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AN EMPIRICAL APPLICATION OF THE TOBIN'S Q THEORY IN HOUSING INVESTMENTS IN SOUTH AFRICA

BY

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Date: …………/……………/………………

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DEDICATION

In loving memory of Benson and Lieza Sitima

ABSTRACT

This study examines the patterns in the housing investments in South Africa in an attempt to understand if the possibility of the Tobin Q can be used to interpret the patterns and trends in the South African residential investments. The study, in its quest to explore and expose this intermporal relationship, it makes use of the South African annual time series data from 1960- 2010. The data was computed in different economic and econometric analysis software for better and reliable output, depending on the different level econometric technique that is required and need to be captured by the study. The dynamic investment equation is estimated using general- to- specific ARDL approach to magnify this connection and trends. The study established that combined asset prices and the levels of residential investment affect the long run investment performance rather than the Tobin Q. In the short run the lagged values of the Q, Business investment and residential investments seemed to be influential driving forces of private investment in South Africa. Even if the capital reserves in South Africa seem to be healthy, there is always a dire call for policy to be geared in the direction of the accessibility of credit to guarantee a supplementary conducive investment climate.

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LIST OF ABBREVIATIONS

2SLS	Two stage Least Squares
3SLS	Three Stage Least Squares
ABSA	Amalgamated Banks of South Africa
ADF	Augmented Dickey Fuller
ANOVA	Analysis of Variance
AP	Adjusted Prices
ARDL	Autoregressive Distributed Lag
BINV	Business (Equity) Investments
ECM	Error Correction Model
FNB	First National Bank
GDFI	Gross Domestic Fixed Investment
GDP	Gross Domestic Product
Gets	General- to- Specific
GFC	Gross Fixed Capital
HINV	Housing (Residential) Investments
IMF	International Monetary Fund
LCM	Lagrange Multiplier
Q	Average Tobin's Q
TINV	Total Investments

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Introduction

Understanding the forces driving private investment has been at the apex of many economic and financial studies (Chapell and Chang (1984); Jutther (1987); Osterberg (1995); Erenburg and Wohar (1995); Doukas (1995); Hannessy, Levy and Whited (2007); Faria and Mollick (2010); Madsen (2012); Basin, Gillman, and Pearlman (2012**);** and Makhavliv and Zauner (2012)). In Keynesian AD- AS model of the economy, private investment is the most volatile component of aggregate demand and is highly correlated with total output (Sorensen and Whitta- Jacobsen, 2010: 446).

In order to understand the component of private investment, this study explores one of the most vital subsectors in investment markets in South Africa, which is the residential investment market of owner- occupied housing by empirically testing the asset investment market using Tobin's Q theory. Tobin's Q theory is a theory of investment first propounded by James Tobin (1962) and later formalized by Tobin and Brainard in 1977. Tobin's Q theory is defined as a theory of investment that relates the level of investment to the ratio of market replacement value of capital (Wildasin, 1984). The Q theory emphasizes the relationship between firm's investments decisions and the stock market (Dornbush, Fischer and Startz, 1998: 329). In this regard Tobin's Q is simply a ratio of real capital assets to their existing replacement expenditure (cost) of these assets (Tobin and Brainard, 1977).

Private investment can be delineated as investments that are held by individuals and not the state, more often than not these private investments can facilitate in producing productive capital, and this source of new "claim" of physical capital is modeled as equity shares, in which one share represents each unit of capital (Tobin, 1982: 179). The effect of the private equity on the Tobin Q was advocated by Tobin (1982); wherein Tobin recommended that market valuation of old capital goods typically differ, up or down, from replacement cost, explicitly, from the costs of producing and installing at a normal pace of new capital goods of the same type. These digressions are, in turn, the incentives for the variations in the rates of investment, that is, faster or slower than normal. *Ad hoc*, when equity markets place high value on capital goods, the margin above replacement cost induces investors to speed up capital accumulation hence, a classical conjecture on the element of natural interest rate versus market interest rate. To attest to this, in most countries private investments has become more and more policy relevant in both emerging and developed economies in recent years more than ever after the global sub- prime mortgage crisis in the credit markets (Jongwanich and Kohpaiboon, 2008).

Housing investment is an important component of total private investment, even though less volatile than business investment (Sorensen and Whitta- Jacobsen, 2005: 431). In the residential market for example, at any given point in time there is a certain market price for houses of a given size and quality. This price may from time to time exceed the cost of constructing a similar new house of similar size and quality, that is, replacement cost. If the market price exceeds the replacement cost, the more profitable it will be for construction firm to build and sell new houses. By interdiction, one can expect that at a higher level of housing investment there is a greater likelihood in discrepancy between the market price and replacement costs of housing. The market price can deviate from the replacement cost for a long time, since it takes time for new construction to produce a significant increase in the existing housing stock, and in view of the fact that it is time- consuming to shift economic resources into the construction industry if construction activity becomes more profitable due to the market price of housing thus making residential investment less volatile (Sorensen andWhitta- Jacobsen, 2005: 433). In a similar but not strict way, the stock prices as well as other asset markets such as the credit market operate in a comparable manner. Taking the stock prices and business investment for instance, if the market value of stock price exceeds the replacement cost (for plant and equipment). It is more profitable for the firm to invest in new investment and increase the market value to its shareholders.

South Africa has been embodied by different business cycles over the past 50 years, ranging from troughs to booms all enduring an invariant amount of time. Some were more severe than others while other where extensive and long lived. On contrary, some were diminutive and short lived. Of great interest was the turbulent and more volatile business cycles ever witnessed which cropped up in the first decade of the 21st century in South Africa. This period was essentially characterized with scores of economic upheavals such as the rand crises, global depression, and domestic strikes *inter alia*.

Residential investments in South Africa were equally affected by these events in the financial sector both globally and domestically. For example, the global economy has been at the brisk of recovery since the sub- prime mortgage recession in early 2007 and late 2008 in addition to the financial turmoil in Europe predominantly in Greece, Spain and Italy in 2010, erstwhile other parts of Asia, which caused investor uncertainty in the markets. Under such scenario, investors have shifted their portfolios towards emerging markets from the traditional developed markets, for the reason, such as highlighted by Mishkin (2004), which a decline in the housing market value causes a decline in the net worth of companies hence collateral, this causes less protection for investors and results in investment and output to decline in these economies.

