An Empirical Investigation of the Relationship between Capital Flows and South African Assets

Research Report

Presented to

The Graduate School of Business
University of Cape Town

In partial fulfilment of the requirements for the
Masters of Business Administration Degree

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FT MBA 2010

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Full-Time Master of Business Administration: 2010

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Acknowledgements

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I would like to convey my heartfelt gratitude to my supervisor Sean J. Gossel for unparalleled guidance and unfailing confidence in my work throughout this project. It is only because of his expertise, extraordinary professionalism as a dedicated supervisor and constant motivation that this project has been possible. Special appreciation also goes to the MBA Administration department.

I certify that the analysis conducted and the results presented throughout this research report are my own work and that all references are accurately reported.

Nayen Kavia
ABSTRACT

This study empirically investigates the relationship between capital flows and asset classes in South Africa using quarterly generated time series data from 1995:Q3 to 2010:Q4.

This research is imperative for policy makers to determine the relationship between asset classes and capital flows. The study employs econometric techniques such as Unit Root test, Multivariate Cointegration, Error Correction Mechanism and Wald tests.

Using the Johansen and Juselius (1990) co-integration analysis, there is evidence in the data to deduce that the four variables have a stable single long run co-integrating relationship. A Vector Error Correction Model (VECM) is used to establish a short-run link between asset classes (represented by equity, bonds and housing prices) and total capital flows. The short-run and long-run relationships in the model are detected to be stable after checking for autocorrelation and heteroskedasticity in the error correction term residuals.

The findings in particular show that, the bond market has negligible granger-causation on capital flows, but stocks and housing are significant drivers to capital flows. In addition, the evidence also implies that house prices granger cause stocks and capital flows, further confirming that house prices are driven by strong fundamentals including stock prices.

Given South Africa’s legacy as a growing emerging market, the reasons for the findings are not surprising and support other academic literature with views on financial liberalization and capital market development.

KEY WORDS: 
Vector Error Correction, Equity, Bonds, Housing, Capital Flows, Granger Causality, Cointegration.
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List of Acronyms

ADF  Augmented Dickey Fuller
AE   Advanced Economies
ALBI All Bond Index
ALSI All Share Index
ASA  Absa Medium Price Housing Index
ASAMHI Absa Medium Price Housing Index
EM   Emerging Markets
FDI  Foreign Direct Investment
FPI  Foreign Portfolio Investment
GDP  Gross Domestic Product
IMF  International Monetary Fund
JJ   Johansen and Juselius
PP   Phillips Perron
SA   South Africa
SARB South Africa Reserve Bank
VAR  Vector Autoregressive
VECM Vector Error Correction Model
1 Introduction

1.1 Research Area and Problem

Over the past decade, financial globalization has accelerated as domestic financial markets have grown rapidly as a greater proportion of financial capital has come to be traded across international borders. This heightened degree of globalization had had positive and negative impacts on emerging market economies. On the one hand, emerging countries have experienced periods of stability and growth, with foreign capital facilitating efficient allocation of savings by channelling financial resources to their most productive uses irrespective of location. However, on the other hand, financial liberalization has caused a surge in capital flow volatility, leading to periodic episodes of asset price bubbles, and currency appreciation.

Many emerging markets have received large capital inflows in recent years, reversing a trend of outflows for much of the 1980’s period. Much of this new capital is in the form short-term portfolio investment, including bonds, equities, and short-term instruments such as certificates of deposits and commercial paper (Claessens et. al, 1995). Furthermore, according to Karolyi and Stulz (2003), by the year 2000 gross cross-boarder flows between U.S. residents and foreign residents had increased to 245% of GDP, largely in the form of portfolio flows, from a mere 4% of GDP in 1975 (Karolyi, 2003). Furthermore, Sarno & Taylor, (1999), cite World Bank (1997) in mentioning that emerging markets are still underweight in foreign investors’ portfolios, and that foreign investors are still relatively unfamiliar with EMs, hence these markets may be quite susceptible to cyclical conditions in major industrialized countries and more prone to investor herding behavior than AEs financial markets.

SA forms part of a basket of emerging countries that have benefited from increased capital flows and financial integration with the global economy. At the same time, SA has experienced tremendous volatility in the exchange rates and an increased risk of asset price bubbles on the back of relatively little foreign direct investment (FDI), but considerable amounts of foreign portfolio investment (FPI). Capital flows can bring substantial benefits to the recipient country, but different types of capital flows may have different effects (Ahmed, Arziki, & Funke, 2007). Net capital flows have increased to around $5.3 billion in quarter 3 of 2010, from $3 billion in the beginning of the year. FPI is the main constituent of the inward flows and the upward trend, supported by better fundamentals and growth prospects, is rebounding to levels just below the 2008 sub-prime financial crisis period. The figure below shows the recent financial account flows in SA.
It has been more than over a decade since the virulent financial crisis devastated several East and South Asian Countries. However, the current financial and economic crisis, including the Euro Zone sovereign crisis, is once again raising fears in EMs of capital flight or a sudden stop of capital inflow possibly leading to severe macroeconomic problems such as real depreciation and credit crunches. SA like other emerging markets and transition economies has run high current account deficits in the last years and is under scrutiny due to perceived threats to stability (Draper, Freytag, & Voll, 2009). Previous crisis have been generally considered as the outcome of a combination of misguided financial and exchange rate policies with overreaction of foreign lenders and investors to temporary shortfalls in international liquidity, rather than vulnerabilities emanating from structural payments imbalances and excessive internal indebtedness (Akyuz, 2009). Compared to developed countries, Although emerging countries are relatively more exposed to fluctuations in global capital flows, which usually result in large swings in net capital flows, African markets are small, thinly traded, largely illiquid, and further lack depth and infrastructure hence making them more risky to investors (Adjasi, 2009). Since liberalization of SAs capital markets in 1994-1995, domestic policy has focused on making the country attractive to foreign investors as an investment destination among the leading global markets.

Going forward capital flows into SA are expected to remain strong, although their composition may change and capital flows from developed countries are expected to continue to emerging countries, including SA; however the composition of these flows may be more in favour of portfolio flows (IMF Strategy, Policy, and Review Department, 2011). Over the period 1994-2002, SA has attracted three times more portfolio investments, as a percentage of GDP, than the other EMs, 70% of these flows were in the form of equity and peaked at almost 6% of GDP during 1997-2000. The portfolio inflows to SA during this time coincided with the portfolio outflows from the East Asian and Latin American countries (Ahmed et. al, 2007).

Figure 1: Financial Account Flows in SA (IMF Strategy, Policy, and Review Department, 2011)
At this stage, it is worth noting the effect of ‘financial contagion’ that could affect SA. Contagion is associated with dependencies among countries allowing shocks in one country to affect others, irrespective of their geographical locations (Karolyi, 2003). For SA, contagion can be linked to its developed country trading partners and other financially linked emerging countries with similar investment attractions or investor profiles. Particularly, considering that Jenkins and Thomas’s (2002) argue that investors tend to see SA as the largest and most favoured investment market in Sub-Saharan Africa for three reasons. Firstly, SA has the best developed and liquid financial markets including hosting subsidiaries of many large foreign owned multinationals. Secondly, the reintroduction of SA into major indices has boosted the country’s participation in global portfolios as investors attempt to replicate the composition of these indices. Lastly, country-specific pull (domestic) factors are positioning SA to receive greater shares of foreign inflows, these include high real and nominal yields, a disinflationary trend supported by appreciation in the rand and moderate public debt ratios (IMF Strategy, Policy, and Review Department, 2011).

The SA economy has witnessed a process of structural transformation since the advent of democracy in 1994, which has included the development of a relatively sophisticated bond market. Although Kapingura & Ikhide (2011), and Ambrosi (2010) report that the SA debt market still only comprises a a fraction of the world’s debt market, it does constite the bulk of the African debt market. Unfortunately, As South Africa’s equity and bond markets reintegrated into the global economy, the country has been impacted by emerging market crises, including the Asian crisis in 1997-1998, and more recently, the global financial crisis (Duncan & Kabundi, 2011). The figure below shows the non-resident purchase of shares and bond over the subprime period.

Figure 2: Non-Resident Net Purchases of Shares and Bonds (IMF Strategy, Policy, and Review Department, 2011)

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1 See Calvo and Reinhart (1995), For Latin American Evidence on how financial linkages (FDI, bank lending, capital market activities) in one country can affect another negatively. Eichengreen and Ross (1999) also explain in detail the channels or transmission mechanisms of a contagion.

2 For example, the creation of the Global Emerging Markets Local Currency Bond Index (GEMEX) in 2008, where SA carries a 10% weight is mentioned as one of the factors contributing to enhanced efficiency and safety attracting investors (Kapingura & Ikhide, 2011).
An important dimension of financial stability is the increased volatility of asset prices and the subsequent development of asset price bubbles. Hence, the anticipated and recent increased capital flow volatility and possible formation of asset price bubbles have important implications for SA’s financial stability. To date, the bulk of the literature on capital flow volatility has focussed on measuring, modelling capital flow volatility, rather than on empirically investigating the links between capital flow volatility and asset price volatility. Hence, this proposed research seeks to fill this gap in a South African context.

1.2 Purpose of Study

This study seeks to investigate the effects of total capital flow on three financial asset classes. Hence, the objectives of this research are the following:

i. To determine the degree to which total capital flows is associated with the Johannesburg Stock Exchange (JSE) All-Share Index (ALSI).
ii. To determine the degree to which total capital flows is associated with the Bond Exchange of South Africa’s (BESA) All Bond Index (ALBI).
iii. To determine the degree to which total capital flows is associated with the ABSA Bank House Price Index (ASAMHI).
iv. To investigate whether macroeconomic fundamentals are associated with financial assets.

1.3 Research Questions

The primary question this paper seeks to answer is:

*Does total capital flow have an effect on SA’s three main financial asset classes?*

In addition to the above primary question, three secondary research questions will also be investigated (where H0 refers to the original hypothesis, null hypothesis or commonly accepted hypothesis, whereas H1 is the alternative hypothesis):

**Secondary Research Question 1: Total capital flow and ALSI**

H0: Total capital flow has an effect on the All Share Index (Equity Prices) of SA.  
H1: Total capital flow has no effect on the All Share Index (Equity Prices) of SA.

**Secondary Research Question 2: Total capital flow and ALBI**

H0: Total capital flow has an effect on the All Bond Index (Bond Prices) of SA.  
H1: Total capital flow has no effect on the All Bond Index (Bond Prices) of SA.

**Secondary Research Question 3: Total capital flow and ASAMHI**

H0: Total capital flow has an effect on the ASAMHI (Medium House Prices) of SA.  
H1: Total capital flow has no effect on the ASAMHI (Medium House Prices) of SA.
1.4 Research Assumptions

It is assumed that:

i. Data obtained to conduct the research is of a generally acceptable standard and will allow correct application of the proposed econometric modelling, supporting economic theory and econometric estimation techniques to produce the most accurate results. Reputable sources have been used to obtain the data.

ii. The model and estimation techniques are sufficiently robust when applied to emerging countries. It is also considered that the methodologies to be applied are applicable to the type of data used.

iii. The data applied to the study are taken with the SA economy operating in a normal and stable state, ‘ceteris paribus’.

iv. The study makes use of indices for analysis. It is assumed that the methodology with which the indices are prepared are up to standard and that the indices appropriately reflect market sentiments by providing a holistic view of performance.

v. This research has been based on the assumption that the total capital flow chosen as the dependant variable does in fact have an association with the 3 chosen financial asset classes (ALSI, ALBI, ASAMHI) and that the relationship does not change over time.

vi. It also assumes that the aggregate of the capital flow liabilities account represent the total or net capital inflows into SA. The total capital flow is also considered as the dependant variable and it is considered that these do have an impact on the explanatory variables of financial asset price volatility in SA.

vii. This research aims to use the Vector Error Correction (VECM) to study the association between the variables selected above. The list of explanatory variable could be incomplete. No reference is made to Cash and other very short term investments (less than 90 days) in this study mainly due to unavailability of properly prepared and sufficient data. At the time of this research, the suggested proxy for cash, the Alexander Forbes Money Market Index (AFMMI) was under review concerning the methodology used in preparing it. The AFMMI is prepared daily on an interest accrual basis and would have been averaged for a quarter to represent the effective term yield.

viii. This study assumes that there are no significant structural breaks in the time series. The incorporation of structural breaks was also constrained due to software limitations.

