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Contagion and interdependence of African Equity Markets

Olatunde, Olufemi Babatunde

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Title

Contagion and interdependence of African Equity Markets

Student name

Olufemi Babatunde Olatunde

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Business Administration

(MARCH 2011)

ABSTRACT

Background

This study examines the topic of contagion and interdependence of select African equity markets. Interdependence is measured over a five year period split into a full period, pre-crisis period and a crisis period. Also, contagion effects on five African equity markets as a result of the United States (US), sub-prime triggered financial crisis are ascertained.

This study has two aims. First, it seeks to determine the strength of the relationship between equity markets in Africa. Secondly, it examines if any of the selected African markets suffered contagion effects as a result of perhaps the hardest hitting financial crisis of all time.

Using data supplied by a financial research firm, I-net Bridge, data representing closing market indices over a six-year period (2004 to 2009) for six equity markets (including that of the US and five African equity markets) were collated and analysed for the purpose of the study.

Results

The results of this study are generally consistent with those of previous studies with respect to both research aims. Results show that African equity markets show very weak statistical relationship with each other. With the exception of South Africa and Egypt results also point to weak statistical relationship with the US's equity market. This is in line with previous research attempting to establish interdependence of African markets. With regard to the second research aim, three of the countries tested for contagion (Egypt, South Africa and Nigeria) were found to have suffered contagion effects as a result of the US- sub-prime triggered financial crisis. The other two, Botswana and Kenya, did not suffer contagion effects. These results are partly consistent with those of previous research. Past research often showed South Africa and Egypt to have suffered contagion effects as a result of financial events.

DECLARATION

I, **Olufemi Babatunde Olatunde**, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Olufemi Babatunde Olatunde

Signed at ……

On the …….. day of …… 2011

DEDICATION

To my wonderful and loving parents

For your support and sacrifice

ACKNOWLEDGEMENTS

My thanks go to the following people:

To members of my family for giving me their support through the years.

To my Supervisor, Professor Kalu Ojah for painstakingly providing me with his support and expert knowledge.

To Mr Doug Taylor and Dr. Thabang Mokoaleli-Mokoteli for their guidance and support and for sharing their expert knowledge.

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CHAPTER 1: INTRODUCTION

1.1 Purpose of the study

The purpose of this study is to determine whether select African equity markets suffered contagion effects as a result of the US sub-prime crisis of 2007. It also seeks to understand statistical relationships between these equity markets in the years 2004 - 2009.

1.2 Context of the study

The year 2008 witnessed perhaps the greatest financial crisis since the great depression (Wade, 2008). It was tagged the sub-prime crisis because it arose as a result of sub-prime mortgage loans granted to borrowers of poor credit standing to enable them finance the purchase of property. According to Crouhy et al., (2008), borrowers of sub-prime mortgage loans were unable to repay loans granted to them thereby having a knock-on effect on both the US financial system and several other financial systems and economies across the world.

It is important to note that world markets have become more integrated in recent times. This increased integration has come in terms of increased trade and cooperation between and amongst countries. For example, Lloyd (1999) in describing the increased interdependence of world economies, distinguished economies as 'world economies' and 'global economies'. He defined world economies as all economies in the world and global economies are defined as economies of countries that are integrated to such an extent that it is difficult to analyse their events and policies without a mention of the economies with which they are integrated. Furthermore, he discussed the increased involvement of more world economies as global economies.

This increased interdependence has led many economists, academics and financial analysts to study the extent to which events in one part of the world affect another. This is of increased interest particularly because of investment interests and because analysts and other interested parties want to know the extent to which diversification

of investments and resultant reduction of risks across world markets is possible (Hon, 2004).

On the one hand, global integration is beneficial to economies and financial institutions that operate in them. Both Levine (2001) and Bekaert et al., (2002) highlight the importance of global integration and liberalisation of economies. They suggested that global integration makes it possible for companies to access funds with lower costs which may translate to benefits via increased economic activity. Conversely, however, global integration exposes countries to financial crises. Collins and Biekpe (2003) suggest that the extent of integration of an economy with the rest of the world determines the extent of it suffering from shocks as a result of financial crises. The more developed countries which are seen as being more integrated in terms of globalisation often suffer more shocks and contagion effects as a result of world events (for example, the September 11 World Trade Centre attacks in the US and the Argentine crisis of 2002) (Hon, 2004; and Boschi, 2005). Edwards (1998) points out that some advocates of some type of cross border capital flow restriction, advocate for it because of their belief that it may help reduce or even eliminate spillover effects as a result of contagion across emerging markets.

As a result of the possible effects of crises spillover, there has been increased interest in emerging economies and the role they could play in helping investors diversify their portfolio. Harvey (1995) suggests emerging markets' equity returns (which include African national markets) normally have low correlations with developed markets. He goes further to state that most of these developing markets normally have abnormally high returns when compared with their developed counterparts. Also, on a positive note, emerging economies were found to have more predictable returns as compared to their developed economies counterpart. Thus an argument could be put forward for the attractiveness of emerging economies and the role they could play in helping investors diversify their global portfolios.

In addition, African countries are seen as new frontier markets for investors. According to the IMF (2008) most African countries have consistently grown faster than most of the developed economies. They go on to highlight the role African countries could play as a second frontier market for investors. Although noting its relative illiquidity compared to other emerging markets, Senbet and Otchere (2008)

highlight the attractiveness of African markets in terms of returns to investors. They show that the returns on select African markets are comparable to those of Asian and Latin American countries (which are regarded as attractive emerging economies in terms of return on investment).

The following table shows the Sharpe measure and returns for select African countries. These countries include the five selected for the purposes of this research.

Risk-adjusted performance of African Stock Markets (Senbet and Otchere 2008).

Table 1: Performance based on local currency (1990-2006)

(All figures in percentage)

Country	**Mean[1] return**	**Sharpe[2] Measure**	**P/E[3] ratio (mean)**	**P/BV[4] ratio**
Botswana	25.93	0.5	13.5	6.73
Cote d' Ivoire	9.88	0.1	7.39	1.71
Egypt	103.07	0.39	15.02	4.02
Ghana	44.72	0.28	7.4	4.47
Kenya	18.87	0.06	17.19	2.24
Malawi	15.18	-0.64	n/a[5]	n/a
Mauritius	15.85	0.41	8.69	1.2
Morocco	25.64	0.6	18.62	2.55
Namibia	16.69	0.08	7.11	1.74
Nigeria	33.77	0.53	15.51	3.21
South Africa	16.78	0.24	12.8	3.32
Swaziland	8.02	-0.06	n/a	n/a
Tunisia	22	0.45	13.16	1.33
Zambia	13.16	-0.94	n/a	n/a
Zimbabwe	164.48	0.24	10.73	3.58
Pre- 1999	31.53	n/a	n/a	n/a
Post- 1999	322.05	n/a	n/a	n/a
Africa	38.35	0.54	12.26	3.01
Malaysia	9.32	n/a	21.72	2.08
Mexico	31.51	n/a	18.63	3.84

Table 2: Performance based on United States Dollar (USD) (1997-2006)

(All figures in percentages)

Country	Mean Return	Sharpe Measure	P/E ratio (Mean)	P/BV (mean)
Botswana	31.92	0.69	13.5	6.73
Cote d' Ivoire	9.2	0.19	7.39	1.71
Egypt	30.04	0.29	15.02	4.02
Ghana	0.64	-0.72	7.4	4.47
Kenya	27.82	0.25	17.19	2.24
Mauritius	9.8	0.22	8.69	1.2
Morocco	13.94	0.31	18.62	2.55
Namibia	5.57	-0.19	7.11	1.74
Nigeria	13.42	-0.03	15.51	3.21
South Africa	11.63	0.03	12.8	3.32
Tunisia	1.91	-0.14	10.73	1.33
Zimbabwe	105.67	0.05	21.72	3.58
Pre- 1999	11.09	n/a	18.63	2.08
Post- 1999	30.2	n/a	12.26	3.84
Africa	21.8	0.1	n/a	3.01
Malaysia	22.67	n/a	21.72	2.08
Mexico	24.85	n/a	18.63	3.84

[1]Mean return: Average returns using daily closing price indexes of the market.

[2]Sharpe Measure: Excess return by measure of risk.

[3] P/E ratio (mean) (Price/Earnings ratio): Market price / earnings on all stocks multiplied by 100

Table 1 and 2 show that African countries performed quite well in terms of returns to the investor for the periods 1990 to 2006 (local currency) and 1997 to 2006 (USD) respectively. This is even more so after adjusting for risk. The annual returns in local currency terms for the period average at 38.35% and the SHARPE ratio is at 0.54%. These returns compare favourably with Malaysia and Mexico, two emerging market countries which average at 9.32% and 31.51% respectively. What is even more impressive is that these returns still remain very attractive when converted to the US dollar, averaging an annual return of 21.80% and a SHARPE ratio of 0.10.

The possibility of higher returns notwithstanding, African economies are exposed to possible contagion effects as a result of financial crises due to globalisation and increased trade with other economies of the world. This has prompted studies on contagion on African economies in times of crises. For example, Collins and Biekpe (2003) looked at contagion effects on African markets due to the Asian financial market crash of 1997. Similarly, Siriwardana and Dollery (2002) investigated contagion effects of the Asian crises on Southern African economies. Although the contagion effects of the most current global financial crises on African markets still remain to be effectively appreciated and assessed, Morales and Andreosso-O'Callaghan (2010) in a conference paper titled "The global financial crisis: world market or regional contagion effects?" attempted to look into contagion effects of the current global financial crisis as it pertains to African countries. The question is "are African markets globally integrated to such an extent as to have suffered contagion effects as a result of the US subprime triggered financial crisis of 2007?. "

This research aims to answer this question by observing market indices of the US stock market (Dow Jones Industrial Average) and six of African stock markets namely; South Africa (Johannesburg Securities Exchange), Nigeria (Nigerian Stock Exchange) and Kenya (Nairobi Stock Exchange) and Botswana (Botswana Stock Exchange) and Egypt (Egyptian Stock Exchange). The market data was obtained from I-net Bridge and covers two time periods, first 2nd January 2004 to 17th September 2007 (representing the pre-crisis period); second, 18th September 2007 to 20th February 2009 (representing the crisis period). Also statistical relationships between African national stock markets are ascertained for the same time periods.

The remaining sections are organised as follows: the remainder of this chapter covers the statement of the problem and the objectives which the research aims to meet, significance of the study and the limitations of the study. Chapter 2 covers the literature review on the interdependency of financial markets, financial crises and contagion. The literature review section covers areas such as; the intra and inter regional relationships between equity markets, a history of crises in financial markets and a look at markets in which the topic of contagion has surfaced. Chapter 3 covers the research methodology section which delves into such areas as the research methodology, research design, a definition of the population and sample, reliability and validity of the data. Results are presented in chapter 4 and presented in chapter 5 while concluding remarks in chapter 6 completes the study report.

1.3 Problem statement

As stated earlier, the increased interdependency of markets increases the possibility of financial crisis spreading from one part of the world to another. This could create problems for otherwise healthy markets in that they start exhibiting the same symptoms as those of the crisis ridden market. This phenomenon therefore creates problems for interested parties for example, global investors and economists, who may want to know to what extent diversification across markets is possible.

