), the housing bubble in the US developed between 2001 and 2006 when the central bank lowered the federal funds rate and government agencies (which will be discussed later) encouraged and targeted credit growth towards the housing industry in particular (a long-term production process). Subsequently, credit induced demand caused the doubling of housing prices during this time frame (Prychitko 2009:215).

Adding to the abovementioned about the Austrian school, is the addition that the Austrians are said to have theorized that the increase in expectations of relative prices (home and other assets) encourages firms and money managers to assume higher levels of risk in investments, such as the sub-prime mortgage securitize (Prychitko 2009:215).

**Monetarist School**

Monetarists as a collective, rely heavily on their quantity theory of money in all aspects of their macroeconomic study. It is believed that the money supply is responsible for all variations in output in the short run and price level in the long run. It should as such come as no surprise that the quantity of money plays the leading role in the Monetarists explanation of the financial crisis (Snowdon & Vane 2005:163-164).
The Monetarist view is, mostly, undistinguishable from the Austrians with reference to the origins of the crisis. Schwartz (2009), who was Milton Friedman’s co-author on the now famous, “A Monetary History of the United Sates” – (1963), blames expansionary monetary policy along with a number of the common elements of the crisis which all the schools to one degree or another mention (these will be discussed later). She states that:

“It has become a cliché to refer to the asset boom as a mania. The cliché, however, obscures why ordinary folk become avid buyers of whatever object has become the target of desire. An asset boom is propagated by an expansive monetary policy that lowers interest rates and induces borrowing beyond prudent bounds to acquire the asset. The Fed was accommodative too long from 2001 on and was slow to tighten monetary policy, delaying tightening until June 2004 and then ending the monthly 25 basis point increase in August 2006” (Schwartz 2009:19).

There is little doubt that the late Milton Friedman would have come to a similar conclusion to that of Schwartz (2009) and as such, the Austrians. Despite these similarities, however, the two schools should not be confused. Beyond the vastly differing policy recommendations which the schools offer, Friedman believed the Austrian business cycle did not pass the empirical test. Friedman (1993) conducted a series of empirical tests in which he investigated whether a larger expansion was followed by a larger contraction. He states in his conclusion, “there appears to be no systematic connection between the size of an expansion and of the succeeding contraction, whether the size is measured by physical volume or by dollar value.” He further notes, “for one thing, it would cast grave doubt on those theories that see as the source of deep depression, the excesses of the prior expansion (the Mises cycle theory is a clear example)” (Friedman 1993:171-172).

However, this criticism of the Austrians did not go without rebuttal. Skousen (2005) responds directly to Friedman (1993) and suggests that the Japanese recession of the 1990’s and the US dotcom bubble and bust of the early 2000’s fits the model of the Austrian cycle perfectly. Furthermore, Woods (2009) gives further evidence, relating the recent financial crisis to the Austrian business cycle.
Arguments and Counter-Arguments

The blame of poor monetary policy for the financial crisis has, however, not gone unchallenged. Greenspan (2011) is of the opinion that monetary policy was powerless to stop this bubble. He believes that it was long-term interest rates that “galvanised home asset prices” and not the overnight rates of central banks. Through a number of regression and correlation tests he shows a far superior correlation between the long-term interest rate and housing prices than between overnight rates and housing prices during the time period of 2002-2005 in the United Sates (Greenspan 2011:236-237). Accordingly, he states,

“This should not come as a surprise. After all, the prices of long-lived assets have always been determined by discounting the flow of income (or imputed services) using interest rates on assets of comparable maturity. No one, to my knowledge, employs overnight interest rates - such as the federal funds rate - to determine the capitalization rate of real estate, whether it be the cash flows of an office building or the imputed rent of a single-family residence.” (Greenspan 2011:237)

However, there are those that disagree with this synopsis. Most notable, John Taylor, (renowned for his development of the monetary policy rule, “the Taylor Rule”) who contends that monetary policy action after 2001 was the principle cause of the US housing market price bubble. As evidence of this, he shows a significant inverse correlation with a lag between federal funds rate and housing starts from 1959-2007. He continues to state that according to his monetary policy rule, the central bank had set unacceptably low funds rate during 2002-2005. Consequently, he claims, “housing starts jumped to a 25-year high… The surge in housing demand led to a surge in housing price inflation. [The] jump in housing price inflation then accelerated the demand for housing in an upward spiral.” (Taylor 2007)

His argument against the idea of a “global savings glut” forcing long term interest rates downwards is that there is simply no significant evidence of this. He states that, “on the contrary… the global savings rate - world savings as a fraction of world GDP - was low in the period 2002-2004 period, especially when compared with the 1970’s and 1980’s” (Taylor 2009:9).

Greenspan (2011) nonetheless makes a fairly significant case against Taylor’s (2007) conclusion stating that in the “Taylor’s Rule”, there are no asset price inputs. The Taylor rule is structured to indicate the proper federal funds rate to balance the trade-off between
unemployment and inflation; and housing prices cannot simply be substituted for the consumer price index (CPI). Ultimately, Greenspan (2011) conclude, “the Taylor rule clearly cannot be applied to asset prices, especially when benign product price inflation is almost surely a necessary condition for an income-producing-asset price bubble” (Greenspan 2011:238).

Nonetheless, similar arguments go back and forth throughout the literature and will undoubtedly go on for many years to come. This section was merely a brief introduction to these thoughts, in order to give the reader a more encompassing view of the 2007 financial crisis.

Synopsis

Regardless of the root cause behind the housing price bubble, all schools agree that the development of the sub-prime mortgage market in the 1990’s played a significant role in the eventual size of the bubble; and the size and extent that the eventual housing price burst had on the world economy. Originally, the sub-prime mortgage market served mainly those potential homeowners who had an adequate income for a fixed rate mortgage, but an insufficient down payment to receive a prime loan. This combined with the high growth rate of housing prices from approximately 1997; resulted in sub-prime lending being seen as increasingly profitable for investors (Greenspan 2011:204-205).

With great demand from Europe, financial firms began to accelerate the pooling and packaging of subprime mortgages beginning in late 2003. Arising over the same period was the US governments newly created objective to meet expanded “affordable housing goals”, for low and moderate income housing. Thus, adding to the demand from Europe was the demand by two US government sponsored enterprises (GSEs) - the Federal National Mortgage Association and the Federal Home Loan Mortgage Association. For 2003 and 2004, the GSEs accounted for 42 and 49 percent respectively of all newly purchased subprime mortgage securities retained on investor’s balance sheets (Greenspan 2011:205).

Developers of securitized assets needed to find a way to increase their supply with this extraordinary level of demand; and ultimately this was done through the offering of adjustable-rate mortgages (ARM), which had initially lower monthly payments. By the
second quarter of 2007 ARMs soared to nearly 62 percent of first mortgage sub-prime originations (Greenspan 2011:205).

A “classic euphoric bubble” had grown with virtually all subprime mortgage originations being securitized by 2007, compared with less than half in 2006. As illustrated above, this was driven by the rapid increases in housing prices which in turn made the subprime mortgage securitize so profitable. With an eventual deflation in the housing prices, came a deflation of subprime mortgage securities which were exceedingly overvalued. As such, the bubble had burst and chaos ensued with traders all trying to get out of a market in which they were over exposed. Greenspan (2011:210) explains his thoughts on why an equity bubble bursts in a simple yet eloquent manner stating, “all bubbles burst when risk aversion reaches its irreducible minimum, that is, when credit spreads approach zero” (Greenspan 2011:210).

2.3.2 The Crash of Lehman Brothers

By July 2007, collapse of the sub-prime mortgage market was expected by most analysts still to have limited consequences as it represented only about 12 percent of the US mortgage market, which in turn was only approximately 30 percent of the US fixed income market. Expected losses in subprime loans were routinely dealt with in the US stock market and widespread contagion across asset classes, and especially across countries, was thought to be highly unlikely. For instance, on 17 May 2007, the chairman of the US Federal Reserve, Ben Bernanke, stated: “We believe the effect of the troubles in the subprime sector on the broader housing market will be limited and we do not expect significant spill over’s from the subprime market to the rest of the economy or to the financial system” (Raddatz 2009:2).

Macroeconomic data also gave no indication of the pending disaster. High frequency data for the US economy such as industrial production, retail sales and exports did not turn down until October 2008. Although there were a minority who “preached prophecies of doom” for the US real economy, the consensus forecast for the fourth quarter of 2008 and first quarter of 2009 declined only by a few tenths. Published in October 2008, the IMF forecasted 6 percent world GDP growth for 2009. (Dooley & Hutchison 2009:5)

But 15 September 2008 would bring with it rapidly shifting forecasts of economic growth. Lehman Brothers, after enduring massive losses in the sub-prime mortgage market and
withdrawals from investors field for bankruptcy. And it is at this point, when the US government allowed Lehman Brothers to go under, which much of the literature marks as the critical turning point in the crisis. A few days later, Ben Bernanke made his famous statement, “we may not have an economy on Monday” (Swedberg 2010:71).

And throughout literature, many economists agree that this was in fact the defining moment in the financial crisis. Robert Lucas, winner of the 1995 Noble Memorial Prize in Economic Sciences, said, “Until the Lehman failure the recession was pretty typical of the modest downturns of the post-war period ... After Lehman collapsed and the potential for crisis had become a reality, the situation was completely altered” (Lucas 2009:67). Alan Blinder, another highly regarded economist wrote, “everything fell apart after Lehman... after Lehman went over the cliff, no financial institution seemed safe. So lending froze, and the economy sank like a stone. It was a colossal error, and many people said so at the time” (Blinder 2009) (Swedberg 2010:72).

Henry Paulson, Treasury Secretary of the US at the time, explained two months later what the implications of the Lehman Brothers failure were:

“We had a system crisis. Credit markets froze and banks substantially reduced interbank lending. Confidence was seriously compromised throughout our financial system. Our system was on the verge of collapse, a collapse that would have significantly worsened and prolonged the economic downturn that was already under way.” (Paulson 2008)

Thus, it was largely the evaporation credit which was attributed with the slowdown of the global economy. Dooley & Hutchison (2009) argue that this “evaporation” was the consequence of two simultaneous occurrences: a sudden and immense scurry by US and European banks to not only significantly deleverage but increase available liquidity, whilst there was for all intents and purpose a run on the US money market in October 2008. The effect of these simultaneous phenomenon’s was a massive decrease in availability of credit not only in the US and Europe but essentially around the globe with the interconnectedness of the financial markets.

10 Going into the explicit detail behind the specific causes and reasons for the crash of Lehman Brothers is outside the scope of this dissertation. For more information on this, one could see Tibman (2009) or Swedberg (2010).
So with a global credit shortage and widespread panic, “bricks and mortar” investment all but ceased, corporate financing costs inflated substantially and global trade diminished as trade finance became harder to acquire and significantly more expensive to afford (Dooley and Hutchison 2009).

2.3.3 Crisis Spreads to the Rest of the World – Including South Africa

Swedberg (2010) highlights that after the crash of Lehman Brothers there was a crisis of confidence not only in the US, but globally. Banks tightened lending. Financial market traders sold off any and all positions. Panic ensued and fundamentals seemed to be of little concern (Swedberg 2010:72-76).

As a side-note, Bagehot (1873) perhaps highlights the ultimate flaw when he said, “We should cease ... to be surprised at the sudden panics (in the banking system). During the period of reaction and adversity, just even at the last instant of prosperity, the whole structure is delicate. The peculiar essence of our banking system is an unprecedented trust between man and man; and when that trust is much weakened by hidden causes, a small accident may greatly hurt it, and a great accident for a moment may almost destroy it.” (Swedberg 2010:73).

It is thus argued that the direct effects of Lehman Brothers collapse – those which result from direct interaction with the firm – are of an inconsequential magnitude when viewed on a global scale. But it is rather the indirect effects, the weakening of the trust in the banking system, which resulted in financial markets around the world experiencing considerable losses (Swedberg 2010:91).

Nonetheless, it is also contended that the Lehman Brothers collapse triggered a very real financial shock around the world with trade credit evaporating and international trade declining sharply and uniformly. Not only trade credit but credit in general became increasingly hard to obtain. Whether driven by panic, liquidity shocks or an alteration in the perceived fundamental risks, globally banks called in loans and tightened loaning regulations (Dooley & Hutchison 2009:3-4).

11 For particular points as to why confidence is essential in the banking industry in particular, see Swedberg (2010).
Globally, the effects were severe. There was a flawed assumption that emerging Asia would be protected from the crisis by their: low exposure to US subprime loans and securities; plentiful international reserves; current-account surpluses; higher share of interregional trade; improved banking systems; and the ability to implement counter-cyclical macroeconomic policies. As GDP fell by an average annualized rate of 13 percent between September 2008 and March 2009 in Hong Kong, Malaysia, Singapore, South Korea, Taiwan, and Thailand this expectation was seemingly proven incorrect (Goldstein & Xie 2009:2-3).

From a peak of nearly 14 percent in the second quarter of 2007, China’s growth dropped to 6.8 percent in the fourth quarter of 2008, with exports still down by 21 percent in June 2009 from a year earlier. In total, emerging Asia’s exports fell at an annualized rate of 70 percent between September 2008 and February 2009 (Goldstein & Xie 2009:3).

As expected, equity markets in the region suffered massive loses too. Using MSCI indices, the peak-to-trough (approximately from the fourth quarter 2007 to the first quarter 2009) decline in emerging Asia was 61 percent. This is similar to that seen in Latin America, which over the same period experienced a 57 percent retraction in its MSCI index (Goldstein & Xie 2009:9).

Individually Brazil, Argentina, Chile, Mexico, Venezuela and Columbia all suffered from recessions. Brazil decreased from 5.1 percent real GDP growth in 2008 to -1.3 percent in 2009; Mexico decreased from 3.3 percent real GDP growth in 2007 to -3.7 percent in 2009; and Argentina decreased from 7 percent real GDP growth in 2008 to -1.5 percent in 2009 (Goldstein & Xie 2009:9).

However, neither Asia, nor Latin America suffered the affliction of the financial crisis to the extent that Western Europe did. This was mainly attributable to the direct exposure many of the European financial institutions had to the US banking system and the US sub-prime mortgage sector. The retail bank, Northern Rock, was the first major United Kingdom (UK) casualty. After five months of publicised distress in the bank and attempts to find a public sector solution, on 17 February 2008 the nationalisation of the bank was announced. After further trouble with almost all other banks in the UK, it was finally announced in October 2008 that the UK government had created a £50 billion fund for the recapitalisation of ailing banks (Goddard, Molyneux & Wilson 2009:363-364).
Throughout Western Europe, banks were exhibiting fragility. UBS, the world’s second largest manager of private wealth assets, based in Switzerland suffered massive losses through its investments in the US sub-prime sector. They required a SFr15 billion injection of capital underwritten by a syndication of banks early in 2008, and then in October of 2008, the Swiss government bailed them out with a SFr6 billion purchase of a convertible bond issue. By the end of 2008, UBS had posted almost SFr50 billion in write-downs and losses (Goddard et al. 2009:364).

Adjusted for the size of its economy, Iceland’s banking failure of 2008 is the largest in history according to the IMF; with its three largest banks all having to go into receivership. Germany’s IKB Deutsche Industriebank, Hypo Real Estate\textsuperscript{12} and Commerzbank\textsuperscript{13} all required government intervention to continue operations whilst private sector solutions were found for a number of other banks who came under pressure from the crisis. Concomitantly, banks in Spain, France, Ireland, Belgium, Denmark and Austria all also suffered severe consequences from the sub-prime crisis in the US\textsuperscript{14} (Goddard et al. 2009:364-370).

In totality, GDP in the European Union (EU) fell by an estimated 4 percent in 2009, leading to the bloc’s first recession since the early 1990’s and its worst performance on record. Labour markets were predictably affected with the number of people unemployed in the EU-27 increasing by 5.4 million between March 2008 and May 2009. Stock markets in the UK, Germany, Spain, France and many others in Western Europe were down over 30 percent from their high to low points over the period 2007-2009. Exports and imports from the EU fell similarly, down about 20 percent from third quarter 2008 to first quarter 2009 (Hodson & Quaglia 2009).

Ultimately, the crisis in the EU which began in 2007 continues to this day and has transformed into the heralded, “European Debt Crisis”. Greece, Ireland, Spain and Portugal in

\textsuperscript{12} Hypo Real Estate is a holding company comprising of a number of specialised property finance banks, including Depfa Bank.

\textsuperscript{13} Germany’s second largest bank

\textsuperscript{14} See Goddard et al. (2009)
particular are coming under severe pressure with assistance from third parties required to refinance their government debt\(^\text{15}\) (Arghrou and Kontonikas 2011:2).

By the end of 2009, it was expected developing nations would lose incomes worth at least $750 billion. In Africa; Kenya experienced net portfolio outflows of $48 million in June 2008 and $12 million in October 2008 with the Nairobi Stock Exchange 20 Share Index dropping by 35 percent in 2008. In Nigeria, stock market capitalisation fell by 46 percent over 2008, and the All Share Index lost 67 percent from March 2008 to March 2009. The Ugandan All Share Index lost 28 percent of its value in October 2008 alone and in Zambian, the Lusaka Stock Exchange All Share Index declined by 29 percent over the period December 2007 to December 2008 (te Velde 2009:2-18).

Growth statistics read relatively satisfactorily with Nigeria, Uganda and Zambia emerging from the crisis relatively unscathed. However, there were those who were not as fortunate; with Ghana more than halving its real GDP rate from 2008 to 2009 and Kenya went from just under 7 percent growth in 2007 to 1.5 in 2008 and 2.6 in 2009 (CIA World Factbook 2012).

The South African financial sector was, to a large extent, cushioned against the negative impact of the crisis due to its minimal integration with the world financial system and a prudent regulatory framework. This combined with limited reliance on foreign current denominated assets and liabilities; and limited exposure to high risk securities, resulted in the sector remaining fairly unscathed compared to much of the western world (Dlamini 2010:5 & 7).

Nonetheless, South African banks were impacted negatively by the crisis, although in an indirect manner. After several years of high credit growth, the negative impact of the lower real economic activity lead to the sector experiencing higher fund costs and increased impairments (Dlamini 2010:5). Powell & Steytler (2010:5) explain that, “the effect of the global financial crisis (on South Africa) was that commercial credit… evaporated… and net financial inflows turned to net outflows.”

Despite the financial sector evading direct consequences, the South African economy as a whole did not avoid what would be its first recession in 17 years\(^\text{16}\). The last quarter of 2008

\(^{15}\) For more on the European Debt Crisis and/or the effects it is having on global growth, one could see: Arghyrou & Kontonikas (2011); Baer, Dias & Duarte (2012); Belkin, Mix & Nelson (2010); Bruyckere, Gerhardt & Schepens (2012); De Grauwe & Ji (2012); Featherstone (2011); and Zahariadis (2012)
brought with it the first contraction of real domestic product in 10 years. It came as a result of falling global demand and fading consumer and business confidence. The volume of exports contracted by 6.3 percent whilst at the same time the volume of imports also decreased by 6.7 percent, with the largest negative contributions coming from the manufacturing sector (Dlamini 2010:9).

In order to understand the devastation of this fourth quarter of 2008, one has to take a brief look at the recent history of the South African economy. Since 1999 the economy had grown steadily with real growth averaging 5 percent between 2003 and 2007. By 2007, it was even approaching the 6 percent level required by governments Growth Employment and Redistribution Strategy (GEAR) macroeconomic policy to halve poverty and unemployment by 2014. Per capita GDP had also grown by 22 percent since 1999, fixed capital investment by 10 percent since 2002 and more than 1.5 million jobs had been added to the economy in the past five years (Powell & Steytler 2010:4).

The first two quarters of 2009 brought with it sharp declines in GDP of 7.4 and 2.8 percent respectively and overall, there was a 1.8 percent GDP contraction in 2009. According to a 2010 Organisation for Economic Co-operation and Development (OECD) survey of the South African economy “the change in the growth rate of real GDP between 2008 and 2009 represented the largest single-year slowdown on record for South Africa; and was larger than in most advanced and emerging economies, though far from being the worst” (Powell & Steytler 2010:4).

Beyond the impact of the financial sector troubles on the South Africa economy, which have already been touched on, the OECD survey also attributes the cause of the recession to trade declines and reductions in consumer demand and private investment in the economy. The manufacturing sector’s value added declined by 12.2 percent in the first nine months of 2009 due to sharp year on year declines in the output of the automotive industry (34 percent), the furniture industry (20 percent) and the textiles and clothing sector (14.6 percent). These declines combined with lower global commodity demand for South African exports (such as gold, platinum and chrome) in turn affected export volumes and thus the trade deficit (Powell & Steytler 2010:5).

16 In the next section on South Africa financial markets, greater emphasis shall be placed on the effects of the crisis on the stock market, bond market, currency market, banking market, mineral commodity market and trade market.
Late in 2009, growth began to recover with GDP rising by 3.2 percent in the fourth quarter due to “a recovery in the global economy, higher commodity prices and sustained growth in government spending” (Powell & Steytler 2010:5). Ultimately, the recession was far less severe than elsewhere as it was offset by robust growth in the construction industry (value added grew by 8.4 percent in 2009) in preparation for the FIFA Soccer World Cup, lower oil prices and because the country did not experience any major bank or firm failures (Powell & Steytler 2010:5).

The South African government did make an attempt to alleviate the stress placed on the economy and on 19 February 2009 they issued a document entitled, “Framework for South Africa’s Response to the International Economic Crisis,” which outlined government’s response to the financial crisis. Within the framework South Africa’s main objective object, to stimulate growth and employment is highlighted; the chief driver of which was the R846 billion in infrastructure expenditure. The majority of this expenditure went in the way of building new power stations, public transport infrastructure and upgrading bulk water supply infrastructure (Powell & Steytler 2010:13).

2.4 REVIEW OF THE SOUTH AFRICAN FINANCIAL MARKETS

This section will give a brief overview of the South African financial markets. An historical perspective will be taken whereby crucial changes to the regulatory and political environment shall be highlighted and the resultant effect this had on the respective financial market. Specifically, the role of foreign and global integration shall be highlighted and the impacts this has had. Ultimately, the effect the global financial crisis had on these markets shall be emphasised and examined. The financial markets which shall form the basis for this section shall be: the stock market, bond market, exchange rate, commodities market, banking sector, and international trade.

Crucially, to understand some of the discussion which takes place in the sections, a brief examination of the changes in the South African political environment needs to take place. The Nationalist Party in 1948 assumed power in South Africa and passed legislation that instituted the apartheid system – a system under which people from different racial groups had different rights. This in turn prompted worldwide condemnation and marked the beginning of sanctions against the country in the hopes of bringing to an end the apartheid
regime. These sanctions, however, did not intensify until 1985 and they continued until the apartheid regime was dismantled in 1994\textsuperscript{17} (Coulibaly 2005:4-5).

2.4.1 Stock Market

The South African stock market is administered by the Johannesburg Stock Exchange (JSE) and was established on 8 November, 1887. The JSE went unregulated until 1947 when the Stock Exchange Control Act (SECA) was introduced which was the first legislation applicable to the operation of exchanges in South Africa. SECA and its subsequent revisions governed the JSE until 1995 when substantial amendments were made which resulted in the deregulation of the JSE through the introduction of a limited liability corporate and foreign membership. The period 1985-1992 was mainly characterised by the closure of the market to foreign investors largely due to sanctions introduced by the rest of world and the National Party’s, “prescribed asset regulation,” which emphasised investment in domestic equities rather than money or bond market instruments (JSE 2012; Hearn, Piesse & Strange 2010:490).

Following the lifting of all sanctions by 1994, the JSE began to reintegrate with global investors. Switching from large outflows prior to 1994, the South African Reserve Bank (SARB) estimated that South Africa experienced net inflows of R2.6 billion in 1994 and R16.6 billion in 1995. The JSE’s share of foreign portfolio investment increased from 6 percent in 1985 to approximately 15 percent in 1994. At the end of 1995, the International Finance Corporation’s (IFC) global emerging market index and investible emerging market index had South Africa as its largest weighting, 15 and 27 percent respectively (Coulibaly 2005:7).

Since 1995, the JSE has undergone many changes including shifting from the open outcry trading floor in 1996 to the centralised automated trading system known as the Johannesburg Equities Trading (JET), to a real-time stock exchange news service in 1997; and then to the introduction of a new insider trading act in 1999. Over the past 17 years the JSE has attempted to align its standards and operations with those of other major world exchanges in the hopes of opening itself to foreign participation. Today the JSE has a market capitalisation

\textsuperscript{17} In 1992 the European Commission lifted sanctions against South Africa; with the US, Norway and India following in 1993 and the United Nations (UN) in 1994.
of over R4 trillion and was heralded in the 2010 and 2011 World Economic Forum (WEF) Global Competitiveness report, as having the best regulation of security exchanges out of 142 countries (JSE 2012; Hearn et al. 2010:490).

However, it has not all been good news for the JSE as the number of listed companies declined from 732 in 1990, to 403 in 2004. It has been argued that this is largely due to South Africa’s largest listed companies moving their primary listings to London to be more attractive to international investors\(^\text{18}\). Regardless of the cause, it has resulted in decreased trade on the JSE (Yartey 2008:11).

Nonetheless, the turnover ratio\(^\text{19}\) which is used by many analysts as a measure of transaction costs\(^\text{20}\) has increased from under 10 percent in 1993, to 80 percent in 2003 and then to over 200 percent in the second quarter of 2009; an indication of increased foreign activity. Foreigner ownership of shares in the JSE would corroborate this claim as there has been an increase from 15 percent in 1994, to 33 percent in 2011. This is reflected in net portfolio flows measured by the SARB, which reached as high as R49.82 billion in the first quarter of 2006. Although, the volatility of these portfolio flows is worth noting as there was a net portfolio outflow of R1.12 trillion in the fourth quarter of 2008, corresponding to the aforementioned crash of Lehman Brothers (Yartey 2008; SARB 2012; Steward 2012).

\(^{18}\) This includes: Anglo American, Old Mutual, SA Breweries, Liberty Life, BHP Billiton, Mondi and many others.

\(^{19}\) Defined as the value of total shares traded to market capitalization

\(^{20}\) Markets with high transaction costs are thought to indicate less efficient markets than those with low transaction costs.
The JSE All Share Index (ASI) had experienced a period of rapid growth from 2003 to mid-2008, growing from just over 7500, to 31841 in May 2008. This trend, however, was not
sustained and with global markets beginning to exhibit signs of weakness, the ASI dropped to 27702 by the end of August 2008. Following the collapse of Lehman Brothers in September, panic gripped the market and by October 2008, the ASI was at 20991. By March 2009 the ASI was at 18640; its lowest since December 2005 (JSE 2012).

Figure 3 – South African All Share Index, January 2000 – March 2012

Source: JSE Limited 2012

2.4.2 Bond Market

In the late 1980’s government parastatals such as Eskom, the National Treasury, Telkom and Transnet began to make a market in their own bonds. By creating an informal market they increased their bonds liquidity, lowering coupon rates demanded by investors to the eventually point that these bonds were trading at a lower yield than government bonds. The market was initially self-regulated and in 1989, the firms voluntarily created the Bond Market Association (BMA) (BESA at a Glance and Historical Background 2010:4).