1.5 Research Ethics and Informed Consent

This research paper has not involved any human subject and has made use of historical and forecasted economic and financial data from publicly accessible databases. The required ethical clearance protocol has been followed and ethical clearance was provided by the UCT. All sources of information were referenced avoiding plagiarism. A signed ethical clearance form has also been submitted with the research proposal for this study.

1.6 Layout of the Research Proposal

The remainder of this research proposal is structured as follows: Section 2 provides a review of the theoretical and empirical literature. Thereafter, Section 3 covers the proposed research methodology to be employed in the proposed study. Attention is then given to preliminary tests that will be employed to
the data prior to applying the model. Section 4 details the research plan, timetable and budget. And Section 5 ends with a proposed bibliography.

2 Literature Review

This section will briefly explore the literature relating to the topic of this proposed research, the literature is explored on a contextual basis and the strengths and weaknesses of the studies are evaluated. The literature review will also demonstrate that the dynamics between capital flow and asset price volatility is not a thoroughly researched area, especially in the context of SA. Finally, empirical studies on methodology comparisons will be briefly described.

The majority of readings differ in at least one or more of the following respects:

a) Objective  
b) Sources  
c) Complexity and details of investigation  
d) Asset classes investigated  
e) Emerging versus developed economy

The literature review is presented in four sections. The first section looks at capital flows, components and related studies, the second section looks at asset classes and asset bubble papers (methodologies and viewpoints of different researchers). The third section aims to identify similar studies and the final section summarises the literature review.

2.1 Capital Flow Components

This section describes capital flows and the different types of capital flows in more detail. The SARB has reclassified capital flows in line with international norms into three main categories; these are FDI, FPI and other foreign investments.

2.1.1 Foreign Direct Investment

Capital inflows are characterized as FDI if the investor acquires a lasting management interest, typically 10% or more, in the foreign enterprise. FDI has three components, namely equity investment, reinvested earnings and short-term and long-term intercompany flows (Ahmed et. al, 2007). Conventional wisdom says FDI is the least volatile, least reversible, long-term and most stable form of capital flow, as it constitutes mainly of investment in highly illiquid fixed assets which are difficult to sell off in case of a crisis. FDI is also largely influenced by country specific pull factors including long term profitability expectations related to a country’s fundamentals rather than being influenced by speculation and interest rate forces (Sula & Willet, 2006).

3 The stability view of FDI has several arguments, especially in the case of local financing of FDI, outflows in the form of bank collateral for loans and portfolio flows may occur in times of instability. As cited in Sula & Willet (2006), Bird and Rajan (2002) and Fernandez-Arias and Hausmann (2001) provide concise views on the stability and reversibility of FDI.
According to the IMF classification, the distinction between FPI and FDI is not clear-cut, as an equity investment above 10% is considered as FDI irrespective of how quick it could be reversed. FDI is viewed as an important source of funds for economic development as it supplements domestic savings and helps improve the country’s economy through facilitating the transfer of new technology, improved resource allocation, improved market access and human capital development (Ahmed et al., 2007; Sula & Willet, 2006) and Cassens, Dooley, & Warner, 1995). In contrast Musila and Sigue (2006) (citing Razin et al., 1999) suggest that FDI may have adverse effects on employment, income distribution and national sovereignty in low-income economies.

Sula & Willet, (2006) argues that FDI flows could also cause instability, especially if the degrees of reversibility of the physical investment versus the full range of activities associated with the investment are not considered appropriately. In addition, Sarno & Taylor (1999), reports that especially in times of crisis, FDI may cause instability by allowing other types of flows to mask it, for example, a sudden change in perception of macroeconomic fundamentals may force some permanent nature of the investment to remain but profit repatriations and collateral activities may increase as foreigners will lien assets in ways to repatriate initial investments. Hence such flows may leave the country in the form of FPI. Furthermore, Claessens et al. (1995) find that FDI flows are often as volatile and unpredictable as short-term FPI flows.

Nevertheless, much of the observed stability of FDI is expected to be real. For example, Krugman (2000) points out that in case of downturn, firm market values may fall substantially and inflows may be generated to take advantage of bargains. Furthermore, a study by Ahmed et. al (2007) aims to link and identify the common determinants of FDI and FPI. In this study, according to Ahmed et. al FDI inflows to SA amounted to 1.5% of GDP per year, whereas FPI amounted to 3.5% of GDP. It was also noted in this same study, that there are a number of policy variables, such as trade openness in comparison to competitors, growth infrastructure and law and order, that contribute to SAs lower share of FDI compared to FPI. The paper then concludes by suggesting that to further increase FDI, SA should relax capital controls and aim to reduce exchange rate volatility via increased sterilisation by the SARB.

In another study Aghion, Bacchetta, & Banerjee (2004) examine the effects of financial liberalization on stability of macroeconomy, and find that in the case of economies with intermediate financial development full financial liberalization may actually destabilize and induce chronic phases of growth with capital inflows followed by a collapse with capital flight. They also find that FDI never destabilizes since foreign direct investors come with their own credit and their ability to invest is unrelated to the state of the economy. They also suggest that FDI acts as a stabilizing force, unlike foreign lending it does not depend on the credit worthiness of the domestic firms, and furthermore it is precisely during slumps that FDI comes in so as to benefit from the low prices of the country-specific factor. In addition, Edwards (1991) study (as cited in Alfaro, Kalemli-Ozcan, & Volosovych, 2007) shows that government size and openness are important determinants of FDI from AEs to EMs during the period

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4 Overall this suggests that economies at an intermediate stage of financial development should consider carefully how they liberalize their capital accounts. In fact the strategy of allowing only FDI at early stages of financial development is what most AEs have done (Aghion, Bacchetta, & Banerjee, 2004).

However, even though FDI can be withdrawn and cause instability, it is least likely to be affected by financial market inefficiencies, such as herding effects and is also considered to have the largest permanent component (Sarno & Taylor, 1999).

The literature above agrees that FDI is the more desirable form of capital flow, due its long term nature, high stability and potentially non withdrawable benefits to the economy. Thus FDI will be considered in the model for this study.

### 2.1.2 Foreign Portfolio Investment

Portfolio investment flows include portfolio debt flows and non-debt creating portfolio equity flows. These flows are considered to be the hottest of the various components of capital flows as investors can sell their stocks or bonds more easily and quickly than FDI and other flows, especially on well traded exchanges such as the JSE (Sula & Willet, 2006).

Short-term capital movements are deemed as speculative and reversible (hot money) (Claessens et. al, 1995). Brink and Viviers (2003), suggest that although FPI is volatile and perceived as risky, the risks are generally well known and can be managed to a degree. Furthermore FPI is associated to the impact of information or news and associated herding behaviour. This is partly because mutual fund, institutional and index fund managers display similar patterns of investment usually creating capital surges or withdrawals in sync and thereby creating instability to a specific region (Sula & Willet, 2006). Index traders heavily invest in portfolio flows and are termed as investors who purchase baskets of equities in different proportions within EM indices such as the International Finance Corporation (IFC) Emerging Market Index (Schoeman, Robinson, & Wet, 2000).

According to Sau (1994) , FDI is rigid and felt strongly in the goods market, whereas FPI is flexible and prevalent within the asset market. This follows Carlson & Hernandez (2002), who cite Rodrik and Velaso (1999) suggesting that FPI is driven by investors who are seeking higher returns and when they leave due to adverse and uncertain market conditions they are likely to cause highly destabilizing effects, especially to economies that don’t have strong fundamentals.

Due to the obvious disadvantages of high levels of FPI a country attracts, and the fact that is short term and largely driven by interest differentials (Claessens et. al, 1995), it is viewed as speculative and harmful as opposed to FDI that is long term and comes with tangible benefits. Furthermore, short term inflows, can cause an appreciation in exchange rates thereby increasing domestic inflation and resulting in interest rate hikes to curb inflation. Such high interest rates are usually associated with higher defaults, thus worsening country credit rating and causing outflows, which if severe enough can cause a full blown financial crisis (FitzGerald, 1999).

In another study, Demir (2009) employs firm level panel data to 3 countries separately, his empirical analysis suggests that financial liberalization when accompanied with increasing volatility of short-term capital flows or FPI has an economically and statistically significant negative effect on new
fixed investment spending of private real sector firms in all three countries. This study also further mentions that developing countries are expensively trying to self-insure themselves against the increased volatility in financial markets by accumulating large sums of unproductive, idle, and in fact quite costly foreign exchange reserves that offer very low rates of return.

None the less FPI is important to a country as it complements FDI. In particular, a liquid financial assets market may encourage FDI as it provides a platform for foreign owned companies to raise capital from the domestic stock market which can be used for further expansion (Brink & Viviers, 2003). In the case of SA, the JSE is a large stock market with a significant number of companies having large market capitalizations. Another benefit of FPI as stated by Knill (2005), is that in the long run FPI might reduce a country’s dependence on capital flows by improving and stabilizing the domestic markets setting well enough to lessen the impact of sudden future outflows of FPI.

Aghion, Bacchetta, & Banerjee (2004) analyses the moral hazard problem associated with FPI, they suggest that in an economy with an intermediate level of financial development there will be a higher tendency for banks to over lend especially during a boom thus causing instability. Calvo (1999), as cited in Gabriele, Boratav, & Parikh (2000), analyses the interaction between informed and uninformed investors in vapidal markets, deducing that assymetric information can lead uninformed investors to misinterpret informed investors actions (such as selling securities, thus portfolio flows, to meet obligations in home country), generating financial panic and ultimately resulting in declining output in developing countries.

Rousseau & Wachtel, (2000) in their findings underscore the potential gains associated with developing deep and liquid financial markets and enhanced portfolio investment may benefit a recipient country. They provide four reasons. Firstly, an equity market provides investors and entrepreneurs with a potentially simple exit mechanism. For example, the attraction of venture capital and private equity investors in a country with a developed liquid stock market. Secondly, the inflows of both FDI and FPI are an important source of funds for developing and transition economies, especially the existence of an equity market facilitates the capital inflow and thus the ability to also finance a current account deficit. Thirdly, the provision of liquidity through organized exchanges encourages both international and domestic investors to transfer their surpluses from short-term assets to long-term capital and thus helping finance investment in projects that have economies of scale. And lastly, well developed equity markets provide both an informational mechanism evaluating the performance of domestic firms and incentives to managers to perform well.

To clarify, the composition hypothesis proposes that not all capital flows are equal. In particular the maturity structure of external debt (the greater the share of short-term debt, the more likely a crisis) and the currency denomination (the greater the share of the short-term debt, the more likely a crisis) are robustly related to the probability of a crisis (Wei, 2006). On the other hand FPI is expected to be significantly more volatile than FDI flows, especially with the current trend of increased deregulation, decreases in transaction costs and the susceptibility of FPI to be more sensitive to movements in short-

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5 FPI can also be destabilizing since a change in market sentiment can lead to massive outflows which often lead to exchange rate crisis (as in Mexico in 1995 and Czech Republic in 1997).
term differentials in rates of return. Furthermore, empirical results also provide strong evidence that there is a statistically significant permanent component in equity flows and bond flows, both major constituents of FPI (Sarno & Taylor, 1999). FPI is also known as “hot-money” and typically consists of equity and bond investments that are short-term, mostly unproductive and move rapidly between countries (CUTS, 2003).