The aforementioned therefore becomes a problem if investors seeking to invest across markets are unaware of which markets are easily susceptible to crisis originating outside of its borders.

This research therefore aims to bridge the gap by identifying which of the six selected African markets suffered contagion effects as a result of the US- sub-prime triggered financial crisis. Also, it aims to explore the strength of the relationships existing between these selected African markets using statistical models.

1.4 Objectives of the study

Arising from the aforementioned problem statement (above) therefore, the main objective becomes that of solving the problems identified therein. The issues

identified in the problem statement above can therefore be broken down into two objectives to be solved as follows:

1.4.1 *Objective 1*

The first objective is to ascertain the relationships between African national markets for the period under review.

1.4.2 *Objective 2*

The second objective is to identify which African equity markets were subject to contagion effects as a result of the US sub-prime triggered financial crisis of 2007 for the period under review.

1.5 Significance of the study

This study of contagion effects is well established (Forbes and Rigobon, 2002; Collins and Biekpe, 2003). However, there is a significant gap in the existing literature on these topics with regard to African national stock markets both in the light of the US-subprime triggered financial crisis and other financial market impacting events.

The significance that the knowledge of interdependence brings is that it enables investors who know which markets are interdependent to be diversified adequately across African equity markets. In addition, the knowledge of which African equity markets were subject to contagion effects enables investors to be appropriately diversified across these markets.

This study therefore seeks to establish which of the selected African equity market was exposed to contagion effects as a result of the US sub-prime triggered financial crisis. It also aims to establish the statistical relationship among select African equity markets.

1.6 Delimitations of the study

A number of events (in the six selected African markets) happened before, along side and after the subprime crisis; for example, the Kenyan political uprisings of 2008 and the Nigerian banking crises of 2008. While acknowledging these events and the impact each may have had on the financial markets of individual countries, this study only focuses on the US subprime triggered financial crisis.

1.7 Definition of terms

Cost of capital- "expected return for the use of a firm's stock" (Lambert, Leuz and Verrecchia, 2007)

Emerging markets- described as economies which are in a transitional phase of development and economic reform. These economies are seen as having high economic growth rates (Investopedia, 2010). Stock markets which show same features as those in developed economies (IMF, 2008).

Frontier markets- A term used to describe markets which are less liquid and smaller than those markets in the larger and more advanced emerging market economies (IMF, 2008).

Financial markets- Markets in which financial products are exchanged for value (Heffernan, 1990).

Refinance- the substitution of an existing debt obligation with a new debt having different terms (Crouchy et al., 2008)

Securitisation- the pooling together of debt instruments into a single financial product thereby distributing the risk inherent in them (Crouchy et al., 2008)

Diversification- A portfolio strategy designed to reduce the risk in a portfolio by combining various types of investment (having differing risk qualities) in one portfolio thereby producing the optimum risk-return ratio.

1.8 Assumptions

The following assumptions have been made regarding the study:

a. The accuracy of the data that would be used in this study is assumed. Strong reliability is placed on data source.

b. The total number of observations (daily returns) involved in the study will be sufficient for the purpose of statistical analysis.

c. The period for review would be long enough to ascertain statistical relationships between data sets

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This literature looked into previous work done as regards interdependence of markets, financial crises and contagion. First, a discussion ensued on the interdependence of markets. Issues such as the benefits of knowing how interdependent markets are and the relationship of markets within and across regions are looked at. This is then followed by a definition of financial crisis and a history of financial crises in financial markets. Subsequently, a background discussion on the US-subprime triggered financial crisis followed. Following this is a definition of contagion, its transmission channels and a discussion around a number of markets affected by financial crises in which the topic of contagion has surfaced.

In the conclusion of the literature review section, a summary on both the topic of interdependence of markets and contagion is given. Also, a mention is made as to how the knowledge regarding the research questions can be beneficial to all stakeholders. This is followed by a statement of the research questions.

2.2. Interdependence of markets

Interdependency refers to the extent to which subjects depend on each other. In the financial sense however, interdependency refers to the extent to which markets depend on each other. This dependency is reflected in the strength of the relationship existing between them which is expressed through statistical methods.

Koutmos (1996) emphasised the importance of interdependence of markets. He noted how the knowledge of interdependency between markets can be beneficial to policy-makers and investors. He explained that knowledge with regards to how markets interrelate enables policy-makers to identify the desirable and undesirable effects of market interdependence. This then allows appropriate policies to be made with regard to benefiting from or mitigating the effects brought about as a result of the interdependency of markets. This for example, would include the introduction of efficiencies to benefit from an interdependent economy.

On the one hand, markets which are not interdependent create room for investors to benefit from diversifying their investment portfolio. Harvey (1995) explained that emerging stock markets returns often have low correlations with developed stock markets returns and therefore investors could benefit from diversification and from investing a portion of their portfolio in emerging markets. Low correlation between markets implies that risk can be diversified away and therefore investors can reap positive returns in foreign markets when the home market witnesses negative returns. Gilmore and McManus (2002) found that central European equity stock markets (which are regarded as emerging stock markets) had low correlations with the US market and that US investors could have benefited from diversifying into these markets.

On the other hand, however, investors who are invested across markets which show an interdependent relationship are better able to predict movement in equity prices. Cajueiro and Tabak (2006) found evidence of short and long run predictability of four out of six transition European markets' equity returns which were earlier found to be interdependent.

A number of reasons are given as to why interdependency between stock markets exists. Pretorius (2002) summarised them as; economic integration, contagion effects and stock market characteristics. Economic integration he explained as not only arising from trade but from factors such as co-movement in economic indicators like interest rates and inflation. Contagion effects he describes as "co-movement that cannot be explained by economic fundamentals". Lastly, stock market characteristics he describes as factors such as industrial similarity, stock market size and volatility which also influence the level of market interdependence.

Most studies relating to interdependence have tended to point to stronger interdependence of equity markets within regions. This is especially true for markets existing within the emerging markets space. Hung and Cheung (1995) tested the strength of the relationship of five emerging Asian economies for periods between 1981 and 1991 (by dividing into two sub-periods spanning five years each). Although their studies find no co-integration in the first sub-period, they find that these economies are co-integrated with each other in the second sub-period (after converting stock indices to reflect US dollar prices). Narayan et al. (2003) studied the

relationship amongst four South Asian countries; Bangladesh, India, Pakistan, Sri Lanka. They found that each of these markets had a significant influence on each other. Furthermore, Majid et al. (2009) tests the strength of the relationships existing between the ASEAN economies of Malaysia, Indonesia, Thailand, Singapore and Philippines before and after the US financial crisis of 1987 using stock market indices. They attempted to examine both short and long term relationships for periods spanning nine years before and after the crisis respectively. They found that these economies generally have a strong relationship with each other, both in the short and long term.

Studies relating to interdependency in Latin America are few but tend to point to a strong interdependent relationship amongst countries' stock markets within the region. Chen et al. (2002) examined the relationship within this region . Their study covered six countries which include Columbia, Venezuela Mexico, Argentina, Brazil and Chile and covered from 1995 to 2000. By employing co-integration analysis and error correction vector auto regression (VAR) techniques, their results showed a strong interdependent relationship amongst stock markets of this region. Subsequently, Fujii (2005) tested the relationship among four Latin American stock markets namely Mexico, Argentina, Brazil and Chile. This test covers an eleven year period spanning 1990 to 2001. The research pointed to a strong relationship between these markets with Brazil having the strongest influence on the others.

Results for interdependency within the developed markets arena are mixed. While, Koutmos (1996) pointed to a more integrated European stock market, Ewing et al. (1999) provides evidence of a less integrated North American equity market. Koutmos (1996) tests for the relationship associations existing in the European equity markets of UK, France Italy and Germany. He uses daily data from each of the equity markets and covered a 5 year period from 1986 to 1991. His findings pointed to a more integrated European market. Chelley-Steeley and Steeley (1999) examined interdependency of five European markets (UK, Germany, Switzerland, Italy and France) after the removal of exchange controls and found a more integrated European market. Ewing et al. (1999) tested for integration of North American equity markets following the US stock market crisis of 1987. They found no evidence of co-integration present in the three markets of US, Canada and Mexico.

Research that attempted to study relationships among African equity markets has been virtually non-existent. The reason for this may not be far fetched. African markets have been found to be largely illiquid, unsophisticated and are relatively small in size (market capitalisation) and hence the non-interest (Senbet and Otchere 2008). This said however, the one available research points to weak relationships existing between African national stock markets.

Collins and Biekpe (2003) examined the relationship between ten African markets. This they did by correlating weekly market data for a 6 year period spanning 1995 to 2001. Although they find 14 significant relationships evident within correlation coefficients, most of the relationships are generally weak. With the exception of the relationship between South Africa and Egypt, They found that stronger relationships in African national stock markets are more evident along regional lines. They concluded that strong intra regional trade is responsible for this rather than fundamentals. Furthermore, they performed granger causality tests to also understand the casual relationships. The only causal relationship existing is that between South Africa and Zimbabwe.

As opposed to finding intra regional relationships, a number of studies examined inter-regional relationships between equity markets i.e. relationships between regions. Results for this have been mixed. Gilmore and McnManus (2001) established that low correlation existed between the US equity market and three Central European stock markets. Otchere (2001) examined the relationship between South Africa and seven of the developed world's equity market. His study covered a thirteen year period from 1987 to 2000. He found that with the exception of Japan all the other equity market tested show a strong long run relationship with South Africa. Johnson and Soenen (2003) examined the relationship between the US (North America) and a mix of Latin and North American equity markets for an eleven year period from 1986 to 1999. Their results pointed to a strong relationship between the US and these markets. Fujii (2004) examined the relationship between equity markets located between Asia and Latin America. He found that an interdependent relationship existed between markets of both regions.

Although African equity markets face challenges, most of which stem from the nature of their economies, IMF (2009) notes an increase in trade of African countries with

themselves. It would therefore be interesting to note whether this trend would reflect in the strength of relationships existing between countries within the region.

2.3. Background discussion on financial crises, the US subprime crisis and contagion.

Sachs, Tornell, Velasco, Calvo and Cooper (1996) pointed out that a country with weak economic fundamentals is more susceptible to financial crises. Baldacci, de Mello and Inchauste (2002) described a financial crisis as leading to a slowdown in economic activity and subsequently creating social problems for the society. They note the impact which financial crises have on the standard of living of individuals. In the same vein, .Bussiere and Fratzscher (2006) described a financial crisis as having a weakening effect on the economic fundamentals of an economy.

A history of crises in financial markets can be traced back to the US. This crisis, the first recorded in modern times occurred between the years 1930 to 1933. It was triggered by a banking crisis which occurred after a depression in 1929. It was therefore tagged the great depression as a result of it being the longest economic depression in the Country's history (Bernanke 1983).The world has since witnessed a number of financial crises thereafter, including a number of which occurred in the recent past. Examples include; the Mexican peso crises of 1994, Asian crises of 1997 and the Russian crises of 1998, to mention but a few.

Financial crises can be divided into various types including: currency crises, banking crises, sovereign debt crises, private sector debt crises and equity market crises.