Another milestone was reached in 1991 when government followed in the footsteps of its parastatals and created a market for its own bonds. This saw the R150 (R indicating the bond was issued by the National Treasury) replace the E168 (E indicating the bond was issued by
Eskom) as the benchmark yield for other bonds. In 1992, South African Breweries became the first issuer of a corporate bond (BESA at a Glance and Historical Background 2010:4).

Initially all bonds were settled in cash, however, this brought with it other associated risks. Thus, in 1993 the Central Securities Depository (CSD) was formed which lead to the first electronic net settlement. In 1995 the CSD began the immobilisation of listed bonds, doing away with the physical script and rather registering owners with a “virtual” bond (BESA at a Glance and Historical Background 2010:4).

Finally, in May 1996, due to the amendments in the Financial Market Control Act, the bond market in South Africa became its own official financial market named the Bond Exchange of South Africa (BESA). BESA is a self-regulating body that operates within the framework set out by the Financial Market Control Act; and a set of rules approved by the Financial Services Board (FSB). In essence, BESA is directly responsible for ensuring the overall stability, security and regulatory administration of the bond market in South Africa and regulates the bond trading activities of all its member firms. BESA entered a new era in December 1997 when it successfully converted from a mutual association to a public company (South African Business Guidebook (SABG) 2004/2005).

BESA, within two years of its licensing, was serving the most liquid emerging bond market in the world with a market velocity\(^{21}\) of an impressive 22 times its own market capitalisation. Off shore participation was already high, accounting for one quarter of total turnover. Particularly with the East Asian crisis of 1997/1998, vast pools of money fled from that region into the South African bond market in the search for high yields. With local interest rates soaring above 20 percent and the yield on governments benchmark R153 rising to 15 percent, the high yields they were searching for were found (BESA at a Glance and Historical Background 2010:4).

The trading system, closer to the turn of the century, also went through three distinct periods of changes. BESA had traditionally been run with a face-to-face trading floor similarly to that of the JSE in the earlier years. However, in 1998, the trading floor was closed and the market began running via a telephone trading system. But with the evolution of trading shifting

\(^{21}\) The number of times the total year end market value of its listed bonds had been turned over during its previous 12 months.
towards automated trading floors, the BESA adopted the Bond Automated Trading System (BATS) in the year 2000 (BESA at a Glance and Historical Background 2010:5).

In 2002, discussions began as how best to overcome the stalemate caused by conflicting user interests in legislation and running of the exchange. From these discussions spawned the eventual implementation of a new business model and a new system of governance. Three bodies were established to deal with the governance concerns: Firstly, a restructured Governing Committee was created which was fully aligned with the principles of the King Code of Corporate Governance. The second body was the Bond Traders Association (BTA) comprising solely of bond traders, such that their unique concerns may be heard. Thirdly and finally, the Stakeholder Forum was created, composed entirely of non-trading debt issuers and asset managers who were separate from the bond market, in that they had no direct interchange with it (primarily they were suppliers of the goods to a retail chain and customers of that chain) but had a stake in the efficient running of it. All these steps constituted what BESA called its Resilience Exchange Model (REM) and was approved by members in late 2002 (BESA at a Glance and Historical Background 2010:5).

Although the market is currently dominated by government bonds; local governments, parastatals, public enterprises and major corporates also have rand denominated listings. As at 31 December 2003, the exchange had a listing of more than 300 debt securities issued by 51 borrowers, with a total nominal value of more than R506 billion. (SABG 2004/2005) In 2008, BESA had a total nominal value of more than R825 billion, with the market trading volume of just over R19 trillion (Bond Exchange 2012).

Historically, the 10 year note for the South Africa Government between 1997 and 2012 averaged 10.7 percent, reaching an all-time high in August 1998 of 20.7 percent, a record low of 6.84 percent in July 2012. Of particular interest is the trend of increasing yields from January 2006 to June 2008, where yields on the 5-10 year notes increased from 7.81 percent to 10.42 percent. However, following the crash of Lehman Brothers, there was a marked reversal of this trend, and the yield reached 7.56 percent by January 2009. Since then the yields have been far more stable, ranging between 6.84 and 8.61 (SARB 2012).
2.4.3 Exchange Rate

On 14 February 1961 the South African rand was introduced and became legal tender throughout South Africa\textsuperscript{22} and was pegged to the pound sterling at a rate of R2 = £1. For the preceding ten years, this essentially remained the case until August 1971 when the rand shifted from being pegged to the pound sterling to being pegged to the US dollar. Throughout the period of 1971-1979 the rand was pegged to either the pound sterling or US dollar with frequent alterations to the level of the peg, taking place in the form of discrete step changes (Jonsson 2001:244; Aron, Elbadawi & Kahn. 1997:2).

An integral part of the exchange rate was control on capital movements or exchange controls. In the aftermath of the Sharpeville shootings of 1961 and the political upheaval, existing controls were intensified. Residential flows were restricted whilst the sale of assets by non-residents were placed in block rand accounts, which made the process of repatriation of capital a challenging one (Aron et al. 1997:2).

Shifting of monetary policy regime in 1980 brought with it greater flexibility being advanced in the foreign exchange and capital markets. A dual exchange rate system was introduced and

\textsuperscript{22} Prior to this the South African pound had been used as the currency of legal tender.
in place between 1979 and 1983. What this essentially entailed was financial transactions by non-residence were valued at a discount exchange rate (the so called, “financial rand mechanism”) whilst the commercial exchange rate which was announced daily by the SARB in line with market forces was used for current account transactions (as well as repatriation of profits, interest and dividends) (Jonsson 2001:244; Aron et al. 1997:2).

In 1983 the dual exchange rate was abandoned and the commercial exchange rate became the official exchange rate, subject to Reserve Bank intervention. Capital controls on non-residence were also abolished and although controls remained for residents, a more lenient approach was taken to applications from residents for direct investment abroad (Aron et al. 1997:2).

The gold price decline in 1983 brought with it a sharp decline in the rand and in 1985 following the debt crisis, (which originated due to the refusal of American banks to roll over South Africa short term foreign debt) came the reversion back to the dual-exchange rate system. The dual-exchange rate system remained in existence until the unification of the rand a decade later in March 1995. Following the unification of the rand, capital controls were liberalized for South African residents while virtually all controls were eradicated for non-residents (Aron et al. 1997: 2; Jonsson 2001:244).

From 1995, with the floating of the South Africa rand combined with steady exchange control liberalisation; and the ever increasing openness of the economy to foreign trade and investment, there has been a resultant high volatility in the value of the rand. With respect to stability, the value of the rand in fact crashed (against a basket of trading currencies) by more than 15 percent in 1996, 1998, 2001, 2006, 2008 and 2011; reflecting how vulnerable South Africa has become to international financial markets (Bond 2009:15).
The year 2001 proved to be a particularly poor year for the South Africa currency. After a steady decline throughout the year, the last four months brought with it 42 percent depreciation against the US Dollar. After widespread public concern, the Myburgh Commission of Inquiry was established and mandated with investigating the causes of the depreciation. The final report indicated several economic factors were responsible for the depreciation although they could not find a definitive rational for the acceleration of the depreciation in the last quarter (Bhundia & Gottschalk 2003:3).

During the financial crisis, the rand proved to be similarly volatile. In the second week of October 2008, the currency decline by 9 percent, whilst the following week it decline by 10 percent. In essence, the US dollar/Rand went from R7.26 on 1 August 2008 to R11.11 on 24 October 2008; a 53 percent depreciation (Bond 2009:18; SARB 2012).
2.4.4 Commodity Market

South Africa’s reliance on commodities as a source of income and economic growth has been well documented and appreciated. Even if one goes as far back as the early 1900’s, its significance in the economy is apparent. In 1911/12 minerals comprised of 81.2 percent of South Africa’s total exports, with gold and diamonds alone accounting for 63.5 and 15.1 percent respectively (Bell, Farrell & Cassim 1999:6).

Moving forward approximately forty years, gold was still an intricate cog in the South African economy. Of particular importance was the opening of the Orange Free State gold fields in 1951, which saw gold output increase almost uninterruptible from 358 thousand kilograms to a peak of 1 million kilograms in 1970. Given the fixed gold price of $35 per fine ounce (which existed from 1933 to 1970), gold exports in US dollars rose in a similarly striking manner (Bell et al. 1999:7).

The 1970’s brought with it a commodity price boom. As an illustration of this, the price of gold increased from the fixed rate of $35 per fine ounce in 1970 to $52 per fine ounce in 1972; and then to a high of $613 per fine ounce in 1980. It wasn’t just gold, however, almost all mineral commodities experienced sudden price appreciation. Exports of gold and “other
mining” (coal; platinum; iron ore; diamonds; etc.) grew at 18.3 and 12 percent respectively, in constant US dollar terms (Bell et al. 1999:9-11).

Moving forward again, in 1996, South Africa had the largest reserves of gold, platinum group metals, titanium, chromium, manganese and vanadium in the world; whilst it was the largest producer of gold, platinum group metals, chromium and vanadium. Nonetheless, compared to the 1970s and 1980s the direct impact of mining, especially gold mining, on the South African economy had significantly decreased. (Khun, Minnitt, Monson, & Stilwell 2000) In the year 2000, platinum according to the value of sales figures, became South Africa’s greatest mineral asset (Stats SA (a)).

In 1998, mining directly accounted for 11 percent of GDP and 540 000 jobs compared to accounting for 26 percent of GDP in 1980. (Khun et al. 2000) Today, according to data from Stats SA, mining directly accounts for 5.1 percent of South Africa’s GDP with iron ore, coal, platinum group metals; and gold being the dominant drivers of this growth (Stats SA (b)).

In totality, from 1980 to 1996, the mining production index was seen to decrease slightly; however, one has to consider the changing productivity levels of different mineral groups. For instance, the gold production index decreased from 112 in 1980, to 82 in 1996 whilst the mining production index (excluding gold) increased from 87.3 in 1980 to 112.7 in 199623 (Khun et al. 2000).

Looking at the statistics from 1998 to present day, a similar pattern emerges with the decreasing importance of gold in South Africa’s mining sector. Whilst the mining production index (excluding gold) has increase from 74.63 in 1998, to 105.6 in June 2012, the gold production index has decreased from 171.4 in 1998, to 58.82 in June 201224 (Stats SA (a)).

23 The indexes quoted in this statistic have a base year of 1990.
24 The indexes quoted in this statistic have a base year of 2005.
Figure 7 – Mining production index: Excluding gold, January 1998 – July 2012

Source: South African Reserve Bank 2012

Figure 8 – Gold production index, January 1998 – July 2012

Source: South African Reserve Bank 2012
From a totality perspective, mining is progressively playing a smaller role in the South African economy; it, however, still has an intricate role to play. Encompassing direct and indirect impacts of mining, it is estimated mining contributed to 18 percent of South Africa’s GDP in 2008 whilst accounting directly for 9 percent of total fixed income, 13.3 percent of total private sector investment. When one considers the multiplier effect, mining helped generate 18 percent of total investment in the economy. The mining sector also accounts for R1.4 trillion, or 31 percent of the value of the JSE as of December 2008 (Inggs 2010).

In 2008, the mining sector also employed 518585 people, accounting for 6.1 percent of total non-agricultural employment; with a further 500000 people estimated to receive employment indirectly due to mining activity. The mining sector also paid R32 billion in direct taxes and a substantial portion of indirect taxes, accounting for 17.3 percent of total company tax. These statistics continue to argue the significance of the commodity market in the South African economy, both directly and indirectly (Inggs 2010).

Particularly when discussing the mineral commodity market in South Africa, what is of interest to this dissertation is the impact that the financial crisis had on it. What one notices is that after making a high in June 2008 of R29.88 billion in sales, the market rapidly declined reaching as low as R17.26 billion in January 2009\(^{25}\). This was largely lead by decreased demand for platinum which went from sales of R10.35 billion in June 2008 to sales of R3.56 billion in January 2009. It would ultimately take until March 2011 before total sales in the industry would reach the high set in 2008 (Stats SA (a)).

\(^{25}\) A point worth noting is that the US is not a major market for South Africa minerals, accounting for just over R3.2 billion of sales in 2008 and R2.3 billion in 2009. Compare this to China who accounted for R21.3 billion of sales in 2008 and R30.5 billion in 2009 (Stats SA (a)).
Figure 9 – Total mineral sales, January 1998 – July 2012

![Graph showing total mineral sales from January 1998 to July 2012.](image)

Source: South Africa Reserve Bank 2012

Figure 10 – Sales: Selected minerals, January 1998 – July 2012

![Graph showing sales of selected minerals from January 1998 to July 2012.](image)

Source: South Africa Reserve Bank 2012
Although comparable statistics from before and after the crisis of the indirect influences of the mineral commodity market in South Africa were not attainable at the point of writing, one would expect that with the significant impact of the sector on the economy as a whole, it is not that far an assumption to propose that this massive decline in sales would have reverberated throughout having a similarly noteworthy impact.

2.4.5 Banking Sector

The opening of the Cape of Good Hope bank in 1836 marked the beginning of the banking sector in South Africa. Prior to this stage, banking consisted entirely on short and long term credit to farmers, however, 1836 brought with it the era of private sector banking. Leading from this was the establishment of the London and South Africa Bank in 1861, followed by Standard Bank in 1862. After this point numerous private banks began to emerge throughout the country, however, with the more experienced foreign banks entering the South Africa market, these South African established banks were forced to either liquidate, amalgamate or were simply taken over by these larger institutions (Patel 2004:66).

Today, South Africa’s banking sector is dominated by four banks: Amalgamated Banks of South Africa (ABSA), Nedbank, First National Bank (FNB) and Standard Bank which control 84.6 percent of total banking sector assets as of December 2009\(^{26}\). Also as of December 2009, there were 31 banking institutions in South Africa, and 42 international banks with authorised institutional offices in South Africa. Foreign shareholders held 47.5 percent of the nominal value of South African banking shares in issue, whilst domestic shareholders accounted for 30.4 percent and minority shareholders accounted for 22.1 percent (SARB (b)).

In 1985, the bank supervision department (BSD) was created within the South African Reserve Bank (SARB) to monitor the foreign activities of South African banks. Supervision of domestic activities of all banks was performed by the Registrar of Financial Institutions but was officially transferred to the BSD on 24 April 1987. Prior to 1987, however, banks encountered no active supervision (SARB 2011).

\(^{26}\) Some also refer to South Africa’s big five banks, which includes Investec.
Today, the BSD is still responsible for this supervisory role. The Banks Act (Act 94 of 1994), regulations relating to banks and specific directives passed on from parliament form the three-tier legal framework from which the BSD derive their regulatory and supervisory mandate (SARB 2011).

In general, South African financial institutions have been subjected to fairly conservative financial regulation and risk management practices which lead to fairly limited exposure to foreign structured financial products. Of South Africa’s big five banks it was only Investec, the smallest of the five, which seemed to have suffered any direct impact from the crisis. As early as November 2007, Investec announced a £36 million sub-prime loss, although this pales into insignificance when one considers the write-offs which many US and European banks would record in time to come (Padayachee 2010:7-9).

Also, the average leverage (debt to equity ratio) of South Africa’s big four banks in early 2009 was 16 percent, while European banks averaged 35 percent and some big global investment banks were as high as 50 to 60 percent. Capital adequacy was also high in South African banks, with it being increased from 11.8 percent in January 2008 to 13 percent in December 2008 (Padayachee 2010:7-9).

The 2008 banking supervision annual report highlighted the buffers that had protected the local banking industry, this included: banks had not been allowed to use hybrid structures in their capital base (unlike in the US and UK which did allow it); funding was not reliant upon derivative structures; capital adequacy requirements for banks were increased in good times; and capital adequacy requirements were raised for instances when banks provided a loan which accounted for more than 80 percent of the value of the related property (Padayachee 2010:7-9).

Globally, the initial impact of the crisis was the withering availability of liquidity as capital in international banks was eroded and capital requirements increased, as did funding costs. In line with global trends, bank lending decreased in South Africa over 2008 (from a volume of $170 million in 2007 to $150 million in 2008), however, it was seen to recover all those loses in 2009 (with a bank lending volume of $173 million) whilst globally, this was not the case. In the European, Middle East and Africa (EMEA) global segment, bank loan volumes went

**Figure 11 – Bank loan volumes in South Africa, 2004 - 2009**

Source: South African Reserve Bank 2010

**Figure 12 – Bank loan volumes in EMEA, 2004 - 2009**

Source: South Africa Reserve Bank 2010
Nonetheless, lending in South Africa did experience a substantial decrease, especially when one takes into consideration the trend in bank lending, which had increased from $59 million in 2004 to the $170 million in 2007. Growth in private sector credit fell to 2.34 percent year on year in September 2009, the weakest growth since October 1966. Unsecured and mezzanine lending all but evaporated in 2009, whilst demand for securitized assets decreased significantly. Ultimately, the industries which experienced the largest decline in loans were: food and beverage, mining, property and textiles (SARB 2010; Padayachee 2010:7-9).

The interbank market continued to function normally, however, with a greater preference for shorter-term funding. Other than wholesale funding from Asian countries becoming more accessible, the sources of funding remained for the most part unchanged (SARB 2010).

In totality, South African banking sector assets amounted to R2967 billion at the end of 2009, compared with R3177 billion at the end of 2008, accounting for a 6.6 percent negative growth rate year-on-year. Although gross operating income for 2009 remained similar to that of 2008 (R149.7 billion to R149.2 billion respectively) profitability in the sector was down significantly, from R44 billion in 2008 to R35.2 billion in 2009. This was mainly due to credit losses and operating expenses rising to R35.5 billion and R76.5 billion respectively (December 2008: R29.7 billion and R73.4 billion respectively) (SARB 2011).

2.4.6 Trade

From the colonisation of South Africa by the British in the early 18th century, trade became a central part of economic activity. The earliest available trade data is from the 1860’s, where total exports from South Africa averaged £2 500 000 per annum, with wool exports making up the bulk of this. The 1870’s were marked by the discovery of Gold and Diamonds in South Africa and by the end of the century, exports were in excess of £15 million, with diamonds alone accounting for £4 million (Feinstein 2005:4-6).

However, it was gold which ultimately become South Africa’s greatest export and by 1911/1912 minerals comprised of 81.2 percent of South Africa’s total exports, with gold and diamonds alone accounting for 63.5 and 15.1 percent respectively (Bell et al. 1999:6). For much of the twentieth century, gold dominated South African trade to such an extent that the value of the rand would fluctuate with the gold price. In the 1970’s and 1980’s, government
began to intervene in the hopes of promoting non-gold exports. One of these programmes, established over the 1970’s was the development of harbour facilities, railways and mines. Metal ores were the main focus of this programme and remarkable success was seen with revenues from metal ores exports increasing by 18 percent per year during the 1980’s. Also, during the 1980’s the General Export Incentive Scheme was introduced by the Board of Trade and Industry, which essentially reduced import tariffs on raw materials to be used to manufacture goods for export. Seamingly these and other programmes had some success as gold diminished from accounting for 56 percent of export revenues in 1980, to 36 percent in 1992 (Coutsoukis 2004).

In the hopes of protecting local industries, government over the same period also began taking direct action to limit imports. This direct action was taken primarily through tariffs, surcharges and import licensing. In August 1988, surcharges on some items reached as high as 60 percent in the hope of reducing the demand for imports; but by May 1989, capital goods surcharges were eased from 20 percent to 15 percent (Coutsoukis 2004).

Edwards and Lawrence (2006:18-20) show the significant deviation these policies had on the long-run trend of import growth. Whilst the average annual growth rate of imports from 1960-1970 was 7.8 percent, from 1970-1980 it was 1.9 percent and from 1980-1990, it was only 0.3 percent.

However, it would be a shortfall of one to talk about South African trade in the 1970’s and 1980’s without a brief discussion on trade sanctions and boycotts. The first of these sanctions came with a voluntary arms embargo instituted by the United Nations (UN) in 1963, which was declared mandatory in 1977. The United States Import-Export Bank enforced a prohibition of loans to the country in 1978 whilst the Organization of the Petroleum Exporting Countries (OPEC) first instituted an oil embargo in 1973, which was later strengthened through an Iranian oil embargo in 1979 (Coutsoukis 2004).

The 1980’s brought with it further sanctions, the most prevalent of which being: prohibition of IMF loans in 1983; private banks ceasing almost all loans to the country in 1985; and in 1986 the European Economic Community (EEC) ban on trade and investment, and the initiation of the US Antiapartheid Act which similarly limited trade and discouraged investment. However, in 1991 the US and EEC began lifting sanctions and by 1994, all sanctions from various countries and organisations had been dismantled (Coutsoukis 2004).
From the peak of import volumes in 1974; by 1987 imports were down by 30 percent, proving the success of government and external pressures in limiting South African imports. Nonetheless, the types of imports remained fairly consistent, with industrial imports continuing to dominate. The most important of these imports was machinery, followed by vehicles and transportation equipment, an assortment of chemicals and oil. Despite the sanction introduced by OPEC and Iran, South African imports of oil were estimated to be $1.75 billion in 1987 (Coutsoukis 2004).

The effectiveness of the sanctions on exports was not nearly as significant, although this may be representative of government policies discussed already, which promoted export growth. Nonetheless, this tussle between contractor sanctions and expansionary government policies resulted in what can only be described as a stale mate, with real export growth being 2.6 percent from 1980-1990 (South African Revenue Service (SARS) 2012).

What is apparent in government policy over this era is the simultaneous emphasis on limiting imports, whilst increasing exports. This was done primarily to increase the trade surplus, thus providing the increased foreign reserves necessary to repay outstanding government debt. However, with the lifting of all sanctions by 1994 and reformed government policies designed to reintegrate the country into the global market, South Africa’s trade balance began to change somewhat. In 1994, exports were estimated to have a value of R89.1 billion, whilst imports were estimated to be R59 billion. However, in early 1995, imports began to outstrip exports and for the remainder of the year South Africa’s trade surplus declined at an uneven rate. Nonetheless, with the depreciation of the rand in 1996, exports grew significantly which ultimately strengthened the trade surplus (Coutsoukis 2004).

In the mid-1990’s, South Africa’s main trading partners were the Western European countries, the United States, and Japan. The European Union received 40 percent of South Africa’s exports in 1994 and accounted for 33 percent of its imports. After 1994, South Africa’s trade with the US grew rapidly. In 1995, South Africa imported $2.75 billion worth of US products which represented more than half of all exports by the US to Africa, whilst the US imported $2.21 billion worth of South African products (Coutsoukis 2004).

Importantly, South Africa also belongs to the Southern African Customs Union (SACU) which was formally established with the renegotiation of a pre-existing agreement in 1969. Originally the agreement was between South Africa, Lesotho, Swaziland and Botswana; and then grew to include Namibia when they gained their independence in 1990. It is officially
defined as a customs union in which goods are traded freely among member nations; and common tariffs structures and accounting procedures are followed (Coutsoukis 2004).

As one would expect, from 1991-2000, export volume grew by 5.3 percent whilst import volume grew by 6 percent. What is far more striking is that while import volume continued along this trend from 2001-2004, growing at 6.6 percent, export volume only grew 1.1 percent (Edwards & Lawrence 2006:5).

However, from 2004 to mid-2008, both import and export volumes experienced rapid growth in line with an expanding global economy. According to the export/import volumes index supplied by the SARB, export volumes grew by 38.4 percent from January 2004 to July 2008, whilst import volumes grew by the staggering amount of 58.9 percent. The absolute figures are similarly astounding with exports growing from R372 billion at the beginning of 2004 to R514 billion by the midway point of 2008; whilst imports over the same period grew from R365 billion to R581 billion (SARB 2012).

Figure 13 – Import volumes, January 1980 – April 2012

Source: South African Reserve Bank 2012
Figure 14 – Export volumes, January 1980 – April 2012

Source: South Africa Reserve Bank 2012

Figure 15 – Total exports, January 1980 – April 2012

Source: South African Reserve Bank 2012
After the crash of Lehman Brothers in September 2008, a significant reversal of these trends was seen. Import volumes fell from a high of 132.8 just before the crash, to a low of 103.3 by the third quarter of 2009. It would take the index until the fourth quarter of 2011 for it to fully recover the losses over that period. The export index was even harder hit, falling from 119.3 to 91.8 over the same time period; however, to this date the index has still not salvaged those losses, languishing at 104 in the second quarter of 2012 (SARB 2012).

The absolute figures paint a similarly dismal picture, with imports falling from that high of R581 billion before the crash of Lehman to R452 billion by the third quarter of 2009; whilst exports fell from R514 billion to R394 billion. Similar to the volumes, imports recovered the losses by the fourth quarter of 2011 whereas exports were only at R447 billion in the second quarter of 2012 (SARB 2012).

Presently, the market for South Africa’s exports remains similar to that of 1994, with the US, European Union and Japan still being the chief importers. However, China has rapidly become the main export market, primarily in minerals, for South Africa accounting for over R90 billion in 2011. The European Union as a whole is the largest importer, however, accounting for just over R152 billion, with Germany, the Netherlands and Switzerland being the largest in the region (SARS 2012).
To take a brief look at the US in particular, after reaching a high of importing R18.5 billion worth of South African products in the third quarter of 2008, it more than halved its demand by the second quarter of 2009, with only R8.7 billion of South African products being imported. Although a mild recovery ensued from that low point, exports to the US as of the end of 2011, have never regained the magnitude seen before the crash of Lehman Brothers (SARS 2012).

**Figure 17 – Exports to the United State of America, January 2006 – January 2012**

Source: South African Reserve Bank 2012
CHAPTER THREE

LITERATURE REVIEW

3.1 INTRODUCTION

Before discussing the topics of contagion and a financial crisis, one has to have a complete understanding of what constitutes these two terms. As such, this chapter begins with a discussion on these two terms and their meaning in literature with specific reference to this dissertation. Following this clarification the remainder of this chapter will essentially be broken into two distinct parts: A theoretical and empirical literature review. The theoretical literature review will be further sub-divided into crisis contingent and non-crisis contingent theories, under which relevant concepts will be discussed and expanded upon. The empirical literature review has also been further sub-divided into methodologies relating to the analysis into the presence of contagion and those used to investigate the channels through which contagion is transmitted.