In addition, the “carry-trade” evident in Asia in the 1980s to 2000s was as a result of investors seeking to benefit from distinguishing features of EMs including more predictable, higher and lowly correlated average returns compared to AEs (Bekaert & Harvey, Emerging Equity Market Volatility, 1997). This “carry trade” is now becoming evident in Africa’s markets and is highly destabilizing when FPI is suddenly withdrawn, however the riskiness of EMs helps to control and deter such inflows (Nellor, 2008) (Carlson & Hernandez, 2002).

In particular not only does the volatility and instability of FPI complicate the implementation of macroeconomic stabilization policies, it also creates unpredictable impact on money supply, exchange rate level and stock market volatility. On the other hand, sustained periods of excessive FPI are also dangerous as high capital mobility could result in the formation of asset price bubbles, thus sparking inflationary pressures (Jarita & Salina, 2008) (Khan & Reinhart, 1995).

Finally, Reisen & Soto (2001), examined the impact of all types of capital inflows on growth for a sample of 44 countries and conclude that FPI (equity flows), along with FDI can play positively influence the growth and development process of an economy. In addition since FPI is the most volatile capital flow component and of significant magnitude it will be considered for this study.

2.1.3 Other Investment Flows

Other investment flows are made up of private loan flows, including bank loan flows and other sector loans such as trade finance, finance leases, mortgages and repurchase agreements.

Sula & Willet (2006), confirm contrary to much popular analysis that private loans on average are as reversible as portfolio flows. They argue that during times of financial distress banks are unable to quickly adjust the prices “illiquid” loans and instead respond with a decrease in the quantity of lending. Increased uncertainty in the market, usually accompanied with increased interest rates raises the fear of loan defaults due to increased risk. In such scenarios banks have greater incentives to pull out of crisis countries in order to cut their losses early enough. The shortage of loans will also cause an associated credit-rationing period, and foreign investors will recall their short-term debt and halt lending and rolling over existing long-term debt. In addition, Sarno & Taylor (1999) clarify that the permanent component in commercial bank credit may reasonably be expected to be relatively large, albeit to a lesser extent than FDI. On the other hand, Albuquerque (2003), in his study points out that bank loans
and bond financing are partially inalienable, unlike FDI that largely has inalienable intangible assets which bring little residual value to a recipient country as it is harder to expropriate.

A country that has no access to FDI or FPI inflows may still be able to benefit from other investment flows to finance illiquid investments. Often there has been a surge of academic interests in the over-arching topic of capital flows to Africa, including in the form of debt relief and increased foreign aid. Wei (2006) points out that there is no strong evidence that private foreign debt including international lending has robustly promoted economic growth. Wei cites, Reisen and Soto (2001) that one sometimes finds evidence that international lending is negatively associated with economic growth, and Rajan and Subramanian (2005) adding that official aid does not robustly support growth either.

McKinnon and Pill (1996) (as cited in Kirabaeva & Razin, 2010) show financial liberalization without adequate supervision can result in over borrowing by banks. Banks typically engage in the business of maturity transformations, any mismatches between liquid maturities of the customer deposits and illiquid investments of the bank makes them particularly vulnerable to bank runs. Even a small shock can result in costly asset liquidations and large declines in asset prices. Furthermore domestic bank runs may interact with panics by foreign creditors, especially in the case of an internationally integrated capital market. If a bank has a high fraction of foreign credits, and as assets are typically denominated in domestic currency while debt is denominated in foreign currency, real exchange rate depreciation may cause a bank run as banks will be unable to meet local currency obligations.

Jongwanich (2010) estimation results shows that a swift rebound of capital inflows into the economically recovering Asian region could result into excessive appreciation of real exchange rate especially when capital flows are in the form of portfolio and bank loans (other investments). Rapid real exchange rate appreciation could imply a loss of a country’s competitiveness and the use of capital controls if carefully implemented in such scenarios may be beneficial.

Combes, Kinda, & Plane (2011) shows that bank loans and private transfers respectively have the lowest effect on real exchange rate appreciation in developing countries, despite having been the main component of private capital flows to developing countries in the mid-1980s. The study also shows that commercial bank loans have a higher inflationary potential compared to FDI. Private transfers or remittances act as a buffer helping to smooth consumption especially if they increase during economic slowdowns, but if they come in the form of remittances for investment they can be overheating to the economy and drive the real exchange rate upwards.

Private loan flows are generally considered to be a relatively neglected category of private capital flows due to their relatively small size (Sula & Willet, 2006). In addition, the volatility for other

6 Examples of these intangible assets include human and organizational capital, and technological advances. Inalienability occurs because multinationals usually hire specialized work forces from their host countries or train their own work force. Also high technology industries typically rely on blueprints to secure their investments.

7 As cited in Combes et. al (2011), the theoretical determinants of remittances said Lucas and Stark (1985) in their seminal paper, are driven by the income needs of the migrants family at home or investment motives.
investment flows is somewhat higher for emerging markets and data shows some reliance by emerging markets on these flows (Neumann, Penl, & Tanku, 2009). None the less, they are included in this study.

2.1.4 Capital Flow Studies

This section describes the studies on capital flows and associated measurement techniques from other studies. A number of theoretical contributions have focused on the determinants, measurement and consequences of capital flows.

Aghion et. al (2004), develop a dynamic open economy model in which it implies that capital flow volatility is higher for liberalized countries, especially those at an intermediate level of financial development or economies with imperfect credit markets. In turn, Alfaro et. al (2007) analyse the interaction of institutional quality and policies as determinants of capital flows. Then they look at changes in level of capital inflows and regress them on policy changes and institutional quality changes over time. The study experiments with different ways to measure capital inflows volatility which may not be captures by simple normalization and uses standard deviation of inflows, standard deviation of detrended inflows and normalized versions of these measures\(^8\). Consequently EMs should focus on developing institutional quality and improve policy making together with reduced bank credit to increase stability.

Broner and Rigobon (2004), find that the capital flows to EMs are 80% higher than those to developed countries. The volatility is associated to weak institutions, underdevelopment of domestic financial markets and low income per capita. For a sample of 58 countries, they first run a series of panel regressions focusing on the residuals and the explanatory power of fundamentals rather than on independent variables' coefficients. Surprisingly domestic fundamentals and external factors, such as international interest rates, explain little of the volatility. Instead, persistence of shocks to capital flows and the possibility of contagion fares better in explaining the higher volatility in EMs compared to AEs. Secondly, they take a direct approach and perform cross-sectional volatility regressions, of the unconditional standard deviation of aggregate capital flows on a number of country characteristics. Volatility decreases with higher GDP per capita, better quality institutions and increased financial development.

In another approach, to analyse the volatility of capital flows, Bekaert & Harvey, (1997) focused on returns or prices rather than contributions. They try to assess the determinants of the volatility of stock market returns by fitting a GARCH (1,1) model to the rates of return in emerging markets\(^9\). As a first step, they begin by analysing volatility of country specific determinants on the stock market (such as number of stocks in the national index, asset concentration and the individual cross-sectional volatility of individual stocks listed within the country index). After this, they construct a panel of twenty countries to which they fit and estimate the GARCH model to assess the cross-sectional determinants of volatility. Using the generalized, least squares estimation, the independent variable is

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\(^8\) They try other measures of volatility including such as the standard deviation of de-trended inflows, their analysis shows that de-trending has no effect on their results.

\(^9\) Following Bekaert & Harvey (1997), Broto, Diaz-Cassou, & Erce-Dominguez (2007) also use a GARCH (1,1) model in their study titled “The Sources of Capital Flow Volatility: Empirical Evidence for Emerging Countries”.
the implied volatility and group wise heteroskedasticity and serial correlations is corrected. A problem with using the GARCH approach, as identified by Broto, Diaz-Cassou, & Erce-Domínguez (2008), is data scarcity that leads to convergence problems in the model estimation. The main conclusion of this paper is that capital and financial market liberalizations often increase the correlation of local market returns with world markets without driving up local market volatility.

Neumann et.al (2009), examines the volatility of total capital flows (FDI, FPI and Other Investment) following the liberalization of financial markets. Their methodology involved the use of constructing a five-year rolling window for the standard deviation of capital flows relative to GDP. Although the use of overlapping observations is common in finance and allows one to obtain a larger sample time series, it creates an associated problem for inference. An econometric complication arises as observations are no longer independent due to the induced serial correlations. Neumann et. al solve this biasedness problem by modifying the Newey-West correction as proposed by Bekaert, Harvey, & Lundblad (2006) GMM Framework, which also accounts for the country-specific heteroskedasticity and seemingly unrelated regression (SUR) effects. Their study uses a panel of 26 countries (15 mature and 11 developing countries) and the finalcial liberalization variables as developed by Kaminsky & Schumkler, (2003). They conclude that financial integration into global markets tends to increase the volatility of FDI in emerging economies, whereas it seems to reduce the value of other investment flows in mature economies.

In a similar study, the Global Financial Stability Report (IMF, 2007) uses a five-year rolling window for a sample of fifteen developed and fourteen emerging countries, to assess the domestic determinants of capital inflows for period 1977-2006. They regress the standard deviation of capital inflows, obtained using a five-year rolling window, onto a series of indicators measuring domestic market depth, liquidity, institutional quality and other macroeconomic measures. Contrary to Neumann et.al they do not correct for serial correlation and conclude that financial openness and institutional quality appear to be negatively correlated with capital flow volatility.

However, the use of annual or quarterly capital flow data, can pose some obvious drawbacks to using a rolling window approach. Broto, Diaz-Cassou, & Erce-Domínguez (2008), point out three issues. Firstly, the method entails a loss of observations at the beginning of the sample period; this can give misleading results especially if the time series is short. Seconds, non-robust estimates due to problems of endogeneity and serial correlation as the estimates of standard deviation are strongly dependent on previous periods. Lastly, the computation of standard deviation that uses same weights for older periods tends to underestimate volatility in years of shocks and overestimate in years of no shock. In short, the above limitations will smooth the processes creating difficulties for estimation procedures.

To overcome the drawbacks of Bekaert & Harvey, (1997) and Neumann et.al (2009), Broto, Diaz-Cassou, & Erce-Domínguez (2008) proposes a measure of volatility based on the Engle & Rangel (2008), which comprehensively accounts for uncertainty around lower frequency macroeconomic variables in comparison to financial variables. High frequency equity volatilities is modelled with low frequency

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10 The choice of the window length is fundamentally an arbitrary decision. Shorter windows will have the advantage of having more observations.
macroeconomic volatility, by specifically assigning high frequency volatility as a product of slower moving components which revert to a constant level. By particularly, separating the high and low frequency components of the volatility process using a multiplicative decomposition and by modifying the standard GARCH (1,1) to introduce a trend in the volatility process, they introduce the spline-GARCH model. This semiparametric approach has the potential to capture both long and short run dynamic behaviour of market volatility. In addition, their study also finds that the size of the market relative to GDP and the number of listed companies, as a proxy for diversification opportunities, reduce low-frequency volatility as typically characterised by emerging markets.

The more direct measure of flow variability is the standard deviation in the ratio of the flows to GDP. BIS, also proposes a complementary measure of variability is the degree to which capital flows persist over time.

Ahmed et. al (2007) in their study identify FDI inflows in South Africa are more volatile than inflows in the comparator countries, they measure volatility by the coefficient of variation, defined as the standard deviation of of annual inflows divided by average inflows. In another study, interestingly enough, capital flow volatility is measured using the autocorrelation approach (Becker & Noone, 2008). As found in Sarno & Taylor (1999), FPI (cold flows) have relatively low permanent components and FDI is almost entirely permanent. Following this finding, as cold flows are perceived to be relatively stable they should also display evidence of a strong positive correlation with their past values, likewise hot flows should display strong negative correlation with past values. The absence of such persistence or correlation would suggest that a flow switches signs and is relatively unpredictable. Becker and Noone, calculate the autocorrelation coefficients for each flow in each country over the sample period of 1980-2005. Their results are consistent with using the standard deviation method to assess capital flow volatility. They find a high degree of persistence in the overall balance of payments for atleast one to two years, and large and positive autocorrelation coefficients that decay over time with increases in lags for developed economies. In contrast, capital accounts of emerging economies have less autocorrelation.