Financial crises may at times originate from individual countries, spreading to entire regions and even having global impact. For instance, there was a financial crisis in Mexico in 1994 termed the 'Mexican Peso Crisis'. Although this crisis originally originated in Mexico, it later spread to Argentina and Brazil (South American countries) in early 2005 (Sachs et al. 1996). The US-subprime triggered financial crisis although originating in the U.S. spread outside of its borders to most countries across the globe (Crouhy et al. 2008).

The following table shows a number of financial events which have occurred in the past as well as the country from which they originated.

Table 3: Financial events and country of origination

Date	Event	Base country
May-97	Czech Koruna crisis	Czech republic
Jul-97	Asian crisis	Thailand
Nov-97	Zimbabwean Dollar crisis	Zimbabwe
Jun-98	South African Rand crisis	South Africa
Jan-99	Brazilian Real crisis	Brazil
Jul-01	Argentinean Peso crisis	Argentina
Sep-01	September 11 terrorist attack	United States of America
Jan-02	Complete introduction of the Euro	European Union

(Source: Collins and Gavron, 2003; 577)

The origins of the US subprime triggered financial crisis can be traced back to the early 2000's. During the years 2001 to 2007, the world economy experienced a boom unlike it had ever experienced in the prior thirty years (Wade 2008). In the US, this was no different as the country experienced a booming housing market like no other it had ever witnessed. The boom in the housing market saw an era in which mortgages were extended to borrowers who would not have otherwise qualified for them. Fuelling this scenario, was a low interest rate environment and a search for higher returns on the part of investors (Crouhy et al. 2008). Also, rising property

prices meant that investors were able to refinance their houses based solely on their price rise. Furthermore, Crouhy et al.(2008) explained that the aftermath of reckless lending on the part of financial institutions was that when interest rates began to rise, borrowers were unable to afford repayments on their mortgages.

Subsequently, default on mortgages resulted in bad loans which translated to write down/losses on the part of financial institutions. For example, world wide losses by Insurers and Banks were estimated at over $1.6 trillion as a result of the US subprime triggered financial crisis (Bloomberg 2009).

As a result of investors' reaction to negative news in the financial markets (such as the liquidation of companies like Lehman Brothers), the DJIA witnessed a series of drop in the index notable amongst which were (as represented in table 3 as follows).

Table 4: Notable changes in the DJIA as a result of the US-subprime triggered financial crises of 2008

Date	Drop in index	Index close
September 15, 2008	504.48	10917.51
September 29, 2008	777.68	10365.45
October 15, 2008	733.08	8577.91

(Source: author's computation)

Since the interconnection of markets increases the possibility of crisis spreading from one market to the other, the US-subprime triggered financial crisis spread to other markets around the world. For example, the securitisation of mortgages in the US meant that these securities could be sold to other markets around the world. A consequence of this was that, not only did financial institutions based in the US suffer losses; other financial institutions based in other markets suffered losses too.

A result of the US-subprime triggered financial crisis was that various countries around the world started to feel its impact. National stock markets experienced

losses, some currencies experienced losses in value, imports and exports around the world were greatly affected. This was no different in Africa, as most African countries faced negative consequences as a result of the global financial crisis The IMF stated that the implications of the crisis for sub-Saharan Africa included the following (IMF, 2010):

- Most sub-Saharan African countries witnessed reduced exports with a reduction in some commodity prices. For example, this had a huge effect on the oil exporters. Also, the year 2009 saw a remarkable slowdown in remittances from workers working outside of Africa into Africa.

- There were reduced capital inflows into Africa and a reduction in trade finance. It also caused a reduction of donor aid into Africa.

- It had an effect on the quality of credit portfolios of financial institutions. Albeit not as impacted as their foreign counterparts, a number of African Banks witnessed of losses of financial assets, for example, in the case of local banks having deposits and investments with troubled foreign banks.

- Slowdown in trade, thereby resulting in a reduction in government revenues and finally;

- Economic growth in Africa weakened considerably.

The consequences of this impact on African economies also included slowing consumer demand (which had very negative consequences on businesses), unemployment, and slowing economic growth. All said however, the impact which the crisis had on Africa was less muted than that affecting most parts of the world. Most African countries still displayed positive economic growth albeit less growth than in the past.

The impact of the most current global financial crisis has led many economists, financial analysts and academics to start the debate around contagion and how this present crisis has had a spillover effect on other markets outside of the US.

Subsequently, a number of studies were carried out to find out the extent to which the US sub-prime triggered financial crisis affected other countries. For instance,

Morales and Andreosso-O'Callaghan (2010) in a conference paper titled "The global financial crisis: world market or regional contagion effects?" examined the effects of contagion of the current global financial crisis on African, Middle Eastern, Asian, Eastern European, European and American national stock markets. Similarly, Lupu and Lupu (2009) examined contagion effects across Central and Eastern European stock markets also as a result of the current global financial crisis.

2.4. Contagion defined.

Contagion is derived from the word contagious which means 'to spread' or 'infectious'. In the financial sense however, contagion means the spreading of market disturbances from one market to another. One definition common to a number of the literature on contagion (Collins and Biekpe 2003; Hon, Strauss and Yong 2004) is the one given by Forbes and Rigobon (2002; 2223).They defined contagion as "a significant increase in cross-market linkages after a shock to one country (or group of countries)". According to this definition, contagion is only present if there is a significant increase in co-movements between markets after a shock notwithstanding that the markets could have been highly correlated before and after the shock. The authors distinguish between interdependence and contagion. They distinguished the two on the basis of extent of co-movement between markets prevalent after a financial event/crisis. According to them, interdependence is said to be prevalent if the extent of the co-movement after a crisis is not significant while it is contagion if co-movement increases significantly after a crisis.

Forbes and Rigobon (2002) gave two important advantages of their definition. One, it narrows down the definition thereby making the testing for contagion straightforward. Secondly, it helps provide a straightforward method explaining how shocks are transmitted across markets.

Contagion implies that the crisis originating in one market or country spreads to other areas that were originally unaffected and these markets begin to show the same symptoms as the market in which the crisis originated from.

Results into research that have atempted to test for contagion have been mixed. Forbes and Rigobon (2002) tested for contagion across a series of events and

across world markets. Using correlation and adjusting for heteroskedasticity, they found no evidence of contagion during the 1987 U.S. market crash, 1994 Mexican currency crisis and the 1997 East Asian crisis. Countries included in this study included those in Latin America, Eastern Asia, Europe and other emerging markets (such as China, India, Russia and South Africa).

On the other hand however, Collins and Gavron (2005) established that contagion occurred in eight of nine events in which they tested for contagion. These events included; the Czech Koruna crisis, the Asian crisis, the Zimbabwean Dollar crisis, the South African Rand crisis, the Russian default crisis, the Brazilian Real crisis, the Argentinean Peso crisis, September 11 terrorist attack. These events were tested across six trade blocs spread across different geographical areas covering forty four countries using a correlation-adjusted model. However, the extent of contagion as a result of these events differed. For example, the Argentinean Peso crisis was the most contagious infecting fourteen countries, while the September 11 attacks and the introduction of the Euro had the least impact in terms of contagion. The only event not resulting in contagion was the introduction of the Euro which resulted in increased co-movement with one country, Zimbabwe.

Studies that have examined contagion as it affects African markets have been few. The reasons for this situation remain unknown although unavailable market data and the relative size and importance of African markets comparative to other markets could have been responsible. In sub-Saharan Africa, much of the studies on contagion have tended to focus more on the Southern part of Africa, specifically with a bias towards South Africa. The reason may not be far fetched as South Africa has a relatively larger (in terms of market capitalisation) and more integrated financial market when compared to the rest of its sub-Saharan market counterparts. Collins and Biekpe (2003) propose South Africa's market size and significance in the emerging market arena as reasons for its attractiveness as compared to its African counterparts and perhaps a reason for this bias.

Collins and Biekpe (2003) tested for contagion across eight African national markets as a result of the Asian crisis of 1997. By adjusting for the effects of heteroskedasticity, they find evidence of contagion in only two African countries namely, Egypt and South Africa. Pretorius and de Beer (2004) test for contagion

between South Africa and Zimbabwe as a result of Zimbabwe's economic crisis of the late 1990's. They tested for contagion through two channels, namely; trade and financial channels in explaining the volatility of the South African Rand. Although, they concluded that trade contagion did not exist, they found evidence of financial contagion in the South African currency market.

2.4.1 Transmission channels of contagion

Calvo and Reinhart (1996) identified five channels through which shocks can be transmitted from one country to another. These include: extent of integration of capital markets; trade patterns and arrangement; institutional practises; foreign investor behaviour; and the role of technological factors. Claessens et al. (2001) summarise these channels into two; one arising from fundamentals and the other as a result of investor behaviour.

According to Claessens et al. (2001), the first channel through which contagion spreads is as a result of the normal interdependence between economies. For example, an economy that is interlinked through trade often experience problems when its trading partner is in crisis. They explain that the more globally or regionally integrated an economy, the more likely shocks to one country's equity market are likely to spread to the others. They further explain that countries that are not financially integrated are likely to be more immune from contagion.

Studies have shown that countries which are integrated (regionally or globally) were often found to suffer contagion as a result of crisis. For example, Yang and Lim (2004) established that seven out of eight Asian economies were susceptible to contagion as a result of the crisis which arose as a result of Thailand devaluing its currency. Taiwan which was relatively unaffected by the crisis, was found to have a more independent economy as compared to the rest of the countries chosen for the study. South Africa, which is seen as more globally integrated than the rest of Africa, is often found to have suffered more from contagion. Collins and Biekpe (2003) test for contagion across African equity markets as a result of the Asian financial crisis of 1997, South Africa's equity markets was one of the only two that was found to have suffered contagion effects.

A number of the studies on contagion have tended to find contagion evident along regional lines. Glick and Rose (1999) found five different currency crises across Europe, Latin America and Asia were contagious and spread across regional lines. Kaminsky and Reinhart (2000) also noted that contagion is evident across regions. Both authors note the role of trade and financial sector links and how they influence contagion. However, some contagion studies have focussed on crisis in one country affecting global markets.

Claessens et al. (2001) identified the second channel of contagion transmission as arising as a result of investor and financial agent behaviour. They go on to state that crisis in a particular country can influence investors to behave in a particular way. This behaviour may be rational or irrational. A rational behaviour, for example, could be investors selling off assets in an unaffected market to recoup losses made in affected markets. Conversely, an irrational behaviour would be investors selling off assets just by observing other investors. They refer to investors behaving in the same particular way as 'herding behaviour'.

2.5. Conclusion of Literature Review

Available research shows that equity markets within close proximity to each other tend to show a strong correlation as well as co-movement. This is especially more evident in instances where countries in which they are located have strong trade links with each other. The one available research as it pertains to African national equity markets showed that some amount of interdependency relationship exists between African stock markets albeit more pronounced along regional lines for example within the Southern African region.

Since increased levels of trade between countries tend to cause a stronger interdependent relationship between them, it would be interesting to see whether increased trade and cooperation within sub-Saharan Africa has had any impact on the relationships existing between them and their equity markets.

As stated in the literature review, knowledge of how interdependent markets are enables policy holders to take appropriate action towards enhancing or militating against the effects caused by the interdependency of markets. Also, knowledge of

the interdependency of markets enables investors to take appropriate diversification strategies regarding their investments.