3.2 DEFINITIONS

Not only “contagion”, but also “financial crisis” (which shall be arbitrarily interchange with the term, “crisis”), the supposedly transmitted diseases, is an incredibly imprecise term. The classical view take by Thornton (1978) and Bagehot (1962) restricts the term of “financial crisis” to simply the banking sector. Contemporary literature, however, uses the term more broadly; encompassing events grouped into currency, banking and debt crises. This contemporary view shall be continued as various “crises” are discussed throughout the paper. (Moser 2003:158)

The term, “contagion”, is possibly used even more widely; with even less understanding. In the month following the Russian ruble devaluation in 1998, the Brazilian stock market fell by over 50 percent. Without any precise definition to guide, most academics have agreed that this transmission of a shock from Russia to Brazil is an illustration of contagion. However, the Polish zloty depreciating by 11 percent in the same month as the Russian ruble in 1998 is a more contentious discussion with little agreement. This example illustrates the difficulty in defining the term “contagion” (Claessens & Forbes 2004:3)
Claessens, Dornbusch & Park (2000:179) give an encompassing broad definition which is an appropriate starting point for this discussion, “Contagion is generally used to refer to the spread of market disturbances – mostly on the downside – from one (emerging market) country to the other, a process observed through co-movements in exchange rates, stock prices, sovereign spreads and capital flows. Contagion can occur for different reasons and can conceptually be divided into two categories.”

When a financial crisis cannot be linked to observed changes in the macro economy or other fundamentals and is solely the result of the behaviour of individuals and other financial agents, this is generally thought to be contagion (Claessens, Dornbusch & Park 2000:4). This is the first category of contagion for which some economists have proposed the use of a more specific term, “shift contagion” to describe such a scenario (Claessens & Forbes 2004:4). Forbes & Rigobon (2002:2223) define this term as, “a significant increase in cross-market linkages after a shock to an individual country”27. According to this definition, if two markets show a high level of association after a negative shock, this may not constitute contagion as the markets may have experienced a high level of co-movement during a stable period before the negative shock.

Subsequently, according to this definition by Forbes and Rigobon (2002:2223), the only way to definitively conclude contagion has occurred is if the linkages between the markets improves significantly after the negative shock when compared to a stable period before the shock. In such a case where the co-movement does not increase significantly after the negative shock, one is left to conclude that these strong linkages and resultant co-movements exist in all states of the world. Similarly to Forbes & Rigobon (2002:2223), this paper will use interdependence to refer to this situation (Forbes & Rigobon 2002:2223-2224).

This second category of contagion, “interdependence”, is what Calvo and Reinhart (1996) term, “fundamentals-based contagion,” a phrase which explains simply the foundation for the propagation of a crisis. Thus, according to this definition, interlinked fundamentals and not the irrationality of investors and their herd like behaviour result in the transmission of a crisis (Claessens, Dornbusch & Park 2000:4).

27 There are, however, numerous cases where shift contagion has been defined differently to that used by Forbes and Rigobon (2002), such as in Bae et al. (2003). This Forbes and Rigobon (2002) definition, however, is widely used in literature as it intuitively leads to the use of correlation analysis in the testing of contagion – historically the most popular form of testing for contagion.
The distinction between this shift-contagion and interdependence is as a consequence of shift-contagion being induced by some form of investor irrationality whilst interdependence is induced by a rational market response. Interdependence occurs as a consequence of crisis in one country disturbing the fundamentals in another country, evoking a shift in the equilibrium point. Thus, financial market responses only reflect (anticipated) changes in fundamentals and speed up adjustment to the new equilibrium, but they do not cause the change in equilibrium. On the other hand, shift-contagion results from the irrationality of investors, taking the market away from equilibrium or, the rationality of investors brining the market back to equilibrium, where the previous disequilibrium was as a result of some form of investor irrationality (Moser 2003:162).

Most policy makers, however, prefer a broader and more inclusive definition of contagion, one which encompasses the vulnerability of one country to the events that occur in other countries – regardless of why they occur or whether these are real linkages which are an occurrence regardless of the state of the world. Investors also generally prefer this broader definition as their concern is not why contagion occurs but, rather the presence or absence of the transmission of a crisis (Forbes & Rigobon 2002:2225).

Nonetheless, it is fairly evident from the previous chapter that a crisis was in fact transmitted to South Africa, either directly from the US or from the US to a secondary region and then to South Africa. Regardless, from this anecdotal evidence it is evident that fundamental based contagion did in fact occur. Thus, to shed light on the subject and draw greater inferences from the crisis, the narrow definition shall be used in the testing for contagion.

### 3.3 THEORETICAL LITERATURE REVIEW

For practical purposes, it is more efficient to divide the theories on financial contagion into two distinct groups: crisis-contingent theories and non-crisis contingent theories. Crisis contingent theories imply that cross-market linkages increase after a shock, illustrating that transmission mechanisms change during a crisis. These theories are mostly concerned with investors and political figures that through irrationality, time constraints or changing perceptions or pressures, cause the propagation of crisis across national borders. Non-crisis contingent theories postulate that transmission mechanisms are the same during a crisis as they are during more stable periods, thus implying that cross-market linkages do not increase
after a shock. That is that countries have interconnected fundamentals such as trade and finance linkages that result in the simultaneous movement of their economies, during both stable and crisis periods (Forbes & Rigobon 2001:47).

Although the relevant theories on contagion have been divided up into the two particular categories, it is completely viable to observe a coexistence of the crisis contingent and non-crisis contingent theories. A number of transmission mechanisms may be active in the presence of a crisis or not, whilst, at the same time, a crisis may trigger a new mechanism that otherwise would be inactive (Drakos & Kutan 2005:14).

While each theory has been discussed in detail elaborating how a crisis could be transmitted to foreign equity prices that is, however, where the description of the process has been ended. This has been done as a result of the fact that, the remainder of the process is rather intuitive and recurrent throughout the theories. Simply, a sudden capital outflow negatively impinges upon productivity, financial fragility and current account deficits leading to a decrease in aggregate demand throughout the economy. This decreased demand induces firm bankruptcies, non-performing loans for the banking sector and general price decrease in the majority of asset classes. Consequently, unemployment and poverty ensues as the financial crisis imposes itself upon every sector of the economy (Vaugirard 2004:170).

### 3.3.1 Crisis Contingent Theories

These crisis contingent theories of how a local crisis can be transmitted internationally can be broken down into eight mechanisms: multiple equilibria, exogenous liquidity, informational asymmetries, country re-evaluation, incentive structures and changes in risk aversion, uncertainty channel, investor reassessment of international finance operating systems, and political factors. This group of crisis contingent theories suggests a number of different mechanisms through which a crisis can be transmitted internationally. Although each has its own unique characteristic, fundamentally they each share one important characteristic: the transmission mechanism during (or immediately after) the crisis is inherently different than that before the crisis.
Multiple Equilibria

Multiple equilibria mechanism is essential when investors use a crisis in one country as a sunspot for other countries. The theory itself as a crisis contingent theory, which relies on the irrationality of investors as a whole where there is a change in expectations or beliefs that are unwarranted by the fundamentals (Forbes & Rigobon 2001:47).

Calvo (1996) refers to this as investor “herd behaviour”, where due to the costs associated with determining the fundamentals of each country they have invested in; it is optimal for them to pull out of a group of related markets when they spot signs of nervousness in just one of them. In such a case, marginal cost outweighs marginal benefit of gathering the information.

Calvo & Mendoza (1998) even go on to show that if fixed information costs exceed 1/6 of the mean portfolio return prior to the emergence of the rumour, investors will rationally choose not to assess country-specific rumours. The expected utility gain from knowledge gathering is a very steep curve of the number of countries in the portfolio, with a dozen countries being estimated as the point in which gathering country-specific information becomes an ineffective exercise.

It is at this point one is reminded of Keynes (1936:158-159) who stated: “If I may be allowed to appropriate the term ‘speculation’ for the activity of forecasting the psychology of the market and the term ‘enterprise’ for the activity of forecasting the prospective yield of assets over their whole life, it is by no means always the case that speculation predominates enterprise. As the organization of investment markets improves, the risk of the predominance of speculation does, however, increase. … Speculation may do no harm as bubbles on a steady stream of enterprise. But the position is serious when enterprise becomes the bubble on a whirlpool of speculation.” One would expect that today, Keynes would be thoroughly concerned with global markets when viewing results such as Calvo and Mendoza (1998).

Claessens, Dornbusch & Park (2000) explain that there may be another reason to anticipate this “herd behaviour”. Institutional investors today are facing high reputation costs where their portfolio performance is judged against the market portfolio, rather than on absolute performance and as such, may find it less costly to simply follow the herd.

Bikhchandani, Hirshleifer and Welch (1992) describe this concept, of similar mass behaviour, as a consequence of informational cascades. An informational cascade is thought to occur
when it is optimal for an individual to discard their own information and follow the behaviour of a preceding individual after observing the actions of that individual. Under relatively stable conditions, a sudden information cascade can occur, drastically altering asset prices without any obvious fundamental stimuli driving the actions. (Kaminsky, Reinhart & Vegh 2003:56)

Bringing the discussion back to the multiple equilibria mechanism, Claessens & Forbes (2004:8) illuminate that similarly to a run on the bank, investors could suddenly withdraw from a country if they fear that they will otherwise be left with no claim on a limited pool of foreign exchange reserves. Some believe that these sudden shifts in expectations are one of the most important factors causing contagion. A change in investor expectations causing a shift between equilibria could be triggered by many factors, including fundamental reasons, which makes this a difficult theory to distinguish between being purely crisis contingent or non-crisis contingent (Claessens & Forbes 2004:8). For example, if a crisis reflects and reveals weak fundamentals, investors may rationally conclude that similar countries would also face similar problems, thus leading to contagion.

Masson (1999) showed how a crisis in one country could manipulate investor’s expectations about another country, changing them from a good to a bad expectation; which ultimately results in the crash of the market, with little justification for such a circumstance coming from the macroeconomic fundamentals (Forbes & Rigobon 2001:47).

Mullainathan (1998:4) contends that past events play an important role in the investor’s psyche. His model is based upon the assumption (which it is maintained to be psychologically studied fact) that salient information, when compared to statistical information, have a larger effects on individuals, being more memorable and effective in triggering supportive memories. Thus, when a negative event occurs in one country, this induces a revaluation on investor’s priors (on variables such as debt default) on other countries due to previous memories of contagion. This in turn prompts the allocation of a higher probability of a negative outcome. The resultant downward movement would, as such be a consequence of a negative memory (Forbes & Rigobon 2001: 47).

King & Wadhwani (1990) argue that there is a second form of multiple equilibria, which results from the difficulties of signal extraction, although others have classified the two independently. Moser (2003:163) refers to this as “fictitious interdependence”, where market participants falsely assume interdependence of fundamentals, or at least overestimate the extent of interdependence. In the case of the former, a country-specific shock that should
have no impact on other countries in the case of full information would now be transmitted. In the case of the latter, compared with a case of full information, the transmission would now be in excess compared to what would be a rational equilibrium adjustment (Moser 2003: 163).

It follows that in King & Wadhwani (1990), Masson (1998) and Mullainathan’s (1998) the explanation of the international transmission of a shock is less as a result of changes in the fundamentals and real linkages, but rather a consequence of investor expectations. This branch of theories enables not only a suitable explanation for why crises appear to occur in clusters, but also as to why speculative attacks ensue on economies that are fundamentally stable (Forbes & Rigobon 2001:47).

**Exogenous Liquidity Shocks**

Referred to by Forbes (2000) as a “credit crunch” and Valdes (1996) as a “liquidity run”, it is generally defined as a situation in which there is a simultaneous redemption of assets by investors in a country, to the extent that it is in excess of the debtor countries available resources. For the most part, this occurrence is largely reliant upon the past behaviour of the domestic financial system as a large portion of obligations must be of the short-run nature in order for assets to be withdrawn abruptly and simultaneously. At its very worst, the occurrence of an exogenous liquidity shock can lead to the so called “twin crises”, the simultaneous occurrence of a balance of payments and banking crises (Goldfajn & Valdes 1999:2).

Prior to the “Tequila crisis” of 1994/5 in Mexico, macroeconomic mismanagement was quickly concluded as being the attribute responsible for balance of payment crises, with the primary suspect being an “unsustainable” fiscal deficit. However, it was difficult to pin this conventional view of economic mismanagement on Mexico, as the country had just come out of a period in which important structural reforms had been taken and long stable growth recorded. Although some argue Mexico did represent a few aspects which raised minor concerns about macroeconomic mismanagement, it was close to impossible to assign blame to countries like Korea and Indonesia during the Asian 1997 crisis (Calvo 1999:1).

Calvo (1999:2-3) developed a model in the hopes of explaining these crises in a manner that is not reliant upon economic mismanagement. A key attribute underlining the model is that
there are large fixed costs, compared to the size of investment projects, in obtaining knowledge about emerging-market economies. A team of experts constantly monitoring variables is required if one is to keep track of a country's rapidly changing economic environment. However, there is no great cost differential between learning about macroeconomic variables in a large country like the US and a small country such as Paraguay (Calvo 1999:2-3).

It is proposed that economies of scale are prevalent with the occurrence of large fixed costs. Thus, the financial sector arranges itself around a few specialists. There is as such asymmetric information between investors, generally dividing investors between those who are informed and uninformed. When the fundamentals of a country change, the informed investor receives subsequent signals which they act upon. Additionally, when the informed investor is hit by a liquidity shock (margin calls), he/she is forced to sell their holdings. An uninformed investor to the contrary cannot distinguish between the signals from a change in the fundamentals and a liquidity shock. They suffer what Calvo (1999:3) refers to as a “signal extraction” problem. Thus, a liquidity shock to an informed investor may force him/her to sell their holdings in a particular country. This may be interpreted by an uninformed investor as a change in the fundamentals of that country. If investors then respond in a manner such as the aforementioned “herd behaviour”, a sudden withdraw of assets from that country may ensue, one which was not supported by any fundamental changes to the economic environment (Calvo 1999:3).

Valdes (1996) takes a somewhat different approach to theoretically explain how an exogenous liquidity shock can result in contagion. The basic presupposition of the concept is that countries are generally illiquid, implying that if a considerable amount of investors withdraw assets from a country in the short-run; there are not enough resource to pay what was promised. Additionally, this then impinges negatively on future returns. Combining these two supposed facts, if investors then suddenly demand liquidity, an environment which stimulates the spreading of withdrawals across countries is inherent as one country does not have enough liquid assets to meet investor demand.

What Valdes (1996) is suggesting is that the liquidity of all market participants could be affected by a negative shock in one country. A shortage in liquidity (for whatever reason) could result in investors having to recompose their portfolios, perhaps having to sell off assets in other countries in order to remain in the market, to satisfy margin calls, or to meet
regulatory requirements. Accordingly, if the liquidity shock is large enough, the crisis in one country could force investors to sell off assets in other countries, countries which are fundamentally still sound (Forbes & Rigobon 2001:48).

Calvo (1998) expands this line of thought by explaining that a “lemon problem” may arise in such a situation described by Valdes (1996). If the investors require liquidity after a shock due to their leveraged position, they have two options: they could sell the assets in the crisis country at low-fire sale prices, or alternatively, sell assets held in other countries where they will get far more realistic values when compared to the assets intrinsic value. As such, a relatively small crisis in one country could become contagious due to the associated “lemon problem” and liquidity constraints (Kaminsky, Reinhart & Vegh 2003:57).

It should be obvious at this point, why Forbes (2000) refers to this concept of Valdes’ (1996) as a “forced portfolio re-composition.” Although this is empirically tested differently to the typical case of exogenous liquidity shocks, due to its underlying linkages with an exogenous liquidity shock, it has been included under this subsection.

Kaminsky & Reinhart (2000) take the concept of Valdes (1996) one step further, by applying it to mutual funds. In such a case, a crisis in one country provokes investors to withdraw funds from their mutual fund due to irrational and non-fundamentally driven fears. Thus, to fulfil investor redemptions, mutual funds are forced to sell liquid assets in other markets resulting in the contagion effects of the crisis. (Forbes 2000:5-6)

A third model used to explain the contagious effects of exogenous liquidity shocks was developed by Kaminsky & Reinhart (2000), who focus on the role of commercial banks in the spreading of an initial shock. Foreign banks by calling in loans and drying up credit lines can exacerbate the original crisis but also propagate the crisis by calling in loans elsewhere in the world. The need to recapitalize following loses from the original crisis could subsequently result in a substantial reversal in commercial bank credit in countries where the bank has exposure. (Kaminsky, Reinhart & Vegh 2003:58)

Along a similar line of thought, Allen and Gale (2000) theorizing that it is via overlapping claims that the financial sectors in different regions have on one another that contagion is transmitted. They begin by explaining that the occurrence of liquidity preference shocks are imperfectly correlated between regions and, to provide insurance against this, banks hold cross-regional claims on other banks. Thus, when one region suffers a bank crisis, banks in
other regions suffer a loss due to their claims on the banks in the troubled region being of a lower value. Also, the banks in the troubled region may very well call in their claims from non-trouble regions in order to meet withdrawals. Now, banks in non-troubled regions are obliged to meet these demands and as such, could be forced to cut its lending. On the whole, if these knock on effects are strong enough, it can cause a crisis in the adjacent regions. Furthermore, in extreme circumstance, the crisis passes from region to region and becomes a contagion.

The possibility of contagion within this theory relies heavily on the completeness of interregional claims. Following this though, Allen & Gale (2000) show empirically the completeness of claim structures are more robust than incompleteness of claim structures, underling the significance of their theory as a way in which contagion may be propagated.

Taking the thoughts of Allen & Gale (2000) one step further, Kollmann & Malherbe (2011) suggest that due to international interbank lending, banks adjusted liquidity requirements downwards prior to 2007. This was under the correct assumption that interbank lending provides greater resistance to local increases in withdrawals. However, they argue that this system is less resistant to infrequent global shocks and may have even have contributed to the magnification of the global crisis (Kollmann & Malherbe 2011:7).

Finally, a model developed not initially for its use in the study of contagion, but one which is easy to relate contagion to, is that of Shleifer & Vishny (1997). In an examination of arbitrage investing, they describe how arbitrage is conducted by a relatively few specialized and leveraged investors who tend to take large positions in undervalued assets, bringing the market consistently back to its equilibrium level. However, in the case of a large crisis, it is proposed that even these arbitrageurs suffer from investment withdrawals and a lack of liquidity. As such, when a country is suffering the effects of contagion that is contrary to the fundamental analysis, the arbitrageurs are unable to participate in the market. Furthermore, risk-averse arbitrageurs may choose to liquidate, even when they do not have to, due to the fear that an adverse price movement may trigger a far-reaching cash withdrawal later. (Kaminsky, Reinhart & Vegh 2003:57)

The models illustrated by Calvo (1998), Kaminsky & Reinhart (2000), Shleifer & Vishny (1997) and Valdes (1996), and the extensions of them illustrate how a crisis in one country could result in a contagious effect across international borders through linkages which seemingly are not present during periods of stability (Forbes & Rigobon 2001:48).
Information Asymmetries

Similarly to Calvo (1998), Kodres & Pritsker (2002) developed a model including informed and uninformed investors in which contagion is spread via informational asymmetries, our third category of crisis contingent theories. In their model, which has a rational expectations base, long-run values of asset prices are determined by macroeconomic risk factors which are shared across countries and by country-specific factors. When informed investors receive private information about country-specific risk, they optimally rebalance their portfolios exposure to the shared macroeconomic risk factor in other countries markets. However, due to the asymmetric information, uninformed investors in individual countries interpret this rebalancing of portfolios as change in demand, due to changes in country specific risk. This idiosyncratic shock thus, generates contagion across countries asset markets. (Kaminsky, Reinhart & Vegh 2003:57)

A key attribute of this theory is that contagion can occur between two countries without any common macroeconomic factors being shared between them, provided that both countries share at least one common macroeconomic risk factor with a third country, through which portfolio rebalancing can take place. An important implication is that vulnerability to contagion comes with greater liquidity in markets and greater exposure to internationally traded financial assets. Small, highly illiquid markets would be shielded from contagion as they are likely to be underrepresented in international portfolios (Kaminsky et al. 2003:58).

Country Re-evaluation

Country re-evaluation or what is occasionally referred to as the “wake-up call hypothesis”, indicates that countries with similar macroeconomic fundamentals may suffer a similar fate as investors learn a lesson from a crisis in one country; they apply those lessons to countries with the similar macroeconomic fundamentals (Kaminsky et al. 2003:58).

For example, if a country with a weak banking system is found to be susceptible to an equity crisis, all other countries with weak banking systems will be re-evaluated to adjust accordingly to the changed probability of a financial crisis (Forbes & Rigobon 2001:49). It is after an example that one fully grasps why Goldstein (1998:18) and others refer to this
transmission of a crisis as the “wake-up call” channel; as the propagation is as a result of the realisation of a past mistake in the evaluation of risk and the subsequent correction and not as a result of a new mistake. Similarly, one understands Goldstein (1998:18) now when he says, “I refer to it as a wake-up call because to judge from most market indicators of risk, private creditors and rating agencies were asleep prior to the outbreak of the Thai crisis.”

Importantly, within this theory investors become aware of past irrationalities that forced the market out of equilibrium. Thus, with the realisation or, “wake-up call”, the market is brought to equilibrium instead of away from it. This sort of contagion is as a result of an efficient correction and leads to a more accurate assessment of fundamentals.

Incentive Structures and Changes in Risk Aversion

Essentially, there is a justification that contagion is propagated due to the incentive structures within hedge funds. There are numerous hedge funds that specialise within specific regions of the globe, for instance, East Asia. A crisis in one country (for example Thailand in 1997) in turn induces the redemption of those mutual funds by investors, thus impacting the entire region and not simply the crisis country (Masson 1999:12-13).

Similarly, an increase in risk aversion which may have been brought on by a crisis in another country or below-average returns, may prompt investors to offload assets in order to track their benchmarks more closely. This is due to investors optimal asset allocation model which Schinasi & Smith (2001:159) argue always encourages investors who are leveraged, to reduce risky asset positions when this type of shock occurs. This result is not dependant on margin calls but rather applies to portfolios and institutions that rely on borrowed funds. Thus, a loss on a specific position may be enough to induce an investor to reduce risky positions in all markets. Schinasi & Smith (2001:160) go on to show that the net reduction in risky asset positions is relatively large for low levels of leverage. This could lead to large price declines and currency depreciations if a large number of investors are evaluating according to similar benchmarks or have fixed country portfolios (Schinasi & Smith 2001:160).

Similar to Schinasi & Smith (2001), except explained fundamentally through wealth effects and not the need to track benchmarks, Kyle and Xiong (2001:1402) show that when a trader endures losses, he has a lower capacity for bearing risk. This motivates them to liquidate assets, perceived to be more risky (typically those in emerging markets) resulting in reduced market liquidity, increased price volatility and increased correlation. Through this mechanism, one can see how the wealth effect leads to contagion (Kyle & Xiong 2001:1402).

Value-at-risk models which are being used increasingly at commercial banks can cause similar incentives and behavioural patterns. These models may provide the explanation as to why many investors may find it advantageous to sell many higher risk assets after a shock to one asset (Claessens & Forbes 2004:5).

Although this is a plausible theory, it does deny the effects of other investors in the market, who, it would be assumed, after noticing the troubles of a number of hedge funds, would take advantage of the buying opportunity presented by firms selling assets at underpriced values. Alternatively, it requires that either the aforementioned “herd behaviour” be so enveloping that all investors are similarly affected, or, as suggested by Shleifer & Vishny (1997), that the simultaneous exogenous liquidity effect develop upon the market arbitrages (Masson 1999:13).

**Uncertainty Channel**

Kannan & Kohler-Geib (2009) developed a model in which the greater the surprise a crisis or shock to the system is, the greater and more widespread the resulting effects of contagion. The model begins with a microeconomic underpinning where it is stated that with any investment, the expectations regarding the state of the country’s economy in which the firm is based plays an important role in the expected returns of that investment. However, investors who are assumed to be imperfectly informed about the state of the underlying economy; nevertheless are still able to acquire a form of information-gathering technology that enables them to increase the accuracy of information (Kannan & Kohler-Geib 2009:4-5).

The crucial assumption leading from this is that investors are unsure about the precision of this information-gathering technology. Thus, by observing developments in other countries, they update the perceptions on the precision of the technology. For example, with an unexpected crisis in one country, investors will ascribe a lower belief to the accuracy of the
technology. With a greater degree of uncertainty comes a greater degree of risk and as such, expected returns have to be so much larger to account for this increased risk. Combined with the fact that with fewer benefits related to the use of this technology, less people will implement its use due to its related downgrade in gains-cost ratio (Kannan & Kohler-Geib 2009:5).

From this point, after combining these two factors one has a global increase in uncertainty and a resultant global increase in required returns for investments; inducing withdraws from a number of asset classes and in some cases, from countries all together. In other words, through rational decision making, a crisis in one country can systematically increase the probability of a crisis in another country in which investors have money, due to increased investor doubt in their information (Kannan & Kohler-Geib 2009:5).

From this theoretical grounding, Kannan & Kohler-Geib (2009) go on to show that the Mexico crisis of 1994, the East Asian crisis of 1997, Russian crisis of 1998 and the US crisis of 2007 where all propagated on a large scale around the world due to the related uncertainty present in these crises. Whilst other crises such as Brazil 1999, Turkey 2001 and Argentina 2001 largely remained localised to those countries due to the greater degree to which they were anticipated.

**Investor Reassessment of International Finance Operating Systems**

The concept of international reassessment of international finance operating systems could manifest in a number of ways including increased concern that countries might follow unilateral, confrontational policies regarding foreign private creditors. It could also reflect increased concern, either due to a change in policy or a limited supply of funds, that international financial institutions are less likely to assist countries with financial difficulties (Claessens & Forbes 2004:9).

For example, it has been suggested that the failure of the international community to bail out Russia during its aforementioned currency devaluation in 1998, which was brought on by its debt and balance of payments difficulties, may have been interpreted by market participants as implying that Brazil would not be bailed out of its balance of payments problems either. What ensued was a speculative attack on the Brazilian currency, even though fundamentally, the two countries are not tightly linked through their real sectors (Pritsker 2000:11).
However, there are other arguments surrounding the investor reassessment channel. Dooley (1997) adapted a model almost entirely contrary to this example, whereby contagion is spread by the presence of a bailout in a country. He begins by indicating that emerging economies experienced great inflows of capital during the 1990’s due to the lower US interest rates and debt write downs; and the presence of unexploited resources. When the US interest rates eventually increased, coinciding with a growing scarcity of resources, the capital inflows were retracted causing a crisis in an individual country. What resulted was a crisis in a particular country, leading to a subsequent bailout by the international community. With the bailout, came the interpretation that fewer resources were available for other countries suffering similar capital withdraws who may need bailouts. It thus exasperated the negative sentiment and downside risk, furthering the capital outflows, resulting in a contagion of crises across emerging economies. The model as such assumes a fairly large level of foresight on the part of investors who are thought to have anticipated the international bailout of Asia and also to have anticipated at what point resources had been entirely utilized (Masson 1999:14).

Thus, it is obvious that an argument could be made that a reassessment on any number of these factors mentioned could cause investors to sell a range of assets outside the original country of crises, thereby causing contagion.