2.2 Asset Prices
This section describes asset price booms, bubbles and tests for their detection. It also focuses on the pros and cons of asset price booms and bubbles.

Asset price bubbles are the subject of much debate, with much disagreement on the precise nature and cause of such events. While there are, some useful working definitions of asset bubbles that attempt to explain such events there is no consensus and theoretical ‘statistical’ definition. In fact, for almost every paper in literature that finds a bubble, there is another that relaxes some assumption on the fundamentals and fits the data equally well without resorting to a bubble.

South Africa seems to share some of the characteristics of asset price boom periods in industrial countries (property price booms, easing of monetary policy and strong domestic growth), often followed by periods of weak growth and banking fragility. Asset prices have risen strongly, since 1999 property prices have increased over one hundred per and stock prices have increased by over 50%, both in real
terms (Funke, Kirmer, & Wagner, 2006). Asset price booms however do not last forever. Empirical evidence suggests that sharp corrections in equity prices occurred on average every 13 years, lasting about 2½ years and property prices corrected with a bust once every 20 years, lasting much longer than stock prices (IMF, 2003).

Although the definition of bubbles appears straightforward, testing for its existence could prove a difficult task. How do you determine whether there are bubbles in asset classes? The most frequent and logically plausible method is to compare the price and the markets fundamentals. These fundamentals, can be classified into two categories namely fundamental value and market perception value.

As events evolve, despite suspicions on identification of a bubble, existence of these is usually only confirmed after they burst. The situation of detection of bubbles is even murkier in academic literature, largely concentrating on testing for rational bubbles and ‘explosive’ exponential trends in the time series of asset prices and foreign exchange rates with limited success (Andersen & Sornette, 2003). The problem of identification of bubbles also largely stems from the lack of clear definitions, and that apparent evidence for bubbles can be reinterpreted in terms of market fundamentals that are unobserved by the researcher. There is a wide description of asset bubbles.

Equity prices contain a rational bubble if investors are willing to pay more for the stock than they know is justified by the value of the discounted dividend stream because they expect to sell it an even higher price in the future, making the current high price an equilibrium price (Gurkaynak, 2005).

Asset price booms are also sometime associated with bubbles. Loosely speaking a bubble describes a significant deviation of an asset price from a well-defined fundamental value (Funke et al, 2006; Garber, 2000). In turn, the fundamental value can be measured by three determinants: cash flow received over time, the terminal or residual value of the asset at the end of the holding period and the discount rate applied to future value for current value translations. The deviation away from the fundamental part is commonly also referred to as the bubble component, that does not provide for arbitrage opportunities (Gurkaynak, 2005). Asset prices, in the ‘bubble’ phase will usually exceed fundamental value so long as the agents promoting it expect to sell it for higher future prices. Some of the best tests using the discounting value approach (‘standard’ model) can show whether the data is inconsistent with the presence of bubbles, but not whether bubbles are inconsistent in the data.


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11 Recent emergence of behavioral models that allow for irrational pricing and irrational bubbles are widely covered in Vissing-Jorgensen, (2004).
12 Importantly, equity pricing is rational and there are no arbitrage opportunities in an efficient market.
13 In ‘bubble’ literature, the fundamental value model is also referred to as the present value model, discounted value model and standard model.
14 The bubble part is a non-stationary i.e. a non-unique path, compared to the fundamental part which simply converges to a present value.

Sarno & Taylor (1999) argue, especially after observing the East Asian crisis, that a strong surge in portfolio inflows to developing economies can generate asset market bubbles. Lemi & Asefa (2003), comment that even though economic uncertainty in emerging and developing markets discouraged foreign investors, capital inflows have helped reduce the shortage of capital, especially in African countries. This follows Ventura (2002) paper that outlines a channel showing that bubbles are a substitute for international capital flows.

2.3 Related Empirical Studies

This section reviews the previous studies that have used different models and measures to identify interrelationships between various asset classes, and in some cases including an aspect of capital flows.

Although a number of studies have been conducted on the causal relationship between stock (asset) market proxies and macroeconomic variables, for both developing and developed countries, the dynamic causal relationship studies between capital flows and asset classes is very scant. To the best of my knowledge no publication has been made specifically linking capital flows and financial asset classes for South Africa (or Sub Sahara Africa).

2.4 Summary

The possibility of finding short-run and long-run cointegration can be supported by the above literature, although no direct study has been reviewed which looks at the extent total capital flows affect three asset classes.

The review first looks at the capital flow components in detail and previous studies that have attempted to measure capital flow and associated volatility and its effects on various variables, including the stock market and economic growth. Secondly, the topic on asset prices is tackled with a mixed approach, in that it looks at bubble identification tests and previous studies with an aim to link the asset classes mentioned to this research. Lastly, some empirical studies have been looked into, that are perhaps in a similar tangent to this study, and be it in the methodology employed or the variables used and results obtained.

Therefore, the methodology followed is presented in the next section. It includes unit root test, co-integration, and vector autoregressive modelling and granger causality.
3 Research Methodology

This section outlines the methodology used to conduct the empirical analysis, commending with an outline of the research approach and data collection methods, including some supporting literature on data characteristics. Thereafter, a detailed description of the variables is provided followed by an explanation of the statistical techniques employed.

3.1 Research Approach and Strategy

The research questions in this study will be investigated using empirical models and are thus deductive and quantitative. Leedy and Ormrod (2010) define quantitative research as studies which use statistical analysis applications to measure sample data so as to develop an explanation that researchers can use predictably to other sample sets. Creswell (2002) further notes that the methodology of quantitative research maintains the assumption of and empiricist paradigm. Quantitative research begins with a problem statement and involves the formation of a hypothesis, a literature review and quantitative data analysis. The findings from quantitative research can be predictive, explanatory and confirming invalid source specified. The process will also be deductive to a certain extent as the research will use findings of other studies which are taken to be true based on a number of observable events (Leedy & Ormrod, 2010).

This research is conducted using EViews 6 Student Version software as produced by (Quantitative Micro Software, LLC, 2007).

3.2 Data Collection, Frequency and Choice of Data

The literature review indicates that a considerable number of predictors have been suggested as possible indicators of vulnerability to capital flows, amongst others, macroeconomic, microeconomic and financial variables.

The variables selected for inclusion in this study have been chosen in accordance with; Rahman, Sidek, & Tafri (2009) who used the Malaysian stock index, Kapingura & Ikhide (2011) who used the Bond Exchange of South Africa ALBI and Balciar, Gupta, & Shah (2011) that did their study using the Absa Medium Price Housing Index. The data is available in mixed frequency and covers the period from 1995 to 2010. The variables are as follows:

i. ALBI – \( Y_1 \), Dependant Variable 1
ii. ALSI – \( Y_2 \), Dependant Variable 2
iii. ASAMHI\(^{15}\) – \( Y_3 \), Dependant Variable 3
iv. Total Capital Flows – \( X_1 \), Explanatory Variable 1

It is a common practice for raw time series data used in a study to be transformed to make them statistically useful. Having collected sets of quarterly, monthly, weekly and daily data, appropriate adjustments were made. As suggested by (Brooks, 2008, p. 4), it is a general requirement of all the data used in a model to be of the same frequency. In addition, when including several explanatory variables in a multiple regression or vector autoregression model, all variables must have the same number of

\(^{15}\) The terms ASAMHI and ASA are used interchangeably in this study and refer to the same series.
observations (Koop, 2009, p. 125). Hence, to match the quarterly capital flow data the daily returns of ALSI, weekly yield of the ALBI and monthly index figures of ASAMHI data were all averaged to represent quarterly data with a total number of 62 data points.

The data for all the variables considered in the analysis, including those for the housing index (ASAMHI) are obtained from:

i. SARB Website http://www.reservebank.co.za:
   Total capital flow data was obtained from SARB databases. The data was available in disaggregated form for the three main components of capital flows. Further details are provided below.

ii. I-Net Bridge Database: http://www.i-net.co.za
    I-Net was used as a source for data on the financial asset classes. The ALSI data was available under the J200T code and was in daily format. The ALBI data was available and obtained under the previous bond index code, JAP105, and was in weekly format. I-Net also maintains records of the Absa Housing Prices, the medium prices index was selected for this study under the code ASAMHI.

    This database was to primarily used to ensure the capital flow data obtained from SARB corroborated with the IMF database.

iv. Share-Net Database: http://www.sharenet.co.za
    This database was used to ensure the ALSI and ALBI data obtained from I-Net corroborated with the Share-Net database.

v. ABSA Bank: http://www.absa.co.za
    This database was used to ensure ASAMHI data obtained from I-Net corroborated with the ABSA Bank database. ABSA was also consulted for a brief on the methodology used in the construction of this index.

The time series variables used have been shown in graphical form in Appendix A.

**Capital Flow Data:**

The capital flow data was obtained from the South African Reserve Bank (SARB) and was cross-checked with the IMF International Financial Statistics database for possible discrepancies. The codes used to generate the data are as follows:

i. KBP5640K - Capital Movements of Liabilities: Total direct investments
ii. KBP5644K - Capital Movements of Liabilities: Total portfolio investments
iii. KBP5650K - Capital Movements of Liabilities: Total other investments
62 observations in total were selected for SA capital flows covering the period from 1995:Q3 to 2010:Q4. Following the approach of (Broner & Rigobon, 2004) and also (Leape, Leape, & Lynee, 2010), the three capital flow components are then added together to produce a total capital flow series.

Capital flow data was available in disaggregated form from the SARB but this proposed research makes use of total capital flows so as to take account of possible substitution effects16 (Becker & Noone, 2008).

Asset Classes:

The study makes use of three indices comprising equities, bonds, and house prices. The data for these asset classes was available in mixed frequency, higher than that of the total capital flows.

The main advantage of using high frequency data is that it is more suitable to capture the nature of volatility crisis and sudden structural shifts, but at times data for certain variables is not available in high frequency. In such a case, to match the explanatory variables frequency, the asset class data that was obtained in mixed frequency had to be made into quarterly time series by making use of the linear extrapolation technique. Following (Knedlik, 2006) and (Lichetta, 2009) a quarterly series can be created in two ways, either by averaging weekly or daily data, or linear interpolating semi-annual or annual data. As discussed above, this helps to ensure that the frequency of the explanatory variable matches the dependant variable frequency. A possible disadvantage of applying this extrapolation technique to the time series data could be the forced introduction of a moving average component, which can cause difficulties when undertaking the empirical investigation (Knedlik, 2006)17.

Equities

Equities in the context of this study refer to the JSE/FTSE ALSI, which is a capital-weighted composite index that is generally used to track equity performance or total return. The ALSI is well managed and updated every 15 seconds allowing minute by minute intra-day plotting. The ALSI also only considers “free float” shares and does not account for shares held by founders, families, director and employee scheme or shares locked up in strategic holding or owned by government (Money Web, 2009).

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16 For example debt instruments can be structured to take on the characteristics of an equity investment, while beyond a certain threshold portfolio investment in classified as FDI. Short term loans can also be continuously rolled over mimicking the traits of long term bonds. Also lumpy, large and lengthy cross-border mergers and acquisitions can cause volatility in only the FDI component of capital account. Further to this, when domestic financial markets are deep, liquid and well developed there is no compelling reason to confirm that capital entering a country will leave in the same form, most likely switching will occur.

17 For more details visit http://en.wikipedia.org/wiki/Interpolation
The ALSI data was obtained from I-Net Bridge on a daily basis (1995: June 30 to 2010: Dec 31). However, since the capital flow data is on a quarterly basis, the daily ALSI data was extrapolated to produce quarterly frequencies\(^{18}\).