The importance of this knowledge therefore leads to the first research question:

Research Question 1

Ascertain the relationship between pairs of the six selected African markets.

The research question is represented in the following hypothesis as follows;

H_0: There is no relationship between pairs of African equity markets.

H_1: There will be a strong positive relationship between pairs of African equity markets.

Contagion is a phenomenon which shows an increase in market co-movement as a result of financial crisis. Markets which show strong interdependent relationships with each other before a crisis are more likely to suffer contagion effects when one of them witnesses a crisis. Although research on contagion as it relates to African national stock markets have been few, available research as it pertains to contagion and African national markets seems to suggest that African markets are largely insulated from contagion as a result of financial crisis. Collins and Gavron (2005) found little evidence of contagion as a result of multiple financial events on African national stock markets. Also, Collins and Biekpe (2003) found contagion evident in only two out of eight national markets in which they tested for contagion as a result of the Asian financial crisis of 1997. It is important to note that the only two markets that suffered contagion as a result of this crisis (Egypt and South Africa) are more integrated globally than other African markets. Their stock markets have also be found to be more liquid and sophisticated than the rest.

The above said however, African equity markets are showing increased integration with the rest of the world. These markets, also referred to as the 'second front-tier' markets have seen increased interest by international investors in recent times (IMF 2010). The increased integration of African markets seems to suggest they could be exposed to contagion as a result of financial crisis.

Therefore, it would interesting to establish whether the recent US- subprime triggered financial crisis had any contagion effect on African countries selected for the purpose of this research. The answer to this question is not only relevant to policy holders who may be interested to know so as to introduce such measures as relief measures to help alleviate the effects of the crisis, it is also important to international investors who may wish to have a portion of their portfolio invested in African national markets so as to benefit from diversification.

The importance of this knowledge therefore leads to the second research question:

Research Question 2

Ascertaining which of the five African national stock markets selected for the purposes of this study suffered contagion as a result of the US-subprime triggered global financial crisis.

CHAPTER 3: RESEARCH METHODOLOGY

This research will use a quantitative research method in analysing data aimed at answering the research questions. It will employ the following tools in answering the research questions: Pearson's Product Correlation model and the DCC GARCH model. The Pearson's Product Correlation model will be adjusted for heteroskedasticity inherent as a result of biasness in the data.

3.1 Research methodology /paradigm

King et al. (1994) noted the difference between quantitative and qualitative methods of research. They explained that while quantitative research uses numbers and statistical methods to seek general descriptions or establish casual relationships, qualitative research tries to achieve this with other methods excluding the use of statistical methods.

Bogdan and Biklen (1998) explained that quantitative research tends to focus on facts and it tries to explain behaviour. King et al. (1994) pointed out that research results from quantitative research are easily replicable by other researchers. This research method dwells on testing theories and measuring relationships that exist between variables.

Johnson and Onwuegbuzie (2004) while highlighting the importance of quantitative and qualitative research paradigms, advocate for a mixed research paradigm with the aim of drawing strengths and minimising weaknesses arising from the afore mentioned paradigms.

Golafshani (2003) summarises instances when the use of quantitative research paradigm is more appropriate. These instances he presents as follows:

- When the research work dwells on facts, which are then used to predict behaviour
- These facts are in numerical format and they can be summarised
- A mathematical process will be employed in the analysis of numbers

- The final result will usually be presented in a numerical format

This study is based on secondary analysis of quantitative data obtained from I-net Bridge, a financial research firm. The data consists of closing market indices for each of the selected African markets and the selected US equities' market. The analyses will include descriptive statistics, a correlation model and the General Auto Regressive Conditional Heteroskedasticity (GARCH) analysis.

3.2 Research Design

First, market data are summarised using descriptive statistics tables which show measures such as mean, variance skewness and kurtosis of market returns. These measures will help to better understand each of the selected markets under investigation.

Subsequently, correlation coefficients are used to measure the strength of association between African markets for the period under review. Correlation coefficients are used to analyse interdependence among select African national stock markets and the base country's stock market index, the US's Dow Jones Industrial Average (DJIA). The correlation coefficients will be built to show the relationship between each pair of country and is presented in the form of a matrix.

Finally, a GARCH analysis model will help to establish which of the selected African national stock markets suffered contagion effects as a result of the US sub-prime triggered financial crisis. The GARCH analysis model consists of two parts; the first involves establishing a GARCH model while the second is establishing correlation coefficients using a Dynamic Conditional Correlation (DCC) model. Correlation estimates from the DCC model will be measured before and after the US sub-prime triggered financial crisis to establish contagion. Contagion will be evident where there is a substantial increase in correlation estimates of the pre-crisis period over the post -crisis period.

3.3 Population and sample

3.3.1 Population

The population of this study is the stock marker indices of all African national stock markets. There are currently 29 national stock markets across Africa.

3.3.2 Sample and sampling method

As opposed to selecting the entire population, a sample which is a portion of the population can be chosen for the purpose of a study (Berenson, 2009). In this case, a sample of five African national stock markets was chosen out of a total population of 29 national stock markets (appendix 3). The sample is closing stock market indices for five African national stock markets and the base country's (US) market index, the Dow Jones Industrial index. The dataset from the African countries include those of South Africa (Johannesburg Securities Exchange), Botswana (Botswana Stock Exchange), Kenya (Nairobi Stock Exchange), Nigeria (Nigeria Stock Exchange) and Egypt (Egyptian Stock Exchange)..

The sampling method employed is a convenience sampling method. These stock markets were selected based on the fact that they are of strategic importance in their regions. The data covers two periods, namely; the pre and post crisis period. The dates for these periods are 02 January 2004 to 17 September 2007 and 18 September 2007 to 20 February 2009 respectively. A total of 967 observations are recorded for the pre-crisis period and 375 observations are recorded for the crisis period.

The market data is in the form of secondary data and was sourced from I- net bridge. They supplied the closing market indices for each day for the period under review.

3.4 Significance of the selected African markets

It is important at this point to discuss the significance of each of the selected markets sampled. These markets are significant as they are located in distinct geographical regions. Two of them, South Africa and Botswana are situated in Southern Africa.

Kenya is situated in East Africa, while Nigeria is situated in West Africa. The last market, Egypt is situated in North Africa.

Firstly, it is important to note that a number of studies (Collins and Biekpe, 2003; Collins and Gavron, 2005 and Senbet and Otchere, 2008) that have attempted to examine events impacting African markets, have tended to focus on four of the selected markets, namely; Kenya, Nigeria, Egypt and South Africa. The reason for this may not be far-fetched. These markets represent significant markets within their region and are in turn of significance to global investors investing in African markets.

The following table shows indicators of stock market development of African markets and two developing markets outside of Africa. The indicators are described in terms of number of listed companies, market capitalisation as a percentage of GDP, liquidity percentage and turnover ratio percentage. Beyond the geographical spread, these indicators point to the significance of three of the five markets selected for this research.

Table 5 : Indicators of stock market development: 2006 figures

	Number of[1] domestic listed companies	Market[2] capitalisation (% of GDP)	Liquidity[3] (%)	Turnover[4] ratio (%)	Market[5] capitalisation ($ million)
Botswana	18	38.22	0.78	2.39	3947
Cote d' Ivoire	40	23.70	0.26	3.68	4155
Egypt	603	86.97	14.51	55.23	93477
Ghana	32	13.40	0.40	3.42	1729
Kenya	51	53.71	1.94	15.76	11378
Mauritius	41	55.80	1.99	5.99	3598
Morocco	65	86.13	6.33	32.85	49360
Namibia	9	8.50	0.25	4.56	93
Nigeria	202	28.62	1.79	13.84	32819
South Africa	401	280.41	75.76	49.52	715025
Swaziland	NA	NA	0.14	NA	14
Tanzania	NA	NA	0.19	NA	540
Tunisia	48	14.68	1.53	15.24	4446
Uganda	NA	NA	0.01	NA	254
Zambia	NA	NA	0.39	NA	945
Zimbabwe	80	530.02	11.24	7.86	26557
Africa- mean	133	101.68	7.84	17.53	NA
Africa- mean (excl South Africa)	108	85.43	3.15	14.62	NA
Africa- median	50	45.97	0.95	10.85	NA
Malaysia	1027	158.00	39.61	NA	NA
Mexico	131	42.00	6.18	NA	NA

(Source: Senbet and Otchere, 2008)

[1] Number of domestic listed companies is the number of listed companies at the end of the year

[2] Market capitalisation (% of GDP- Gross Domestic Product) is market capitaliation at year end divided by GDP multiplied by 100

[3] Liquidity (%) is ratio of the total value of shares divided by GDP multiplied by 100

[4] Turnover ratio is the total value of shares traded divided by average market capitalisation for the year multiplied by 100

[5] Market capitalisation is the total value of shares outstanding at the end of the year.

[6] NA means data not available

In terms of the number of listed companies, three of the national stocks exchanges selected, Nigeria, Egypt South Africa have the highest number of companies listed on their exchanges. The number of companies listed on their exchange (205, 603 and 461 respectively) is more than that of the average of all of Africa's listed companies and also greater than that of Mexico (131), an emerging market also listed on the table. The South African exchange is particularly big not only in terms of number of listed companies but also has a high market capitalisation, liquidity and turnover. It represents the most developed, sophisticated and best regulated market in Africa (Hearn, 2010). The Egyptian market follows South Africa in terms of indicators but is the biggest in terms of the number of companies listed on the exchange. Although not as liquid as South Africa and Egypt, the Nigerian market is the biggest equities market in West Africa and the second biggest in sub-Saharan Africa (after South Africa) in terms of market capitalisation.

In terms of the other two markets, the Kenyan market is the biggest market in the East African region and the only one open to foreign investors (Hearn, 2010). It represents a gateway for investors into the East African bloc. Although the table shows Zimbabwe has being the second biggest exchange (in terms of market capitalisation) within the Southern African sub-region, the Botswana equities' market was chosen as it represents a more stable economy within the region politically and economically.

3.5 Criteria for chosen time period

The full period under observation is divided into two time periods. The first period which represents the pre-crisis period starts from the 2 January 2004 and ends on the 17 September 2007 while the crisis period starts from the 18th September 2007 and ends on the 20 February 2009.