**Political Contagion**

A final crisis contingent theory is that of political contagion. Drazen (1998:9-10) makes two key assumptions in the development of this theory. Firstly, reserve bank presidents are under political pressure to maintain their countries’ fixed exchange rates which is done due to their desire to continue their membership in an integrated unit of countries. Secondly, the countries that are members of this integrated unit determine the value of the membership. Hence, if potential members of the arrangement do not place much weight on meeting the specific requirements and as such are less likely to participate, a country will find it less advantageous to join (Drazen 1998:9-10).

Drazen (1998:9-11) then employs these assumptions to the creation of a model and applies it to the 1992 and 1993 European devaluation. He finds that once one country has abandoned its pegged rate, it is seen as an indication to other countries that their commitment to the membership of the integrated unit is weaker than previously perceived. Thus, it reduces the
political cost on not being a member country due to the relative strength of the union diminishing. This allows other countries to follow suite, increasing the probability of these countries changing exchange rate regimes. Subsequently, exchange rate crises may be bunched together and the transmission mechanism is dependent upon the first country abandoning the pegged rate, taking what is initially a purely country specific crisis and spreading it throughout the member states of the fixed currency regimes (Forbes & Rigobon 2001:48; Drazen 1998:9-11).

3.3.2 Non-Crisis Contingent Theories

This group of theories draws the conclusion that the transmission mechanisms that transfer a crisis from one country to another are present in all states of the economy and there is no significant change in these linkages after a crisis. It is argued that any cross-market linkages that exist after a crisis are a continuation of the linkages that existed before the crisis. These linkages are often referred to as “real linkages” since many are based on economic fundamentals. As such, this group of theories explain how shocks could be propagated internationally but, don’t generate specifically shift-contagion. These theories can be broken down into four broad channels: trade, financial linkages, policy co-ordination; and random aggregate shocks (Forbes & Rigobon 2001:49).

Trade

A well-known and publicised channel through which crises are propagated is that of international trade. As in all economic literature, there is seemingly always another who disagrees with theoretical and empirical findings, however, the channel of trade is largely agreed to be an important transmit-ant of almost all crises (Moser 2003:160).

Kindleberger (1983:227) is amongst those who argue that such trade propagation mechanisms are “too strung out with lags to explain the near simultaneity of… crisis”. However, Moser (2003:161) essentially puts this debate to rest when he points out that agent’s in financial markets are constantly looking forward and respond in anticipation to real impacts; as such causing immediate corrections in asset prices. (Moser 2003:161)
Trade can essentially be divided into two sub-channels: the competition linkage and the domestic demand linkage. The competition linkage which was first illustrated by Gerlach & Smets (1994) in a bi-lateral trade setting occurs when a crisis country experiences either currency depreciation (within a floating exchange rate regime) or decides to devalue its currency (within a fixed exchange rate regime); direct influence from which would manifest on its exports, making them more competitive in the global market (Boschoff 2006:63). The products which are exported are now available at a lesser price in a trade partner’s country, creating greater competition for domestic producers in that country, consequently having a negative impact on domestic sales within that country. The increased imports and decreased exports inevitably impact negatively on the trade deficit of the particular trade partner and ever decreasing foreign currency reserves. This in turn makes the country’s currency more vulnerable to a speculative attack (Glick & Rose 1999:610).

Corsetti, Paolo, Nouriel & Tille (2000) were the next to make a meaningful contribution to this line of literature by illustrating the positive effect that may be induced in bi-lateral trade via a country’s currency devaluation. They argue that the more favourable terms of trade may allow a country to finance higher levels of consumption for a given level of nominal income. In fact, they consider the fact that this effect may dominate the negative effects of the competition linkages and the country that devalues could “beggar thyself” while simultaneously generating a welfare improvement for other countries (Forbes 2002:84).

Corsetti et al. (2000) also took the contribution of Gerlach & Smets (1994) one step further by using micro foundations to extend the concept of the competition linkage to a third market. They showed that the original devaluation of the currency by a particular country impacts other countries exporting to the same foreign markets as they are no longer as competitive, thus reducing their export sales. From this grounding, they illustrated that what generally ensues from the devaluation of countries’ currency devaluation is the devaluation of its trading partners and large competitor’s currencies in the hope of retaining some competitiveness in the global market. The fact that Taiwan and Singapore devalued their currencies during the East Asian crisis of 1997, even though their country’s fundamentals did not appear weak or vulnerable to speculative attack, gives added credibility to the theory of competition linkages and its impact (Claessens, Dornbusch & Park 2000:5).

Boschoff (2006:9) takes the argument further, illustrating that if a crisis country’s exports in a particular production category are large enough, this could put pressure on prices.
internationally. Thus, countries need not even compete with the crisis country for their export competitiveness to deteriorate. Either of the bilateral or third party trade effects could have a direct impact on international countries output, moreover, if the loss in competitiveness is severe enough, it could lead to an attack on a country’s currency as expectations of a pending exchange rate devaluation grow, which would thus give way to the occurrence of contagion within currencies (Forbes & Rigobon 2001:49; Boschoff 2006:9).

An additional paper that deserves mention is that of Paasche (2000). Although the paper does not deal with trade directly, it does illustrate how a small shock to a country’s terms of trade (which may be caused by any number of reasons, including the devaluation of a currency in another country) can be magnified by credit constraints and thereby have large domestic consequences. Also, one could see Harrigan (2000); and Pesenti & Tille (2000) in this respect. Harrigan (2000) shows the impact of devaluations of prices and quantities in the USA and Asia in the format of a non-technical discussion on the East Asian crises of 1997. Pesenti & Tille (2000) discuss the direct impact of bilateral trade flows between countries, as well as the indirect impact of competition in third markets. Competition in third markets and the effects of devaluation in one country are illustrated with several numerical examples (Forbes 2002:84).

A more intuitive transmission mechanism of trade is that of domestic demand linkages or as Forbes (2000; 2002) describes it, the “income effect”, where a crisis in a country causes a reduction in income and corresponding reduction in demand for imports. This in turn negatively influences the exports of that particular country’s trading partners inducing changes in the balance of trade and other fundamental economic factors which may in turn propagate the original crisis to the countries trading partners (Claessens & Forbes 2004:5). Furthermore, Claessens et al (2000:5) indicate that these negative effects transmitted from the original crisis may be anticipated by investors, making the country vulnerable to speculative attacks.

Most of the empirical work done assumes the demand effect is negative, since recent crises have induced an abrupt reduction in economic growth and aggregate demand within the crisis country. However, this crisis which is being spoken of must not be confused with the occurrence of a currency crisis (Forbes 2002:85). As Boschoff (2006:64) argues, if there is concurrent currency devaluation this may, under the right conditions, improve exports and general growth performance in the months and years following the crisis; ultimately
improving the domestic demand effect. Forbes (2002) shows that the empirical results of work done on currency crisis and the demand effect is, for the most part, mixed as far as the effect it has; thus helping to substantiate the argument made by Boshoff (2006).

Financial Linkages

Typically both trade and financial linkages are involved in the process of economic integration of an individual country into the world market. Heavy economic integration – covering trade, investment and other financing links – although beneficial when the global economy is on the rise, can also induce the polar opposite effects when a financial crisis takes place in one of the integrated countries. This has been known to induce reductions in trade credit, foreign direct investment (FDI) and other capital flows (Claessens, Dornbusch & Park 2000:5).

An important note which is implied but not often expounded upon by much of the research in this field, is that the financial linkages that propagate contagion from one country to another take one of two forms. Firstly, it can be directly related and bilateral in nature, such that a shock to one country impacts another countries FDI and other capital flows and as such, the overall economy; due to the fact that the crisis country simply has less capital to invest outside its own country. Secondly, it is indirect in nature whereby, two countries have a common investor and for one reason or another, the common investor pulls out of both in a simultaneously manner (Moser 2003:161).

The grouping of financial linkages has in literature received a rather broad definition, with some of the theories which have received individual recognition in this paper being defined within this category. Such theories would include: endogenous and exogenous liquidity shocks; and country re-evaluation. These theories may very well be defined under this “financial linkages” banner but, in the hopes of indicating their individual significance within the literature, they have been provided with their individual categories (Forbes 2000:18-20; Boshoff 2006:68).

Conversely, it has been decided that balance sheet contagion shall be discussed under this heading due to the lack of individual recognition it receives in the field of financial contagion. Although it was originally developed to explain contagion within different sectors of an economy, with the advent of globalisation and the increasing number of worldwide
conglomerates, it may very well be discussed within the contexts of this paper. Kiyotaki & Moore (2002:46) divide balance sheet contagion into two separate categories: direct and indirect balance sheet contagion (Kiyotaki & Moore 2002:46).

First we consider the concept of indirect balance sheet contagion. Fixed assets such as real estate are used throughout the world to secure financing for business investment. The borrowing capacity of many corporations is thus dependent upon its collateral value. There is as such a leverage effect whereby the firm’s net worth is vulnerable to changes in asset prices. Now if firms use similar assets as collateral, sector specific shocks impacting the assets used widely for collateral (for example, real estate) could produce a country-specific shock influencing large conglomerates with large portions of their business in that specific country. And due to the world wide influence of a number of corporations, contagion may ensue (Kiyotaki & Moore 2002:46).

Now, the theory of direct balance sheet contagion relies on the premise that many of these large global firms borrow from and lend to each other. A shock in one country in which a single one of these firms is over-exposed may induce credit constraints causing a chain reaction in which all the other firms also get into financial difficulty. Furthermore, if there is a disruption of production in one link of the chain due to a default or postponement of debt repayment, then an accumulation of nonperforming loans can cause a widespread loss in output (Kiyotaki & Moore 2002:48).

Pesenti & Tille (2000:6) take a somewhat different approach to explaining the role of financial linkages in the transmission of financial crises. They propose that the global banking sector is becoming increasingly integrated. With this integration comes the increased risk of contagion, a factor which the entire banking sector is aware of. As such, if a major country is hit by a crisis, may it be simply of a currency nature or financial, this has an adverse effect on all banks’ balance sheets. Combined with the knowledge that contagion is a major possibility due to the banking sector integration, a higher risk premium is charged along with a higher equilibrium interest rate as a result of the lower supply of funds. The simultaneous occurrence of these two events can result in a sudden and drastic increase in global interest rates. Consequently, a country’s borrowing cost would rise significantly, reducing credit opportunities and inhibiting the growth of output (Pestini & Tille 2000:6).

Kollmann (2012) takes the concept of bank integration one step further, suggesting that there are a number of banks worldwide which are truly global, in the sense that they operate in
more than one country. He develops a two-country model with a single global bank whose role is to collect money from households and lend it to entrepreneurs in both countries. An unanticipated loan default in one country results in a wealth transfer from banks to entrepreneurs; hence bank capital falls, reducing their ability to transfer capital from savers to borrowers. This induces the deposit rate to fall, whilst the loaning rate rises in both countries leading to lower lending, investment and output in both countries (Kollmann 2012; Kollmann & Malherbe 2011:6).

The point of recognition in all this is that through the defaults in one country, both countries experience an equivalent reduction in economic activity. Testing this model with US and European Area (EA) data shows that shocks that originate in the banking sector account for roughly 20% of the forecast error in investment whilst making up about 5% of the forecast variance in US and EA GDP (Kollmann 2012; Kollmann & Malherbe 2011:6).

The concept of the market liquidity channel is also one which is often discussed under financial linkages and takes the second form of financial linkages discussed, whereby there is a common investor in a number of markets. The theory begins by explaining an intuitive function in financial markets, namely that the greater the liquidity in the markets the lower the market liquidity premium which is required to be paid to enter/exit the market (Didier, Love & Peria 2010: 11).

It is important to recognise, however, that all markets do not come with the same level of liquidity, and as such, liquidity premium. Thus, when an investment manager is required to invest/withdraw investments for whatever purpose (anything from margin call obligations to investor withdrawals), ceterus paribus, that investment manager will invest/withdraw funds from the most liquid markets as the liquidity premium paid to enter/exit such a position is lower than that required in an illiquid market (Didier et al. 2010:11).

If one also takes into account the trend of investment managers to not only invest funds locally but globally, it is theorised that a shock to an economy, for whatever reason, will result in the withdrawal of investments (once more, due to a number of hypothetical reasons: from margin call obligations to investor withdrawals) globally. This in turn will lead to a withdrawal of funds from countries with the most liquid financial markets as the withdrawal of such investment should ceterus paribus result in the lowest costs, and as such, losses. This spread of withdrawn funds could, if severe enough; result in a contagion type event (Didier et al. 2010:11).
Importantly, this market liquidity channel does not change with the onset of a crisis but is present during stable periods and crisis periods. It is thus, positioned under the non-crisis contingent section. However, this channel does require a crisis before the significance of it can be seen (Didier et al. 2010:11).

**Policy Co-ordination**

A third transmission mechanism, that of policy co-ordination, postulates that countries are linked via predetermined agreements that induces the transmission of a negative shock or crisis. For example, there may be a trade agreement stating that if one country devalues its currency beyond a given level, that its trading partners are required to increase trade barriers (Forbes & Rigobon 2001:49).

Loisel & Martin (2001:402) make two meaningful contributions to this literature. Firstly, they indicate the significance of expectations within this theory. Even if a country retains its sovereignty through the policy co-ordination agreements and as such retaining the ability to break any such agreements if the conditions to do so where favourable; if the market has the expectation that the agreement will not be broken, then this expectation itself becomes a self-fulfilling prophecy as the market begins to act upon it (Loisel & Martin 2001:402).

Secondly, but on a separate line of thought, they argue that co-ordination with a country in a crisis reduces the credibility of the co-ordination agreement between the countries. Speculation that the agreement might be severed is enough to transfer the crisis between co-ordinating countries as, individually, they are not as viable an investment opportunity as collectively (Loisel & Martin 2001:402).

**Random Aggregate Shocks**

The fifth and final transmission mechanism of the non-crisis contingent theories is that which contends that random aggregate shocks are able to simultaneously affect the fundamentals of several countries. A simultaneous slowdown in growth in a number of countries could arise from, for example, a rise in the international rate of interest, a contraction in the international supply of capital or a decline in international demand (such as for commodities). Cross-
market correlations between countries affected by this aggregate shock would increase as would be evident by the asset price movement (Forbes & Rigobon 2001:49).

A real world example of this includes movements in capital flows to Latin America, having been identified with changes in the US interest rates. Furthermore, weakening exports of the East Asian countries during 1995-1996 and their financial difficulties thereafter have been attributed to the strengthening of the US dollar against the yen (Claessens, Dornbusch & Park 2000:5).

3.4 EMPIRICAL LITERATURE REVIEW

As was alluded to in the introduction, much of the empirical work done on financial contagion is either concerned with testing whether contagion is present or, the channels through which contagion is propagated. Consequently, the following sections shall be categorized as follows: tests for contagion and tests of transmission mechanisms.

3.4.1 Tests for Contagion

Correlation Tests

Cross market correlation tests are generally the most straightforward of tests used. Where during a stable period the cross market correlations between two countries is measured and then tested for a significant increase after the shock. Contagion is thought to occur according to this definition if there is an increase in transmission mechanisms (which is assumed to be measured by a correlation analysis test) after the shock between the two countries which would be evident by a significant increase in the correlation coefficient (Forbes & Rigobon 2001:51).

The first major contribution to this line of literature was made by King & Wadhwani (1990), where they tested the increase in cross-market correlation of periods of volatility between the US, UK and Japanese markets after the 1987 US stock market crash. They initiated what would become a standard in correlation tests when they decided upon the relevant “tranquil” and “crisis” periods over which the correlation tests would be conducted. The results from the differing correlation tests would then be compared, from which it could be concluded
whether contagion was in existence. If correlation increases from the “tranquil” period (which is thought to represent interdependence between the countries in all periods of time) to the crisis period, contagion is thought to be present and vice versa.

Empirically, using ordinary least squares (OLS), they found that with increased volatility came increased correlation between markets leading to the conclusion that contagion was present over the crisis period.

Lee & Kim (1993) took this approach one step further by examining twelve major markets and their cross-market correlations of periods of volatility after the same 1987 crash. Using the same “crisis” period as King & Wadhwani (1990) of July 1987 to February 1988 and similarly rational expectations assumptions within an OLS model, they found correlations increased from 0.23 before the crash to 0.39 after the crash.

Following the examination of the US crisis of 1987, the next major incidence which gained much attention was the Mexican “tequila” crisis of 1994 which was seen to spread throughout Latin America. Calvo & Reinhart (1996) investigated this, once more using correlation tests, over the time period 1970 to 1993; a time period which is much longer than other comparable studies, such as Calvo, Leiderman & Reinhart (1993); Chauhan, Claessens & Mamingi (1993); and Arias (1994).

Specifically, Calvo & Reinhart (1996) test the correlation between equity markets, Brady bonds and the balances in the capital accounts of eleven different South American countries in order to make an inference about the role of capital inflows. For equity markets, Brady bonds and capital account balances, it was concluded that there was a significant increase in correlation following the Mexican crisis.

Interestingly, the cause of this contagion was thought to be the increases in US interest rates. When US interest rates fell prior to 1994, the region of Latin America, and most notably Mexico, received substantial capital inflows. However, these where largely speculative and as US interest rates were raised investors promptly began to withdraw their capital, subsequently leading to a market panic throughout the region. Following this, it was suggested that countries, predominantly developing countries, put in place regulation protecting themselves from these short-term speculative balances which may be withdrawn at any given moment for any given reason.
Agenor, Aizenman & Hoffmaister (1999) also studied the contagion effects of the 1994 Mexican crisis but, more particularly, the impact it had on the interest rate spreads and fluctuations in output of Argentina. Using monthly data from January 1993 to June 1998, they implemented a vector autoregressive (VAR) model with the variables of: external interest rate spread, the domestic interest rate spread on peso-denominated assets and liabilities, the real lending rate and two different measures of output.

From the application of the model, Agenor, Aizenman & Hoffmaister (1999) concluded that the Mexican crisis of 1994 lead to an increase in the domestic interest rate spreads and a reduction in the cyclical component of output. Thus, the conclusion that contagion was present after the Mexican crisis was drawn, similarly to that of Calvo and Reinhart (1996).

In one of the more thorough analyses, Baig & Goldfajn (1999) tested for contagion in the currency market, stock market, interest rate market and the sovereign spread of five different countries during the Asian crisis of 1997. Empirically, they undertook three sets of analysis to investigate these issues: First, they used correlations and a VAR model to estimate the extent of co-movements in the market during the crisis. Secondly, they tested whether the correlations in these markets increase significantly during the crisis. Thirdly, they estimated the impact of own country and cross boarder news on selected financial markets of the region.

Interestingly, unlike the majority of papers using correlation tests that choose only specific “tranquil” and “crisis” periods to do the testing, Baig & Goldfajn (1999) used a three month rolling window within the chosen “tranquil” and “crisis” periods, using daily data from 1995 to 1998. This was done in an effort to overcome a criticism of correlation tests which had developed, insinuating the choosing of the periods lacked an empirical methodology and was completely subjective. And due to the high sensitivity of the tests to the periods chosen, the tests lacked robustness. The rolling window was thought to overcome this weakness and produce far more robust results. Ultimately, they concluded in favour of substantial contagion in the foreign debt markets whilst results for currency and equity markets were somewhat less conclusive.

It is interesting to note at this stage, as the historical perspective of correlation tests is discussed, that there has been a clear evolution of the model used within these correlation tests. Beginning with the US 1987 crisis where empirically, research was done largely using
OLS up until the more recent, 1997 Asian crisis where the vast majority of research made use of the multivariate VAR model.

Soon after the contribution by Baig & Goldfajn (1999), Forbes & Rigobon (2001) presented what was probably the most influential paper in this field of correlation tests for financial contagion. They illustrated that these tests may be biased estimates of transmission shocks due to the problems of heteroskedasticity, endogeneity and omitted variables; with a rather intuitive “coin example” being given to show the influence of heteroskedasticity\(^{29}\). A simple model, used by Forbes & Rigobon (2001), can be used to illustrate how these three problems can bias tests for cross-market transmission mechanisms. Assume there are two countries whose stock market returns are \(x_t\) and \(y_t\) which are described by the following model:

\[
\begin{align*}
y_t &= \beta x_t + \gamma z_t + e_t \\
x_t &= \alpha y_t + z_t + n_t
\end{align*}
\]

\[
E[n'_t e_t] = 0, \ E[z'_t e_t] = 0, \ E[z'_t n_t] = 0, \ E[e'_t e_t] = 0, \ E[z'_t z_t] = 0, \ E[n'_t n_t] = 0
\]

Where \(e_t\) and \(n_t\) are country specific shocks that are assumed to be independent but are not necessarily identically distributed. Also, the assumption that the return has a mean of zero is made. Shifts in global demand, changes in the international interest rate or any other unobservable aggregate shocks are captured by \(z_t\) and affected both countries, whilst \(z_t\) is assumed to be independent of \(x_t\) and \(y_t\). Stock markets are expected to be endogenous variables as shocks are thought to be transmitted across countries via real linkages (Forbes & Rigobon 2001:57).

Forbes and Rigobon (2001:57) explain that, “If the variance of \(x_t\) goes to zero in the first line of the equation, then all of the innovations in \(y_t\) are explained by its idiosyncratic shock \((e_t)\), and the correlation between \(x_t\) and \(y_t\) is zero. Alternatively, if \(x_t\) experiences a shock and its variance increase, then a greater proportion of the fluctuation in \(y_t\) is explained by \(x_t\). In the limit, when the variance of \(x_t\) is so large that the innovations in \(e_t\) are negligible, then all of the fluctuations in \(y_t\) are explained by \(x_t\), and the cross-market correlation will approach one.”

\(^{29}\) See Forbes & Rigobon (2002:18-21) for this “coin example”
Essentially, the unadjusted correlation coefficient will be biased upwards for any distribution of the error terms when the market volatility increases after a crisis. This unadjusted correlation coefficient is an increasing function of the market variance. As Forbes and Rigobon (2001:57) say, “Basically, changes in the relative variance of the two shocks modify the noise/signal ratio and biases correlation estimates.” Critically, $\beta$ which is the propagation between $x_t$ and $y_t$, remains constant. Thus, there is no contagion present as there is no significant change in how shocks are transmitted across markets. Furthermore, due to the bias created by unadjusted correlation coefficient being an increasing function of the market variance, tests could incorrectly conclude that the propagation mechanisms increased and contagion occurred (Forbes & Rigobon 2001:57).

Endogeneity is another bias which may be attributed to the tests for contagion. If one views equation 1, it is evident that the variables in the equations for $x_t$ and $y_t$ are endogenous, and it is impossible to identify these equations and estimate the coefficients directly. Differentiating between shifts in the coefficients or shifts in the variance becomes impossible to distinguish between, when using correlation coefficients or Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models. (Forbes & Rigobon 2001:57)

Furthermore, the concept of omitted variables is another topic of importance when testing for contagion. The correlation between two markets increases in absolute value and the relative importance of the common component grows the larger the variance of the aggregate shock. Returning to the equation one as an illustration, when the variance of $z_t$ increases, the cross market correlations are biased in the same way as when the variance of $x_t$ increases (Forbes & Rigobon 2001:57).

Forbes & Rigobon (2002) suggest a method of simple equation manipulation in which to overcome the problem of heteroskedasticity, whilst making the assumption that there is no endogeniety or omitted variables. The argument for making these assumptions is that without them, there is no way of estimating the bias and thus no way of making any adjustment to the calculation to adjust for the unconditional correlation coefficient. They do, however, show that the adjustment made is a significant approximation of the unconditional correlation coefficient if it is possible to identify the country where the shock originated and if the change in variance is large.

Forbes & Rigobon (2002) empirically used the VAR model to test the cross-market correlations during the 1997 East Asian crisis, the 1994 Mexican peso devaluation and the
1987 US market decline; using a sample of 28 different countries. Rolling average two-day returns based on each country’s aggregate stock market returns are used to control the fact that markets are open during the same hours. Returns are also calculated using US dollars as the base currency. In the hope of controlling for aggregate shocks or monetary policy co-ordination, interest rates are included in the model.

The findings of Forbes and Rigobon (2002) show that by adjusting for heteroskedasticity via the calculation of an unconditional correlation coefficient, much of what was interpreted as contagion is actually interdependence. They found no evidence of contagion across countries during any of the investigated crises but rather demonstrated that there are strong market co-movements during all stages of the global business cycle.

Corsetti, Pericoli & Sbracia (2003), however, criticise this approach by Forbes & Rigobon (2002); arguing it is overly restrictive and as opposed to previously mentioned papers that may be biased towards a conclusion of contagion due the unconsidered unconditional correlation coefficient, Forbes & Rigobon’s (2002) are over biased towards the conclusion of interdependence. Corsetti et al. (2003:5) go on to say about the methodology put by Forbes & Rigobon (2002) that, “Somewhat surprisingly, it turns out that applying these tests to different samples invariably yields the same answer: regardless of the timing of the crisis episodes and the regional and structural features of the countries in the sample, almost no episodes of international spread of financial turmoil should be viewed as ‘contagion’.”

Consequently, Corsetti et al. (2003) offer a model that does not impose any restrictions on the variance of common factors relative to the variance of country specific shocks. The less restrictive model is then applied to the Hong Kong stock market crisis of 1997 and finds that there is evidence of contagion in at least five different countries. Rigobon (2002) subsequently admits that the correlation adjustments proposed by Forbes & Rigobon (2002) should “not be used” since; the adjustments will be excessive in the presence of common shocks.

However, Rigobon (2002) does attempt to overcome the problems associated with correlation analysis: Heteroskedasticity, simultaneous equations and omitted variables. He does this by making the assumption that if heteroskedasticity, in a sub-sample can be explained by a shift in the variance of only a sub-set of the shocks, then it is possible to test for the stability of the shocks. The advantage of this method is that if the assumption is violated, then the null
hypothesis is rejected and thus, the lack of rejection provides information regarding the
presence of heteroskedasticity.

The sample of daily data of 36 stock markets from 1993 to 1998 is used. Rigobon (2002)
makes use of the Determinant of the Change in the Covariance test (DCC test) which is able
to tell him whether heteroskedasticity is present in the idiosyncratic shocks or in the common
shocks. His testing procedure begins with the estimation of the VAR model, the residuals are
then split up according to their volatility (those occurring during ‘tranquil periods’ and ‘crisis
periods’) and then for the different periods, the covariance matrix of the reduced form
residuals is estimated and the DCC test computed. The conclusions of Rigobon (2002) were,
however, very similar to Forbes & Rigobon (2002), with little evidence of contagion being
found.

Abrahamson & Collins (2004) then apply both the Forbes & Rigobon (2002) and the Corsetti
et al. (2003) methodologies to a sector-by-sector analysis to six Africa country’s in a test for
contagion. The sector-by-sector methodology is quite intuitive, as countries have vastly
different industry mixes. Abrahamson & Collins (2004:9) use an illustration to explain the
insightful methodology. Make the assumptions that countries consist of only two sectors,
finance and resources (which exhibit counter-cyclical behaviour). Assume now that country
A is heavily weighted by resource and country B by financial stocks. If financial stocks go up
by the 10% in both countries and simultaneously resources go down by 5% in both countries,
an overall index would show that country A has experienced growth whilst country B has
experienced a recession. Had a test for interdependence been conducted on the overall index,
a correlation would surely not have been found, and thus no interdependence. However, using
a sector-by-sector methodology, one can see that the countries are in fact interdependent.
Thus, by doing a sector-by-sector analysis, one removes different industry mix bias which
may otherwise be present.