Bonds:

The SA bond market has undergone major development since its inception, resulting in increased efficiency and safety. The 2009 Fitch ratings indicate that the SA bond market is relatively efficient compared to most African bond markets as indicated (Fitch Ratings, 2010). The Bond Exchange of South Africa (BESA) market data shows that turnover in 2007 on the bond exchange reached a record of R13.8 trillion, with R13 trillion occurring in government bond subscriptions (Kapingura & Ikhide, 2011). In addition, IMF (2011) and Faure (2008) confirm that the portfolio flows to SA recently have been concentrated on the sovereign bond market mostly at the longer end of the bond maturity spectrum\(^{19}\).

The BESA All Bond Index (ALBI) consists of the 20 listed and largest SA government and corporate bonds, ranked by market capitalization and liquidity (Bond Exchange of South Africa, 2010).

The ALBI data was obtained from I-Net Bridge (I-Net Bridge code - JAP105) on a weekly frequency covering the period from 1994:W52 to 2011:W20. Again, since the capital flow data is on a quarterly basis, the weekly ALBI data was extrapolated to produce quarterly frequencies.

House Prices:

In South Africa, three of the four major commercial banks, namely, Absa Bank (Absa), Standard Bank and First National Bank (FNB), compile House Price Indices in the private sector. The SARB uses house price indices as inputs to monetary policy interest rate decisions. The house price indices are compiled and released on a monthly basis.

This research makes use of the Absa Medium Size (ASAMHI) House Price Index because Absa Bank has the largest mortgage book among South Africa’s commercial banks (30% of the total mortgage book\(^{20}\) according to (Nhelko & Tlatsana, 2009).

The Absa Medium Size House Price index are based on the total purchase price of houses in the 141m\(^2\) – 220m\(^2\), size category in respect of which mortgage loans were approved by Absa. Absa points out that, the most recent index and price growth data may differ materially from previously published figures, because of Absa’s recent methodology change. As part of the current methodology, Absa first

\(^{18}\) More details on the data transformation is covered in the data transformation section below.

\(^{19}\) The creation of the Global Emerging markets Local Currency Board index (GEMEX) in 2008, where SA carries a 10% weight, has been mentioned as one of the factors contributing to SA’s increased standing in global portfolios.

\(^{20}\) The market share described here is based on long-term average market data. There could have been recent movements among the top three banks operating in this sector.
records transacted house prices and then the prices are smoothed in order to exclude any distorting effects, seasonal factors and outliers in the time series data\textsuperscript{21}.

Monthly house price data was obtained from I-Net Bridge database under the codes ASAMHI (Absa Medium Sized Houses) covering the period from July 1995 to December 2010 (1993:M12 to 2011:M6). Again, since the capital flow data is on a quarterly basis, the monthly ASAMHI data was extrapolated to produce quarterly frequencies.

In addition, to consider the possibility of a double unit root\textsuperscript{22}, the ASAMHI series was also transformed using the natural logarithmic percentage change approach of Koop (2009). Asset returns tend to follow lognormal distributions and thus the log of the return will follow a normal distribution (Koop, 2009). The resulting variable was denoted as LASA\textsuperscript{23}. The graph of both the ASA and log transformed LASA series has been shown in Appendix A.

### 3.3 Sample Period

SA has a history of dominance by apartheid and financial sanctions. As a result, capital flows were mostly out-flowing pre 1995. Towards the end of 1994, sovereign credit ratings for SA were launched facilitating a re-entry into the global capital markets. In March 1995, almost all exchange controls on foreigners were lifted with the removal of the financial rand mechanism and unification of the dual-exchange rate\textsuperscript{24} (Aron, Leape, & Thomas, 2010). The post-apartheid government, with the advent of democracy, adopted a policy of gradual liberalization, which allowed both residents and non-residents free movements of capital into and out of the economy. In turn, this led to large increases in the amount of capital inflows into the country.

The figure below shows net capital flows from 1970 to 2008 in nominal US dollars:

\textsuperscript{21} For additional reading, see Topical Briefing No. 9 of 2003 entitled an Overview of House Price Developments in SA Residential Property market, Topical Briefing No. 6 of 2004 entitled Recent developments in the Real Estate Sector, September 2004 Financial Stability Review and Discussion Paper No.5 entitled House Price Developments, Macroeconomic Fundamental and Financial Stability in South Africa

\textsuperscript{22} Sometime, a series I(0) can be quite smooth, with integrated series I(2) being even smoother than I(1). This implies that double roots can exist depending on what unit root test method is used.

\textsuperscript{23} For LASA it was found that the first differenced series DLASA i.e. the growth rate of house prices is a random walk, and the second difference, which is the change in growth rate is stationary.

\textsuperscript{24} The remaining controls mainly affected the use of domestic capital by non-residents. Administrative procedures also remained in place as a framework for weaker exchange controls.
Common problems with volatility modelling and time series analysis are the availability of data and short sample periods (Koop, 2009). This is evident in the studies of equity, bonds and housing in SA as data was very scarce pre 1995. However, this research will only focus on the period after South Africa’s financial liberalisation, which was when the country began receiving substantial capital inflows, and thus the data runs from 1995:Q2-2010:Q4.

3.4 Data Analysis Techniques and Proposed Pre-Model Tests

This section is comprised of two sections. The first section describes the pre-modelling tests performed on the data to examine their time series properties and the last section proposes a model to fit the transformed data.

3.4.1 Data Transformation

As described in section 3.2 above, quarterly time series were created for ALBI, ALSI and ASA (ASAMHI) by extrapolating the data to quarterly basis. The flows variable (total capital flows) was available in a quarterly format and hence required no transformation. The period of the observation was from 1995:Q3 to 2010:Q4 and 62 observations were available for all the series.

The transformed data was then imported into EViews as series objects for further testing. The time series variables used have been shown in graphical form in Appendix A.

3.4.2 Aside on lagged variables

The concept of lagged variables is fundamental to time series data. The primary focus of this research is to identify the inter-relationships between total capital flows and financial assets and to construct a model to represent this relationship.

Choosing the appropriate lag length is vital, as choosing a lag too small can invalidate the results and lag too large may result in a loss of power. In the case of the VECM the appropriate lag length is
chosen by checking the residuals of the model upon successful re-estimation, and selecting the number of lags when there is an absence of serial correlation in the residuals.

Many software packages create lagged variables automatically with a simple command and thus the associated issue of selection of lag order becomes a data based one. Statistically lag lengths can be selected by sequentially using the t-test approach for whether \( \beta_0 = 0 \) starting with a reasonably large lag length and then testing from lag L-1 sequentially. An alternative approach is to use an information criterion such as the Akaike Information Criteria (AIC) to determine an appropriate lag length. However, in general, a lag order of one is sufficient to capture volatility clustering in auto regressive and error correction model (Bollerslev et al., 1992).

### 3.4.3 Initial Data Testing

The below three sub-sections briefly discuss the tests performed on the data to determine their time series properties and the long and short run characteristics of the variables.

### 3.4.4 Tests for Unit Roots

The concept of stationarity\(^{25}\) is important in establishing a causal links between time series variables. In models where a time-series variable is regressed on another time-series variable, one may get very high R\(^2\) results, even though there is no meaningful relationship. This presents the problem of a spurious relationship between these two variables, where the strong relationship is due to a common trend. If a time series has a unit root, then it is non-stationary. A variable that is level-stationary is thus \( I(0) \), while a variable that must be differenced \( d \) times is thus \( I(d) \). Most economic series are first difference stationary i.e. \( I(1) \).

Thus, when conducting empirical analysis involving time series data it is first necessary to test the data for stationarity. If the data is found to be non-stationary then the series must be differenced \( d \) times before it becomes stationary.

As the use of the more superior Zivot Andrews unit root test, which accounts for structural breaks (Kasman & Ayhan, 2008), is not possible under EViews 6, other approaches to test for unit roots are considered. These are are the Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and Phillips-Perron (Phillips & Perron, 1988) unit root tests.

The ADF test is a based on the autoregressive equation and makes use of the following prediction equation (Glynn, Perrera, & Verma, 2007);

\[
\Delta Y_t = \mu + \beta t + \alpha_j Y_{t-1} - \sum_{j=1}^{p} c \Delta Y_{t-j} + \epsilon_t
\]

The equation sets the null hypothesis as \( \alpha_j = 0 \) (where \( Y \) is the time series, \( t \) the trend variable and \( \Delta \) the first difference) against the alternative hypothesis that \( \alpha_j < 1 \). This test uses the t-stat on the coefficient of the lagged variables. If the t statistic is greater than the test’s critical value, then the ADF rejects the null hypothesis of a unit root, and the variable is stationary. EViews suggests including a

\(^{25}\) By stationarity the researcher refers to a constant mean, variance and autocovariance of the series.
number of lags sufficient to remove serial correlation in the residuals and EViews provides both automatic and manual lag length options (Kohzan, 2010).

PP have developed a more comprehensive theory of unit root non-stationarity, performing tests similar to ADF but incorporating an automatic correction to the Dicky-Fuller process to allow for serial correlation and heteroskedascity in the residuals (Brooks, 2008, p. 330). The null hypothesis is \( \pi = 0 \) and alternate hypothesis is \( \pi < 1 \). The test can be presented by the below equation:

\[
\Delta Y_t, D_t = \beta' + \pi Y_{t-1} + \mu_t
\]

The ADF test may lead to incorrect conclusions in the event of a regime or structural shift (Huang, Yang, & Hu, 2000), whereas the PP test is better at compensating for serial correlation. In addition, the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) (Kwiatkowski, Phillips, Schmidt, & Shin, 1992) test was an additional verification used to validate the results of the low powered ADF and PP test in case they were in conflict.

### 3.4.5 Cointegration

Cointegration means economic variables share the same stochastic trend so that they are combined together in the long run. Even if they deviate from each other in the short run, they tend to come back to the trend in the long run (Luo, Liu, & Picken, 2007). Technically a cointegrated series occurs where the interaction between two I(1) variables result in a I(0) residuals thus eliminating the spurious regression problem, i.e. a long run equilibrium relation exists.

To summarize, if \( Y \) and \( X \) have unit roots, but some linear combination of them is stationary, then we can say that \( Y \) and \( X \) are cointegrated or trend together in the long run (Engle and Granger, 1987). It is often of interest to test, not only for cointegration presence but also for the number of cointegration relationships. Precisely, when working with \( M \) variables, it is possible to have up to \( M-1 \) conintegrationing relationships (and thus up to \( M-1 \) cointegrating residuals). The Johansen method test for the number of cointegrating relationships called the ‘cointegrating rank’. The details of the Johansen test are quite complicated, and beyond the scope of this paper. However, just like any other hypothesis test or the ADF, the Johansen method tests the hypothesis of a certain cointegrating rank with the alternate hypothesis being that the cointegrating rank is higher than the one tested for in the null hypothesis (Koop, 2009, p. 211)

The two common tests for cointegration are the Engle-Granger test (1987) and Johansen Juselius (JJ) (1990).The JJ test is more robust than the Engle-Granger test, especially when there is more than one cointegrating relationship (Brooks, 2008, p. 367) and is used in this research.

### 3.4.6 Structural Breaks

Time series models can sometimes appear to exhibit unit root behaviour when actually they do not have unit roots, especially in the case of a time series characterized by abrupt changes or breaks. These are commonly referred to as structural breaks and can be caused by events such as wars and financial crisis. Ideally, testing for structural breaks should be conducted using a Zivot Andrews test
(Zivot & Andrews, 1992). However, this feature is currently not available in the EViews 6 software used to conduct this analysis. An alternative approach is to use

The Chow test known as the Quandt Likelihood Ratio (QLR) (Quandt, 1960) test and predictive failure test are used to diagnose the structural stability of the parameters in the sub samples (Brooks, 2008, p. 180). Although the EViews software does support this option, the Chow breakpoint test assumes that the researcher knows the points of the structural breaks. However, since the possible break-dates of the data used in this research are not known, it is assumed that no significant breaks occur.