Despite the chaos of the past years, the global economy has grown to 3.6% on headline basis in the fourth quarter of 2011 (European Commission Board [ECB], 2012). This growth comes up due to the diminishing of the trail risk, particularly in Europe, and the supportive monetary policy in Europe that has continued to support growth and investments (ECB, 2012). On another global perspective, the on-going structural shift in China from investment led growth to consumption led growth is by all means not an easy and smooth transition. This in turn has immense implication on the South African residential investment, furthermore housing prices and portfolio decisions by investors in South Africa (Schoeman, Schultz, and Gable, 2012).

1.2 Problem statement

Most economists agree that there is no simple way of telling an erratic movement from a trend movement. It is almost impossible for one to tell whether the current increase in housing prices or the high nominal housing prices in the housing market is merely a result of a disturbance that will soon reverse itself, rather than the beginning of a trend in the asset prices (or even asset markets themselves) and investments in South Africa? This study seeks to explore more on the relationship between housing prices and investment along with decisions made by investors, since there is no one way of telling at time a change that may occurs and later to see which movements were later reversed.

On the other hand it is still an open question whether the monetary and fiscal policies adopted in 2002 and subsequent years were appropriate. The rand crisis resulted in speculate attack by monetary authorities (thus, treasury and South African Reserve Bank [SARB]) on the monetary policy and was further alluded by the Argentinean as well as the Zimbabwean crisis during the same period which resulted in an aggressive fiscal policy (Strydom, 2002). The South African housing prices fluctuated, with various ups and downs along the way making investments to be very unstable. These volatilities in the housing prices have resulted in detrimental effects on investments, in both financial and goods markets in South Africa thereby making investment very risky in South Africa relatively to other emerging markets partners.

1.3 Objective of the study

The main purpose of the study is to examine whether the Q theory can be extended to housing investment, if the investment flows in this market are as much as it is for business investments.

The sub objective of the study is as follows:

- To analyze the trends and developments in housing market as well as private investment in South Africa
- To examine whether Q theory explain the relationship between private investment and housing prices and how these influence the level of overall investments in South Africa
- To provide policy recommendations based on the findings from the study

1.5 Hypothesis of the study

The study will test the following hypothesis:

H_o: Housing market investments do not influence the general total level of investments in South Africa.

H_1: Housing market investments do influence the general total level of investments in South Africa

1.5 Significance of the study

The study will contribute towards literature in a number of ways; the study is likely to be of assistance in comparing the Tobin Q and other alternative theories of investment[1] with their ability to explain housing investments in South Africa. Although various academics and economists have undergone substantial empirical testing and analysis of the Q theory, unfortunately, the evidence already available is not sufficient to provide adequate information on Africa moreover, South Africa in particular.

The relationship between investment and its underlying determinants is of paramount importance in the appraisal of alternative policy for economic policies for economic stabilization. The econometric inception is likely to help in policy making in that it gives an empirical framework to the analysis in South Africa hence an informed economic decision.

Little or no attention has been paid on how the Tobin Q and the alternative investment models on explained investment behavior in the housing industry. It is imperative that this study was triggered by the need for continuous research in the dynamic financial environment since the global financial crises of the credit crunch in the housing market in United States of America and the European Union, since the economy is turbulent and is ever changing. In a world of high capital mobility, the fundamentals of many economic variables such inflation, interest rate, capital flows, and net debt of developing countries have become particularly important, influencing desired long-term capital flows and altering the equilibrium in asset and capital markets hence, affecting the levels of investments.

The connotation to the study is to fill the gap in literature since most of the research that has been done was principally in developed economies and literature has been vaguely silent on developing and emerging economies. To add on, for the most part researches on investment behavior has been in developed countries such as the United States of America, Europe, Asia and of recent a lot research were conducted in Latin American countries nevertheless the majority of these research have been gravely silent to Africa and South Africa in particular.

1.6 Organization of the study

The study is partitioned into six chapters, which will be sorted out as follows:

[1] Jorgenson and Stephenson (1967), Jorgenson and Siebert (1968), Yoshikawa (1980), Hayashi (1982), Wildasin (1984), Cuthbertson and Gasparo (1993), Sorensen and Whitta- Jacobsen (2005) and Dia and Caslin (2009)

Chapter 1: this chapter gives the introductory statements of the study, the problem statement, the objectives, the hypothesis as well as the rational of the study.

Chapter 2: this chapter intends to present an overview of the patterns and trends in the residential market investments in South Africa.

Chapter 3: this chapter will grant and explore various literatures that support the rational of the study. Both theoretical and empirical literature of the study will be reviewed in this chapter.

Chapter 4: this chapter describes the methodology used in the study. The chapter will give the working model specification together with the econometric techniques that the study will implement in the estimation of the model.

Chapter 5: this chapter mainly looks at the representation of the empirical findings of the study. Various econometric techniques and results used are reported in this chapter.

Chapter 6: this is the final chapter of the study; this chapter looks at the summary and policy inferences obtained from the study. The chapter ends with some limitations and hindrances faced in this study, economic, statistical or otherwise.

CHAPTER TWO

PATTERNS AND TRENDS IN RESIDENTIAL INVESTMENTS IN SOUTH AFRICA

2.0 Introduction

This chapter gives an insight of the trends and patterns of residential investment in South Africa in the period of the study. The first section of the chapter looks at the synopsis of the general investment environment in the past and present South African economy. The next sub- section makes a comprehensive as well as meticulous analysis of the different sectors of investment. This section is followed by the build-up of the variables of interest. This chapter ends up with some concluding remarks of the whole chapter.

2.1 Stylized facts

The unique relationship that seem to exist between the real value of investment and the resulting increase in capital, first described by Uzawa's (1960) penrose effect has fascinated many economists and scholars alike, for many decades now.

It is often the difficulty of explaining within the basic paradigms of economic theory why the observed movements of home ownership are there really consistent with rational investor behavior. In the short term the housing markets sometimes give the impression to overreact to news, showing a sign of 'herd behavior[2]' that may seems to affect the behavior of home owners. The movement of private investments in low to middle income countries such as South Africa has become policy relevant due to the ever escalating concerns of persistence global growth imbalances. The phenomenon in the houses prices can also be noticed in business equity prices and affect business in the same way to either buy a new portfolio or simply retain the old portfolio. Moreover, one may also wonder how the large long- term housing market prices fluctuations during the last decade can be recoiled with realistic changes in the long- term earning potential of firms and the demand and supply of housing on the housing market.