These dates were chosen with reference to the movement in the closing market indices with the tranquil period ending when the market starts to show a decline from its highest closing index while the crisis period ends at the lowest closing index value

and at the point at which the market begins to show an uptrend. This is as indicated in the DJIA index graph in figure 1. The chosen dates tie closely with researchers attempting to study the US sub-prime triggered financial crisis (Lupu and Lupu, 2009; Morales and Andreosso-O'Callaghan, 2010)

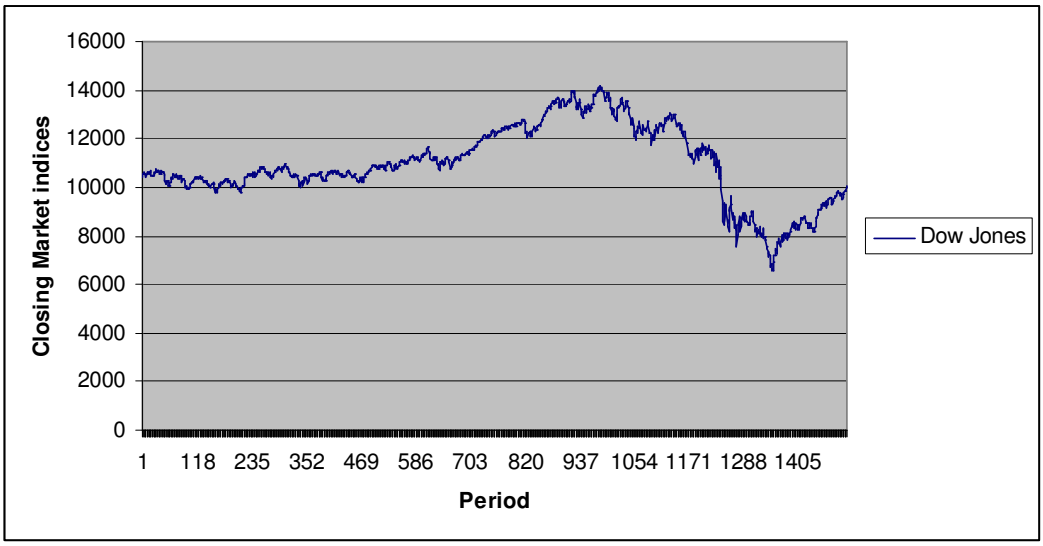


Figure 1 : DJIA closing market indices

(Source: Author's compilation from DJIA daily closing market indices)

A closer look at the graph shows that the market peaked at about 964 (period) representing the start of the crisis nose-diving till about 1353 (representing the end of the crisis) before an upturn began.

3.6 Testing for contagion

In order to establish contagion, statistical tests have to be conducted on market data. Collins and Biekpe (2003) highlighted four methods of testing for contagion. One method, simply establishes the level of correlation between markets before and immediately after a crisis period. Contagion is found to exist if correlations increase significantly immediately after a crisis. If there is no significant change in correlation it is said that the two markets are interdependent. King and Wadhwani (1990) used simple correlation to test for contagion across London and Japanese markets as a result of the US market crash of 1987. They found that both markets experienced increases in correlation in the period following the crash.

The second method still uses correlation but adjusts for market disturbances due to heteroskedasticity. Forbes and Rigobon (2002) suggest that when testing for contagion, a correction for market disturbances due to heteroskedasticity should be made to correct for disturbances in market data which arises because after a crisis (or shock), cross-market correlation coefficients tend to be biased upwards. The adjusted correlation method was used by Collins and Biekpe (2003) in testing for contagion on eight African national stock markets as a result of the Asian financial crisis of 1997. The authors tested data relating to both the tranquil period and crisis period, and find contagion evident in two African national markets.

A third method used in testing for contagion uses probability models to test if contagion will spread to another country simply because of the knowledge of the crisis elsewhere. This method uses conditional probabilities to test if the likelihood of crisis is higher in a country given crisis in another country or set of countries. Eichengreen, Rose and Wyplosz (1996) used this method in testing whether or not currency crises in one market increases the probability of a speculative attack of another currency in another market. They observed market data spanning the period 1959-1993 and covering 20 industrialised countries and found that a speculative attack on one currency increased the odds of a speculative attack on the home market by at least 8 percent.

The last method uses Auto Regressive Conditional Heteroskedasticity (ARCH) and Generalised Auto Regressive Conditional Heteroskedasticity (GARCH) models to estimate variance and covariance transmission mechanism between countries. Edwards (1998) used it to test for volatility contagion across three Latin American countries, namely; Argentina, Chile and Mexico. Using high frequency data on short-term nominal interest rates during the 1990s, he found volatility contagion evident from Mexico to Argentina but none from Mexico to Chile. Wang and Thi (2006) used the Dynamic Conditional Correlation (DCC) bi-variate GARCH model to test for the presence of contagion between the Thailand Stock market and that of countries of the Chinese Economic Area as a result of the Asian flu epidemic. Using correlation coefficients derived from the DCC GARCH model (by testing the pre and post crisis coefficients), they find contagion existed in these markets.

The simple correlation method which simply measures correlation before and after a crisis has a major drawback in that it does not adjust for market disturbances. This has been corrected with a hesteroscedasticity adjusted model which adjusts for the 'noise' in the data. A second method which uses a probit model to test whether the knowledge of a crisis at home increases the probability of a crisis elsewhere also has a disadvantage in that it doesn't show linear relationships between variables (Cerra and Saxena 2002).

This research will utilise a Dynamic Conditional Correlation (DCC) ARCH model in analysing market data. The DCC under the bi-variate ARCH model was proposed by Engle (1982). It uses log likelihood estimation procedures to estimate DCC bi-variate GARCH. GARCH models provide better tools for measuring co-movement and volatility spillovers than other methods.

3.7 Procedure for data collection

Closing market indices were obtained for the five selected African national stock markets as well as the base index, the US's Dow Jones index. Data for the purposes of this research were sourced from a financial research company, I-net Bridge.

3.8 Data analysis and interpretation

Firstly, stock market returns (log-normal returns) were calculated from the closing market indices (representing primary data). Secondly, correlation coefficients were calculated using the Pearson's Product Moment coefficient correlation model. Data analysis (which is displayed in the form of a matrix) shows correlation coefficient model for the pre-crisis period, the post-crisis periods and the whole period under observation.

Correlation coefficient values range from -1 to 1. The closer the coefficient is to either extreme of the range, the stronger the relationship between market returns between countries. Positive coefficients indicate that as the returns in one country increases, it also increases in the other. Conversely, negative coefficients show that market returns increase in one country as it decreases in another. Where the coefficient is zero, there is no relationship between market returns.

The second research question uses a DCC GARCH model in establishing whether or not the selected countries suffered contagion effects as a result of the US sub-prime triggered financial crisis. The DCC GARCH model involves two steps, the first step will establish univariate GARCH model while the second step will estimate the correlation coefficients. Thereafter using t-tests, the coefficients in the pre and post crisis periods will be measured to see if there was a significant increase. DCC GARCH graphs will also help to show whether selected markets suffered contagion.

3.9 Validity and reliability

Golafshani (2003) point out the need for validity and reliability in both qualitative and quantitative research although emphasis is on the latter. This is in part because validity and reliability in a qualitative research may be quite a subjective measure when compared to quantitative research.

He explains that validity shows whether the research measures what it set out to measure and that researchers often determine validity by asking a series of questions which are found in the research of others.

Reliability he defines in terms of consistency and representativeness. He states that if the results of a study are reliable, then it can be generally representative of the total population. According to Cooper and Schlinder (2008) reliability "is a necessary contributor to validity but is not a sufficient condition for validity".

3.9.1 External validity

External validity refers to the outcomes of research findings to be generalised across similar contexts (Cooper and Schlinder 2008).

In terms of external validity, one may argue that this research may be capable of generalisation across a number of sub-Saharan African national markets that carry the same characteristic as the selected markets. This is because a lot of African national markets demonstrate the same characteristic as the selected markets. This is in terms of such factors as illiquidity and underdevelopment (Senbet and Otchere, 2008). It may therefore be safe to say that the findings of this research may to some

extent be capable of generalisation across other similar African national stock markets.

3.9.2 Internal validity

Cooper and Schlinder (2008; 292) define internal validity "as the ability of a research to measure what it was purported to measure". This research will make use of statistical methods to answer the research question. This will be in the form of a correlation coefficient model namely the Pearson's Product Moment correlation model as well as a DCC GARCH model. The methods chosen have been used by past researchers in answering similar questions as it pertains to establishing interdependency and contagion.

3.9.3 Reliability

Cooper and Schlinder (2008; 293) described reliability as the extent to which the results of the analysis does not contain errors or is not influenced by random events. This research in answering the research question will apply a statistical method which models the heteroskedasticity which is inherent in the data. Heteroskedasticity can be described in terms of 'noise' which artificially misrepresents the data for the period of the financial crises.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

Descriptive statistics of market returns are presented first, followed by a correlation coefficient matrix showing the correlation between pairs of selected African countries and their significance. Lastly, the DCC GARCH models are presented.

4.2 Descriptive statistics of sample data

The sample data consists of the daily closing index value of five African national stock markets. The period of observation spans from 2 January 2004 to 17 September 2007 representing the pre-crisis period and 18 September 2007 to 20 February 2009

representing the crisis period. There are 1342 observations in total; 967 for the pre-crisis period and 375 for the crisis period. The descriptive statistics shows measures such as minimum and maximum returns, skewness and kurtosis of returns. The table below shows summary measures such as minimum and maximum returns, skewness and kurtosis of returns.

The skewness provides a measure of the distribution (symmetry), while kurtosis measures the spread of the values of the market returns. Both measures are used to assess the departure from normality. The variance provides a measure of the volatility of market returns.

Table 6: Summary Statistics of market returns: by country and time period

		N	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation	Variance	Skewness	Kurtosis
Total	South Africa	1341	0.062602	-0.03292	0.02968	0.000202	0.0001682	0.006158	3.79E-05	-0.23678	3.968936
	Nigeria	1341	0.10446	-0.0526	0.05186	3.91E-05	0.0001321	0.004838	2.34E-05	-0.22658	22.89558
	Kenya	1341	0.052904	-0.02273	0.030173	-7.6E-06	0.000116	0.004249	1.81E-05	0.43982	7.581357
	Egypt	1341	0.166726	-0.07814	0.088589	0.000367	0.000233	0.008531	7.28E-05	-0.17083	17.0509
	Botswana	1341	0.06778	-0.01422	0.053555	0.00031	6.912E-05	0.002531	6.41E-06	7.673789	156.2996
	Dow Jones	1341	0.081252	-0.03561	0.045637	-0.00011	0.0001484	0.005434	2.95E-05	-0.02297	14.33011
Tranquil Period	South Africa	967	0.050454	-0.0291	0.021355	0.000454	0.0001504	0.004678	2.19E-05	-0.48242	3.608724
	Nigeria	967	0.10446	-0.0526	0.05186	0.000427	0.0001431	0.004449	1.98E-05	-0.18578	41.52881
	Kenya	967	0.033126	-0.01644	0.01669	0.000314	0.0001053	0.003274	1.07E-05	-0.04835	4.822117
	Egypt	967	0.129763	-0.04117	0.088589	0.000896	0.0002507	0.007796	6.08E-05	1.327047	20.50371
	Botswana	967	0.066417	-0.01286	0.053555	0.000612	8.241E-05	0.002563	6.57E-06	10.34556	197.9152
	Dow Jones	967	0.025284	-0.01453	0.010752	0.000125	9.484E-05	0.002949	8.7E-06	-0.22834	1.243731
Crisis Period	South Africa	374	0.062602	-0.03292	0.02968	-0.00045	0.0004595	0.008887	7.9E-05	0.05849	1.494889
	Nigeria	374	0.043963	-0.0243	0.019665	-0.00096	0.0002899	0.005607	3.14E-05	-0.07951	2.768009
	Kenya	374	0.052904	-0.02273	0.030173	-0.00084	0.0003108	0.006011	3.61E-05	0.875868	5.142319
	Egypt	374	0.116562	-0.07814	0.038425	-0.001	0.0005209	0.010073	0.000101	-1.80654	10.94848
	Botswana	374	0.031004	-0.01422	0.01678	-0.00047	0.0001175	0.002273	5.17E-06	-0.54339	16.06901
	Dow Jones	374	0.081252	-0.03561	0.045637	-0.00072	0.0004712	0.009112	8.3E-05	0.184107	4.845635

The table shows the summary statistics of the market returns. Log returns were calculated from market data and a summary of this was calculated using the SPSS statistical software program.