3.4.7 The VECM

As the variables are confirmed to be cointegrated using the Johansen test (Johansen & Juselius, 1990), the short run dynamic changes can be explained though the VECM (Engle & Granger, 1987).

A VECM is similar to a Vector Autoregression (VAR) Model, except that VECM is designed for use with cointegrated and non-stationary time series. In particular, the VECM is more appropriate if the variables in the VAR system are integrated of order one or more (i.e. non-stationary) (Hamilton, 1994). If a VAR model is used for cointegrated data, the estimates produced will be misleading. In essence, the VECM is a restricted VAR model (Hill, Griffiths, & Lim, 2008).

VECM’s are most suitable to capture feedback relationships among macroeconomic variables. A restricted VAR or VECM is superior to a traditional single equation approach for capturing the long-run equilibrium of variables while it incorporates an error correction mechanism to track the short run dynamics among variables (Kapingura & Ikhide, 2011). In short, the VECM restricts the short run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short run adjustment dynamics.

Therefore, it follows that the primary determinant of whether to use a VAR or VECM model is dependant on whether there is cointegration among the I(1) variables. If no cointegration is found then the empirical analysis can be undertaken using the unrestricted VAR approach of Sims (1980), which can be described by the following specification:

\[ y_t = \mathbf{A}_1 y_{t-1} + \ldots + \mathbf{A}_p y_{t-p} + \mu_t \] (1)

Where \( y_t \) is a vector of \( k \) potentially endogenous variables, \( p \) is the number of lags, \( \mathbf{A}_i \) is a \((k \times k)\) matrix of parameters, and \( \mu_t \) is an unobservable error term.

On the other hand, if the I(1) variables are found to be cointegrated then equation (1) can be re-specified as a VECM (Johansen, 1988) with the following specification:

\[ \Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_p \Delta y_{t-p+1} + \mu_t \] (2)

Where \( \Pi = -(\mathbf{A}_1 - \ldots - \mathbf{A}_p) \) and \( \Gamma_j = -(\mathbf{A}_{j+1} + \ldots + \mathbf{A}_p) \)
Hence, equation (2) is obtained from the VAR equation (1) by subtracting \( \Pi_{y_{t-1}} \) from both sides and re-arranging the terms. As a result only \( \Pi_{y_{t-1}} \) contains the I(d) variables, which implies that \( \Pi_{y_{t-1}} \) must contain the cointegrating relationships since it is I(0).

Consequently, \( \Pi_{y_{t-1}} \) is often referred to as the long-run relationship and \( \Gamma \) is referred to as the short-run relationship (Harris, 1995). The long-run vector \( (\Pi) \) is the primary vector of interest and is defined as a multiple of two \( (n \times r) \) vectors, \( \alpha \) and \( \beta \), where \( n \) is the number of cointegrating equations, \( r \) is the number of cointegrating vectors, and \( \Gamma \) is the rank of \( \Pi \). Hence \( \Pi = \alpha \beta' \) where \( \alpha \) is the loading matrix, which denotes the speed of adjustment from disequilibrium, and \( \beta' \) is the matrix of long-run coefficients, which ensures that \( y_t \) converges to a long-run steady state.

It is likely that many relationships in finance are intrinsically interlinked, limiting the use and effectiveness of linear structural models, making the VECM logically plausible.

### 3.4.8 Stability Testing

According to Hendry and Richard (1982), an acceptable model should satisfy several criteria, including having residuals that are completely white noise i.e. exhibit randomness and no patterns. After formulating the VECM model, tests are conducted to establish its stability and robustness.

It is worth noting that not all selected stability tests can simultaneously operate optimally well. For instance a test for heteroskedasticity may operate weakly if the residuals are auto-correlated. Also, the residuals of VECM are often non-normal, and hence for this study the non-normality Bera-Jarque test results are not included.

### 3.4.9 Test for Autocorrelation

The existence of autocorrelation has an important bearing on the results of the VEC estimate. An important assumption for the VECM is that the covariance between the error terms over time is zero. In simpler terms, it is assumed that the errors are not correlated with one another, i.e. they are not autocorrelated. Tests for autocorrelation is carried out on the residuals, as the sample or population disturbances cannot be directly observed\(^{26}\).

Autocorrelation testing also sheds light on how many lags included in the modelling are sufficient for eliminating autocorrelation in the residuals. The lag selection is then cross-checked with the AIC automatic generated value.

EViews supports the Portmanteau (Ljung-Box) test for autocorrelations by employing raw residuals (Kohzan, 2010), and computes the multivariate Ljung-Box Q-statistic for residual autocorrelation up to the specified order.

\(^{26}\) Autocorrelation is also referred to as serial correlation.
3.4.10 Tests for Serial Correlation

The simplest test for serial correlations is the Durbin and Watson (DW) test (1951). The DW however has a number of limitations, including the inability to identify random walk errors, produces invalid results if the regression uses lagged variables and only tests for serial correlation applied to first order processes (Brooks, 2008).

The Breusch-Godfrey LM test addresses these shortcomings. The LM test statistic in the context of misspecification tests follows a $\chi^2$ distribution with degrees of freedom equal to the number of restrictions placed on the model. Asymptotically, this test is similar to the Wald test that follows an $F$ distribution.

A Lagrange Multiplier (LM) test is not only often used to test for the presence of ARCH effects but can also be thought of as a test for autocorrelation in the squared residuals, and can be applied to raw returns data (Brooks, 2008, p. 389). It is also the easiest to apply from the three available test, including the F-test and Wald test as it does not require the estimation of a second regression (Brooks, 2008). Letting $T$ denote the number of observations, the LM test statistic is given by:

$$ (T - r)R^2 \sim \chi^2_r $$

Where $r$ is the number of lags.

EViews reports the multivariate LM test statistic for residual serial correlation up to the specified order.

3.4.11 Test for Heteroskedasticity in the VEC Residuals

The presence of heteroskedasticity in the residuals of the VECM is common. Using graphical methods to detect heteroskedasticity are likely to be of little use and reveal nothing, as it is most likely with financial asset distributions the variance of errors will change over time rather than systematically.

Fortunately, a number of formal statistical tests are available for testing Heteroskedasticity, such as the simpler Goldfield-Quandt (GQ) test, the more useful Whites (1980) general test and the Breusch-Godfrey-Pagan test.

EViews provides the Whites Specification test. Possible solutions for dealing with heteroskedasticity include transformation of the variables into logs or some other measure of size or using heteroskedasticity-consistent standard error estimate corrections (robust feature on EViews) (Brooks, 2008, p. 138).

3.4.12 Granger Causality

The idea of understanding causality, an indication of controllability of a variable given its cause, makes it important for any economic analysis. The existence of co-integration between the two variables suggests the presence of causality between the variables in at least one direction (Engle & Granger, 1987).
There are two broad approaches to identify causality namely the bottom up strategy popularized by Granger (1969) where the series are assumed to be independently generated and tested to see if they are related to each other, and the top down strategy where the series tested to see if they are independent (Kirchgassner & Wolters, 2007).

Granger causality investigates whether two series have a causal relationship by analysing how much of the current value in one series can be explained by past values of the other series. A series is said to be granger caused by another if the lagged values in one series are effective in the prediction of the values of the other, or equivalently, if the coefficients of the lagged series are statistically significant (Dakurah, Davies, & Sampath, 2001).

Sims, Stock, and Watson (1990) and further Toda and Phillips (1993) show that when the variables are cointegrated of order 1, Wald tests of Granger non-causality in levels VAR could be used based on the VECM. The Wald tests are valid asymptotically if there is sufficient cointegration among the variables and are shown to have good properties across a number of specifications.

As Granger representation theorem suggests, if the variables are cointegrated then there must be a causal relationship among them running at least in one direction, a Block Exogeneity Wald test for zero restrictions on the coefficients on the VECM is employed.

EViews suggests that granger causality can be performed by estimating the VECM and using the Block Wald Exogeneity test.

3.5 Research Criteria – Reliability and Validity

Leedy and Ormod define reliability as the probability that the measurement of the variables give a statistically meaningful and consistent result. Reliability is also considered to a prerequisite for validity. Validity of the measurement instrument is emphasized as being the extent to which the instrument measures what it is intended to measure (Leedy & Ormrod, 2010). Reliability of a measurement instrument is further defined as the ‘consistency with which a measuring instrument yields a certain result given that the entity being measured hasn’t changed’.

With regards to this research, as the data used is secondary and obtained from reputable sources, its reliability will emerge from the appropriate statistical analysis of the data. Also the research instrument used, the EViews 6 software package is widely used and referred to being reliable amongst industry leaders. The EViews 6 Student Package has the full functionality available as with the professional version, the only limitation being it would be restrictive with the use of very large data sets. The steps used in the analysis of the data will be detailed allowing future researchers to easily adopt or follow accurately.

Any existence of errors within the secondary data collected is presumed to be not statistically significant for the purpose of this study. In essence as the data is obtained from reputable sources, errors in measurement are not expected, but if existing will be ignored for the purpose of this study. The data obtained is assumed to a suitable sample representative of the population.
Also any material used, as not being the researchers own work or thoughts will be clearly referenced. The researchers will endeavour to make use of well reputed and recent academic literature throughout the study.

At this stage of the research, it is presumed that the data used is reliable, the research instrument is appropriate and the results of the statistical analysis will be valid within the context of the limitation of this report.

3.6 Limitations
After defining the research objectives, reviewing the relevant academic literature, empirical models used and formulating an appropriate research methodology the following limitations are envisaged.

i. The project focuses on the post-apartheid era and thus the data could be limiting in terms of establishing a relationship over the very long term.

ii. The study is confined to studying financial asset classes as broadly captured by the three indices used (ALSI, ALBI and ASAMHI). Effects on other asset classes such as cash have not been considered.

iii. The extrapolation technique used to standardize the frequency across the data may smooth the higher-frequency observations.

4 Research Results
This section summarises the research findings, followed by a detailed description of the methodology followed in the study. This section concludes with a discussion of the findings and the research limitations.

4.1 Initial Testing
Cointegration techniques can be used to establish long-run equilibrium or stationary relationship between non-stationary variables. This combined with the vector error correction models (VECM) can capture both the short-term and long-term dynamics in a given relationship. The below steps are performed as pretesting for cointegration and consequently the formulation of a vector autoregression or vector error correction model.

4.1.1 Unit Root Tests
The levels for all four series were tested for non-stationarity using the ADF and PP unit root tests with a maximum of four lags. The analysis first ran the ADF and PP for the level and then for the difference of each variable.

The null hypothesis is that the series has a unit root (i.e. non-stationary) against the alternative hypothesis that the series is stationary. The decision criteria for the test was that if the t-statistic falls inside the rejection area i.e. outside of the critical values then the test rejects the null hypothesis that no unit root exists.

The tables below show a summary of both the ADF and PP test results.
Table 1: ADF Unit Root Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF with Constant</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows</td>
<td>-4.843 ***</td>
<td>-7.811 ***</td>
<td></td>
</tr>
<tr>
<td>ALSI</td>
<td>0.226</td>
<td>0.000</td>
<td>-5.479 ***</td>
</tr>
<tr>
<td>ALBI</td>
<td>-1.724</td>
<td>0.000</td>
<td>-6.907 ***</td>
</tr>
<tr>
<td>ASA</td>
<td>-0.676</td>
<td>0.000</td>
<td>-1.919 0.000</td>
</tr>
</tbody>
</table>

The ADF unit root test included a maximum of 4 lags chosen on the basis of the Akaike Information Criterion (AIC). ***, **, and * represents significance at the 1%, 5%, and 10% levels respectively.