Economic theory proposes that an increase in housing prices will trigger an increase in economic activity, whereas a significant drop in asset price may be a signal of a future

[2]Herd behavior describes how individuals in a group act together without planned direction

economic downturn (Sorensen andWhitta- Jacobsen, 2005: 433). This may be due to the fact that higher asset prices tend to stimulate private consumption and investments. From the income GDP approach arguments; *in lieu,* imply an increase in the proprietor's income (dividends) and corporate profits, rental income and net interest results in an increase in private income; giving a blue print, thus if private consumption increase due to an increase in return on investments in property and financial markets, this means that household have more to re- invest thereby boosting both output and investment stock in the economy.

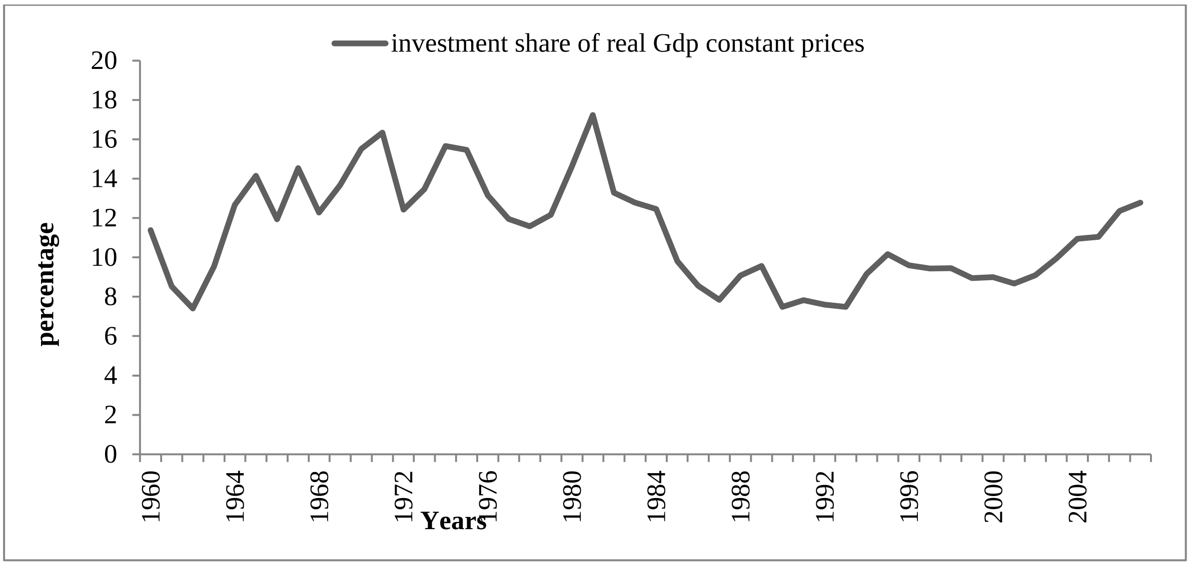
For short periods, technical factors can from time to time have an influence on regulations by central banks or internal banks about size of open positions to control asset bubbles along with investments may for instance, make it necessary to reduce or cover short positions in the nominal and real interest rate in the market at a given moment, this creates a technical, but not genuine, demand for houses or even stocks can create a temporary shortage in the asset market, resulting in an equally temporal strengthening of a asset prices (Potgieter W, *et al* (1991:16).

In the South African residential market, empirically the demand and supply conditions as well as trends of new houses has been reflected in the future residential building activity, against the backdrop of economic developments and their impact on household finances (Du toit, 2011). In this light, the affordability of housing and mortgage finance in South Africa continues to be the most important factors in the housing market. In which it results in situation such that the residential market will likely pay much attention to the future demand for and supply of new houses and is currently expected to be in the segment of smaller- sized houses and higher- density flats and town houses.

2.2 An overview of the general South African Investment environment

The South African economy has gone tremendous changes both on the political arena as well as the economic terrain in the past five decades. All these changes had significant influence on the investment performance of the country. Using the Gross Domestic Fixed Investment (GDFI) and Gross Domestic Product (GDP) values from the Department of trade and South African statistics respectively; Figure 2.1 below shows the patterns in which gross investments have gone through since 1960, as it should be noted this figure is given as a percentage of the South African GDP at constant 2005 prices.

Figure 2.1 Investment share of Real GDP for South Africa, 1960- 2010



Data sources: the dti (2012), Statistics South Africa (2012)

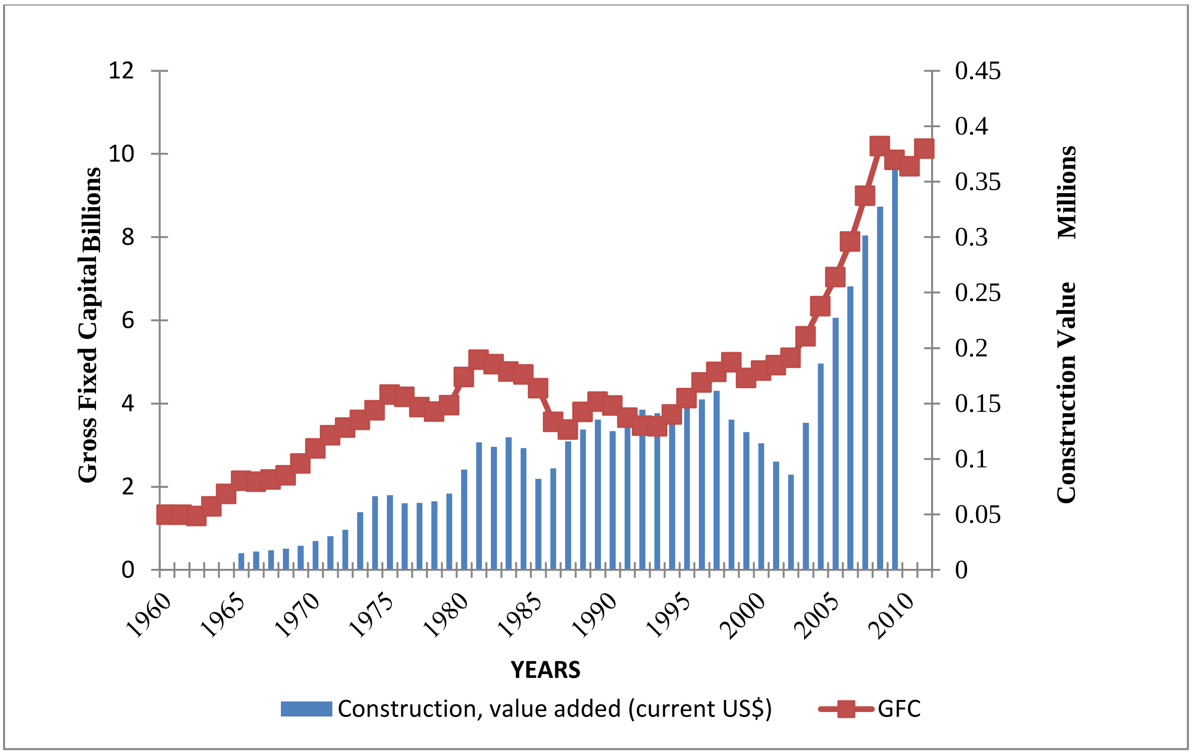
Figure 2.1 above illustrates the patterns in which the gross investment in South Africa fluctuated over the past years. Investment plummeted to its all-time low in the period ranging from 1962- 1963 fiscal year, a 5- year movement shows that the gross investment were only slightly below 8 percent of the real GDP suggesting that in this period the South African government did not prioritize investment. This was followed by a massive increase in investment share to the real GDP. Investment contribution to the total improved by almost 6 percent to approximately 14 percent proposing an increase in both public as well as private investment in 1965. The investment share of the real GDP maintained a rather oscillating around the band width of 12 percent and 16 percent suggesting a period of good economic growth driven by increased investment.