Abrahamson & Collins (2004) use the FTSE Global Classification System which specifies
ten “Economic Groups”, that are referred to as the different sectors and all indices are
converted from the local currency to the UK pound sterling using a time-series of exchange
rates. They investigated the Hong Kong crisis of 1997 and the Russian crisis of 1997. The
findings of the paper are quite extensive if one considers that six countries each with ten
sectors were examined for two different crises with two different methodologies, however, in
both crises, each country seems to experience contagion in at least one of its sectors but, there is no country that seems to be especially vulnerable to contagion.

Billio & Pelizzon (2002) apply the three different methodologies put forward by Corsetti et al. (2003), Forbes & Rigobon (2002) and Rigobon (2002); respectively to the HIS index, Dow Jones and Nikkei during the East Asian 1997 crisis.

Billio & Pelizzon (2002) demonstrate that both the Corsetti et al. (2003) and the Forbes & Rigobon (2002) methodologies are flawed due to their assumption that there are no omitted variables, which was demonstrated through an analysis of volatility. Also, the models are thought to be highly susceptible to the windows of “tranquil” and “crisis” periods. The lack of robustness was shown through a rolling window analysis.

Empirically, Billio & Pelizzon (2002) also show that Rigobon’s (2002) DCC test has little power in a multivariate setting and that it is unable to cope with some types of heteroskedasticity. The DCC tests concluding that contagion is present, may thus be biased to the presence of this type of heteroskedasticity.

Although Billio & Pelizzon (2002) uncover many faults in the methodology used in the testing of contagion, no answers to these problems are given by them, but rather a challenge is put forward for future research to uncover an appropriate measure of contagion between financial markets. It is from this point of time that many other frameworks in the testing of contagion began to receive increased interest, research and recognition.

**ARCH or GARCH Framework**

A second approach used for the testing of contagion is the ARCH or GARCH framework to test for the variance-covariance transmission mechanisms across countries. One of the first papers using this framework was Hamao, Masulis & Ng (1990) investigation into the 1987 US stock market crash and the contagion present between the Tokyo, New York and London stock market indexes. The specific dates examined are between April 1, 1985 and March 31, 1988 and the relative aggregated indexes are used. Importantly, use of daily opening and

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30 For which he used the discussion paper which was published in 2002, rather than the journal article published in 2003 which is sighted in this paper, both of which however carry the same methodology and results.
closing prices is used, enabling them to analyse separately the spill-over of price volatility in foreign markets on the opening price in the domestic market.

Specifically, a GARCH-M model is used. A dummy variable for a day following a weekend or holiday is included in the conditional mean and variance equations to account for higher variances on these days, as noted by, Fama (1965) and Godfrey, Granger & Morgenstern. (1964). The primary specification test used is the Ljung-Box statistic, which is used to test for a lack of serial correlation in the model residuals and in the residuals squared. Hamao, Masulis & Ng (1990) conclude that there are significant spill-over effects from the US and UK stock markets to Japan, however, this is asymmetric as the spill-over’s between the US and UK; and from Japan to the other countries was found to have much less significant statistical relationships.

Edwards (1998) was amongst the next group of researches to undertake the task of testing for volatility contagion. Empirically, he investigated the presences of contagion between nominal interest rates in three Latin American countries, namely: Argentina, Chile and Mexico. These countries in particular, between January 1992 and June 1998, allow one to examine interest rate dynamics under alternative exchange rate regimes and rules regarding capital mobility. Using weekly and monthly data frequencies and six different augmented GARCH models with different specifications, Edwards (1998) showed that there was indeed contagion from Mexico to Chile but not from Mexico to Argentina. Ultimately it was found that interest rate differentials became more sluggish and tended to disappear more slowly after capital controls were introduced than during periods of free capital mobility.

Following Edwards (1998) and Hamao et al. (1990); little new ground was broken on an empirical testing basis of contagion within the ARCH/GARCH framework until Billio & Caporin (2006). After Forbes & Rigobon (2002) brought to light the problems of heteroskedasticity, endogeniety and omitted variables, as illustrated earlier, it was argued by Billio & Pelizzon (2002) that they failed to deal with these problems sufficiently, and simply avoided dealing with the problem of omitted variables by making the assumption of that there were no omitted variables. Billio & Caporin (2006), however, begin to discuss the problem of omitted variables in more detail and suggested a methodology to overcome the inaccuracy which it creates.

They argue that it is important to identify common shocks which affect all countries in the sample as these common shocks do not represent pure contagion but rather reflect economic
and financial linkages that exist between the countries during all periods; crisis and non-crisis. A failure to account for and model these common shocks may result in tests of contagion that are biased towards a finding of contagion. Broadly, there are two primary methods used to identify common shocks. The first relies on the selection of observable variables which can be used as a proxy for a common shock. This can be seen in Bae, Karolyi & Stultz (2003) or Eichengreen, Rose & Wyplosz (1995, 1996).

The second approach involves treating the common shocks as latent and modelling their dynamics. Baig & Goldfajn (1999), which was discussed earlier, used estimated residuals from a VAR model in their contagion test to filter out common shocks. Favero & Giavazzi (2002) and Pesaran & Pick (2004) added additional variables in a structured model which they obtained from a VAR, which were used to account for the common shocks (Billio & Caporin 2006:3).

Billio & Caporin (2006) nevertheless, argue that both these methods are susceptible and highly affected by the choice of the window and its length, and the time zones in the sample which will often require the use of a two-day moving average, which introduces noise into the data. What they propose is to work directly with daily data and to model directly the market relations. Using a simultaneous equation model, they model the overlapping and contemporaneous market relations from the market returns, include lagged values of up to five days (a week). Furthermore, motivated by Ling & McAleer (2003) they model variance spillovers by a multivariate GARCH model. In the model, only the ARCH part has a multivariate structure whilst the GARCH has a structure of only the considered series. Finally, using the Fischer z-transformation, which allows one to construct a test for the changes in correlations which takes advantage of a series asymptotic distribution, they analyse the correlations on a non-parametric basis.

The dataset used by Billio & Caporin (2006) includes six countries: Japan, USA, Singapore, Mexico, Brazil and Hong Kong; with the sample running from the 20th June 1995 to the 16th November 2005. In the empirical analysis they compared two alternative cases: the indices compared in local currencies and the indices expressed in a common currency, for which they used the US dollar. Over the time period examined, two periods of contagion were identified: firstly, during the East Asian crisis of 1997, all countries experienced contagion with the exception of the USA and secondly, all countries in the sample were shown to have been
affected via contagion after the crash of the technology market bubble in the USA in 2000/2001.

Although this methodology would arguably deal with the problems of omitted variables within the GARCH framework, Forbes & Rigobon (2002) argue that the heteroskedasticity that plagues a standard correlation test for contagion also skews all GARCH tests. This is due to the fact that variance-covariance matrices, which are central to a GARCH model, are directly comparable to the correlation coefficients. As such, results will always be skewed towards an outcome of contagion being present.

Billio & Caporin (2005), working with Markov switching models and using regime probabilities to monitor the volatility transmission process, they essentially transform the standard DCC-GARCH model to include Markov switching regimes to develop a MS-DCC model. This methodology is argued to overcome the problems with heteroskedasticity, allowing one to consider dynamic correlation permits to analyse the dynamics of contagion and, finally, an endogenous definition of the crisis period is allowed due to the consideration of a latent Markov chain.

Empirically, they applied this model to a study of seven different countries using stock returns of a daily frequency over the period of January 2000 to December 2003. What they noticed was that, not only was there a lack of contagion from the US to the other countries in the sample but, further a loss of interdependence which they explain, occurs when the links between countries decreases during a crisis. Specifically, they suggested that whenever turbulence starts in a market, the other markets immediately follow suite and suffer the same turbulence, however, as soon as the other markets identify the noisy signal, correlation is reduced as that signal is filtered out. Examples of which are given as: September 11, 2001 and other important periods and dates in the Afghanistan and Iraqi wars.

Although Billio & Caporin (2005) overcame the problems of heteroskedasticity and endogeniety; and Billio & Caporin (2006) overcame the problem of omitted variables, there is still a lack of an overreaching model which enables one to overcome all three problems within one model contained in the ARCH or GARCH framework.
Co-integration Framework

Testing for contagion using the co-integration methodology alters the focus from the change in the short-run relationships between countries after a shock, to the change in the long-run relationship after a shock. Essentially the same basic procedure is used as in the ARCH/GARCH framework however tests for changes in the co-integrating vector are used instead of testing for changes in the variance-covariance relationship (Forbes & Rigobon 2001:51).

An example of a more recent paper using this methodology can be seen in Drakos & Kutan (2005) where they investigated contagion between Greece and Turkey in the stock markets. They made use of broad-based stock market index’s and the currency market with the use of a Vector Error Correction (VEC) model. Month end closing prices for both the Greek and Turkish general indices and exchange rate measure were used, which were expressed in US dollar increments, for the sample period stretching from 1988:10 to 2000:12 and 1986:03 to 2000:12 respectively.

Using the Johansen co-integration approach, they tested for long-run linkages between the two countries and with the use of the VEC model which allows testing for temporal casual chains, the short-run linkages were tested. A vector of dummy variables is included in the Johansen test to account for periods of excessive turbulence or systematic shocks that might distort the estimation and inference. The Johansen test indicates that both the stock market and the exchange rates exhibit co-integration and thus, long-run relationships. The Granger Causality tests show that the Greek financial markets Granger Cause the Turkish financial markets. The only short-run causal linkage was found between the Greek stock market and the Turkish stock market. They then go on to conclude that these short-run and long-run linkages are as a result of trade and financial linkages, however, no actual empirical study was conducted on the linkages themselves, rather the conclusion was drawn from circumstantial evidence as both countries trade and financial partners are relatively similar.

Another example is Gray (2009) who examined whether the US banking crisis of 2007 spilled over to the EU-8 countries (European Union, Czech Republic, Estonia, Hungry, Latvia, Lithuania, Poland and Slovakia) currencies, such that it could be classified as financial contagion. Using daily data and the period of 1 August 2007 as the starting point of the crisis, he tested the links that exist between the countries by viewing the co-integrating vectors and the extent of the Granger causality that exists between the countries before and
after the crisis period. Gray (2009) concluded that links between the seven countries strengthened after the crisis whilst the seven countries links with the Euro remained stable.

As illustrated, the co-integrating framework continues to be used on a small scale by research in the field of contagion but, is generally not considered an accurate measure of contagion since it makes the assumption that over the entire time period, real linkages remain constant. An increase in the co-integrating relationship over time may not be evidence of contagion but rather an indication that cross market linkages have experienced a permanent increase. Furthermore, brief periods of contagion may be missed when one focuses on such long time periods (Forbes & Rigobon 2001:51).

Other Tests

Chan-Lau, Mathieson & Yao (2004) seemingly took up the challenge of Billio & Pelizzon (2002). They began by arguing that even if data is generated from a bivariate normal distribution with a constant correlation coefficient, the conditional correlation of the bottom 50 percent of the smallest returns is different from the conditional variance of the top 50 percent of the largest returns. Furthermore, it was contended that non-linear relationships are unable to be uncovered by correlation analysis (Chan-Lau, Mathieson & Yao 2004). Bae, Karolyi & Stultz (2003:718-719) perhaps argue this point somewhat more eloquently when they say, “None of the concerns expressed about contagion seem to be based on linear measures of association for macroeconomic or financial market events. In fact, these concerns are generally founded on the presumption that there is something different about extremely bad events that leads to irrational outcomes, excess volatility and even panics. In the context of stock returns, this means that if panic grips investors as stock returns fall and leads them to ignore economic fundamentals, one would expect large negative returns to be contagious in a way that small negative returns are not.” Thus, for an appropriate evaluation of large shocks or crisis periods, correlations or GARCH or any other such linear frameworks that give equal weight to small and large returns are not sufficient. Propagation of large shocks across countries may be hidden in a correlation measure due to the large number of days in which nothing of importance is happening.

To address these concerns, Chan-Lau, Mathieson & Yao (2004) suggested that an alternative approach to analyse contagion in financial markets is the Extreme Value Theory (EVT). EVT
has the ability to encapsulate the belief that small shocks are transmitted differently than large shocks. The joint behaviour of extremal realisations (or co-exceedances) of financial prices or returns across financial markets can be quantified using the multivariate EVT techniques (Extremal realisations or co-exceedances are defined as those exceeding a large threshold value)\(^{31}\).

The study was conducted on 17 different developed and emerging economies where weekly stock market returns were calculated in US dollars for the time period of December 31, 1987 to October 25, 2001. Thus, the sample included the Mexican crisis of 1994, the East Asian crisis of 1997, the Russian crisis in late 1998, the Brazilian crisis of early 1999 and the early stages of the Argentinean debt crisis of 2001. Chan-Lau, Mathieson & Yao (2004) were particularly interested in the effects of contagion during bull and bear markets; and concluded that contagion is higher for negative returns than for positive returns. Also, they showed that contagion patterns differ significantly across regions, with Latin America showing an increase in contagion not matched by other regions. Additional, it was found that only the 1998 Russian and Brazilian crises led to a global increase in contagion.

Hartmann, Straetmans & De Vries. (2004) follow a similar EVT approach, making similar arguments for its use. Studying the G-5 countries (Japan, German, United States, United Kingdom and France) they added to the existing literature by not only studying the effects of contagion between equity markets, but also measuring the “flight-to-quality” phenomenon or the movement intra-country from the stock markets to bond markets.

The data was of a weekly frequency for both stock and bond markets over the period of 1987-1999, where stock market crashes were defined as 20% weekly loss and a bond market crash defined as an 8% weekly loss. The strongest extreme linkages were found between national stock market returns, with the “flight-to-quality” occurring as approximately as frequently as simultaneous stock market crashes. This highlights the limits of the propagation of a crisis across asset classes. They went further to show that although single market crashes are a relatively rare event; the conditional probability of a crash in one market, given a crash in another market, was comparable high. However, the probability of a “co-crash” in the bond markets was significantly lower, with it occurring in approximately one out of eight crashes.

\(^{31}\) For more information on this technique, see Chan-Lau et al. (2004).
Bae, Karolyi & Stultz (2003) abandoned the use of the EVT model and correlation framework in general, and instead focused on the large positive and negative return days. To avoid results being dominated by a few observations, they did not compute correlations of large return days, but instead measured the joint occurrence of large return days. Monte Carlo simulations of joint returns are used to determine whether there are more frequent occurrences of large absolute value returns than expected. From this point, a model was created of the joint occurrences of large absolute value returns using multinomial logistical (also referred to as “logit” – the two terms shall be used interchangeable throughout this dissertation) regression. Relative to EVT modelling, an important advantage of multinomial logistic analysis is that it allows one to condition on attributes and characteristics of the exceedance events using control variables measured with information available up to the previous day.

The definition of contagion is the fraction of exceedance events, which were arbitrarily defined as those being either below (above) the 5th (95th) percentile of the marginal return distribution, that is not explained by the covariates (which were: exchanges rates, interest rates and market volatility) but is explained by exceedance in another region. This approach thus, provides one with the ability to account for internal country shocks that originate within that country and as such, by definition, cannot be propagated onto that country.

The number of exceedances is calculated for 17 countries, for the sample period from 1 April 1992 to 29 December 2000, using daily returns data from the Standard & Poor’s (S&P) Emerging Market Data Base. To understand whether the existence of co-exceedances can be explained by conditioning on large absolute value returns, a Monte Carlo simulation experiment is needed to determine what the co-exceedances would be if correlations were constant during the sample period. Within the Monte Carlo simulation, distribution will depend on the assumptions made about the returns generating process. To this end, Bae et al. (2003) test three different assumptions: returns are jointly distributed as multivariate normal; returns are distributed according to the multivariate student t-distribution; and to overcome the problem of heteroskedasticity discussed earlier, where changes in cross-market correlations across quiet and turbulent periods can be biased on heteroskedasticity, the MGARCH was used.

At this point the multinomial logistical regression model is used to find estimates of the probabilities of co-exceedances within regions and across countries. The results from the
model show that Latin America is more likely to experience contagion than other regions, including Asia. And, contagion is more likely to spread from Latin America to the rest of the world than from any other region. Interestingly, Bae et al. (2003) come to the conclusion that contagion is a predictable phenomenon with the use of prior information.

### 3.4.2 Tests of Transmission Mechanisms

Over the past ten years there has been an increased interest in precisely how a shock or crises is propagated from one country to another. This is mostly due to its importance in drawing policy conclusions that may result in the prevention of contagion in the future. A range of statistical methods have been used to exam a variety of crises periods in an assortment of different countries. Not surprisingly, there is large dispute over the diversity of findings (Forbes 2000:7).

Much of the early work was focused upon currency crises and their transmission mechanisms. This formed the bases from which contagion studies on stock markets began and as such, this section begins with a brief overview of some of the more ground-breaking work done in this literature.

Eichengreen, Rose & Wyplosz (1996) were among the first to shift the focus in contagion studies not on the presence of contagion but rather, the channels through which contagion was propagated. Empirically, they did not directly test for contagion, but instead for the increased probability of a speculative attack on a currency, given another country’s currency had undergone a speculative attack. Using quarterly macroeconomic and political panel data from 1959 to 1993, in twenty different industrialized countries, they developed a binary probit model for their empirical tests.

They begin with the creation of an exchange market pressure (EMP) index, which accounted for movements in a country’s exchange rates, interest rates and reserve levels. This in turn was able to capture the three main defences a country has against speculative attacks, enabling one to determine whether a country is going through a currency crisis. From this, and a subsequent model, they were able to ascertain the presence of a currency crisis in a country. The presence or absence of a crisis over a particular time period in a particular country then became the dependant variable in the binary probit model, taking the value of 1 if the crisis was present and 0 otherwise. The independent variables included a dummy
variable for each of the other countries as to whether they were currently going through a crisis and then, ten macroeconomic and political control variables.

Having established the presence of contagion, they moved onto empirically testing the channels through which contagion can be transmitted. To test the trade channel, a slight extension was made to the probit model already developed. The dummy variables that are not equal to zero, are given the multilateral exchange rate model (MERM) weightings that the International Monetary Fund (IMF) has computed in the course of constructing its real multilateral effective exchange rates.

The second channel essentially tested the country re-evaluation or “wake-up call hypothesis”. Eichengreen et al. (1996) focused on country macroeconomic similarities, focussing on seven variables in particular. They did this by “standardizing” the variables such that, if countries have similar standardized growth rates of the relevant variables, then it receives a high weight on the contagion variable (dummy variable previously discussed).

Ultimately, contagion transmitted through trade was found to be stronger than contagion transmitted through the country re-evaluation channel. Although, it is admitted that this may be due to the inability to find a sufficient proxy for this effect.

Continuing the study of contagion channels during currency crises, De Gregorio & Valdes’ (2000) investigated the currency contagion in twenty different countries which was assumed to have occurred after the 1982 US debt crisis, the 1994 Mexican crisis and the 1997 Asian crisis. The aim of the paper was twofold: Firstly, to determine the channels through which a crisis is propagated across countries and secondly, to examine the usefulness of various policy instruments in shielding a country from contagion. This second point, however, will not be discussed in any further detail as the instruments discussed are related to currency contagion, a topic which is outside the scope of this paper.

To test the transmission channels through which contagion is spread, 7 different independent variables are used concerning trade (demand and competitive effects), financial linkages (wake-up call hypothesis) and geographical proximity. This is done in a binary probit model in which the four crisis indicators which make up the studies EMP are the independent variables which are tested individually. Ultimately, trade linkages and geographical proximity are shown to be highly correlated and significant in the explanation of contagion, but it is
concluded that geographical proximity is the most relevant propagation mechanism. Results for other transmission channels are shown to be insignificant.

Forbes (2002) was the first to empirically study all three components of trade linkages in a contagion setting: the demand effect, competition effect and cheap import effects. Investigating exchange rate crises, in particular, and how the trade linkages influenced stock market returns, she examined every country that experienced a crisis from 1 July 1994 to 31 June 1999, along with a sample of developed and developing countries.

Following what had become a popular convention by this stage in time, in the testing of currency contagion channels motivated by Eichengreen et al. (1996); Forbes (2002) created an EMP index. In all, 45 countries and 16 unique crises were investigated in this all inclusive study.

Once the countries and crises where determined, a simple OLS model was presented whereby stock market returns was the dependant variable and each component of the trade channel was a separate independent, along with a set of controlling macroeconomic variables and period dummy variables for each crisis event.32

The results of the study revealed that countries that compete in the same industry as major exports from the crisis country (competition channel) and those that had a large share of exports going to the crisis countries (demand effect) had significantly lower stock market returns during these crises. Forbes (2002), however, does admit that empirically testing only the channel of trade is difficult and may be bias due to the difficulty of separating trade and financial data. Therefore, she did not exclude the importance of financial linkages in the propagation of crises.

Drawing the discussion away from currency crises and towards stock markets; Peek & Rosenberg (1997) were amongst the first to empirically test the exogenous liquidity shock transmission channel. Using semi-annual observations of panel data from September 1988 to September 1995 for the US branch and subsidiaries of eleven city banks, three long-term credit banks, five trust banks and the ten largest regional banks; they investigated the transmission of the Japanese stock market crisis of 1989 to 1992, where the Nikkei index lost over half its value.

32 For details of how each component of the trade channel is computed, see Forbes (2002).
It was illustrated that Japanese bank lending prior to 1989 made up one fifth of all lending in the US and they show empirically, with an OLS model of the determinants of Japanese bank lending to the US that the shock to the Japanese stock market significantly negatively impacted the rate of lending to the US. This was seen through an eight percent decline in loans to the US, which it was hypothesised to have produced the negative results in the US stock market although this was not directly tested.

Following the same concept of testing for financial linkages, Kaminsky, Lyons & Schmukler (2004) examined variations in trading strategies between fund managers and investors using quarterly data for thirteen different mutual funds from April 1993 to January 1999. In particular, these mutual funds were all US mutual funds dedicated to investment in Latin America. Within this time period, four “crisis” periods are indicated to account for the Mexican 1994, Asian 1997, Russian 1998 and Brazilian 1999 crises.

The investigation essentially detailed whether fund managers and investors practised what they referred to as “contagion trading”: whereby they sell (buy) assets in one country when the assets prices fall (rise) in another country. This was done empirically with an OLS model testing for a relation between quantity changes in holdings of particular stocks within the mutual funds and equity returns of those particular stocks.

Finally, Kaminsky et al. (2004) conclude that contagion trading was present from both fund managers and investors whilst indicating, however, that these tests were not conclusive as to whether non-fundamental or fundamental contagion was dually responsible. This test is most closely related to those discussed under the “exogenous liquidity” banner than Forbes (2000) described as “forced portfolio re-composition”.

Using a mutual fund database (with 382 different mutual funds invested in 117 different emerging markets) containing monthly data on its asset allocation by country for the period January 1996 to December 2000; Broner, Gelos & Reinhart (2006) were able to empirically test the effects of portfolio rebalancing (which can be applied to a number of transmission mechanisms) and its ability to transmit crisis across countries.

The testing procedure was done within an OLS model where they regressed changes in portfolio weights on over-exposure, excess gains, gains and the interactions of excess gains with over exposure. The findings essentially indicated that when the funds’ returns are lower than the average portfolio, funds reduce their exposure to countries in which they are
“overweight” and increase their exposure to countries in which they are “underweight”. And, in this way were able to explain the contagion incidences of East Asia 1997, Russia 1998 and, Brazil 1999.

Hernandez & Valdes (2001) were then amongst the first in the literature to study a broad range of crises transmission channels. Applying a very similar approach to De Gregorio & Valdes (2000), which was discussed under currency crises contagion channels; they empirically examine contagion in stock markets and bond spreads (this discussion will be limited to their examination of stock markets). Investigating the Thai, Brazilian and Russian crises which all occurred from 1997 to 1999; they tested once more for the channels of neighbourhood, trade and finance effects and their significance in the transmission of the crises. Specifically, the demand effect or direct trade effect was tested and financial competition in banking sectors, which was supposed to capture the extent of similarity in sources of finance.

They modelled the three crises independently, with a sample period of three months for using weekly data, thus obtaining 12 observations for each of the 17 countries for each of the crises. The testing approach which was not expanded on when discussing De Gregorio & Valdes (2000) shall now be discussed. The OLS model was used, with different weightings given to the different independent variables according to the channel being tested. For example, trade links weights were constructed as the importance of country “j” in the total county “i”s” trade, measured by the sum of imports and exports. Similarly, weights were constructed for the neighbourhood and financial channels.

It was concluded from the empirical work that trade and neighbourhood channels where the most significant in both the Thai and Brazilian crises whilst in the Russian crisis, financial competition was the only significant variable.

As has been illustrated, much of the early research on contagion channels focussed around currency crisis and the channel of trade. However, the shift of research has slowly altered toward stock market variables as currency crises have become less prevalent, although the trade channel remains a central aspect.

Chinn & Forbes (2003), although not directly testing for the transmission mechanisms of contagion, tested the channels through which stock markets are interdependent in a more inclusive manner. They include trade (more specifically: bilateral trade flows and competition


in third markets), bank lending (which could be related to exogenous liquidity shocks) and foreign direct investment channels in their empirical tests using weekly data over the time period of 1996 to 2000, in over 45 different developed and emerging markets.

The estimation was essentially a two-step procedure whereby they first estimated a factor model of returns controlling for global, sectoral and cross-country factors. In the second step, they decomposed the estimate for cross-country factor loading into the aforementioned transmission channels.

Ultimately, Chinn & Forbes (2003) concluded that the primary mechanism, through which interdependence of stock markets was transmitted, was via direct trade flows, whilst bilateral foreign investments were for the most part found to be insignificant.

Collins & Gavron (2003), in a paper that is comparable to this one, regarding the objectives; first establish the presence of contagion using the methodology put forward by Forbes & Rigobon (2002) as discussed above. To test the channels which, then significantly increase the probability of contagion, a binary logit regression model is used. The model is argued to be superior to linear models when estimating binary variables as linear models can give inaccurate, predicted probabilities due to heteroskedasticity, non-normality of error terms or predicted probabilities; can be greater than one or less than zero. Over the period 27 May 1997 to 1 January 2002, ten separate crises periods were identified to have contagiously transmitted across borders.

The channels which were directly tested are those of weak macroeconomic fundamentals, economic and financial links and investor behaviour. Weak macroeconomic fundamentals were empirically tested using the variables: inflation rate, gross domestic product (GDP) and the aforementioned exchange market pressure (EMP) index. To represent economic and financial linkages, three variables in particular were isolated: bilateral trade levels, trade bloc co-membership with the base country, and common bank lending ratios. Then similarly, three separate approaches were used to account for investor behaviour: the likelihood of a common investor, the ease to enter and exit the market; and the informational efficiency of each market.