Total period (before and during the financial crisis)

Table 6 shows that among the six countries displayed (including the US) Egypt had both the lowest and highest daily returns (-7.8 percent and 8.9 percent respectively). The volatility as measured by the variance was highest in Egypt and lowest in Botswana. While the distribution of market returns in South Africa, Nigeria and Egypt and the US were slightly skewed to the left, indicating that there were more low returns than high; those in Kenya were slightly skewed to the right, indicating more high returns than low. Market returns in Botswana was also skewed to the right; however, this skew represented a substantial departure from normality. On the whole, the distribution of market returns in all the countries showed very little evidence of asymmetry, with the exception of Botswana.

Tranquil period (before the crisis)

Similar to the total period, Egypt also recorded the highest and lowest returns during the tranquil period (see table 6). With the exception of Egypt and Botswana, the distributions of market returns across all countries were skewed to the left. The tranquil period was characterised by positive mean returns. The highest market volatility, as indicated by the variance, was in Egypt while the lowest was in Kenya.

Crisis period

Egypt's market also had the lowest return during the crisis period. In contrast, to the tranquil period however, the US market recorded the highest return. With the exception of Botswana and the US, there was greater volatility in market returns across countries after the financial crisis than during the tranquil period (see table 6). Compared with the tranquil period, the crisis period was characterised by negative mean returns. In addition the distribution of market returns in Nigeria, Egypt and Botswana were skewed to the left while those of South Africa, Kenya and the US were skewed to the right. In line with one of the characteristics of financial variables, all stock returns are in leptokurtic distribution as explained by the kurtosis figures.

The returns are also shown in the form of a line graph in Figures 2-6 as follows:

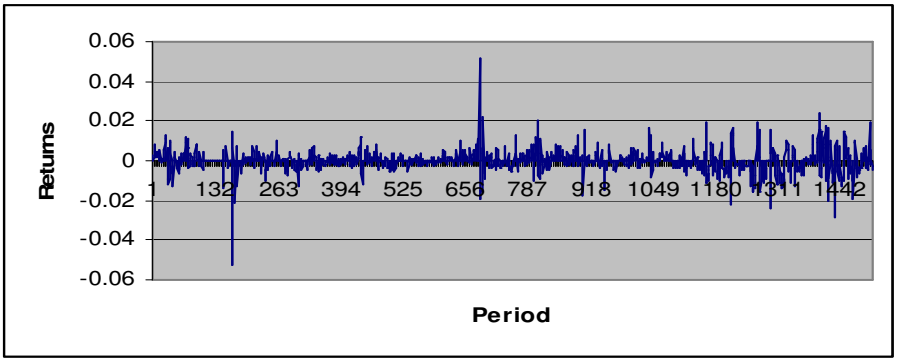


Figure 2: South African (JSE) Stock Returns

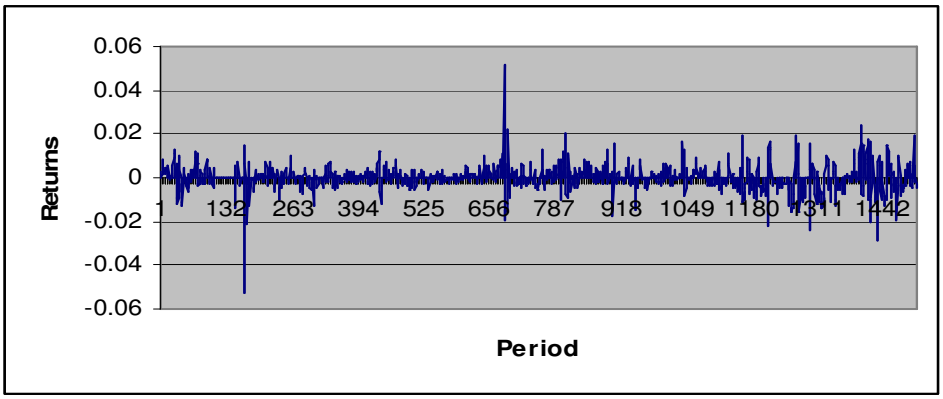


Figure 3: Nigerian (NSE) Stock Returns

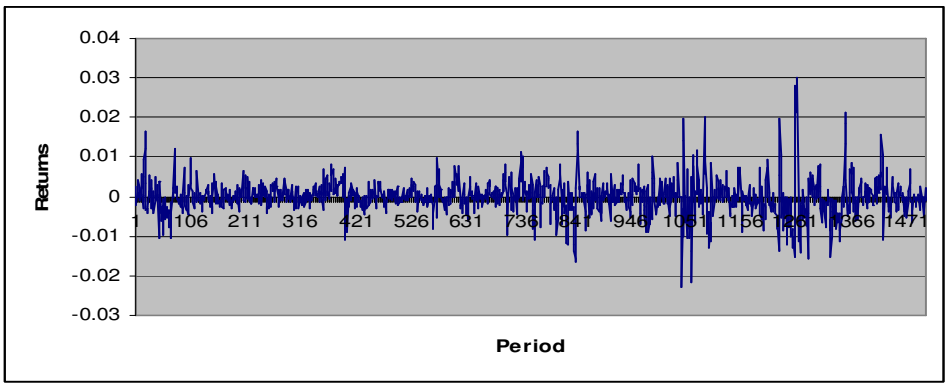


Figure 3: Kenyan (NSE) Stock Returns

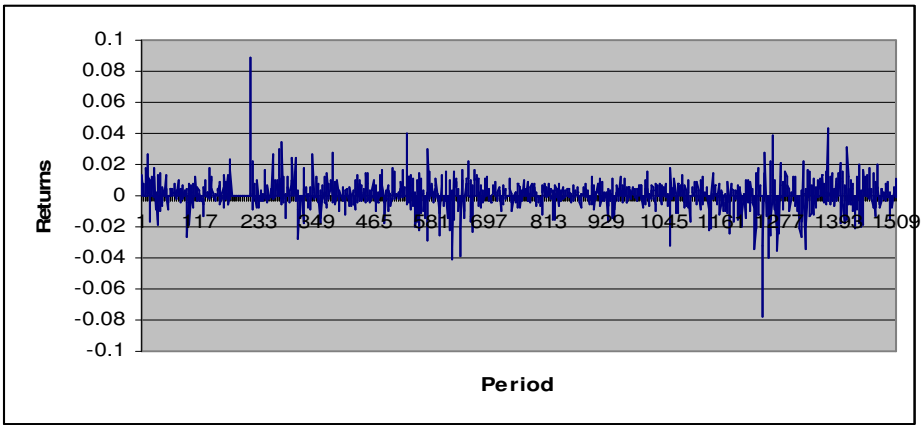


Figure 4: Egypt (ESE) Stock Returns

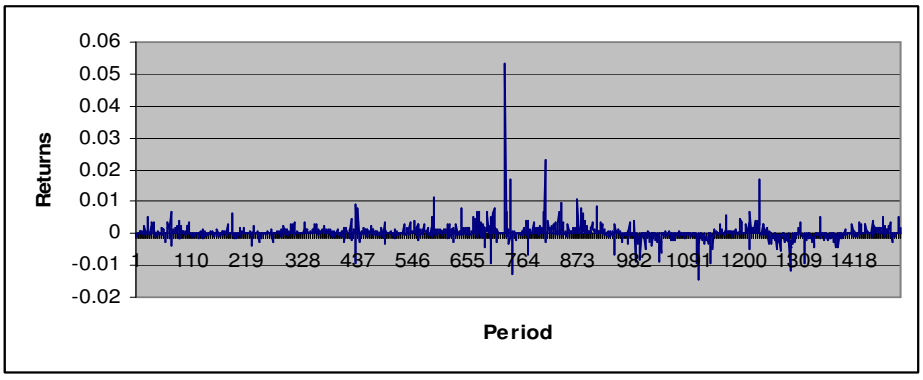


Figure 5: Botswana (BSE) Stock Returns

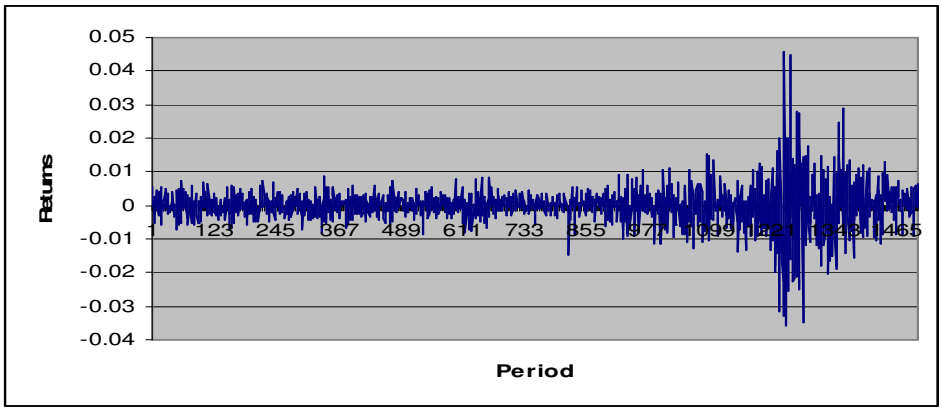


Figure 6: United State's (DJIA) Stock Returns

Figures 2 to 7 show the returns for each of the markets for the period under observation. It clearly shows Egypt's market having the highest and lowest returns as the y-axis on its graph reflects a positive and negative return of +0.10 and -0.10 respectively. Volatility is shown through length of the spikes in each of the graphs.

4.3 Interdependence of Selected markets

Table 7, 8 and 9 show the interdependence of selected African markets with themselves and the DJIA. This is represented via correlation matrix tables which show the unadjusted correlation coefficients of each pair of markets. Three matrix tables are shown representing the relationships existing for the full, tranquil and the crisis periods. Significant coefficients are indicated in bold (black or red). Coefficients are significant either at the 1 percent or 5 percent level.

Results indicate six significant relationships existed during the full period; two existed during the tranquil period and four during the crisis period. The results show the strongest and most consistent relationship between any two African countries which existed was that of Egypt and South Africa. The DJIA and South Africa also showed significant correlation coefficients for the three time periods. Kenya and Egypt and the DJIA showed significant coefficients during the crisis period. Nigeria and Botswana showed no significant relationship with any of the other markets. Although most coefficients were positive they generally showed a weak relationship.

Correlation coefficient values range from -1 to 1. The closer the coefficient is to either extreme of the range, the stronger the relationship between market returns between countries. Positive coefficients indicate that as the returns in one country increases, it also increases in the other. Conversely, negative coefficients show that market returns increase in one country as it decreases in another.