The South African GDP reached its maximum share of output in 1981, this was followed by the biggest plunge of investment share of the real GDP, and investment fell to 8 percent. Thus an 8 percent fall from the 1981 figure of 16 percent. This could have resulted from the prevalent industrial actions faced in South Africa in 1982in particular in the manufacturing sector. The investment figures struggled to rise above the 9 percent share of the real GDP, this was due to the political and structural economic changes taking place at some stage in the period, this trend continued up to the end of the first millennium, while the investment share continued to rise ever since the 2000, this could have been as a result of a new political stability and economic policies that are aimed to achieve economic growth through an investment inclined policies.

2.3. Residential investment in South Africa

The residential investments in South Africa, in the past 50 years have gone through numerous phases as the economy moved from one business cycle to the other. Many of the investment restrictions in the residential investment exist between the constraints of gross fixed capital formation (GFC). If the value of residential investment is embedded in the construction value of the value added project of residential property constructed in the past 5 decades and Gross fixed capital formation is indexed for the productive capacity of the residential investment sector. The composite exposition graph in Figure 2.2 shows the dynamics, patterns as well as the relationship among gross fixed capital and the construction, value added in the residential market, both figures are given in current United States Dollars (US$), nonetheless the construction value is given in current dollars and the GFC is given in 2005 constant prices.

Figure 2.2 Residential investment and capital consumption in South Africa, 1960- 2010



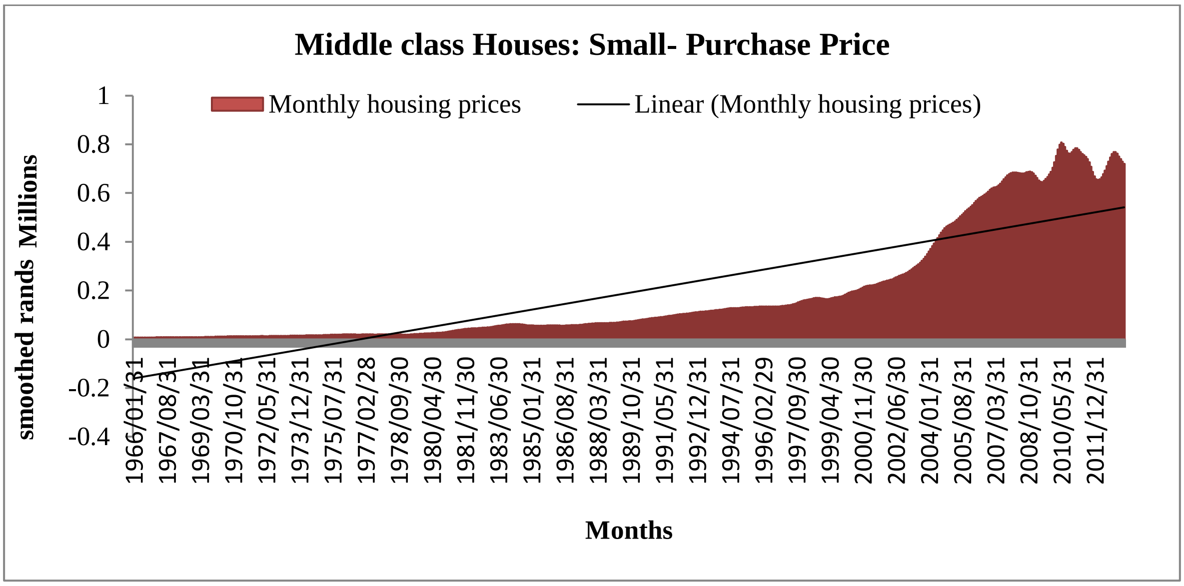
Data sources: African Development Bank (2012) and International monetary fund (IMF, 2012)

Figure 2.2 above shows an intertwined and interrelated relationship in the behavior of residential investment and fixed capital. The graph shows a perpetual positive relationship between gross fixed capital and the construction value in South Africa. Both construction value and the GFC showed a steady increase from the early 1960s to the early 1980s. This shows that the favorable business cycles enjoyed in the period and favorable interest rates, inflation and a general stable macro environment, which in turn lend a hand on mortgage and construction in this period. The construction figures and the GFC figures started fall from the early in 1980s followed by a fluctuations in the low regions, this phenomenon continued to 1995. This was a possibility of the hostile political, social and economic conditions that prevailed in this period. The phase was generally characterized with a low business cycle, high interest rate, high inflation and a poor performance of the rand. Other conditions included the sanctions against, at that time, apartheid government and the political transition that followed after in 1994; this caused a great distress on housing investment and capital formation as a way of exorbitantly high mortgage premiums and general low business confidence. In the last decade from 2000 – 2010 demonstrated a high levels of construction and Gross Fixed Capital (GFC) reaching an all-time highs in both the construction value and GFC, this be evidence for the South African government commitment in infrastructure development through various government initiatives and policies. To understand the dynamics in the residential market in South Africa, the study takes a look at housing prices, affordability of houses and housing cost in the last 8 years from 2006- 2013.