Table 2: PP Unit Root Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>PP with Constant</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows</td>
<td>-4.843 ***</td>
<td>-26.119 ***</td>
<td></td>
</tr>
<tr>
<td>ALSI</td>
<td>0.647</td>
<td>0.000</td>
<td>-5.470 ***</td>
</tr>
<tr>
<td>ALBI</td>
<td>-1.671</td>
<td>0.000</td>
<td>-7.364 ***</td>
</tr>
<tr>
<td>ASA</td>
<td>0.374</td>
<td>0.000</td>
<td>-1.965 0.000</td>
</tr>
</tbody>
</table>

***, **, and * represents significance at the 1%, 5%, and 10% levels respectively.

The results indicate that the capital flows (Flows) are I(0), assets (ALSI, and ALBI) are I(1), while the house price index (ASA) is I(2). Having determined that the asset variables are not stationary in levels, the next step of the analysis is to determine whether a combination of the variables is stationary by testing for cointegration.

4.1.2 Cointegration Test

A necessary condition for the cointegration test is that all the variables should be integrated at the same order or contains a deterministic trend (Engle & Granger, 1987). Since the ADF and PP tests find the asset variables are non-stationary, a test for cointegration evaluates whether any long-term relation exists between the variables.

Testing for cointegration was conducted using the approach of Johansen (1988). The optimal lag length of one and maximum of four was selected based on the SIC. Identification of the number of cointegrating relationships is based a 5% critical significance level based on MacKinnon-Haug-Michelis (MacKinnon, Haug, & Michelis, 1999).
The results of the cointegration test finds that there is no cointegration among the three asset classes (ALBI, ALSI, and ASA)\textsuperscript{27}. However, when the cointegration test was run including the capital flows, a single cointegrating relationship was identified, indicating that the flows have a cointegrating relationship with the assets\textsuperscript{28,29}. Consequently, a conservative approach was adopted and the empirical model made use of a vector error correction model with one cointegrating relationship rather than an autoregressive model.

### 4.2 VECM

Once the JJ (1990) methodology confirmed co-integration of the series, residuals from the equilibrium equation are modelled to estimate the error correction terms. Although co-integration, using the JJ (1990) methodology confirms unidirectional causality, it fails to indicate the direction of causality among the variables. The VECM derived from the long run co-integrating vectors appropriately detects granger or temporal causality (Koop, 2009).

Following the Granger representation theorem (Engle & Granger, 1987), the VECM has co-integration relations built into the specification so that it restricts long run behaviour of the endogenous variables to converge to their co-integrating relationships while allowing for short run adjustment dynamics (Granger, 1986). The co-integration term is also known as the error correction term (ECT) since deviations from long run equilibrium are corrected gradually through a series of partial short run adjustments. The ECT can also be represented as the speed of adjustments (Masih & Masih, 1996).

Thus, short term variations are captured and predicted by the error correction term in the VECM (Engle and Granger, 1987). Choice of lag length is vital before estimating both the VECM and Block Wald Test. Hence following Brooks (2008), a lag length of 4 lags was selected\textsuperscript{30}. Thereafter, an unrestricted VEC model was run on the variables across the whole sample period, using a maximum of four lags, treating all four variables as endogenous.

The extract below from the VEC Estimates, shows the error correction terms.

<table>
<thead>
<tr>
<th>Error Correction:</th>
<th>D(FLOWS)</th>
<th>D(ALBI)</th>
<th>D(ALSI)</th>
<th>D(ASA,2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoinEq1</td>
<td>-1.02901</td>
<td>-0.000177</td>
<td>0.005803</td>
<td>5.87E-05</td>
</tr>
<tr>
<td></td>
<td>-0.31395</td>
<td>-0.00011</td>
<td>-0.00279</td>
<td>-4.20E-05</td>
</tr>
<tr>
<td></td>
<td>[-3.27759]</td>
<td>[-1.57053]</td>
<td>[2.07853]</td>
<td>[1.41349]</td>
</tr>
</tbody>
</table>

\textit{Table 3: Extract of the VEC Estimates - Short Term Cointegrating Coefficients}

\textsuperscript{27} See Appendix B for the summarised results of the cointegration test of the assets.

\textsuperscript{28} See Appendix C for the summarised results of the cointegration test of all of the variables.

\textsuperscript{29} See Appendix D for the results of the cointegration graph.

\textsuperscript{30} The optimal lag structure was determined by using the individual t-statistic for the lagged variable plus the Schwarz Bayes Information Criterion.
The values above are the (short-run) cointegrating coefficients of the model. The flows and the ALSI speed of adjustment coefficients are significantly different from zero. The results suggest that movements away from equilibrium are corrected for by changes in flows and equity rates.

The VECM shows that the relationship between flows, ALSI and ASA is significant at the 5% level. The significant of the $F$-statistic, $t$-statistic and chi-square statistic indicates economic endogeneity of the variables, besides ALBI which can be said to mildly exogenous.

The ECT sign for the model is significant and negative with a coefficient of -104658.9 and a $t$-statistic of -3.28, implying that in the short run any deviations from the long run equilibrium will feed back on the changes in the independent variable (flows) to force the movements towards the long run equilibrium. The ECT is also referred to as the speed of adjustment (-5.3%) to equilibrium (calculated as the ECT divided by the total average capital flows, $= -104658.9 / 19,746.315$). If the system is exposed to a one standard deviation shock, the system capital flows will fluctuate by 5.3% and take about 20 periods (80 months) to return to equilibrium in the long-run. The speed of adjustment is quite slow, as every quarter, only 5.3% of the disequilibrium in capital flows is adjusted.

Through the VECM framework, two types of Granger causality tests can be performed: the short-run Granger non-causality test and long-run causality through the weak exogeneity test. In this study, the short-run Granger non-causality (Granger Causality/ Block Exogeneity Wald) is used, which calculates joint $F$ statistic of the dynamic variables.

$F$ tests of the differenced explanatory variables give us an indication of the short term causal effects, whereas the long run causal effects is implied through the significance of the $t$ tests for the lagged error correction term, which contains the long term information since it is derived from the long run cointegrating relationships.

### 4.3 Stability Tests

In order to ensure that the VECM was correctly specified and stable, the VECM was assessed using the Portmanteau test for autocorrelation and LM-test for serial correlation with 12 lags. As a further check on residuals, the test for heteroskedasticity was performed. Finally the unit root graph was extracted.

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31 See Appendix E for the full results of the VECM.
Table 4: Summarised Results of Stability Tests

4.3.1 VEC Residual Portmanteau Tests for Autocorrelations.

The null hypothesis of no residual autocorrelations up to lag $h$ is not rejected, indicating no autocorrelation in the residuals. The results for this test are shown under Appendix F.

4.3.2 VEC Residual Serial Correlation LM Tests.

The LM test is performed to examine the evidence of the first order serial correlation. The LM test confirms that there is no significant serial correlation present in the residuals at lag order $h$, i.e. the null hypothesis of no serial correlation is not rejected.

The results for this test are shown under Appendix G.

4.3.3 VEC Residual Heteroskedasticity Tests.

The heteroskedasticity test involved an auxiliary regression of the squared residuals on the original regressors and all their squares, and testing the joint significance of the regression. The results confirm that there is no significant heteroskedasticity in the residuals, as the $p$-values are consistently in excess of 0.05. Thus there is no white noise, and the results of the model are stable.

The results for this test are shown under Appendix H.

4.3.4 AR Roots Graph

The AR root or table, reports the inverse roots of the AR characteristic polynomial. The estimated model is stable, stationary, if all the roots have modulus less than one and lie inside the unit circle.

The AR roots graph presented in Appendix I show that all roots lie inside the unit circle, except for the one cointegrating relationship, further indicating that the VECM is stable and the standard errors are acceptable.

<table>
<thead>
<tr>
<th>Portmanteau Tests</th>
<th>LM Tests</th>
<th>Whites Heteroskedasticity Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chi-sq</td>
<td>LM-Stat</td>
</tr>
<tr>
<td></td>
<td>Q-Stat</td>
<td>Prob.</td>
</tr>
<tr>
<td>Lags</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3.711317</td>
<td>NA*</td>
</tr>
<tr>
<td>2</td>
<td>10.30467</td>
<td>NA*</td>
</tr>
<tr>
<td>3</td>
<td>19.40813</td>
<td>NA*</td>
</tr>
<tr>
<td>4</td>
<td>23.61967</td>
<td>NA*</td>
</tr>
<tr>
<td>5</td>
<td>33.9015</td>
<td>0.0056</td>
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<td>6</td>
<td>53.17271</td>
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<td>7</td>
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<td>8</td>
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<td>9</td>
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<td>10</td>
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<td>0.1926</td>
</tr>
<tr>
<td>11</td>
<td>121.2758</td>
<td>0.2586</td>
</tr>
<tr>
<td>12</td>
<td>133.5275</td>
<td>0.3512</td>
</tr>
</tbody>
</table>
4.4 Granger Causality / Block Wald Exogeneity

The concept of Granger causality, by which we actually understand precedence, is based on the idea that a cause cannot come after its effect (Granger, 1969).

Having established the number of cointegrating vectors, we tested for causality among the four variables. A VECM based Granger Causality/Block Exogeneity Wald Test was employed to ascertain the direction of causality.

Granger-causality from $X_k$ to $X_j$ means that the conditional forecast for $X_j$ can be significantly improved by adding lagged $X_k$ to the information set. The feasibility of the Granger-causality tests depends on the stationarity features of the system. If the series are stationary, the null hypothesis of no Granger causality can be tested by standard Wald tests (Lütkepohl, 1991).

Results for the Granger Causality/ Block Exogeneity Wald Test is shown in the table below.
Empirical results show evidence of lead-lag interaction between the series. Of significant interest, was to test for unidirectional causality from capital flows to asset classes.

Capital flows are Granger caused by stocks and housing data, although bonds marginally Granger causes capital flows. Chi-sq values associated with the variable, at the 10% significance level, confirms...
unidirectional and bidirectional causality between the variables. Based on this, the causality map for each variable is summarised as below.

![Causality Map](image)

**Figure 4: Granger Causality/ Block Wald Exogeneity Flow Chart**

The map shows that equity and housing movements Granger cause capital flows, and bonds very insignificantly Granger causing capital flows. In addition, there is a bidirectional causal relationship between equities and house prices.

This result accords with Lee & Yoon (2007). It agrees with the premise that capital flows almost entirely come through the stock markets rather than the domestic bond market, and strongly supports the imperfect substitutability between bonds and stocks. The findings also concur with the Odhiambo (2010) South African study of stock markets. The paper claims stock market development granger cause economic growth (and in turn capital flows). Other findings that accord with this studies view on the relation between capital flows and equity are Adam & Tweneboah (2009), Mahmoud (2010) and Tabak (2002).

On the perspective of the equity and housing markets, the findings concur with Fratzscher, Juvenal & Sarno (2010) who find that equity market shocks and housing price shocks are major determinants of the current account (and hence capital flows). They also suggest relative asset price changes in these classes; can be a potent source of capital inflow adjustments. In addition, Balcilar, Gupta, & Shah (2011), cite Rapach and Strauss (2007, 2009) reporting evidence that numerous economic variables such as stock prices potentially predict movements in the housing sector. It is also important to note that movements in house prices are not solely affected by stock prices, but other fundamental factors such as interest rates and wealth effects.

The conclusion to be drawn from the Granger causality test is that, capital flows, equity and house prices are endogenous while bonds are weakly exogenous to the system. This inference has important implications for econometric modelling of stock markets and capital flows, as recommended in the conclusion.
5 Conclusion

This study explores cointegration and causality relationship among capital flows and three important asset classes, ALBI, ALSI and ASA in South Africa using quarterly time series data from 1995:Q3 to 2010:Q4.

The study uses a VECM based causality test to establish short-run links between asset classes, represented by the ALBI, ALSI and ASA series and total capital flows. The JJ (1990) methodology is used to reveal a single long-run cointegrating relationship. The three main research question have thus been answered successfully with capital flows not Granger causing the rise of prices in any of the asset classes, but instead the well developed and deep stock and housing market Granger causing and attracting capital flows to South Africa. The findings also confirm the existence of a single long-run equilibrium between the four variables.