Table 7: Correlation matrix between selected countries for the Full Period (02-01-04 to 20-02-09)

	Country					
Country	South Africa	Nigeria	Kenya	Egypt	Botswana	Dow Jones
South Africa	1.000					
Nigeria	-0.005	1.000				
Kenya	**0.055**	-0.017	1.000			
Egypt	**0.161**	0.018	**0.108**	1.000		
Botswana	0.027	**0.073**	-0.008	0.027	1.000	
Dow Jones	**0.209**	-0.015	0.019	**0.060**	0.043	1.000

Table 7 shows that the relationship between pairs of African countries in the full period, in terms of market returns, was generally weak. Nevertheless, four of these relationships were statistically significant. The strongest positive relationship was between Egypt and South Africa. In contrast, the strongest negative relationship was between Nigeria and Kenya; however, this relationship was not statistically significant.

The relationship between the US and each of the African markets was weak. Additionally, two of these relationships were statistically significant; South Africa and Egypt, with the former showing the stronger relationship with the US.

Table 8: Correlation matrix for the tranquil period (02-01-04 to 17-09-07)

Country	South Africa	Nigeria	Kenya	Egypt	Botswana	Dow Jones
South Africa	1.000					
Nigeria	-0.040	1.000				
Kenya	-0.007	0.024	1.000			
Egypt	**0.092**	0.002	0.022	1.000		
Botswana	0.026	0.059	-0.011	0.012	1.000	
Dow Jones	**-0.091**	0.011	-0.005	-0.013	0.020	1.000

Table 8 shows that the relationship between African markets was generally weak in the tranquil period. In addition, only one of these relationships was statistically significant; South Africa and Egypt. This was also the strongest positive correlation between pairs of African countries.

The US market returns was significantly correlated with only the South African market returns.

Table 9: Correlation matrix for the tranquil period (18-09-07 to 20-02-09)

	Country					
Country	South Africa	Nigeria	Kenya	Egypt	Botswana	Dow Jones
South Africa	1.000					
Nigeria	0.014	1.000				
Kenya	0.089	-0.100	1.000			
Egypt	**0.229**	0.009	**0.181**	1.000		
Botswana	0.000	0.029	-0.070	-0.001	1.000	
Dow Jones	**0.344**	-0.053	0.018	**0.104**	0.053	1.000

Table 9 shows that the African markets remain weakly correlated during the crisis period. Similar to the tranquil period, the relationship between South Africa and Egypt was statistically significant. In addition, these two markets were more positively correlated than in the tranquil period. Also, the relationship between Kenya and Egypt was statistically significant. It is noteworthy that there was no relationship between market returns in South Africa and Botswana.

The relationship between the US and each African country was also weak but statistically significant in two instances: with South Africa and Egypt.

4.4 GARCH DCC Model

The DCC GARCH model is shown from tables 10 to 15. Except for Nigeria, all other coefficients are positive and significant indicating that volatility is captured by the GARCH (1,1) model. Most of the estimated parameters are significant at the 5% level. Also except for Nigeria, the sum of the coefficients of squared past disturbance and that of past variance is less than one indicating that shocks die with time. The sum of the shocks being close to one indicates a persistent and high volatility.

Subsequently, correlation estimates are calculated from the DCC (δ_2) for the pre and post crisis periods for each of the markets. All coefficients shown are significant at the 1% level and t statistic is used to test for consistency in the pre and post crisis periods. An increase in DCC correlation coefficient over the pre-crisis period implies contagion effects. `

The tables for the DCC model and the final results are shown as follows:

Table 10: Estimation of GARCH (1,1) Process for Botswana Returns

Dependent Variable: RB

Method: ML - ARCH (Marquardt) - Normal distribution

Date: 03/06/11 Time: 07:11

Sample: 1 1509

Included observations: 1509

Convergence achieved after 142 iterations

Presample variance: backcast (parameter = 0.7)

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	-0.210927	0.042245	-4.992926	0.0000
C	0.000593	7.40E-05	8.016020	0.0000
	Variance Equation			
C	1.42E-08	2.57E-09	5.541823	0.0000
RESID(-1)^2	0.052173	0.002526	20.65543	0.0000
GARCH(-1)	0.961252	0.001353	710.3524	0.0000

R-squared	-0.035901	Mean dependent var	0.000297
Adjusted R-squared	-0.036588	S.D. dependent var	0.002427
S.E. of regression	0.002471	Akaike info criterion	-9.493608
Sum squared resid	0.009199	Schwarz criterion	-9.475983
Log likelihood	7167.927	Hannan-Quinn criter.	-9.487044
Durbin-Watson stat	1.756535		

Table 11 : Estimation of GARCH (1,1) Process for DJIA Returns- US

Dependent Variable: RDJI

Method: ML - ARCH (Marquardt) - Generalized error distribution (GED)

Date: 03/06/11 Time: 07:25

Sample: 1 1509

Included observations: 1509

Convergence achieved after 20 iterations

Presample variance: backcast (parameter = 0.7)

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
GARCH	-0.917264	4.798148	-0.191170	0.8484
C	0.000175	9.25E-05	1.891102	0.0586
Variance Equation				
C	1.26E-07	5.51E-08	2.291434	0.0219
RESID(-1)^2	0.068185	0.014450	4.718778	0.0000
GARCH(-1)	0.927297	0.014184	65.37763	0.0000
GED PARAMETER	1.234283	0.058253	21.18847	0.0000

R-squared	-0.000499	Mean dependent var	-1.11E-05
Adjusted R-squared	-0.001163	S.D. dependent var	0.005592
S.E. of regression	0.005596	Akaike info criterion	-8.281461
Sum squared resid	0.047187	Schwarz criterion	-8.260311
Log likelihood	6254.363	Hannan-Quinn criter.	-8.273585
Durbin-Watson stat	2.245007		

Table 12 : Estimation of GARCH (1,1) Process for Egypt Returns

Dependent Variable: RE

Method: ML - ARCH (Marquardt) - Normal distribution

Date: 03/06/11 Time: 08:06

Sample: 1 1509

Included observations: 1509

Convergence achieved after 172 iterations

Presample variance: backcast (parameter = 0.7)

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
GARCH	-12.49849	9.271099	-1.348113	0.1776
C	0.001546	0.000648	2.385721	0.0170

Variance Equation

C	1.35E-06	2.62E-07	5.168408	0.0000
RESID(-1)^2	0.018406	0.002376	7.747365	0.0000
GARCH(-1)	0.962578	0.005919	162.6138	0.0000

R-squared	0.003181	Mean dependent var	0.000518
Adjusted R-squared	0.002520	S.D. dependent var	0.008573
S.E. of regression	0.008562	Akaike info criterion	-6.759689
Sum squared resid	0.110472	Schwarz criterion	-6.742064
Log likelihood	5105.185	Hannan-Quinn criter.	-6.753125
Durbin-Watson stat	1.800100		

Table 13 : Estimation of GARCH (1,1) Process for Kenya Returns

Dependent Variable: RK

Method: ML - ARCH (Marquardt) - Normal distribution

Date: 03/06/11 Time: 09:00

Sample: 1 1509

Included observations: 1509

Convergence achieved after 56 iterations

Presample variance: backcast (parameter = 0.7)

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
GARCH	1.198511	8.116584	0.147662	0.8826
C	0.000156	9.68E-05	1.606986	0.1081

Variance Equation

C	3.61E-07	6.26E-08	5.762253	0.0000
RESID(-1)^2	0.164519	0.014584	11.28107	0.0000
GARCH(-1)	0.826187	0.009672	85.41904	0.0000

R-squared	-0.000770	Mean dependent var	2.34E-05
Adjusted R-squared	-0.001434	S.D. dependent var	0.004269
S.E. of regression	0.004272	Akaike info criterion	-8.504037
Sum squared resid	0.027500	Schwarz criterion	-8.486412
Log likelihood	6421.296	Hannan-Quinn criter.	-8.497473
Durbin-Watson stat	1.025606		

Table 14 : Estimation of GARCH (1,1) Process for Nigeria Returns

Dependent Variable: RN

Method: ML - ARCH (Marquardt) - Generalized error distribution (GED)

Date: 03/06/11 Time: 09:11

Sample: 1 1509

Included observations: 1509

Convergence achieved after 57 iterations

Presample variance: backcast (parameter = 0.7)

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
GARCH	-0.524886	0.130632	-4.018046	0.0001
C	9.14E-09	2.86E-08	0.319846	0.7491
Variance Equation				
C	7.40E-10	1.74E-10	4.256213	0.0000
RESID(-1)^2	0.661471	0.086810	7.619740	0.0000
GARCH(-1)	0.702279	0.008994	78.07986	0.0000
GED PARAMETER	0.366857	0.011216	32.70959	0.0000

R-squared	0.000303	Mean dependent var	3.82E-05
Adjusted R-squared	-0.000361	S.D. dependent var	0.005218
S.E. of regression	0.005219	Akaike info criterion	-9.044940
Sum squared resid	0.041053	Schwarz criterion	-9.023790
Log likelihood	6830.407	Hannan-Quinn criter.	-9.037063
Durbin-Watson stat	1.353391		

Table 15: Estimation of GARCH (1,1) Process for SA Returns

Dependent Variable: RSA

Method: ML - ARCH (Marquardt) - Normal distribution

Date: 03/17/11 Time: 08:54

Sample: 1 1509

Included observations: 1509

Convergence achieved after 17 iterations

Presample variance: backcast (parameter = 0.7)

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
GARCH	2.307217	5.816208	0.396687	0.6916
C	0.000413	0.000162	2.546571	0.0109

Variance Equation

C	3.66E-07	1.37E-07	2.671634	0.0075
RESID(-1)^2	0.100989	0.014622	6.906730	0.0000
GARCH(-1)	0.891123	0.015624	57.03445	0.0000

R-squared	-0.001890	Mean dependent var	0.000265
Adjusted R-squared	-0.002555	S.D. dependent var	0.006219
S.E. of regression	0.006227	Akaike info criterion	-7.692869
Sum squared resid	0.058427	Schwarz criterion	-7.675244
Log likelihood	5809.270	Hannan-Quinn criter.	-7.686305
Durbin-Watson stat	1.934381		

Table 16: Correlation Estimates using DCC (δ2) Results between country returns and DJIA returns (standard errors in parenthesis)

Country	Pre	Post	Entire
Botswana	0.997(0.0001)	0.329(0.05)	0.969(0.0009)
Egypt	0.68(0.08)	0.959(0.007)	0.96(0.005)
Kenya	0.76(0.02)	0.48(0.08)	0.83(0.009)
Nigeria	0.82(0.02)	0.89(0.01)	0.85(0.01)
South Africa	0.86(0.03)	0.91(0.02)	0.90(0.01)

All coefficients are significant at 1% level

Table 16 shows correlation estimates using DCC (δ_2). An increase in correlation estimates implies the presence of contagion. Results show that Egypt, Nigeria and South Africa all witnessed an increase in correlation estimates over the pre-crisis period. Botswana and Kenya witnessed a decrease in correlation estimates.