2.3.1.2 Housing Prices in South Africa

Apart from the general statistics in the fixed capital and construction values, the study seeks to check the dynamics in the housing prices in which, in turn, affect the investment behavior of both buyers and sellers in the residential investment sector in South Africa. The study makes an extrapolation as way of the graphical presentation of quarterly data of the average housing prices in the last decade.

Figure 2.3 South Africa Average House Price, 196:01- 2011:12



Data Source: FNB housing survey data (2012)

The trend lines shows positive and escalating housing prices in an average housing occupants. The graph shows that in the early 2006 the housing prices for an average housing unit ranging from R250 000- R300 000 which is slightly below the trend average line of above R300 000 in the first 15 months.

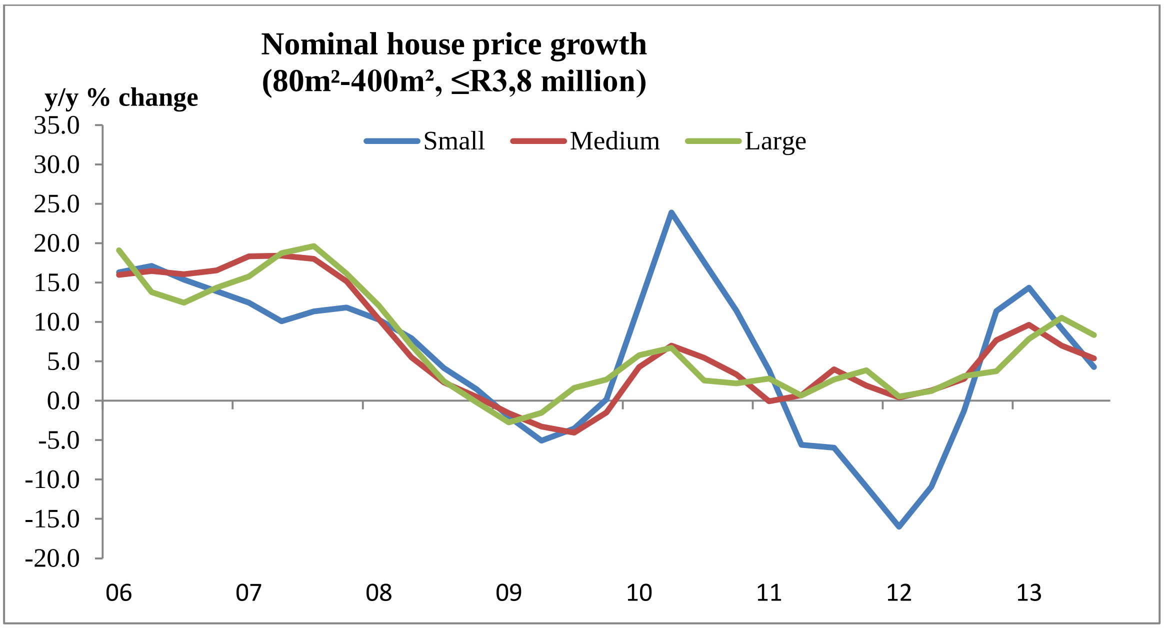
The housing prices increased from July 2002 to around August 2004, the price range for an average housing unit in South Africa in this period ranged between R300 000 – R450 000, however this shows that the housing in South Africa were relatively cheaper since this price is below the trend line.

The housing prices continued to increase between R500 000 – R750 000 per housing unit in the period between September 2004 to August 2009, and this was also infect above the trend line gives an idea about the housing prices being a bit expensive in this period. The housing prices continued to soar from R750 000 to approximately R900 000 in the last month of 2010.

The dynamics in the housing prices are consistent with the construction and investment figures shown in Figure 2.3 above. The data clearly shows that the high levels in the residential investments in the last decade, in South Africa could have been triggered *inter alia* by the lucrative housing prices shown in Figure 2.3.

The study employs quarterly data from ABSA housing survey from January 2006 – December 2013.

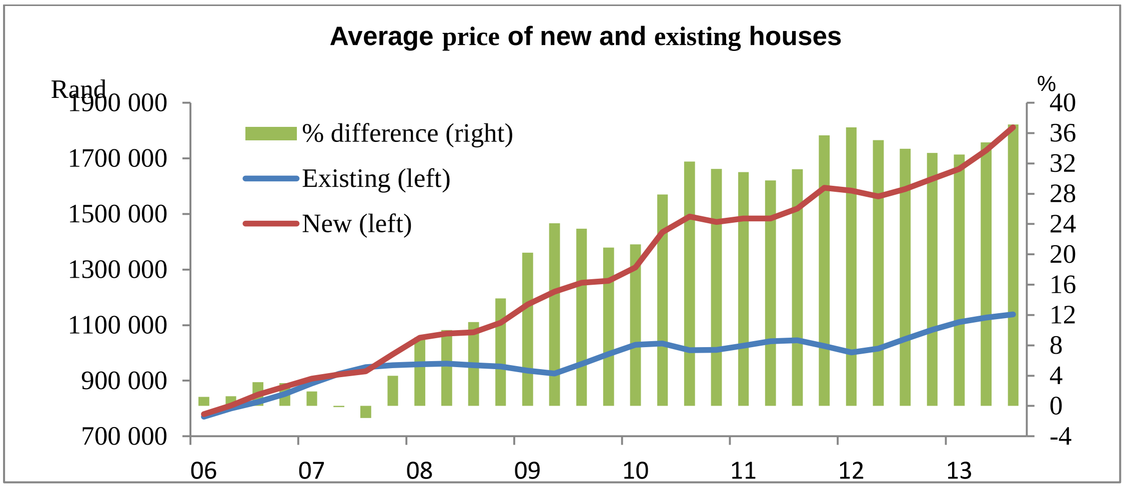
Figure 2.4 Nominal House price growth in South Africa, 2006:Q1- 2013:Q4



Data Source: ABSA Home Loans (2013)

In Figure 2.4 above, the figure illustrates the nominal housing prices since January 2006 to December 2013, for small, medium and large houses in the monthly data. The graph shows that house prices have been relatively growing from year to year since 2006 until the first quarter of 2008. House price started to decline in the last quarter of 2008 to first quarter of 2010. The fall was mainly attributed to global financial crisis in this period, which had catastrophic effects on residential properties around the world. However, this devastating period was followed by an increase in the houses prices in South Africa. The housing prices grew in 2010 and 2011 with largest growth being in the small houses, yet, the houses in small category started to fall negatively in the last quarter of 2012. This might be due to government intervention to RDP houses forcing prices to fall.