From this study, it is evident that capital flows play an important role in the South African capital markets. It is widely accepted that asset prices play an important role in transmission of monetary policy. In South Africa, the stock market plays a major role in attracting capital flows. Policymakers may design policies to encourage capital inflows, and, at the same time, to ensure that capital inflows are stable. Authorities should aim to boost bond market development through strengthening the existing prudential regulations and supervisory mechanisms hence deepening the market and increasing liquidity. Granger causality from the model suggests that the bond market as an investment choice is less attractive. Policy makers in particular should be aware of not developing one financial market extensively at the expense of the other, in this case the stock market.
6 Future Research Directions

The empirical analysis conducted in this study has identified an assortment of additional areas of research that could be used to further explore the relationship between asset classes and capital flows in South Africa. These are listed and briefly discussed below.

6.1 Portfolio Flows

Considering that a large portion of the capital flows to South Africa are biased towards portfolio flows (Ahmed et. al., 2007), it would make sense to ignore the disaggregated ‘substitution’ effect, of FDI and other investments, and analyse the effect of FPI on the asset classes. Such studies are scant, although some papers attempt, albeit with different objectives and methodologies, for example Jansen (2003), Oseni & Enilolobo (2011), Duasa & Kassim (2008) and Adam & Tweneboah (2009).

6.2 High Frequency Data

The quarterly frequency of the flow data limits the research ability to uncover monthly or weekly price and causality effects. High frequency data would also allow for greater precision in determining contemporaneous components of the short run covariance between variables. Therefore, one possible extension to this study (for South Africa) would be to use a proxy for flow data as demonstrated in Neely & Fawley (2011). Neely & Fawley (2011) propose that order flows from banks and financial customers can be used a proxy for capital flows and vice versa.

6.3 Structural Breaks and Causality

As most of the series are of level or differenced non-stationary and cointegrated, a Toda & Yamamoto (1995) and Dalado & Lutkepohl (1996) (TYDL) causality test is proposed.

This test over fits the existing restricted VAR model with additional lags. The ability to incorporate the effect of structural breaks, including using the Zivot & Andrews (1992) or Gregory & Hansen (1996) unit root test, as described in section 3.4.6, can be better analysed if a TYDL approach is used (Kasman & Ayhan, 2008).

Swanson, Ataman, & Maria (2001) show that a modified Wald test performs well irrespective of the cointegration properties of a series, whereas the sequential Wald tests due Toda and Phillips (1993) performs well in cointegrated data. Further, the power of this test improves when Seemingly Unrelated Regression (SUR) models are used for the estimation (Ramabaldi & Doran, 1996). In this study, the restricted VAR had to be re-specified to fit this model.

Although the weak regressors used in the test may lead to losses in power and efficiency in small samples, this procedure is usually applied to validate the results obtained from conventional approaches. In this study, this was not possible due to software limitations and working with a small sample size.

6.4 Standard Bank Housing Index

The Absa Medium Price Housing Index, as used in this study, is not a fully encompassing reflection of the house price dynamics in South Africa as it considered only medium price houses, however it was the best available at the time of this study.
The Standard Bank Housing Index, at the time of this study was unavailable. None the less, this index is developed in corroboration with Econometrics (Pty) Ltd., and involves the derivation of a reasonable National Median Property Price that is based on a median house price for the full spectrum of houses. The index is available from January 1995 and has limited backward revisions. Standard Bank currently has a residential property share of about 26% (Nhelko & Tlatsana, 2009).

6.5 Alexander Forbes Money Market Index (AFMMI)

This study aimed to include the full range of financial asset classes for South Africa. However, the AFMMI, which is a proxy for cash, was not available at the time of this study. Further research, including this index may give a good indication of the short-term inflows of money, such as three-month term deposits.

6.6 ARDL Methodology

In order to overcome the limitations of the JJ(1990) methodology of problems with the levels of integration, Pearsin and Shin (1997) propose an Autoregressive Distributed Lag (ARDL) Model. The ARDL method holds even when the underlying variables are cointegrated and non-stationary, as shown by Odhiambo (2010). Odhiambo (2010) uses stock market capitalization (as a proxy for stock market development) against real GDP in his causality tests.

As a scope for further research and a worthy extension to this study, further experimentation with the use of stock market capitalization (instead of stock prices) as proxy for stock market development and an ARDL methodology may perhaps give similar results to residual based cointegration/ECM tests of Engle & Granger (1987) or the maximum likelihood test of JJ (1990).

As South Africa, does not have a comprehensive housing stock list that is spread by size and market value, using real estate capitalization for analysis may not be possible at this stage therefore forcing the use of house price indices. However, Ling & Naranjo (2003), in their study have made use of real estate investment trust market capitalization as a suitable indicator of real estate investments.

However, given that this was a preliminary investigation without much literature precedent, the study concentrated on examining only the equilibrium relationship among the macroeconomic variables and sector indices.

In summary, it is presumed that by extending this research along the data and methodological lines discussed above, a clearer and more complete picture of the characteristics of South Africa’s asset classes may be ascertained.
7 References


Appendices

Appendix A

Figure 5: Time Series Variables
## Appendix B

### Cointegration Test of the Assets

Sample: 1995Q2 2010Q3  
Included observations: 56  
Series: ALBI ALSI D(ASA)  
Lags interval: 1 to 4

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### Appendix C

#### Cointegration Test of All the Variables

Sample: 1995Q2 2010Q3
Included observations: 56
Series: FLOWS ALBI ALSI D(ASA)
Lags interval: 1 to 4

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

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Appendix D

Figure 6: Cointegration Graph

Cointegrating relation 1
### Appendix E

**Vector Error Correction Estimates**

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& -443.097 & -0.15882 & -3.94017 \\
\text{D(ALBI(-3))} & 847.7602 & -0.008328 & -3.360669 \\
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\text{D(ALSI(-2))} & 43.96184 & 0.000401 & -0.028494 \\
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\text{D(ALSI(-3))} & 27.7089 & -0.003208 & 0.010385 \\
& -20.7839 & -0.00745 & -0.18482 \\
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\text{D(ASA(-1),2)} & 1124.258 & -0.421254 & 7.320256 \\
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\text{D(ASA(-2),2)} & -4667.102 & -0.052588 & -9.044954 \\
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| R-squared | 0.756051 | 0.277469 | 0.487416 | 0.689643 |
| Adj. R-squared | 0.646916 | -0.045768 | 0.258102 | 0.550799 |
| Sum sq. resids | 8.82E+09 | 1133.441 | 697639.9 | 154.512 |
| S.E. equation | 15237.3 | 5.461445 | 135.4952 | 2.016459 |
| F-statistic | 6.927676 | 0.8558407 | 2.125538 | 4.967032 |
| Log likelihood | -607.9672 | -163.6751 | -343.5035 | -107.8783 |
| Akaike AIC | 22.35597 | 6.488396 | 12.91084 | 4.495654 |
| Schwarz SC | 23.00698 | 7.139401 | 13.56185 | 5.14666 |
| Mean dependent | 1053.393 | 0.821195 | 47.30428 | -0.035119 |
| S.D. dependent | 25643.03 | 5.340598 | 157.3083 | 3.00863 |
| Determinant resid covariance (dof adj.) | 3.77E+14 |
| Determinant resid covariance | 7.99E+13 |
| Log likelihood | -1214.167 |
| Akaike information criterion | 46.07738 |
| Schwarz criterion | 48.82607 |

Table 6: VEC Estimates
### Table 7: VEC Residual Portmanteau Tests for Autocorrelations

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<td>20.2351</td>
<td>NA*</td>
<td>NA*</td>
</tr>
<tr>
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<td>NA*</td>
<td>24.7706</td>
<td>NA*</td>
<td>NA*</td>
</tr>
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<td>0.0028</td>
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</tr>
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<td>0.0036</td>
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<td>0.0441</td>
<td>72.17962</td>
<td>0.0136</td>
<td>48</td>
</tr>
<tr>
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<td>0.0497</td>
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<td>0.0105</td>
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<td>0.0913</td>
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<td>0.0168</td>
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</tr>
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<td>0.1926</td>
<td>121.9751</td>
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<td>133.5275</td>
<td>0.3512</td>
<td>154.3049</td>
<td>0.0566</td>
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</table>

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution
### Appendix G

**Table 8: VEC Residual Serial Correlation LM Tests**

<table>
<thead>
<tr>
<th>Lags</th>
<th>LM-Stat</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15.13725</td>
<td>0.5146</td>
</tr>
<tr>
<td>2</td>
<td>19.43001</td>
<td>0.247</td>
</tr>
<tr>
<td>3</td>
<td>18.49973</td>
<td>0.2955</td>
</tr>
<tr>
<td>4</td>
<td>10.14028</td>
<td>0.8592</td>
</tr>
<tr>
<td>5</td>
<td>13.46763</td>
<td>0.6383</td>
</tr>
<tr>
<td>6</td>
<td>21.28575</td>
<td>0.1678</td>
</tr>
<tr>
<td>7</td>
<td>15.49269</td>
<td>0.4889</td>
</tr>
<tr>
<td>8</td>
<td>21.18365</td>
<td>0.1716</td>
</tr>
<tr>
<td>9</td>
<td>16.06606</td>
<td>0.4484</td>
</tr>
<tr>
<td>10</td>
<td>12.34608</td>
<td>0.7198</td>
</tr>
<tr>
<td>11</td>
<td>16.17259</td>
<td>0.441</td>
</tr>
<tr>
<td>12</td>
<td>18.27209</td>
<td>0.3082</td>
</tr>
</tbody>
</table>

Probs from chi-square with 16 df.
### Appendix H

**VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)**

<table>
<thead>
<tr>
<th>Joint test:</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Chi-sq</td>
<td>df</td>
<td>Prob.</td>
</tr>
<tr>
<td>355.7545</td>
<td>340</td>
<td>0.2674</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual components:</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent</td>
<td>R-squared</td>
<td>F(34,21)</td>
<td>Prob.</td>
<td>Chi-sq(34)</td>
</tr>
<tr>
<td>res1*res1</td>
<td>0.558743</td>
<td>0.782097</td>
<td>0.7443</td>
<td>31.2896</td>
</tr>
<tr>
<td>res2*res2</td>
<td>0.359971</td>
<td>0.347383</td>
<td>0.997</td>
<td>20.15838</td>
</tr>
<tr>
<td>res3*res3</td>
<td>0.753784</td>
<td>1.890913</td>
<td>0.0635</td>
<td>42.21192</td>
</tr>
<tr>
<td>res4*res4</td>
<td>0.593978</td>
<td>0.903567</td>
<td>0.6133</td>
<td>33.26275</td>
</tr>
<tr>
<td>res2*res1</td>
<td>0.569704</td>
<td>0.817754</td>
<td>0.7063</td>
<td>31.90343</td>
</tr>
<tr>
<td>res3*res1</td>
<td>0.872915</td>
<td>4.242447</td>
<td>0.0005</td>
<td>48.88322</td>
</tr>
<tr>
<td>res3*res2</td>
<td>0.620041</td>
<td>1.007914</td>
<td>0.5045</td>
<td>34.72228</td>
</tr>
<tr>
<td>res4*res1</td>
<td>0.729852</td>
<td>1.668677</td>
<td>0.1094</td>
<td>40.87168</td>
</tr>
<tr>
<td>res4*res2</td>
<td>0.622179</td>
<td>1.017113</td>
<td>0.4953</td>
<td>34.84201</td>
</tr>
<tr>
<td>res4*res3</td>
<td>0.709716</td>
<td>1.510084</td>
<td>0.1612</td>
<td>39.74407</td>
</tr>
</tbody>
</table>

Table 9: VEC Residual Heteroskedasticity Tests
Appendix I

Inverse Roots of AR Characteristic Polynomial

Figure 7: AR Roots Graph
Appendix J

Figure 8: Residuals Graph