Collins & Gavron (2003) concluded that the inflation rate and the liquidity index lagged at nine months are the only significant components of channels at a five percent level. This would suggest that it is neither one of the individual channels which independently induces
contagion, but rather, a combination of the individual channel effects which subsequently generates contagion.

Then, most recently, Didier, Love & Peria (2010) investigated the channels through which the 2007-2008 financial crisis was transmitted from the US stock market to countries around the world. Using monthly data for 83 different countries, they tested specifically whether the crisis was transmitted via real linkages (trade, more specifically: the competition and domestic demand linkages), financial linkages (such as changes in risk aversion or exogenous liquidity shocks) or the previously named, “wake up call hypothesis”.

Focusing on the collapse of Lehman Brothers on the 15 September 2008 as the turning point in the crisis, they identified and distinguish between the period before and after this collapse. Empirically they tested the channels individually in an OLS model, using a number of different variables as proxies for the channel and dummy variables to indicate before and after the crisis date. Not surprisingly given the nature of the crisis, they found the main channel of transmission was financial. They also found evidence of a wake-up call in the first stage of the crisis, when countries with vulnerable banking and corporate sectors exhibited a higher co-movement with US stocks. On the other hand, no indication was found that trade was a significant channel through which the crisis was propagated.

Interestingly, although a number of different channels and methodologies have been discussed, for the most part similar data sets have been the focus of the investigation. Forbes (2000) was the first to study the transmission channels of contagion between countries without making use of macroeconomic data. Her argument was that within a country, there are large variations in how an individual firm is affected by a crisis, variations which are not captured by macroeconomic data. Furthermore, with the high correlation between macroeconomic data for financial and trade channels, it is increasingly difficult to empirically test for these channels individually with certainty that the other is not producing a bias within the results. Firm-level data does not exhibit these same shortcomings.

In order to perform this firm level analysis, Forbes (2000) constructed a new data set of financial statistics, industry information, geographical data and stock returns for over 10 000 companies in 46 different countries. This information was then used to test how individual firm’s stock market returns are affected through the following transmission channels: product competitiveness; an income effect, credit crunch, a forced-portfolio re-composition and a wake-up call or, what was referred to in the paper as country re-evaluation. The period of
investigation was dependent upon the crisis investigated. Two crises were investigated, the Asian crisis of 1997 and the Russian crisis of 1998. The “pre-crisis” period was defined as being one year from the earliest developments of the crisis and the “crisis period” was thought to be two weeks for the Russian crisis and twelve weeks for the Asian crisis.

Forbes (2000) began with the use of a univariate model, however, went on to explain the limitations of such a model in a multiple country analysis. She then went on to use a VAR model based on the methodology of Sefcik & Thompson (1986). To contend with the problems of heteroskedasticity and cross-correlation in returns, the sample of firms was divided into different portfolios, and then these portfolios were used to estimate the impact of firm characteristics on returns during a specific event. The results essentially showed that the product-competitiveness (named, “competition linkage” in this paper) was an important transmission mechanism during the latter part of the Asian and Russian crises along with the income effect (referred to as the “demand effect” in this paper). However, she concluded that country specific effects can have a greater influence than all the transmission mechanisms combined.

Boshoff (2006), following the lead of Forbes (2000), conducted a firm level study in the case of South Africa to investigate transmission channels of the 1997 Asian crisis, the 1998 Russian crisis and the 2001 Argentinean crisis. Boshoff (2006) essentially investigated the following transmission channels: trade linkages, both competition and domestic demand linkages individually; incentive structures and changes in risk aversion; endogenous liquidity shocks; and exogenous liquidity shocks. The data set was created from the income statements, balance sheets and general company information of thirty-two South African companies.

Boshoff (2006) used a multivariate regression model and the Sefcik & Thompson (1986) methodology to create exactly identify estimates. Due to the possibility of information overlaps, a number of dummy variables where introduced, the first controlling for a Rand hedging effect, the second controls for firm size, which may impact with the transmission of shocks and thirdly, a set of dummy variables is included for various industry groups. For all three crises, no channel indicates any significant effect as a result of contagion. These results

33 Although Boshoff (2006) gave different names to the transmission channels, they ultimately equate to these channels, names used in this dissertation and their ensuing theoretical backing.
however cannot be directly compared to Forbes (2000) as one should consider that her study was conducted on United States firms whilst Boshoff (2006) is a study of South Africa firms although, the two contrary results are somewhat interesting.

As stated, the advantage of being able to distinguish between trade and financial channels is undoubtedly this firm-level study techniques most desirable trait however; it does come with a number of disadvantages. Firstly, if a limited number of firms are studied such as in Boshoff (2006), this produces a sample bias, limiting the ability of the researcher to draw broad, economy wide conclusions. Secondly, with a number of different countries being investigated, such as in Forbes (2000), different country accounting standards make it increasingly difficult to compare and contrast accounting records. And thirdly, there are a number of extreme outliers which one can only assume represent reporting errors (Forbes 2000:12).

3.5 CONCLUSIONS

The concept of financial contagion has become increasingly popular over the past two decades with the seeming increase in simultaneous economic crises occurring around the world. With this popularity has come a broad variety of theoretical arguments as to the foundation for this increasingly recurring economic phenomenon. Nonetheless, Forbes & Rigobon (2001:53), importantly, note that “although some of these papers use very different definitions of contagion, the consistency of this finding is remarkable given the range of techniques utilized and periods investigated.”

Drakos & Kutan (2005) also pointed out that none of the theories illustrated in this chapter require mutual exclusivity and as such, it is completely viable to test for the coexistence of a number of different contagion theories within one framework. This argument put forward, by amongst others, Drakos & Kutan (2005), was what has lead the majority of papers on testing for the presence of financial contagion to take an a-theoretical approach and rather rely on a strict definition of what, in fact, constitutes financial contagion. The sectoral approach taken by Abrahamson & Collins (2004), to overcome the bias of average index measures, is undoubtedly the most logical and intuitive of methods, however, the ability to obtain sectoral data for different countries with the same parameters is what makes this approach difficult, if not all together infeasible. Whilst using a test which utilizes only extreme outliers, used by
Bae et al. (2003) amongst others and within the EVT framework, overcomes the bias towards giving large weightings to periods of relative stability. Beyond overcoming this bias, these methodologies also circumnavigate the much written about problems of heteroskedasticity and endogeneity which have been shown to plague the previously more popular correlation and GARCH tests. Relative to EVT modelling, however, an important advantage of multinomial logistic analysis (Bae et al. 2003) is that it allows one to condition on attributes and characteristics of the exceedance events using control variables measured with information available up to the previous day.

Thus, the definition for contagion used is one fairly similar to that of Bae et al (2003) and fits the objective of using a definition which is narrow, allowing one to make inferences on shift-contagion. As such, contagion shall be referred to as the fraction of exceedance events in a particular sector that is left unexplained by its own covariates, but is explained by the exceedance from another region. However, if sectoral data is not obtainable, this definition will have to be applied to an overall index of the relative stock markets.

At this point in time, this is undoubtedly the most complete test of contagion available. Unlike the co-integration tests though, it does lack the ability to make conclusive claims about interdependence. As indicated earlier, however, if a crisis moves from one country to another and is not due to financial contagion, one can only conclude that it is either as a result of independent shocks occurring in individual countries at the same time or more likely, in the case of the 2007-2008 financial crisis, due to interdependence.

As for direct tests of transmission mechanisms of a crisis, a theoretical framework is a more feasible methodological approach. Verick (2010) and Powell & Steytler (2010) amongst others suggested that South Africa was impacted by the financial crisis of 2007-2008, for the most part, via trade and financial linkages. Didier et al. (2010) and Dooley & Hutchison (2009) who did analyses on the transmission of the crisis to emerging markets also suggested the primary propagation mechanism was trade and financial channels. As such, these transmission channels will form the basis for the investigation. Also, it is difficult to quantify the variable of financial panic or irrationality and if one attempted to do so it may introduce doubts around the credibility of the results. Consequently, the performance of a proper econometric analysis for such channels has not been included, although some have argued they may be relevant.
Due to the fact that this study is limited to South Africa and the US, the demand effect channel is the only feasible trade channel which can be conclusively studied.\footnote{As all other trade channels are conditional upon a third countries participation in the transmission.} Whilst within the financial linkages channel, exogenous liquidity shocks have gained the most recognition for the transmission of the 2007-2008 financial crisis (see: Didier, Love & Peria 2010; Brunnermeier (2008); Acharya, Philippon, Richardson & Roubini 2009) and consequently shall be the channel in which financial linkages are investigated.

With such a vast variety of theoretical frameworks, what one notices when considering the literature is that each particular framework is limited in the research conducted on it. Combined with the fact that contagion can take place in a number of different financial variables (such as exchange rates, mutual funds, banking crises, stock markets, etc.) which consequently mitigates many such papers, in their usage within the parameters of this research; finding relevant literature proved particularly challenging.

Nonetheless, a number of comparable papers were found; and from this it was apparent that there were three primary types of data sets which were used. Firstly, those which incorporated mutual fund data\footnote{See Kaminsky et al. (2004) and Broner et al. (2006) amongst others.}, however, this requires is a number of funds (such that there is not a sample bias) with the same fund mandate of investing in the region/s of concern. However, there is not a sufficient number mutual funds mandated to invest in the US and South Africa only, subsequently rendering this approach impractical for the purposes of this research.

Secondly, one could use the firm-level data set\footnote{See Forbes (2000) and Boshoff (2006) amongst others.}, though this comes with its unique challenges. The primary concern is that South African accounting standards are governed by International Financial Reporting Standards (IFRS) whereas the US accounting standards are governed by United States Generally Accepted Accounting Principles (US GAAP). As such, this leads to material differences in accounting reporting, making it difficult to compare and contrast financial statements. Additionally, Forbes (2000) also highlighted that the data set included a number of extreme outliers, a fact which she attributes to reporting errors.
The third primary data set used, is that of macroeconomic data. It leads intuitively that if one is to test fundamental linkages such as trade and finance, that macroeconomic trade and finance variables should be used. The principle argument against this dataset is that stock markets are primarily forward looking in nature and as such react according to estimates about future economic activity, whereas macroeconomic data is a present indicator of economic performance. Thus, the use of both data sets in a single model ultimately results in insignificant variables, as the stock market is not forward looking by consistently the same interval, or even correct in such predictions. In the case of the 2007-2008 crisis, however, the stock market did not predict at all the consequences which would ensue. Instead of pre-empting the crisis and being forward looking, anecdotal evidence suggest the stock market was reactionary; changing with the macroeconomic environment which was, by many accounts, unanticipated. As such, the use of macroeconomic data would seem to be the most relevant approach to undertake the analysis of the transmission mechanisms.

Of the methodologies examined that of Didier, Love & Peria (2010) stands out as being the most applicable this research. The methodology included interaction independent variables, which resulted in an interpretation of variables that can ultimately speak to the primary objectives that were set forth. It also provides a significant coverage of trade and financial variables which allows one to make conclusive inferences about the relevant channels.

The methodology entails the use of an OLS and although it is tempting to look down upon this as a somewhat inferior econometric tool for analysis, one should be cognisant of the fact that the OLS model has primarily dominated this field of literature. Predominantly though, the OLS tool in this case speaks directly to the objectives of this dissertation, from which conclusive deductions and recommendations can be drawn.

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38 See Chinn & Forbes (2003), Collins & Gavron (2003), Erhamann et al. (2009), Quinn & Voth (2008) and, Didier et al. (2009), amongst others
CHAPTER FOUR

METHODOLOGY

The frameworks for all empirical tests conducted in this paper are discussed within this section. In particular, two tests will be conducted: Firstly, a test for contagion in which the analytical framework is discussed, which leads to the development of the binomial logit model which will be used for the empirical study. Secondly, a test for different transmission mechanisms shall be done. A theoretical framework is discussed which leads to the development of the OLS model which is used to test for the relevant channels.

4.1 TESTS FOR CONTAGION

4.1.1 Introduction

The newer school of thought when testing for financial contagion is primarily focus on extreme values (or exceedances) and it is this central point of interest which is continued in this dissertation. The concept for the development of the binomial logistical regression model comes for the most part from Bae, Karolyi & Stultz (2003); and Chan-Lau, Mitra & Ong (2007). Although, as expressed in the conclusion of the last section, a sectoral approach similarly to Abrahamson & Collins (2004:9), would have been the most appropriate, however, data unavailability has led to this test being conducted using the aggregate measure of stock market returns.

The section shall be broken down into two distinct subdivisions, namely: an analytical framework behind the development of the model and the model itself and its precise components. Relevant data issues unique to the model and its development in South Africa over the given time period were discussed in section 4.3.

4.1.2 Analytical Framework

Essentially, the empirical model is within an a-theoretical framework. The independent variables used are those which were implemented by Bae, Karolyi & Stultz (2003) and Chan-Lau, Mitra & Ong (2007) (a number of which were also used in De Gregorio & Valdes (2000)) due to their statistical importance in helping to explain and predict exceedances within the model.
The definition of contagion in the context of this methodology is, contagion is the fraction of exceedance events that is left unexplained by its own covariates but is explained by the exceedance from another region. The influence of this definition is that contagion is only present in extreme positive/negative returns; as these lead to irrational outcomes, excess volatility and even panics. If small negative returns are transmitted across countries this is simply evidence of interdependence. Thus, in order for contagion to be measured, only the extreme returns should form part of the model. Correlations that give equal weight to small and large returns are not sufficient (Bae, Karolyi & Stultz 2003:718-719).

4.1.3 Empirical Model

The starting point is defining the extreme values or exceedances. This is done by calculating the change in weekly returns:

\[ \Delta R_{it} = \frac{R_{it} - R_{it-1}}{R_{it-1}} \]  

...(1.a)

Then stack all \( \Delta R_{it} \) observations from equation (1.a) and calculate the threshold, defined by Bae et al (2003) as \( T_5 \) and \( T_{95} \) for the bottom 5 percent and top 5 percent tails respectively. Observations that fall above or below these thresholds are defined as exceedances.

A co-exceedance is defined as the probability that a particular country will experience a large positive/negative shock as a result of a shock to another country in the sample. The co-exceedance for each country \( i \), at time \( t \) are defined as binary variables \( y_{it} \), such that:

\[ y_{it} = 1 \text{ if } \Delta R_{it} < T_5, \text{ and } 0 \text{ otherwise} \]  

...(2.a)

\[ y_{it} = 1 \text{ if } \Delta R_{it} > T_{95}, \text{ and } 0 \text{ otherwise} \]  

...(3.a)

Where:

- \( T_5 \) is the 5th percentile threshold in the left tail of the distribution
- \( T_{95} \) is the 95th percentile threshold in the right tail of the distribution

The point needs to be made that positive exceedances shall be modelled separately from negative exceedances so that comparisons can be drawn with the conclusions.
Now, the estimation for the conditional probability that country \( i \) will experience an exceedance at time \( t \), conditional on country \( j \) \((j \neq i)\) experiencing an exceedance after controlling for various covariates is:

\[
P_i = \frac{\exp(x'\beta_j)}{1 + \sum_j \exp(x'\beta_j)} \quad \ldots(4.a)
\]

Where:

- \( \beta \) is the vector of coefficients
- \( x \) the vector of independent variables

The independent variables, \( x \), include the intercept, the conditional volatility of the South Africa stock market returns at time \( t \) \((h_t)\), the average exchange rate changes in South Africa \((e_t)\), the average interest rate level in South Africa \((i_t)\), and the US stock market returns \((c_t)\).

The conditional volatility is estimated as EGARCH(1, 1). Contagion across country’s is then defined as the fraction of the exceedance events that is left unexplained by its own covariates (explanatory variables), but is explained by exceedance in another region (in this case, the US). Thus, in order for contagion to be found, the variable of US stock market returns \((c_t)\) must be found to be significant. If found to be significant, one would reject the null hypothesis of contagion not being present and accept the alternative hypothesis the contagion is present.

The goodness of fit in logit models is given by the McFadden (1974) \( R^2 \). This statistic is the likelihood ratio index, computed as:

\[
R^2 = 1 - \frac{l_w}{l_z} \quad \ldots(5.a)
\]

Where:

- \( l_w \) is the unrestricted likelihood
- \( l_z \) is the restricted likelihood

### 4.2 TESTING FOR TRANSMISSION MECHANISMS

The model developed in this sub-section draws on the work of Didier, Love & Peria (2010). The discussion shall be broken down into two distinct subdivisions, namely: a theoretical
framework behind the development of the empirical model; and the model itself and its precise components. Relevant data issues related to the model are discussed in section 4.3.

4.2.1 Theoretical Framework

As motivated in the conclusion of chapter two, trade and financial linkages are the primary mechanisms through which the financial crisis of 2007-2008 is hypothesised to have been transmitted through into the South African economy. As such, these form much of the theoretical basis for this section. Specifically, because we are dealing with only the US and South Africa within this study, the only trade linkage that shall be investigated is the demand effect as the other two possible trade linkages require multiple countries to be included within the empirical model. Financial linkages are what was referred to as the channel of exogenous liquidity shocks in the previous chapter, or what Forbes (2000) called the “credit crunch channel”.

The demand effect refers to a situation where a crisis in one country causes a reduction in income and a corresponding reduction in the demand for imports in that country. From a South Africa perspective, this would negatively influence firms that rely on exporting their output to the crisis country (Claessens & Forbes 2004:5). This could once again be seen through anticipated lower returns and the resultant drop in share price.

Exogenous liquidity shocks essentially refer to a situation in which there is an international reduction in credit availability, raising the cost of capital to firms. The companies that would be hardest hit by such a situation are those that are more reliant upon short-term debt to finance inventories and provide working capital (Forbes 2000:19).

Also under the financial linkages banner is that of market liquidity. Market liquidity could theoretically play an important role in the transmission of a crisis as a market with greater liquidity provides lower transaction costs. As such, if participants in numerous financial markets around the world were required to withdraw capital, citius paribus, they would withdraw from the most liquid market as the liquidity premium paid to invest originally (which they would ultimately lose after withdrawing) would be the lowest (Didier et al. 2010:11). Also, market liquidity according to Kaminsky et al. (2003:58) is hypothesised to play an important role in contagion spread by information asymmetries. Small, highly illiquid markets would be shielded from contagion as they are likely to be underrepresented in international portfolios. Whereas large, highly liquid exchanges (such as South Africa) are
hypothesised to have greater representation in international portfolio’s and as such, are more susceptible to contagion.

4.2.2 Empirical Model

To examine the channels through which the financial crisis was transmitted from US (the epicentre of the crisis) to South Africa, a model is estimated where South African stock market returns are a function of stock market returns in the US. The determinants of South Africa’s stock market co-movement with the US are investigated by interacting US returns with various country level variables. A distinction is made between, before and after the collapse of Lehman Brothers in September of 2008, as this is considered by many to be an important turning point in the crisis (for example refer to Dooley & Hutchison 2009; Raddatz 2009; Didier, Love & Peria 2010) (Didier; Love; Peria 2010:7).

The empirical model can be summarised by a general equation, equation 1b below:

\[ R_{SA,t} = \beta_{pre}D_{pre}R_{US,t}X_{SA} + \beta_{post}D_{post}R_{US,t}X_{SA} + \epsilon_{SA,t} \]  

Where:

- \( R_{SA,t} \) is the stock return in South Africa at time \( t \)
- \( R_{US,t} \) is the return on the US stock market at time \( t \)
- \( D_{pre} \) is a dummy variable that equals 1 for the period before the collapse of Lehman Brothers (January 2002 – August 2008), 0 otherwise
- \( D_{post} \) is a dummy variable that equals one for the period after the Lehman Brother collapse (September 2008 – April 2009), 0 otherwise
- \( X_{SA} \) is a variable that captures the effects of the transmission channels between the US and South Africa. Thus, it captures the effects of the trade channel, for which four different variables are used; and the financial channel for which six different variables are used. Details on the various variables used to test the transmission channels can be seen in Table 20 in the appendix.
- \( \beta_{pre} \) and \( \beta_{post} \) indicate the extent to which different factors explain the co-movement between the US and South African.
Essentially, the general equation above will become ten separate equations which will be identical except for the differing individual variables used in $X_{SA}$, applied to capture the effects of the transmission channels.

To make interpretation of the variables and resultant transmission channels easier, all the independent variables are standardized before interaction with US returns. Essentially, the regressors are transformed by subtracting their mean and dividing them by their standard deviation. Hence, the coefficients of the interactive variables can be interpreted as being the change in co-movement due to a one standard deviation change in a regressor.

### 4.3 DATA ISSUES

For the methodology pertaining to testing for contagion, the observation window of 1 July 2007 to 1 April 2009 shall be used with a weekly data frequency, resulting in 91 observations. The variables in particular which shall be used are: the conditional volatility of the South African stock market (which shall be calculated with an EGRACH model and using the JSE All Share Index as a proxy for South African stock market returns), average exchange rate changes in South Africa (the bilateral exchange rate between the US and South Africa shall be used as the proxy for the exchange rate in South Africa), the average interest rate level in South Africa (where interest rates shall be proxied by the 91-day treasury bill rate); and US stock market returns (for which the S&P 500 shall be used as a proxy) shall be used.

For time and simplicity considerations, all variables used for the methodology for testing of transmission mechanisms have been listed in Table 20, under the appendixes section. In the table, all variables have been named under sub-sections for the relevant channel which they shall be used to examine, along with being given a relevant definition and data source from which the data is obtained.

The complete observation window will be from 1 January 2002 to 1 April 2009, however, using time dummy variables the test shall be done separately for the periods 1 January 2002 to 31 September 2008 and then from 1 October 2008 to 1 April 2009. This is to account for possibility of changes in the transmission mechanism which may have occurred after the collapse of Lehman Brothers in September 2008 as described by Didier, Love & Peria 2010 and others.
CHAPTER FIVE
ESTIMATION

This chapter is essentially the application of the methodologies discussed in the previous chapter. As such, it shall be divided into two main sections: tests for contagion and tests for transmission mechanisms. The tests for contagion section shall implement a logit model and will be able to conclude whether, in fact, contagion occurred from the US to South Africa over the period of the recent financial crisis according to the strict definition of contagion used in this paper. The tests for transmission mechanisms shall implement an OLS model and will determine to what extent trade and financial variables played a role in propagating the crisis from the US to South Africa.

5.1 TESTS FOR CONTAGION

The a-theoretical framework introduced in chapter four to test for contagion shall now be implemented. To begin with, unit root and stationarity test will be conducted on all the relevant variables and where variables are non-stationary, their first differences. From there, the binary logit model shall be developed, with the relevant output then being discussed and examined.

5.1.1 Unit Root and Stationarity Tests

Before any estimation can take place, the variables being used must be tested for stationarity. This is to avoid the problems associated with nonstationary data such as generating a spurious regression, the infinite persistence of shocks and the invalidation of the standard assumptions made for asymptotic analysis (Brooks 2008:318-320).

The tests used will be the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. The ADF and PP tests are specifically unit root tests where the null hypothesis of a unit root is tested against the alternative hypothesis of the series being stationarity around a deterministic trend\(^{39}\). The

\(^{39}\) For more detail on these tests one can see Dickey & Fuller (1979, 1981) and Phillips & Perron (1988) respectively.
KPSS test is used to test the null hypothesis that the time series is stationary around a deterministic trend against the alternative that it is a unit root or greater. It is used as a confirmatory test to add greater power to the unit root tests.40

Tables 1-3 below show the relevant results for each of the three tests (Note that under the section “model selected”, CT indicates that a constant and trend was used, C indicates that just a constant was used, whilst “none” indicates neither a constant nor a trend were used):

Table 1: ADF test

<table>
<thead>
<tr>
<th>Series</th>
<th>$h_t$</th>
<th>$e_t$</th>
<th>$i_t$</th>
<th>$c_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: has a unit root</td>
<td>-9.053302</td>
<td>-2.468495</td>
<td>-0.315821</td>
<td>-2.188318</td>
</tr>
<tr>
<td>Test Critical Values:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>-4.062040</td>
<td>-4.063233</td>
<td>-3.503879</td>
<td>-2.590622</td>
</tr>
<tr>
<td>5%</td>
<td>-3.459950</td>
<td>-3.460516</td>
<td>-2.893589</td>
<td>-1.944404</td>
</tr>
<tr>
<td>10%</td>
<td>-3.156109</td>
<td>-3.156439</td>
<td>-2.583931</td>
<td>-1.614417</td>
</tr>
<tr>
<td>Model Selected</td>
<td>CT</td>
<td>C</td>
<td>C</td>
<td>None</td>
</tr>
<tr>
<td>Decision at 10%: Reject $H_0$</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>

40 For more detail on the KPSS test one can see Kwiatkowski et al., (1992)
41 See Chapter 4.2.3 for reference to variable abbreviation explanation.
Table 2: PP test

<table>
<thead>
<tr>
<th>Series</th>
<th>$h_t$</th>
<th>$e_t$</th>
<th>$i_t$</th>
<th>$c_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: has a unit root</td>
<td>-9.498095</td>
<td>-2.278630</td>
<td>-0.584589</td>
<td>-1.941016</td>
</tr>
</tbody>
</table>

Test Critical Values:

<table>
<thead>
<tr>
<th></th>
<th>1%</th>
<th>5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Value</td>
<td>-4.062040</td>
<td>-3.459950</td>
<td>-3.156109</td>
</tr>
<tr>
<td>Critical Value</td>
<td>-3.503879</td>
<td>-2.893589</td>
<td>-2.583931</td>
</tr>
<tr>
<td>Critical Value</td>
<td>-2.590622</td>
<td>-1.944404</td>
<td>-1.61417</td>
</tr>
</tbody>
</table>

Model Selected: CT, C, C, None

Decision at 10%:
- Reject $H_0$: YES
- NO
- NO
- YES

Table 3: KPSS test

<table>
<thead>
<tr>
<th>Series</th>
<th>$h_t$</th>
<th>$e_t$</th>
<th>$i_t$</th>
<th>$c_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: series is stationary</td>
<td>0.043334</td>
<td>0.168970</td>
<td>0.313115</td>
<td>0.234718</td>
</tr>
</tbody>
</table>

Test Critical Values:

<table>
<thead>
<tr>
<th></th>
<th>1%</th>
<th>5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Value</td>
<td>0.216</td>
<td>0.146</td>
<td>0.119</td>
</tr>
<tr>
<td>Critical Value</td>
<td>0.739</td>
<td>0.463</td>
<td>0.347</td>
</tr>
<tr>
<td>Critical Value</td>
<td>0.216</td>
<td>0.146</td>
<td>0.119</td>
</tr>
</tbody>
</table>

Model Selected: CT, C, C, CT

Decision at 10%:
- Reject $H_0$: NO
- YES
- NO
- YES

One should note that the values indicated in the row specified by the null hypothesis are the relevant tau statistics. The variable $h_t$ was found to be stationary at a 1 percent level of significance by both the ADF and PP tests and as such, the null hypothesis of unit root was rejected. The confirmation tests, the KPSS test, confirms these results by failing to reject the null hypothesis of stationarity within a 10 percent level of significance.
The ADF and PP tests both fail to reject the null hypothesis of nonstationarity in the case of the variables $e_t$ and $i_t$. With regards to the confirmatory KPSS test, the test rejected the null hypothesis of stationarity at a 5 percent level of significance for the variable $e_t$, thus confirming both the ADF and PP results. Whilst, for the variable $i_t$, the KPSS test failed to reject the null hypothesis of stationarity within a 10 percent level of significance, which is a conflicting result, adding uncertainty to the findings of the ADF and PP tests.