Figure 2.5 Average price of new and existing houses in South Africa 2006:Q1- 2013:Q4



Data Source: ABSA Home Loans (2013)

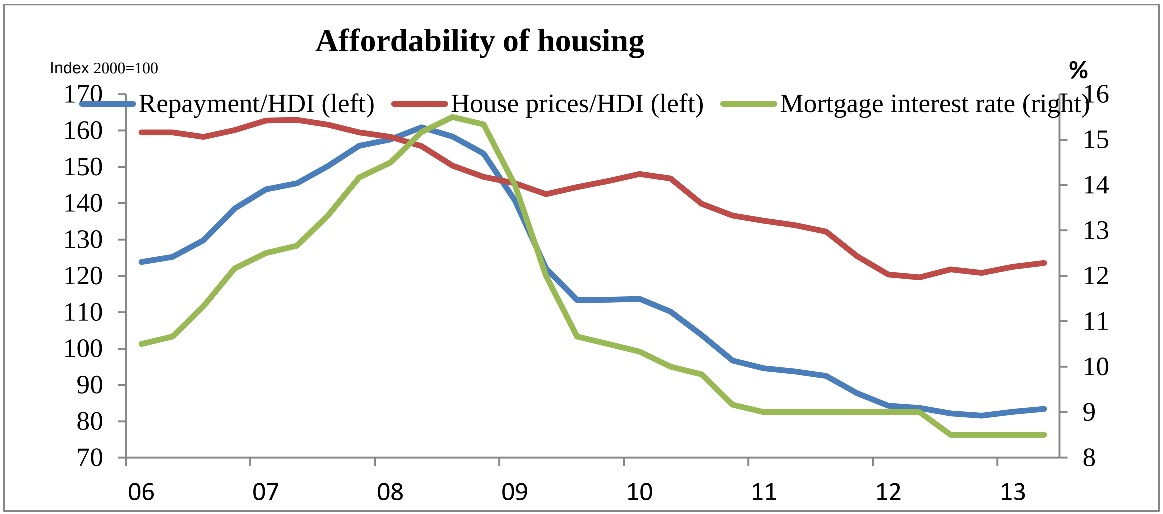
Quarterly data for new house loans Absa received and approved in the period 2006- 2013. The average nominal price trend in South African residential investment markets are shown in Figure 2.5 above. The housing prices of a new house continued to soar while the price of old houses were not growing as much. These trends show that the difference between an existing houses perpetually increased year on year. Figure 2.5 sows that the highest difference between the average price of a new house and an existing house was in the first quarter of 20012 and the lowest was just before the sub- prime mortgage crisis in the last quarter in 2007. The Figure 2.5 also shows that the price trends of a new house for mortgage finance increased by 14% year on year (y/y) basis to approximately R1 811 300 in the third quarter of 2013, subsequently rising by 10,6% y/y in the previous quarter.

In real terms, the average price of a new home in the period of the study rose by 7% y/y in the third quarter of 2010 compared to 4,5% y/y in the second quarter. In Figure 2.5 above, the average price of an existing house increased by a nominal 8,4% y/y to R1 138 900 in the third quarter, after rising by 11,1% y/y in the second quarter. Real price growth of 1,8% y/y was recorded in the third quarter with regard to existing homes, down from 5% y/y in the second quarter. a result of these trends in the average price of new and existing homes, it was as much as R672 400, or37,1%, cheaper to have bought an existing house than to have a new one built in the third quarter of 2013. According to the quarterly ABSA quarterly review, the general rise in the average price of a new house is related to the jump in building costs over the past three quarters compared with figures in the preceding year (Du Toit, 2013).

2.3.2 Affordability and Building cost of Houses in South Africa

To understand the dynamics in the South African residential market, it is imperative that this study takes a look at trends in terms of affordability of houses and the cost associated with owning a house in South Africa. Figure 2.6 below takes a look at the affordability of a small house in South Africa. The figure looks at house prices, repayment and mortgage interest rate as factors that affect the affordability of housing. In Figure 2.6 housing affordability, is measured as ratios of house prices and mortgage repayments to household disposable income (HDI), the figure shows that housing affordability was relatively stable in the last 8 years however it was still high in the 2006 to 2008, however it started to decrease on average in the last 4 years.

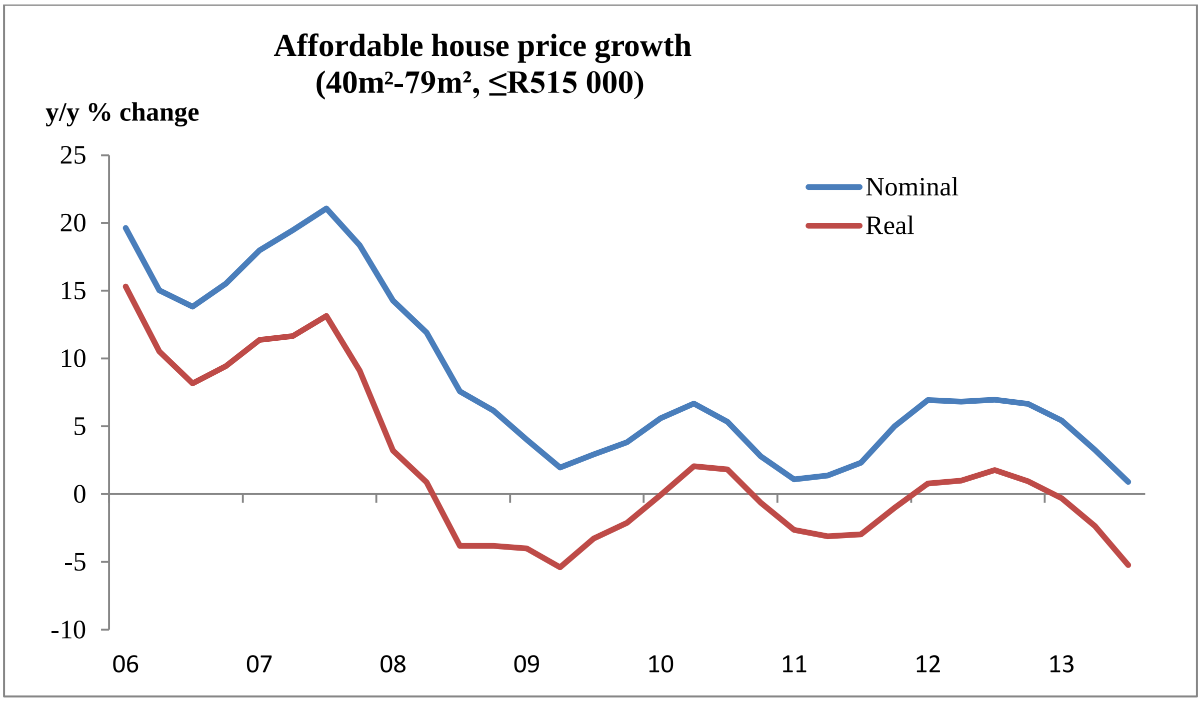
Figure 2.6 Affordability of Housing in South Africa, 2006:Q1-2013:Q4