4.5 SUMMARY OF THE RESULTS

In answering the first research question, table 6 was drawn up to show correlation coefficients between pairs of countries under investigation. The strength of the relationship existing through correlation coefficients was used to analyse interdependency. Although overall results show six significant relationships for the full period, only four significant relationships were found between the selected African countries. Of all the selected African markets only South Africa and Egypt showed a significant positive relationship with each other in the three periods investigated. Three other significant relationships were found; Egypt and Kenya, Egypt and South Africa and Botswana and Nigeria. However, these three relationships were not consistent for all the three periods under investigation.

In answering the second research question, DCC models which formed part of the analysis were presented on tables 10 to 15. Table 16 showed correlation estimates calculated for the pre and post crisis periods from results using the DCC models. Contagion is found to be evident if correlations increased from the pre-crisis to the

crisis period. Results show that three of the selected African markets, Nigeria, Egypt and South Africa suffered contagion effects.

CHAPTER 5: DISCUSSION OF THE RESULTS

5.1 Introduction

This chapter is divided into two broad sections. In the first section, selected African national markets are discussed while the second section discussed the findings of research questions vis-à-vis previous findings.

5.2 The selected equities' markets

Five equity markets from a total population of 26 markets across Africa were selected for the purposes of this research. The period under observation is 2 January 2004 to 20 February 2009. The period under observation was divided into two periods namely; the pre-crisis (tranquil) and the crisis period. The pre-crisis period began from 2 January 2004 and ended on 17 September 2007 while the crisis period began on 18 September 2007 and ended 20 February 2009.

The data which this research represents are closing daily market indices. With the exception of public holidays, there are five closing market indices for each week and a total of 1362 market indices. Returns were calculated from the available market indices for the selected period.

A summary of the returns relating to the selected markets, show that Egypt consistently had the highest returns amongst the selected markets. The country was also the most volatile as indicated by its variance figures.tility. This is not surprising as Egypt's equity market has consistently shown higher returns as well displaying higher volatility (on average) in comparison to other African equity markets. (Chukwuogor, 2008; Senbet and Otchere 2008)

Apart from two of African equity markets, Kenya and Nigeria showing negative mean returns for the entire period, other markets displayed results consistent with the time periods- positive returns during the tranquil period and negative during the crisis period. Apart from the US-subprime triggered financial crisis, the peculiarity of Kenya

and Nigeria results (for the full period) may have been as a result of other events which impacted negatively on their markets.

5.3 Results on interdependence of markets

Previous researches established that markets which are located close to each other to show strong interdependent relationships. This is especially true for emerging markets in places like Asia. Past researches have consistently shown that stronger interdependency exists between markets in this region (Narayan 2003; Majid et al. 2009).

Unadjusted correlation coefficients are calculated and a matrix is drawn up from results showing association between pairs of countries. Interdependency would imply correlations closer to +1. Results show that with the exception of Egypt and South Africa, the other markets show very weak relationship with each other. However, a closer look at results shows an increasing association between some of these markets in the crisis period. South Africa and Nigeria; Kenya and South Africa and Kenya and Egypt all show increased correlations during the crisis period as compared to the tranquil period. Although reasons for this stronger association over the period remain unknown, one of the reasons for this increased correlation during the crisis period could be as a result of negativity in financial markets all over the world which meant these markets tended to move downwards during this time.

Although previous research indicated a strong relationship between countries of the Southern African region, it is surprising to note that results of this research point to a weak relationship that is not statistically significant between South Africa and Botswana, two countries within the Southern Africa region. Egypt and South Africa are the only two countries to have been found previously to have strong inter-regional relationship. Strong inter-regional relationship existing between Egypt and South Africa is not surprising as these two countries were previously found to have strong statistical relationship with the US market.

5.4 Results on establishing contagion

Five African equity markets were tested for contagion effects that may have arisen as a result of the US- subprime triggered financial crisis. Results from the DCC GARCH model show that Egypt, South Africa and Nigeria suffered contagion effects. Botswana and Kenya were found not to have suffered contagion effects as correlation estimates calculated from the DCC GARCH model showed lower estimates for the crisis period over the tranquil period.

These results are not surprising as two of the countries, Egypt and South Africa have been found to have suffered contagion effects in past events. Using an adjusted correlation coefficient method, Collins and Biekpe (2003) found these two countries to have suffered contagion effects as a result of the Asian crisis of 1997. Forbes and Rigobon (2002) find South Africa to have suffered from contagion effects as a result of the Mexican Peso crisis. With respect to the most recent US- subprime triggered financial crisis, Morales and O'Callaghan (2010) find Egypt and South Africa to have suffered contagion effects. The third country found to have suffered contagion effects, Nigeria, is not seen to be prone to contagion as a result of financial events.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

In this section, the study concludes while providing references to past published research with respect to differences in outcomes. In addition, a recommendation is made to stakeholders who were mentioned in the earlier sections of this research. Lastly, suggestions are proposed for further research.

6.2 Conclusions of the study

In the earlier sections in this study, interdependence was defined as the extents to which subjects depend on each other. In equity markets, interdependence shows through the strength of the statistical relationship existing between markets. With reference to the only available research with respect to this topic as it relates to African markets, fourteen significant relationships were identified between pairs of African markets. Most of these relationships although significant were found to be weak. The results of this research as it pertains to the first research question on interdependency were consistent with past research. African markets show very weak relationship with each other.

Many reasons abound for this and are reflected in reasons given by Pretorius (2001). African markets trade too little with each other. Geda and Kebret (2008) while noting relative lack of integration of African economies give reasons such as economic, political and institutional constraints as to why there is insufficient trade between African economies. Also, another reason given, stock market characteristics, can also help explain the low level of interdependence of African markets. African markets are largely fragmented and are not readily accessible to outside investors.

The second research question asks the question which of the selected African equity markets were subject to contagion as a result of the US sub-prime triggered financial crisis. Results of the data analysis showed that three of the five selected African equity markets suffered contagion effects. These countries are Egypt, South Africa and Nigeria. The other two which did not suffer contagion were Botswana and Kenya.

Past research has consistently shown South Africa and Egypt to have suffered contagion effects and therefore the results of this research did not come as a surprise. Although, results showed that Nigeria suffered contagion effects, past research points to the country having not suffered from contagion effects as a result of financial events (Collins and Biekpe, 2003; Hon 2004).

6.3 Recommendations

As part of this study, interdependence of African equity markets was investigated. Subsequently, markets which suffered contagion effects as a result of the US-subprime triggered financial crisis were identified. The results of the first part of the study showed weak statistical relationships between the identified markets. The second research question showed three of the five selected African equity markets suffered contagion effects.

In the earlier sections of this study, stakeholders that could benefit from bridging the gap which this research fills were identified. Having answered the research questions, the following recommendations are made to those stakeholders:

- African markets still have weak statistical relationship with each other. With the exception of Egypt and South Africa, investors invested across the selected African markets will benefit from diversification across these markets as a result of the low correlation existing between them.

- Botswana and Kenya were found not to have suffered contagion as a result of these two mentioned markets were relatively immune from contagion in past events, the US sub-prime triggered financial crisis. Since these two countries have been previously found not to have suffered contagion, global investors could invest a portion of their portfolios in these markets to provide a 'safety net' in times of negative financial impacting events.

- Very little research exists as it pertains to African equity markets. In view of the positive prospects for most African economies (for example; high growth rates, democratisation of most African countries) more should be done in the area of research by academia to better understand African equity markets.

6.4 Suggestions for further research

This study looked into interdependence of African equity markets from periods spanning across 2004 to 2009. It also identified African equity markets which suffered contagion effects as a result of the US-subprime triggerd financial crisis.

Important questions for future research as it pertains to this topic that can be investigated are as follows:

- An investigation as to whether African equity suffered contagion effects as a result of more recent crisis like the Greek debt crisis, the North African crisis (uprisings in North Africa and the Middle East).
- The inclusion of more African markets in the study of interdependence of her markets.
- The contagion effects of the stock market crisis in Nigeria on other African equity markets.

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APPENDIX 1

Data request from I-Net Bridge

Mon, 10 January, 2011 9:33:57

Research information
From: olufemi olatunde
<femiolatunde2004@yahoo.co.uk>
View Contact
To: info@inetbridge.co.za

Hello

I am currently working towards my research as part of the requirement for completing my Master of Business Administration (MBA) degree.

My research topic titled "contagion and interdependence of African equity markets" aims to look at evidence of contagion in view of the recent global financial crisis across five African markets. It also aims to establish statistical relationships across these markets.

In view of this, i would need market data to enable me carry out the research. Specifically, the data needed pertains to daily returns or daily closing indices (preferably the former) of the following national stock markets.

- Egyptian Stock Exchange
- Nigerian Stock Exchange
- Nairobi Stock Exchange
- Botswana Stock Exchange
- Johannesburg Stock Exchange
- Dow Jones Industrial Average

The data spans between 15 October 2007 to15 October 2009.

Your assistance will be highly appreciated in this regard.

Kind regards
Olufemi Olatunde
MBA candidate
University Of Wiwatersrand Business School
Johannesburg- South Africa

Mobile:0722880717

APPENDIX 2

STOCK EXCHANGES IN AFRICA

No	Exchange	Location	Founded	Country
1	(Bourse Régionale des Valeurs Mobilières)	Abidjan	1998	Ivory Coast
2	Bourse d'Alger	Algiers	1997	Algeria
3	Botswana Stock Exchange	Gaborone	1989	Botswana
4	Douala Stock Exchange	Douala	2001	Cameroun
5	Bolsa de Valores de Cabo Verde	Mindelo	2005	Cape Verde
6	Egyptian Stock Exchange	Cairo	1883	Egypt
7	Ghana Stock Exchange	Accra	1990	Ghana
8	Nairobi Stock Exchange	Nairobi	1954	Kenya
9	Libyan Stock Market*	Tripoli	*2007*	Libya
10	Malawi Stock Exchange	Blantyre	1995	Malawi
11	Stock Exchange of Mauritius	Port Louis	1988	Mauritius
12	Casablanca Stock Exchange	Casablanca	1929	Morocco
13	Bolsa de Valores de Moçambique*	Maputo	1999	Mozambique
14	Namibia Stock Exchange*	Windhoek	1992	Namibia
15	Abuja Securities and Commodities Exchange	Abuja	1998	Nigeria
16	Nigerian Stock Exchange*	Lagos	1960	Nigeria
17	Rwanda Over The Counter Exchange	Kigali	2008	Rwanda
18	Khartoum Stock Exchange	Khartoum	2000	Sudan
19	Swaziland Stock Exchange	Mbabane	1990	Swaziland
20	Dar es Salaam Stock Exchange	Dar es Salaam	1998	Tanzania
21	South Africa - Alternative Exchange Johannesburg	Johannesurg	2003	South Africa
22	Bond Exchange of South Africa	Johannesburg	1996	South Africa
23	South African Futures Exchange	Johannesburg	1997	South Africa
24	Johannesburg Securities Exchange	Johannesburg	1887	South Africa
25	Bourse des Valeurs Mobilières de Tunis	Tunis	1969	Tunisia
26	Uganda Securities Exchange	Kampala	1997	Uganda
27	Agricultural Commodities Exchange of Zambia	Lusaka		Zambia
28	Lusaka Stock Exchange	Lusaka	1994	Zambia
29	Zimbabwe Stock Exchange	Harare	1993	Zimbabwe