The variable $c_t$ was found to be stationary at a 5 percent level of significance for the ADF tests and a 10 percent level of significance for the PP test. As such, the null hypothesis of a unit root was rejected for both tests. However, the KPSS test failed to confirm these findings by rejecting the null hypothesis of stationarity at a 1 percent level of significance.

Thus, from the tests conducted, only the variable $h_t$ was found to be stationary by all three tests performed. As such, the first difference of all variables was taken, these were then again put through the relevant unit root and stationarity tests to confirm their stationarity.

The unit root and stationarity tests outputs for the variables first differences are now represented below in tables 4-6. These tables have been presented with the same format as tables 1-3.

### Table 4: ADF test for variables when first differenced

<table>
<thead>
<tr>
<th>Series</th>
<th>$h_t$</th>
<th>$e_t$</th>
<th>$i_t$</th>
<th>$c_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: has a unit root</td>
<td>-7.973824</td>
<td>-7.857192</td>
<td>-8.061903</td>
<td>-7.836437</td>
</tr>
<tr>
<td>Test Critical Values:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>-3.507394</td>
<td>-3.504727</td>
<td>-4.063233</td>
<td>-4.063233</td>
</tr>
<tr>
<td>5%</td>
<td>-2.895109</td>
<td>-2.893956</td>
<td>-3.460516</td>
<td>-3.460516</td>
</tr>
<tr>
<td>10%</td>
<td>-2.584738</td>
<td>-2.584126</td>
<td>-3.156439</td>
<td>-3.156439</td>
</tr>
<tr>
<td>Model Selected</td>
<td>C</td>
<td>C</td>
<td>CT</td>
<td>CT</td>
</tr>
<tr>
<td>Decision at 10%:</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
Table 5: PP test for variables when first differenced

<table>
<thead>
<tr>
<th>Series</th>
<th>( h_t )</th>
<th>( e_t )</th>
<th>( i_t )</th>
<th>( c_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_0 ): has a unit root</td>
<td>-68.33833</td>
<td>-7.836437</td>
<td>-7.955202</td>
<td>-7.947257</td>
</tr>
</tbody>
</table>

Test Critical Values:

- 1%: -3.504727, -3.504727, -4.063233, -4.063233
- 5%: -2.893956, -2.893956, -3.460516, -3.460516
- 10%: -2.584126, -2.584126, -3.156439, -3.156439

Model Selected: C, C, CT, CT

Decision at 10%: Reject \( H_0 \) YES, YES, YES, YES

Table 6: KPSS test of variables when first differenced

<table>
<thead>
<tr>
<th>Series</th>
<th>( h_t )</th>
<th>( e_t )</th>
<th>( i_t )</th>
<th>( c_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_0 ): series is stationary</td>
<td>0.307549</td>
<td>0.092752</td>
<td>0.106995</td>
<td>0.059588</td>
</tr>
</tbody>
</table>

Test Critical Values:

- 1%: 0.739, 0.739, 0.216, 0.216
- 5%: 0.463, 0.463, 0.146, 0.146
- 10%: 0.347, 0.347, 0.119, 0.119

Model Selected: C, C, CT, CT

Decision at 10%: Reject \( H_0 \) NO, NO, NO, NO

For all the variables (\( h_t \), \( e_t \), \( i_t \) and \( c_{i,t-1} \)) all three tests conclude that when I(1), they are stationary. With the ADF and PP tests, the null hypothesis of a unit root (or I(2) if the original series that is not first differenced had to be used) is rejected with a 1 percent level of significance. The KPSS test fails to reject the null hypothesis of stationarity.
5.1.2 Binary Logit Model

The logit model approach is able to overcome the limitation of the Linear Probability Model (LPM) which can produce estimated probabilities that are negative or greater than one. It can do this by using fitted values that are bounded within the (0,1) interval, effectively transforming the regression model. Visually, the fitted regression model will appear as an S-shape rather than a straight line, as is the case with the LPM. Obviously this model is not linear, and cannot be made linear by a transformation; and as such cannot be estimated using OLS. Therefore, the process of maximum likelihood is used instead (Brooks 2008:514 & 515).

At this point a binary logit model is developed. As discussed in the previous chapter, this begins with finding the points of extreme values or exceedances within the sample data of the JSE All Share Index. This process starts with finding the change in weekly returns and then from this, finding the observations within the bottom 5 percent and top 5 percent tails of the distribution. The point needs to be made at this stage, that positive exceedances shall be modelled separately from negative exceedances so that comparisons can be drawn with the conclusions. These exceedances are then given binary attributes, defining them as one if within a tail, and zero otherwise.

Table 7: Logit model output for bottom tail exceedances

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>∆ Prob</th>
<th>Standard Error</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-94.85283</td>
<td>-0.4374996</td>
<td>53.65932</td>
<td>-1.767686</td>
<td>0.0771</td>
</tr>
<tr>
<td>c_t</td>
<td>-27.73304</td>
<td>-0.01279159</td>
<td>17.61416</td>
<td>-1.574474</td>
<td>0.1154</td>
</tr>
<tr>
<td>e_t</td>
<td>1.627570</td>
<td>0.0075070</td>
<td>0.913410</td>
<td>1.781860</td>
<td>0.0748</td>
</tr>
<tr>
<td>h_t</td>
<td>0.141700</td>
<td>0.0006535</td>
<td>0.075420</td>
<td>1.878816</td>
<td>0.0603</td>
</tr>
<tr>
<td>i_t</td>
<td>6.959228</td>
<td>0.00320987</td>
<td>4.183517</td>
<td>1.663487</td>
<td>0.0962</td>
</tr>
</tbody>
</table>
Table 8: Diagnostic values for the logit model output of the bottom tail exceedances

<table>
<thead>
<tr>
<th>Diagnostic Statistic</th>
<th>Diagnostic Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>McFadden R-squared</td>
<td>0.539679</td>
</tr>
<tr>
<td>S.D. dependent var</td>
<td>0.229135</td>
</tr>
<tr>
<td>Akaike info criterion</td>
<td>0.305827</td>
</tr>
<tr>
<td>Schwarz criterion</td>
<td>0.443786</td>
</tr>
<tr>
<td>Hannan-Quinn criter.</td>
<td>0.361485</td>
</tr>
<tr>
<td>Restr. deviance</td>
<td>38.73432</td>
</tr>
<tr>
<td>LR statistic</td>
<td>20.90410</td>
</tr>
<tr>
<td>Prob(LR statistic)</td>
<td>0.000331</td>
</tr>
<tr>
<td>Mean dependent var</td>
<td>0.054945</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.187017</td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>3.007877</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-8.915110</td>
</tr>
<tr>
<td>Deviance</td>
<td>17.83022</td>
</tr>
<tr>
<td>Restr. log likelihood</td>
<td>-19.36716</td>
</tr>
<tr>
<td>Avg. log likelihood</td>
<td>-0.097968</td>
</tr>
</tbody>
</table>

Before the model was developed, all variables were first differenced such that they are all stationary so that valid interpretations of signs and significance level can be made. Additionally, within a logit model, one needs to be aware that the coefficients do not hold any interpretable value. This is due to the non-linear function of the logit model. However, the coefficients can be transformed to obtain the required relationship between changes in the variables and the probability of an exceedance event\textsuperscript{42}. This transformation, which is essentially differentiating the logistic function with respect to the variable in question have been done already and are under the heading “Δ Prob” in tables 7 and 9.

\textsuperscript{42} For information on this transformation one can see Brooks (2008:519) or Griffiths, Hill & Lim (2008:428-429).
Considering the variables individually, one would notice the magnitude and significance of the constant. However, Stevenson (2008:7) shows that within a time-series experiment, the logit models constant lacks a meaningful interpretation as it is dependent upon the number and types of controls used within the model.

The variable $c_t$, which is representative of the S&P 500, is insignificant at a 10 percent level. Interestingly, however, it is shown to have a great impact on bottom tail exceedance events, with a 1 percentage decrease on the S&P 500 week on week, increasing the probability of a bottom tail exceedance event on the JSE All Share Index by 1.2 percent. The sign is also negative, as it was expected to be, due to a decrease in the S&P 500 being expected to induce a negative response (tend towards a bottom tail exceedance) by the JSE All Share Index. Nonetheless, due to the insignificance of the variable, one can only conclude that contagion is in fact not present in bottom tail exceedances.

The Rand/Dollar exchange rate (given by the variable $e_t$), the conditional volatility of the South Africa stock market returns (given by the variable $h_t$) and the average interest rate level in South Africa (given by the variable $i_t$) were all found to be significant at a 10 percent level. A unit increase in the Rand/Dollar exchange rate (in other words $1 US can buy an additional R1 South African) was found to increase the probability of a bottom tail exceedance event by 0.75 percent. The sign of the derivative being positive is, as is expected, due to a weakening of the Rand being an indication that people are selling their Rand’s in exchange for other currencies, and in order for this to occur Rand denominated illiquid assets need to be sold off and made liquid. An example of an illiquid assets being sold off would be shares on the JSE. As such, it is not surprising to find weakness of the rand is a strong indicator of a bottom tail exceedance event in the JSE All Share Index.

A unit increase in the average interest rate level was found to increase the probability of a bottom tail exceedance event by 0.32 percent. This result is also in line with expectations as, an increase in the interest rates increases the risk free rate. Consequently, a higher risk free rate increases the rate of return required by investors in stock markets. If the stock market cannot meet this higher required rate of return without taking on greater risk, money would theoretically move from the stock market to the fixed income market.

Finally, the conditional volatility of the JSE All Share Index, which was found to be the most significant indicator of bottom tail exceedance events, was found to increase the probability of a bottom tail exceedance event by 0.065 percent for a unit increase in volatility. In order to
get an understanding of the impact of this, one has to consider that the mean volatility measured was, 0.0023, with a maximum downside movement of volatility of -12.554 units. Thus, if one takes this into consideration, a -12.554 movement in volatility increases the probability of a bottom tail exceedance event by, 0.82 percent, which is still a relatively small amount.

This result of volatility increasing the probability of bottom tail exceedance events is also in line with expectations as a bottom tail exceedance event is by nature, a large downward movement in the market, which essentially results in an increase in any volatility measurement. As such, it is not surprising to find that volatility is a significant indicator of a bottom tail exceedance event.

A brief point needs to be made on the variables and their relevant “∆ Prob” values. Although at first glance these values appear very low, this is in line with other similar research. Primarily this is due to the large number of variables which are taken into account when pricing equity markets, combined with the low probability of what has been defined as an exceedance event.

Moving onto the diagnostic statistic, the first point of references is the McFadden R-squared. The McFadden R-squared is a type of “pseudo” R-squared in as far as it is not like the R-squared found OLS regression, where R-squared measures the proportion of variance explained by the model. The McFadden R-squared is not measured in terms of variance, as in logistic regression variance is fixed as the variance of the standard logistic distribution. As Brooks (2008) said, “(the McFadden R-squared) does not have any intuitive interpretation,” nonetheless it is still widely used as a general measure of goodness of fit with values above 0.4 being considered a strong goodness of fit. As such, the value of 0.53 in the presented output would indicate a strong fit of the variables in the explanation of bottom tail exceedance events.

Along a similar interpretation of the McFadden R-squared, is the log likelihood statistic. It is used as an omnibus test to see if the model as a whole is statistically significant. It essentially calculates twice the difference between the log likelihood of the current model and the log likelihood of the intercept only model. It is used in the calculation of the LR statistic which is comparable to the overall F-test of model significance in regression. It is a test statistic for the

43 See Bae et al. (2003)
null hypothesis that all the model coefficients are zero except the intercept, against the alternative that at least one of the coefficients is not zero. The LR statistic has a chi-square distribution if the null hypothesis is true, with the degree of freedom equal to the number of explanatory variables, here four. Prob(LR statistic) is the p-value for this test, and what it indicates to us in this case is that we reject the null hypothesis at a 1 percent level of significance is rejected in favour of the alternative that at least one of the coefficients is not zero.

Having now discussed the results of the logit model conducted on the bottom tail exceedance events, the output for the logit model conducted upon the top tail exceedance events shall now be discussed.

Table 9: Logit model output for top tail exceedances

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Δ Prob</th>
<th>Standard Error</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-61.92317</td>
<td>-0.071916</td>
<td>34.89634</td>
<td>-1.774489</td>
<td>0.0760</td>
</tr>
<tr>
<td>e_t</td>
<td>104.6194</td>
<td>0.0121503</td>
<td>75.03882</td>
<td>1.394204</td>
<td>0.1633</td>
</tr>
<tr>
<td>h_t</td>
<td>4.099126</td>
<td>-0.001088</td>
<td>2.240823</td>
<td>1.829295</td>
<td>0.0674</td>
</tr>
<tr>
<td>i_t</td>
<td>-0.937230</td>
<td>0.002028</td>
<td>0.578190</td>
<td>-1.620974</td>
<td>0.1050</td>
</tr>
<tr>
<td>C</td>
<td>1.746790</td>
<td>0.004760</td>
<td>1.532670</td>
<td>1.139704</td>
<td>0.2544</td>
</tr>
</tbody>
</table>
Table 10: Diagnostic values for the logit model output of the top tail exceedances

<table>
<thead>
<tr>
<th>Diagnostic Statistic</th>
<th>Diagnostic Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>McFadden R-squared</td>
<td>0.671043</td>
</tr>
<tr>
<td>S.D. dependent var</td>
<td>0.229135</td>
</tr>
<tr>
<td>Akaike info criterion</td>
<td>0.249911</td>
</tr>
<tr>
<td>Schwarz criterion</td>
<td>0.387871</td>
</tr>
<tr>
<td>Hannan-Quinn crit.</td>
<td>0.305569</td>
</tr>
<tr>
<td>Restr. deviance</td>
<td>38.73432</td>
</tr>
<tr>
<td>LR statistic</td>
<td>25.99238</td>
</tr>
<tr>
<td>Prob(LR statistic)</td>
<td>0.000032</td>
</tr>
<tr>
<td>Mean dependent var</td>
<td>0.054945</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.143996</td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>1.783201</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-6.370968</td>
</tr>
<tr>
<td>Deviance</td>
<td>12.74194</td>
</tr>
<tr>
<td>Restr. log likelihood</td>
<td>-19.36716</td>
</tr>
<tr>
<td>Avg. log likelihood</td>
<td>-0.070011</td>
</tr>
</tbody>
</table>

Starting once more with the variable $c_t$, which is representative of the S&P 500, one notices it is similarly insignificant at a 10 percent level. Bae et al. (2004) and Chan-Lau et al (2004) both drew inferences from this variable by comparing it to the same variable in the bottom tail exceedance test. From the relative significance levels, they were able to identify that contagion is more likely for bottom tail exceedances than top tail exceedances, highlighting the asymmetric nature of the financial transmission mechanism across stock markets.

However, in the tests conducted here, where variables in both tests have been found to be insignificant, meaningful inference is not possible.
What one notices throughout the remainder of the results is that all variables, with the exception of Rand/Dollar exchange rate, are less significant than their counterparts in the bottom tail exceedance test. In fact, once more with the exception of the Rand/Dollar exchange rate, all variables are insignificant at a 10 percent level. What this essentially indicates is that top tail exceedances are, to a lesser degree, explained by fundamental macroeconomic conditions, indicating greater irrationality.

Changing focus to the probability calculations, once more all signs are as theory would predict with: a one unit strengthening of the Rand against the US dollar resulting in an increased probability of a top tail exceedance event by 0.108 percent. A one percentage increase on the S&P 500 week on week increases the probability of a top tail exceedance event by 1.22 percent. A one unit increase in volatility increases the probability of a top tail exceedance by 0.20 percent. Finally, a one unit increase in the interest rates results in an increase in the probability of a top tail exceedance event by 0.48, however, due to this result only being significant at a 26 percent level, which is too high to make a conclusive claim, the result can largely be excluded.

Ultimately, however, due to the insignificance of the variable for the S&P 500, once more the primary conclusion from this data is that contagion did not occur in top tail exceedances over the period of observation.

Once more, the McFadden R-squared is very high at 67 percent, indicating a strong goodness of fit; however, as stated above, this is merely an indication of goodness of fit and not an irrefutable measure such as the R-squared in an OLS regression. Nonetheless, this McFadden R-squared is higher than that found for a prior exceedance test, suggesting a greater goodness of fit. This is contrary to the earlier expectation of greater irrationality present in the top tail exceednaces. However, with the McFadden R-squared holding little statistical power, it is difficult to base any conclusion upon it.

The Prob(LR statistic) indicates once more that the null hypothesis at a 1 percent level of significance is rejected in favour of the alternative, that at least one of the coefficients is not zero.
5.2 TESTS FOR TRANSMISSION MECHANISMS

The procedure discussed in chapter four for the testing of the transmission mechanisms through which contagion is propagated shall now be implemented in this section. Due to the findings in the previous section which rule out that contagion occurred between the US and South Africa, this forthcoming analysis is one of interdependence transmission mechanisms; rather than contagion. Specifically, tests for trade and finance channels shall be investigated.

The section begins with similar unit root and stationarity tests conducted in the last section and then considers the OLS tests. The tests shall be divided into three sections: Firstly, a discussion of the results of the trade channel analysis; secondly, a discussion of the financial channel analysis; and thirdly, an encompassing analysis which includes all significant variables from the trade and financial channel analyses.

5.2.1 Unit Root and Stationarity Tests

To recap briefly, stationarity tests are conducted to avoid the problems associated with nonstationary data such as generating a spurious regression, the infinite persistence of shocks and the invalidation of the standard assumptions made for asymptotic analysis (Brooks 2008:318-320).

Tables 11-13 seen below show the relevant results for each of the three tests (Note that under the section “model selected”, CT indicates that a constant and trend was used, C indicates that only a constant was used, whilst “none” indicates neither a constant nor a trend was used).
### Table 11: ADF test

<table>
<thead>
<tr>
<th>Series</th>
<th>$R_{U_{S,t}}$</th>
<th>$R_{S_{A,t}}$</th>
<th>$a_{T,t}$</th>
<th>$b_{T,t}$</th>
<th>$c_{T,t}$</th>
<th>$d_{T,t}$</th>
<th>$e_{F,t}$</th>
<th>$f_{F,t}$</th>
<th>$g_{F,t}$</th>
<th>$h_{F,t}$</th>
<th>$i_{F,t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: has a unit root</td>
<td>-1.660</td>
<td>-1.244</td>
<td>-1.185</td>
<td>-4.137</td>
<td>-2.796</td>
<td>-2.898</td>
<td>-2.780</td>
<td>-3.205</td>
<td>-3.098</td>
<td>-2.616</td>
<td>-1.871</td>
</tr>
</tbody>
</table>

Test Critical Values:

- **1%**: -4.122, -4.122, -5.125, -5.125, -4.886, -4.886, -4.992, -4.886, -7.006, -7.006

Model Selected

<table>
<thead>
<tr>
<th>Decision at 10%: Reject $H_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>YES</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
</tbody>
</table>

### Table 12: PP test

<table>
<thead>
<tr>
<th>Series</th>
<th>$R_{U_{S,t}}$</th>
<th>$R_{S_{A,t}}$</th>
<th>$a_{T,t}$</th>
<th>$b_{T,t}$</th>
<th>$c_{T,t}$</th>
<th>$d_{T,t}$</th>
<th>$e_{F,t}$</th>
<th>$f_{F,t}$</th>
<th>$g_{F,t}$</th>
<th>$h_{F,t}$</th>
<th>$i_{F,t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: has a unit root</td>
<td>-1.490</td>
<td>-0.391</td>
<td>-1.360</td>
<td>-0.864</td>
<td>-1.746</td>
<td>-2.856</td>
<td>-2.780</td>
<td>-1.561</td>
<td>-3.098</td>
<td>-2.851</td>
<td>-2.563</td>
</tr>
</tbody>
</table>

Test Critical Values:

- **1%**: -4.058, -4.058, -4.886, -4.886, -4.886, -4.886, -4.886, -6.292, -6.292
- **5%**: -3.120, -3.120, -3.829, -3.829, -3.829, -3.829, -3.829, -4.450, -4.450

Model Selected

<table>
<thead>
<tr>
<th>Decision at 10%: Reject $H_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>NO</td>
</tr>
</tbody>
</table>

---

44 See Table 20 in the appendix for variable abbreviation explanation
Table 13: KPSS test

<table>
<thead>
<tr>
<th>Series</th>
<th>$R_{US,t}$</th>
<th>$R_{SA,t}$</th>
<th>$a_{T,t}$</th>
<th>$b_{T,t}$</th>
<th>$c_{T,t}$</th>
<th>$d_{T,t}$</th>
<th>$e_{F,t}$</th>
<th>$f_{F,t}$</th>
<th>$g_{F,t}$</th>
<th>$h_{F,t}$</th>
<th>$i_{F,t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: series is stationary</td>
<td>0.359</td>
<td>0.369</td>
<td>0.428</td>
<td>0.166</td>
<td>0.189</td>
<td>0.148</td>
<td>0.089</td>
<td>0.279</td>
<td>0.100</td>
<td>0.500</td>
<td>0.324</td>
</tr>
<tr>
<td>Test Critical Values:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>0.739</td>
<td>0.739</td>
<td>0.739</td>
<td>0.216</td>
<td>0.739</td>
<td>0.216</td>
<td>0.216</td>
<td>0.216</td>
<td>0.216</td>
<td>0.216</td>
<td>0.216</td>
</tr>
<tr>
<td>5%</td>
<td>0.463</td>
<td>0.463</td>
<td>0.463</td>
<td>0.146</td>
<td>0.463</td>
<td>0.146</td>
<td>0.146</td>
<td>0.146</td>
<td>0.146</td>
<td>0.146</td>
<td>0.146</td>
</tr>
<tr>
<td>10%</td>
<td>0.347</td>
<td>0.347</td>
<td>0.347</td>
<td>0.119</td>
<td>0.347</td>
<td>0.119</td>
<td>0.119</td>
<td>0.119</td>
<td>0.119</td>
<td>0.119</td>
<td>0.119</td>
</tr>
<tr>
<td>Model Selected</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>CT</td>
<td>C</td>
<td>CT</td>
<td>CT</td>
<td>CT</td>
<td>CT</td>
<td>CT</td>
<td>CT</td>
</tr>
<tr>
<td>Decision at 10%: Reject $H_0$</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

One should note that the values indicated in the row specified by the null hypothesis are the relevant tau statistics. For a quick summation of these results, one can see that the ADF and PP tests both failed to reject the null hypothesis of there being a unit root for all but one of the variables, therefore indicating all are nonstationary.

The variable that was an exception, $b_{T,t}$, which is total exports to GDP, was found to reject the null hypothesis of a unit root at a 5 percent level of significance in the ADF test only. The PP test failed to reject the same null hypothesis whilst the confirmatory test, the KPSS stationarity test, rejected the null hypothesis that the series is stationary. Thus, only one out of the three tests indicated that the series was stationary.

The only other variables in the KPSS test where the null hypothesis of the series being stationary was not rejected were $c_{T,t}$, $e_{F,t}$ and $g_{F,t}$. All other variables were found to be nonstationary and as such, confirming the findings of the ADF and PP tests.
Table 14: ADF test for variables when first differenced

<table>
<thead>
<tr>
<th>Series</th>
<th>$R_{US,t}$</th>
<th>$R_{SA,t}$</th>
<th>$a_{T,t}$</th>
<th>$b_{T,t}$</th>
<th>$c_{T,t}$</th>
<th>$d_{T,t}$</th>
<th>$e_{F,t}$</th>
<th>$f_{F,t}$</th>
<th>$g_{F,t}$</th>
<th>$h_{F,t}$</th>
<th>$i_{F,t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: has a unit root</td>
<td>-2.184</td>
<td>-3.728</td>
<td>-4.091</td>
<td>-4.970</td>
<td>-2.981</td>
<td>-5.140</td>
<td>-5.540</td>
<td>-4.052</td>
<td>-5.572</td>
<td>-2.821</td>
<td>-1.658</td>
</tr>
<tr>
<td>Test Critical Values:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>-2.772</td>
<td>-5.125</td>
<td>-4.992</td>
<td>-5.295</td>
<td>-2.817</td>
<td>-4.298</td>
<td>-4.992</td>
<td>-4.200</td>
<td>-4.992</td>
<td>-3.007</td>
<td>-3.007</td>
</tr>
<tr>
<td>Model Selected</td>
<td>None</td>
<td>CT</td>
<td>CT</td>
<td>C</td>
<td>C</td>
<td>CT</td>
<td>C</td>
<td>CT</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Decision at 10%: Reject $H_0$</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

Table 15: PP test for variables when first differenced

<table>
<thead>
<tr>
<th>Series</th>
<th>$R_{US,t}$</th>
<th>$R_{SA,t}$</th>
<th>$a_{T,t}$</th>
<th>$b_{T,t}$</th>
<th>$c_{T,t}$</th>
<th>$d_{T,t}$</th>
<th>$e_{F,t}$</th>
<th>$f_{F,t}$</th>
<th>$g_{F,t}$</th>
<th>$h_{F,t}$</th>
<th>$i_{F,t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Critical Values:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Selected</td>
<td>CT</td>
<td>None</td>
<td>CT</td>
<td>None</td>
<td>None</td>
<td>C</td>
<td>CT</td>
<td>C</td>
<td>CT</td>
<td>CT</td>
<td>None</td>
</tr>
<tr>
<td>Decision at 10%: Reject $H_0$</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
The ADF and PP unit root tests both come to the same conclusion for all variables once they were first differenced, which is that the null hypothesis of a unit root is rejected at, at least a 10 percent level of significance, thus indicating all series are stationary. The confirmatory KPSS stationarity test confirms these results by failing to reject the null hypothesis that the series is stationary within a 10 percent level of significance range, for all but two variables. The variables which rejected the null hypothesis of stationarity were $a_{T,t}$, $b_{T,t}$ and $e_{F,t}$, however, with both the ADF and PP in agreement that the series are stationary, the KPSS is not significant enough on its own to draw an alternative conclusion from. Thus, it is safe to conclude at this point that all variables are stationary when first differenced.

Thus, before the next step in the econometric analysis can take place; all variables are first differenced to ensure stationarity.