Data Source: ABSA Home Loans (2013)

This stable trends in terms of affordability of houses in South Africa was mainly due to the result of trends in house price and disposable income growth, as well as a stable mortgage interest rate, currently at a 40-year low of 8, 5% per annum. The housing prices in the South African residential market has unrelentingly to be subdued since 2008, showing a relatively low nominal growth on year-on-year basis early 2012, with month-on-month price trends under pressure since late 2011. In real terms, house prices have deflated further up to January 2012, based on headline consumer price inflation of 6.3% year-on-year (at the time of writing). Despite the low mortgage interest rate, many households' ability to take advantage of the favorable trends in housing affordability continued to be affected by factors such as employment, income, savings, living costs, debt levels, as well as credit-risk profiles (as reflected by the state of consumer credit records), the NCA and banks' lending criteria in the case of mortgage loan applications for buying property.

Figure 2.7 Affordable House price growth in South Africa, 2006:Q1- 2013:Q4

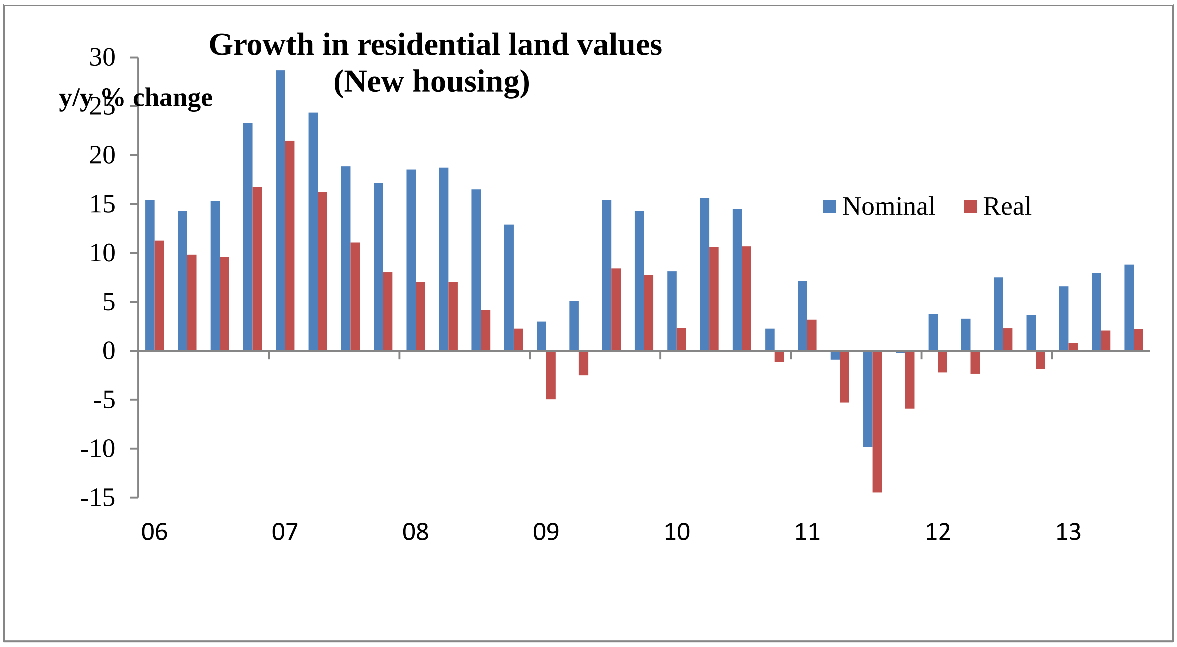


Data Source: ABSA Home Loans (2013)

The distinction between nominal and real affordable house price is important because it helps the study to under the importance of inflation in affecting the affordability of housing prices. Figure 2.7 shows the nominal and real affordability of housing, the graph shows that the year-on-year growth in the average nominal price growth of affordable housing (homes of $40m^2$ — $79m^2$) continued its gradual downward trend, from approximately 23% in the third quarter of 2007 to 0, 9% in the final quarter of 2013. In Figure 2.7 also shows that the real prices in the affordable segment continued to fall faster than nominal prices. The real prices dropped from approximately 15% in final quarter of 2007, dropping to 5, 2% y/y in the third quarter of 2013.