### 5.2.2 The Ordinary Least Squares (OLS) Model

To find the channels through which the financial crisis was transmitted from the US to South Africa, the JSE All Share Index returns have been regressed upon an interaction variable which is made up of US returns (S&P 500) and a country-level variable. Also, a distinction has been made between two periods: before and after the collapse of Lehman Brothers in September 2008 since, as discussed above, it is considered to be a turning point in the crisis and a changing point in the transmission mechanism. Thus, two slope dummy variables are
attached to the interaction variable to account for, before and after the crash of Lehman Brothers.

To make comparisons of variables and different transmission mechanisms easier, all independent variables prior to their interaction with US returns have been standardized. Hence, the coefficients on the regressors can be interpreted as being the change in the co-movement due to one standard deviation change in the regressor. As the significance of variables drops considerably when combining different transmission characteristics in one model and the problem of multicollinearity among the variables, estimates shall be reported with only one regressor used at a time. To test the robustness of results, the most significant variables shall be combined in a single model, results of which shall be discussed at a later stage, however, these are interpreted with caution for the above motioned concern.

As pointed out above, only the demand effect trade channel is investigated in this study, as it is limited to a two country sample, the results of which follow below.

Table 17: Testing the significance of the trade channel

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients values and standard errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model I</td>
</tr>
<tr>
<td>Exports to the US</td>
<td></td>
</tr>
<tr>
<td>*Pre-Lehman</td>
<td>0.0037</td>
</tr>
<tr>
<td>Exports to the US</td>
<td></td>
</tr>
<tr>
<td>*Post-Lehman</td>
<td>0.0116***</td>
</tr>
<tr>
<td>Total Exports</td>
<td></td>
</tr>
<tr>
<td>*Pre-Lehman</td>
<td>0.0011</td>
</tr>
<tr>
<td>Total Exports</td>
<td></td>
</tr>
<tr>
<td>*Post-Lehman</td>
<td>0.0059</td>
</tr>
<tr>
<td>Total Trade</td>
<td></td>
</tr>
<tr>
<td>*Pre-Lehman</td>
<td>0.0015</td>
</tr>
<tr>
<td>Total Trade</td>
<td></td>
</tr>
<tr>
<td>*Post-Lehman</td>
<td>0.0066</td>
</tr>
<tr>
<td>Agriculture Exports</td>
<td></td>
</tr>
</tbody>
</table>
What one first notices, when viewing the results, is that none of the variables before the collapse of Lehman Brothers are significant. Indicating that before this time, trade was of little importance in the transmission mechanisms. However, after the collapse of Lehman Brothers, two variables are found to be significant at a 1 percent level. These are exports to the US as a percentage of GDP and agricultural exports as a percentage of GDP, which when undergoing a one standard deviation change, result in a 1.16 percent and 1.67 percent increase in the co-movement between the S&P 500 and JSE All Share Index returns respectively.

Firstly, to comment on exports to the US*Post-Lehman, it is interesting to note that this is significant whilst total exports*Post-Lehman is not. What this indicates is that it is not simply exports in general that transmitted the crisis, but rather exports to the US in particular which explain the transmission of the crisis. Also, one notices that Model I has a substantially larger R-squared value which further emphasises and confirms this result.

Another interesting point arises between agriculture exports*Post-Lehman, which is significant, and mineral exports*Post-Lehman, which is not. This gives an indication that trade composition is also important in the consideration of transmission mechanisms. One would expect mineral exports to be more significant as these are exports (such as gold, platinum, iron ore, ect) which are highly sensitive to changes in global economic occurrences (income elastic) and thus share prices. Agricultural exports, on the contrary, are products which are less sensitive to changes in global economic events (income inelastic) as people...
will always require food for survival. It leads that this is a somewhat surprising result; a result which is further emphasised when viewing and comparing the R-squared values.

Finally, one has to refer to a few other observations in the output presented. All signs of coefficients are positive and thus, as expected. This is the expectation as one would expect a positive relationship between various measures of trade of a country and the share prices of that country. Then also, the Durban-Watson statistics for all variables indicates the various models discussed up until now do not suffer from autocorrelation.

At this point the discussion shall move onto the finance channel, with the output of the relevant tests being discussed below.

Table 18: Testing the significance of the finance channel

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients values and standard errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model I</td>
</tr>
<tr>
<td>FDI Inflows *Pre-Lehman</td>
<td>0.0004</td>
</tr>
<tr>
<td>FDI Inflows *Post-Lehman</td>
<td>0.0041</td>
</tr>
<tr>
<td>Portfolio Inflows *Pre-Lehman</td>
<td>0.0003</td>
</tr>
<tr>
<td>Portfolio Inflows *Post-Lehman</td>
<td>0.0114**</td>
</tr>
<tr>
<td>Other Inflows *Pre-Lehman</td>
<td>0.0002</td>
</tr>
<tr>
<td>Other Inflows *Post-Lehman</td>
<td>0.0157*</td>
</tr>
<tr>
<td>Stock Market Turnover *Pre-Lehman</td>
<td>0.0078</td>
</tr>
<tr>
<td>Stock Market Turnover *Post-Lehman</td>
<td>0.0120***</td>
</tr>
<tr>
<td>Stock Market Cap *Pre-Lehman</td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Stock Market Cap *Post-Lehman</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diagnostics**

<table>
<thead>
<tr>
<th>R-Squared</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0107</td>
<td>0.2932</td>
<td>0.6707</td>
<td>0.7178</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prob(F-statistic)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.9424</td>
<td>0.1483</td>
<td>0.0022</td>
<td>0.0423</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Durban-Watson Stat</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2422</td>
<td>0.5590</td>
<td>1.1079</td>
<td>1.7748</td>
</tr>
</tbody>
</table>

Notes: *, **, *** denote significance at a 10 percent, 5 percent and, 1 percent level respectively

This table considers the importance of financial variables in the transmission of the crisis from the US to South Africa. Once more, the first thing one will notice is that all variables before the collapse of Lehman Brothers are found to be insignificant at a 10 percent level. But, after the collapse, there is a marked change in the transmission mechanism with four out of the five finance variables being significant. Specifically, other inflows *Post-Lehman is significant at a 10 percent level, portfolio inflows *Post-Lehman and stock market capitalisation*Post-Lehman at a 5 percent level, and stock market turnover *Post-Lehman at a 1 percent level. Respectively when other inflows *Post-Lehman, portfolio inflows *Post-Lehman, stock market capitalisation*Post-Lehman and, stock market turnover *Post-Lehman undergo a one standard deviation change, the result is a 1.57 percent, 1.14 percent, 1.59 percent and a 1.2 percent increase in the co-movement between the S&P 500 and JSE All Share Index returns.

Both stock market capitalisation *Post-Lehman and stock market turnover *Post-Lehman speak directly to market liquidity and the role it plays in the transmission of the crisis. As indicated, both were found to be significant after the crash of Lehman Brothers and as such, market liquidity was an important factor in the transmission. Even if a market is not directly exposed to the US stock market (i.e. individual and corporations do not hold US stocks), its market might co-move with the US stock market if the economy is very open to financial flows and the stock market is very liquid. This is as a result of investors who were exposed to the US being forced to redeem investments from other areas, to make up for these massive losses. It makes intuitive sense for them to exit open and liquid markets where one does not pay a large premium for this liquidity and thus pay an extra premium for exiting an investment position. Leading from this, it is of little surprise that liquidity was found to be a significant channel for the crisis to enter the South African market as it is a well observed fact.
that South Africa has one of the most liquid financial markets in the developing world and the most sophisticated in Africa.

The other three variables speak more specifically to capital account openness (exogenous liquidity) and once more as indicated above, other inflows *Post-Lehman and portfolio inflows *Post-Lehman were found to be significant whilst FDI inflows* Post-Lehman was not. This finding is very similar to that of Dieder et al. (2010) who stated that capital account openness was a large determinant in the transmission of the crisis after the crash of Lehman Brothers, specifically portfolio inflows and other inflows. However, it is surprising to find the FDI variable insignificant, as there was a noticeable decline immediately Post-Lehman. Nonetheless, portfolio flows and other inflows follow expectations as with the massive “credit crunch” discussed above in chapter two which occurred in the US, and to a lesser extent Europe, it is unsurprising to find these effects transmitted directly through foreign financial flows into South Africa.

At this point the estimation of all significant variables previously discussed in a single model, will be discussed. As mentioned above, this is done in part to refer to the robustness of results. The relevant table follows below.
Table 19: Testing the significance of multiple factors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1335.553</td>
<td>32.666</td>
<td>40.885</td>
<td>0.0000</td>
</tr>
<tr>
<td>Exports to the US * Pre-Lehman</td>
<td>0.0043</td>
<td>0.0028</td>
<td>1.5262</td>
<td>0.1708</td>
</tr>
<tr>
<td>Exports to the US * Post-Lehman</td>
<td>0.0086</td>
<td>0.0139</td>
<td>0.6148</td>
<td>0.5581</td>
</tr>
<tr>
<td>Agriculture Export * Pre-Lehman</td>
<td>0.0013</td>
<td>0.0016</td>
<td>0.8489</td>
<td>0.4240</td>
</tr>
<tr>
<td>Agriculture Export * Post-Lehman</td>
<td>0.0178</td>
<td>0.0122</td>
<td>1.4594</td>
<td>0.1878</td>
</tr>
<tr>
<td>Portfolio Inflows * Pre-Lehman</td>
<td>0.0008</td>
<td>0.0025</td>
<td>0.3213</td>
<td>0.8021</td>
</tr>
<tr>
<td>Portfolio Inflows * Post-Lehman</td>
<td>-0.0025</td>
<td>0.0039</td>
<td>-0.6426</td>
<td>0.6364</td>
</tr>
<tr>
<td>Other Inflows * Pre-Lehman</td>
<td>0.0009</td>
<td>0.0017</td>
<td>0.51444</td>
<td>0.6975</td>
</tr>
<tr>
<td>Other Inflows * Post-Lehman</td>
<td>-0.0056</td>
<td>0.0068</td>
<td>-0.8291</td>
<td>0.5593</td>
</tr>
<tr>
<td>Stock Market Turnover * Pre-Lehman</td>
<td>0.0010</td>
<td>0.0029</td>
<td>0.5835</td>
<td>0.6358</td>
</tr>
<tr>
<td>Stock Market Turnover * Post-Lehman</td>
<td>0.0268</td>
<td>0.0009</td>
<td>0.1236</td>
<td>0.0489</td>
</tr>
<tr>
<td>Stock Market Cap * Pre-Lehman</td>
<td>0.0074</td>
<td>0.0034</td>
<td>2.1938</td>
<td>0.2723</td>
</tr>
<tr>
<td>Stock Market Cap * Post-Lehman</td>
<td>0.0234</td>
<td>0.0011</td>
<td>1.6149</td>
<td>0.0963</td>
</tr>
</tbody>
</table>
Firstly, one notices as going through the variables, is how few of them, when combined in this multi-variable model, are significant – this includes: Exports to the US * Pre-Lehman; Exports to the US *Post-Lehman; Agriculture Export *Pre-Lehman; Agriculture Export *Post-Lehman; Portfolio Inflows *Pre-Lehman; Portfolio Inflows *Post-Lehman; Other Inflows *Pre-Lehman; Other Inflows *Post-Lehman. Two, however, do stand out: stock market turnover *Post-Lehman and stock market capitalisation *Post-Lehman, which are both significant at a 10 percent level. Once more, one observes that both variables are after the crash of Lehman Brothers which further emphasises the change in transmission which took place after this incident. As one may recall from the above analysis, both these variables speak not only to the financial channel but, specifically, to the role of market liquidity in the transmission of the crisis. Thus, it is evident at this stage that market liquidity is the prominent channel through which the crisis was propagated from the US to South Africa.

### Diagnostic Values

<table>
<thead>
<tr>
<th>Diagnostic Values</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared</td>
<td>0.9873</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.9112</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>83.992</td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>7054.630</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-38.4795</td>
</tr>
<tr>
<td>F-statistic</td>
<td>12.9776</td>
</tr>
<tr>
<td>Prob(F-statistic)</td>
<td>0.2094</td>
</tr>
<tr>
<td>Mean dependent var</td>
<td>1196.681</td>
</tr>
<tr>
<td>S.D. dependent var</td>
<td>281.9239</td>
</tr>
<tr>
<td>Akaike info criterion</td>
<td>11.3699</td>
</tr>
<tr>
<td>Schwarz criterion</td>
<td>11.4394</td>
</tr>
<tr>
<td>Hannan-Quinn criter.</td>
<td>10.9011</td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>1.9737</td>
</tr>
</tbody>
</table>
Specifically as well, due to the methodology used, one can interpret the coefficients as indicating a 2.7 percent and 2.3 percent change in the co-movement (between measures of market liquidity to the S&P 500 and the All Share index) respectively, due to a one standard deviation change in the variables themselves.

The remainder of the variables are for the mostly, insignificant. This does not completely rule out any role they had to play in the transmission of the crisis but, simply is an indication that their role was not one of great importance.

When viewing the adjusted R-squared (which is the preferred measure of goodness of fit in such a large model) 91.1 percent gives an indication that this model is very successful in the explaining the movements of the JSE All Share Index over the period analysed. The Prob(F-statistic) is obviously not as significant as one would hope but, is understandable when viewing the number of insignificant variables in the model. Finally, the Durban-Watson statistic indicates the model does not suffer from autocorrelation.

Although these results prove interesting, one does interpret them with caution as the variables are thought to suffer from multicollinearity. As such, the ultimate conclusion shall not be drawn from these findings, but rather from those in table 18 and 19.
CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSIONS

The Global Financial Crisis is ultimately judged by many, as being the most significant global recession since the Great Depression and undoubtedly the most virulent ever. Though it should be mentioned that the South African economy was largely shielded when compared to global compatriots, primarily due to astute regulation in the banking sector it was, however, unable to avoid the crisis in its entirety. Banking, trade, equities, bonds, exchange rates and other key markets were significantly impacted, which concluded in the 2009 recession; South Africa’s first in 17 years.

The objective of this dissertation was to determine whether this crisis in South Africa was a function of financial contagion or simply interdependence emanating from the US and to establish via which channels, if any, the crisis was transmitted to South Africa from the US.

To overcome the bias of giving large weightings to periods of relative stability, a test which utilizes the extreme outliers was developed. An a-theoretical approach was used, with the definition that contagion is the fraction of exceedance events that is left unexplained by its own covariates, but is explained by the exceedance from another region, being the central justification for the model. Primarily based on the work of Bae et al. (2003), a logit model was developed whereby the extreme outliers of the JSE All Share Index were modelled by the S&P 500 and a number of fundamental covariates.

Work on the transmission mechanisms between the US and developing nations done by Aissa, Aloui & Nguyen (2010) and Chudik & Fratzscher (2011) amongst others; and that done specifically on South Africa by Verick (2010), Powell & Steytler (2010) and others, indicates that it was primarily through trade and financial channels that the Global Financial Crisis was transmitted to South Africa. As such, these channels formed the basis for the analysis with specifically the demand effect channel, exogenous liquidity shock channel and market liquidity channel, forming theoretical backings in the models.

The macroeconomic data set was ultimately decided upon, as being the most practical and beneficial data set from which a number of OLS models were developed; testing each variable separately such that specific inferences could be made. The variables themselves
were interaction variables, which lead to further interpretable information pertaining to the transmission mechanisms. Dummy variables were used to account for the periods before and after the crash of Lehman Brothers due to the hypothesised significance of the event in the transmission of the crisis.

Considering the definition of contagion used, both in the case of bottom tail exceedances and top tail exceedances, contagion was not present. What is found specifically in the case of bottom tail exceedances is that many of the covariates explain the developments in the All Share Index. Thus, the bear market which ensued after the crash of Lehman Brothers is explained for the most part by country wide macroeconomic fundamentals rather than irrational panic induced by the bear market exhibited in the S&P 500 over this period. This finding does not rule out irrationality entirely, as on an individual basis one is always likely to find examples of irrational behaviour; but in the case of the market as a whole, contagion and thus irrationality was not a significant contributor.

Also, at this point one could make the statement that contagion is statistically more likely to have occurred in bear markets than bull markets over the period of observation. This is consistent with findings by Bae et al. (2004) and Chan-Lau et al (2004), who observed contagion only in bear markets and not in bull markets.

Having significantly ruled out contagion as a factor in the South Africa recession, one is left with two options as to why a crisis can occur in two country’s simultaneously, namely: interdependence, which causes the country’s fundamentals and thus, economies, to move in a parallel fashion or; it was simply a chance event that both suffered an economic crisis at the same time. It is on this point that the testing for transmission mechanisms sheds some light.

What is first observed when viewing the results is the importance of the Lehman Brothers liquidation in the transmission of the crisis. This was hypothesised to have had a significant effect due to the impact it had on drastically drying up credit in the US, and to an extent, globally. This hypothesis was proved correct as the channels that were shown to be significant in the transmission were only significant after this event.

When examining the trade channel the initial critical reference point is that, it is not total exports which are significant in explaining the co-movement of South African and US returns but rather specifically, exports to the US. Thus, through the trade channel, it is fair to say that
the original crisis in the US was in fact propagated directly from US - South African trade\textsuperscript{45}. This is a substantial finding from which one can deduce that it was not a global demand shift to the left which initially resulted in the propagation of the crisis, but more specifically, a shift in US demand for South African goods which transmitted the crisis to South Africa. Having ruled out the possibility of contagion, one must conclude that this is as a result of interdependence between the countries or rather, dependence of the South African economy on the US.

Staying within the trade channel, another important point is the significance of trade composition in the transmission of the crisis. Whilst it was slightly surprising to find that mineral exports were not significant in explaining the transmission of the crisis; perhaps more surprisingly, agricultural exports were significant. A point to note, however, is that these are measures of total agricultural and total mineral exports, and not simply those specific exports to the US. Thus, one can assume that due to the aforementioned small role that US imports of South African minerals plays in South Africa’s total exports of minerals, that this channel would not have been significant. It remains surprising, however, due to research by Aissa et al. (2010) who argue that countries with greater reliance on commodities\textsuperscript{46} had a larger dependence on the US over the period of the Global Financial Crisis. As such they infer that the crisis was transmitted through this commodity channel to these countries, a conclusion which is proven false in the case of South Africa with the results found in this dissertation.

With reference to the agriculture exports, however, the US remains a small contributor as an importer of these South African goods; with the Netherlands, United Kingdom, Zimbabwe, Mozambique and Germany being the primary trade partners in the sector (Legare 2010). One would assume agriculture to be an insignificant channel in the transmission, due to the nature of the product, being a basic necessity which is largely income-inelastic. There have, however, been fundamental arguments for the decrease in agriculture exports over this time,

\textsuperscript{45} Although it is conceivable (and probably correct) that the effects of the crisis on South Africa were amplified due its trade effects on secondary countries with whom South Africa is a trade partner, but the transmission from the point of origin was in fact the direct linkage between the US and South Africa.

\textsuperscript{46} Particularly in their research they focus on Brazil and Russia in this regard.
with the volatility of the rand negatively impinging on exports and agriculture output being severely affected by rising input costs\textsuperscript{47} (National Development Agency 2009).

Moving onto the financial channel, the findings are consistent with that of Didier et al. (2010), who did an analysis on the transmission mechanisms of the Global Financial Crisis to a range of economies (excluding South Africa). Ultimately, the findings were that capital account openness was essential to the transmission of the crisis, making the country vulnerable to exogenous liquidity shocks. FDI inflows were found to be insignificant, which is justifiable as these inflows are primarily characterised as long-term investments, which would typically, be less concerned with cyclical movements and more engrossed with the long-term trajectory of investments. Whilst portfolio inflows (and to an extent, other inflows) are of a far different nature, primarily short-term, these adjust daily to the slightest change in market outlook. These were found to be significant channels in the transmission of the crisis. With global uncertainty and the perceived short-term risk in the South Africa market, combined with a liquidity shock which enveloped the US and to an extent Europe; together culminated in mass outflows of capital and ultimately played an important role in transmitting the crisis to South Africa.

Market liquidity was also found to be an imperative channel, with both stock market turnover and stock market capitalisation being significant variables. This continues to meet expectation as the Johannesburg Stock Exchange remains the most liquid exchange in Africa; and with foreign investors facing liquidity shocks, it is intuitive from theory that the South African market would suffer largely from investor withdrawals.

\section*{6.2 RECOMMENDATIONS}

Most policy recommendations from this and other crises revolve around the stability of fiscal debt burdens, improved flexibility in exchange rate and labour markets, and strengthening financial systems. These are, however, all areas in which South Africa has achieved much

\textsuperscript{47} The price index for fertilizers showed the largest increase - 103.6 percent for the year ending March 2009. However, other increases were also apparent - machinery trucks and implements increased 32.9 percent; costs of seeds increased by 21.6 percent and; costs of feeds increased by 20.1 percent (National Development Agency 2009).
success and which invariably assisted, fundamentally in limiting the transmission of the Global Financial Crisis.

From a theoretical perspective, this dissertation contributes to the ever growing literature on the rationality in financial markets. Here, the argument from these findings is that in the case of the JSE All Share Index, market participants as whole reacted rationality during and in the wake of the Global Financial Crisis. Consequently, it is recommended that one makes the assumption of rationality if future modelling of the JSE should occur over the time period in question.

From an investor perspective, there is evidence that there are benefits to international portfolio diversification. If the market is unlikely to respond irrationally to a foreign economic shock, then there are definite benefits to be had from international portfolio diversification if the other countries used, have little fundamental linkages (interdependence) with South Africa. Although this is not a conclusive finding for the primary reason that investors have little concern for the narrow definition of contagion used in this dissertation. In the context of portfolio diversification; they are principally focussed on correlations and the absolute movement of markets in relation to one another. Also, other countries specifically would need to be tested before any conclusive claims could be made. Nonetheless, it does raise an interesting point and is definitely a field for further research.

Then from a policy perspective, if one makes the assumption that the stock market is a sufficient proxy for the economy as a whole, one could argue that the economic recession was in fact a rational reaction to shifting fundamentals. A new, lower equilibrium point was now the reality where the demand for credit, goods and services was at a reduced level and supply of credit had similarly decreased. It does as such follow, that the stimulus package introduced as a policy response to the crisis by the South African government comes into question48. This response only slowed the movement of these fundamentals to this new equilibrium point and could not in fact change what this equilibrium point had shifted to, in the long run49.

48 The South African government increased funding for public investment projects with an allocation of R 690 billion over the three year period, 2009 to 2011. In absolute terms, South Africa’s stimulus package is the largest in the region and would even rank fourth in the world.

49 This recommendation holds provided one ascribes to both the crowding-out theorem and the Ricardian debt equivalence theorem.
What other crises have indicated, in particular the East Asian crisis of 1997, is the risk short-term capital flows introduce into a market. This point is once more brought to the forefront with “portfolio flows” and “other flows”, both being significant in the transmission of the crisis to South Africa. These investments have a number of positive effects, none less than allowing domestic corporations easier access to capital, but these positive affects need to be considered in relation to the negative implications that accepting such investments gives rise to. Accordingly, the recommendation from this is that, further research should be done on this topic in particular, and the net effect capital control polices may have as a regulatory policy measure in South Africa be investigated\textsuperscript{50}.

6.3 LIMITATIONS OF STUDY

The primary limitation in testing for financial contagion was the inability to obtain sectoral data for the US and South Africa, for an empirical investigation of contagion which excluded the bias of average index measures highlighted by Abrahamson & Collins (2004). This dissertation would have been the first work to simultaneously overcome the average index bias, whilst circumnavigating the bias of giving large weightings to relative periods of stability.

Considering the results we are now aware of, it also would have been interesting to include a number of different variables to further account for trade composition differences. Thus, a number of different trade sectors could have been introduced to observe their relative importance in the transmission of the crisis; perhaps another point for further research.

Although not a limitation of this study, as the primary objective was to investigate contagion between the US and South Africa; but further research could include a number of different countries. This is done such that the cheap import effect and competition effect could be tested, along with the presence of contagion from other markets and their relative impact on the JSE and South Africa.

\textsuperscript{50} This is a point similarly highlighted by the IMF who endorsed, in some countries, the use of capital controls in the wake of the Global Financial Crisis. In February 2010, the IMF officially declared that there may be a role for capital controls as a regulatory policy tool even if there is no crisis to react to.
APPENDIX

Table 20: Variable definitions and sources

<table>
<thead>
<tr>
<th>Variable Name and Symbol</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA Stock Market Returns (%) - $R_{SA,t}$</td>
<td>Quarterly SA stock market returns between July 2007 and April 2009 – JSE All Share Index</td>
<td>Johannesburg Stock Exchange</td>
</tr>
</tbody>
</table>

**Trade Channel**

<table>
<thead>
<tr>
<th>Exports to US / GDP (%) - $a_{T,t}$</th>
<th>Exports to the US divided by current GDP</th>
<th>South African Revenue Service (SARS) and IMF International Financial Statistic CD-ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports / GDP (%) – $b_{T,t}$</td>
<td>Total exports to current GDP</td>
<td>IMF International Financial Statistic CD-ROM</td>
</tr>
<tr>
<td>(Exports + Imports) / GDP (%) - $c_{T,t}$</td>
<td>Export and import to current GDP</td>
<td>IMF International Financial Statistic CD-ROM</td>
</tr>
<tr>
<td>Agricultural Exports / Exports (%) - $d_{T,t}$</td>
<td>Agricultural raw material exports to total merchandise exports</td>
<td>South African Revenue Service (SARS) and IMF International Financial Statistic CD-ROM</td>
</tr>
<tr>
<td>Mineral Exports / Exports (%) - $j_{T,t}$</td>
<td>Mineral Exports to total merchandise exports</td>
<td>South African Revenue Service (SARS) and IMF International Financial Statistic CD-ROM</td>
</tr>
</tbody>
</table>

**Financial Channel**

<table>
<thead>
<tr>
<th>FDI Inflows / GDP (%) - $e_{F,t}$</th>
<th>Foreign direct investment inflows divided by current GDP</th>
<th>IMF International Financial Statistic CD-ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Ratio</td>
<td>Description</td>
<td>Source</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td>--------</td>
</tr>
<tr>
<td>Portfolio Inflows / GDP (%) - $f_{F,t}$</td>
<td>Portfolio investment asset inflows divided by current GDP</td>
<td>IMF International Financial Statistic CD-ROM</td>
</tr>
<tr>
<td>Other Inflows / GDP (%) - $g_{F,t}$</td>
<td>Other asset inflows divided by current GDP</td>
<td>IMF International Financial Statistic CD-ROM</td>
</tr>
<tr>
<td>Stock Market Turnover (%) - $h_{F,t}$</td>
<td>Ratio of the value of total shares traded to average real market capitalization</td>
<td>South Africa Reserve Bank</td>
</tr>
<tr>
<td>Stock Market Capitalization / GDP (%) - $i_{F,t}$</td>
<td>Ratio of the value of listed shares to GDP</td>
<td>Johannesburg Stock Exchange</td>
</tr>
</tbody>
</table>
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