In order to understand the patterns in terms of affordability of housing prices in South Africa, this study looks at land value of housing units. The Figure 2.8 below shows the patterns according to ABSA home loans research division. Using quarterly data from 2006 to 2013, the following trends are reported in Figure 2.8 below:

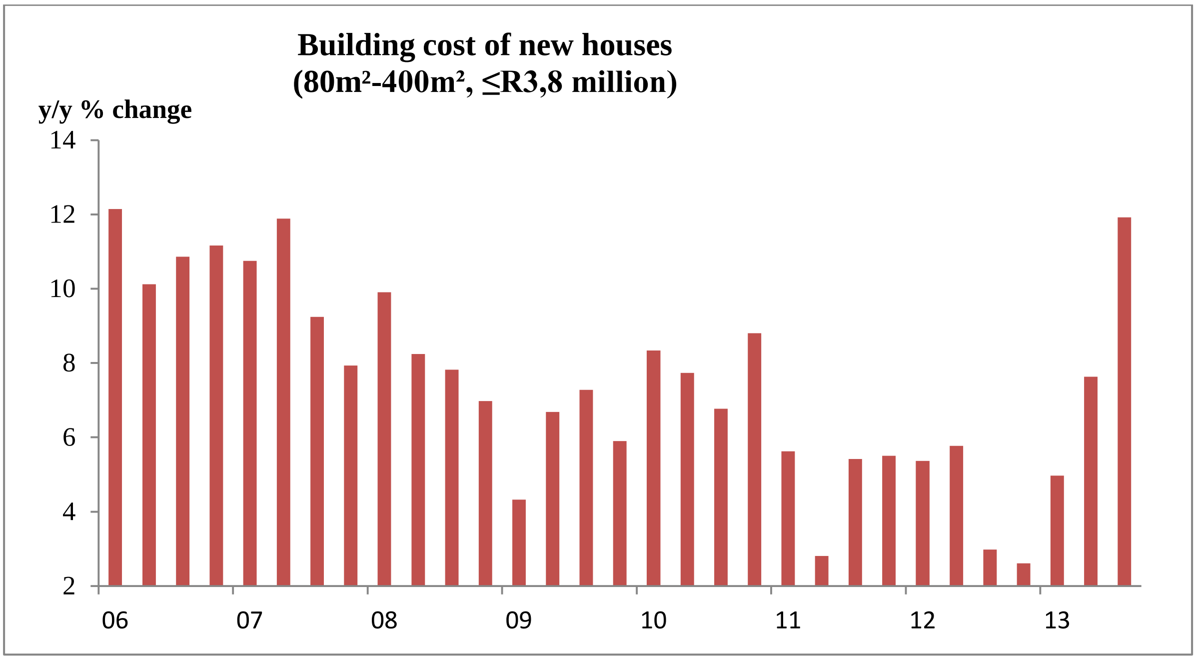
Figure 2.8 Affordable House price growth in South Africa, 2006:Q1- 2013:Q4



Data Source: ABSA Home Loans (2013)

In Figure 2.8 the graph shows that both the nominal and real growth of land values for new houses increased almost perpetually in the 3 years from the first quarter of 2006 t0 last quarter of 2008. However the real residential land values dropped in 2009 mainly because of the panic caused by the sub- prime mortgage crisis in America and Europe. The biggest drop in South African residential value was in the third quarter of2011 due to some disturbance in the domestic mortgage pressures. To understand these trends the study incorporates the building costs associated with the residential value of houses. The trends of building cost of new houses are given in Figure 2.9 below:

Figure 2.9 Building Cost of new Houses in South Africa, 2006:Q1- 2013:Q4



Data Source: ABSA Home Loans (2013)

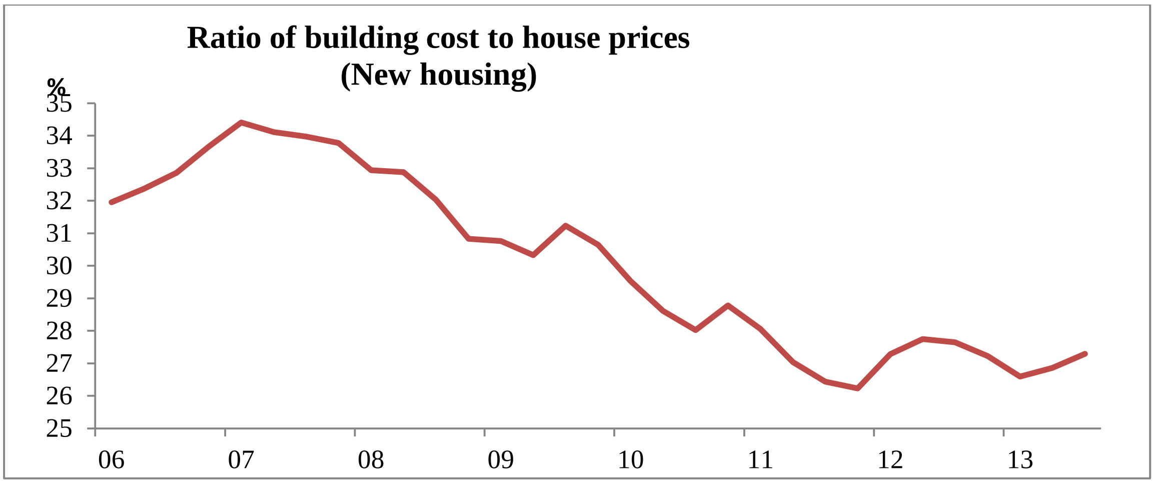
The building costs in South Africa have been increasing since the first quarter of 2006. The lowest building costs were seen in the first quarter of 2009, second quarter of 2011 and the final quarter of 2012. The building costs in South Africa on average are approximately around 8% on year on year change basis.

Factors impacting building costs, and eventually the price of new housing, include building material costs; equipment costs; transport costs; labor costs; developer and contractor profit margins; and the cost of developing land for residential purposes, which is impacted by aspects such as finance costs, land values, the cost of rezoning, the cost of preparing land for construction and holding costs in general (Du Toit, 2013).

The aggregate Q in South African residential market

As mentioned in the preceding chapter of this study, the original Q theory suggested that the market value of old capital goods may differ up or down from its replacement cost, in other words, the differentials between producing and installing of capital goods[3]. As a rule of thumb Tobin and Barnaid (1962), in their hypothesis suggested that the Q should be oscillating around 0 and 1, whereas 1 means the asset is overvalued and 0 being undervalued. Using a simple calculation adopted from the Nobel lecture essay of Professor Tobin (1962) applied to South African aggregated data in combined land values and residential market and aggregated capital figures, the following patterns are reported below by a graphical exposition Figure 2.10 below:

Figure 2.10 Ratio of Building cost to house prices of new Houses, 2006:Q1- 2013:Q4



Data Source: ABSA Home Loans (2013)

Figure 2.10 above shows that the Q value in South Africa has been virtually falling in the past 5 years, suggesting that the property has been slightly overvalued in the early 1960s. The slope shows that there has been a negative relationship between installation cost of new capital and its replacing cost over the years, thereby causing a gradual decrease in the Q value in these markets. The Q value improved in the years from 2007 – 2008 nevertheless it started to decline as rapidly as before. In the last decade from 2000- 2010 the Q has been relatively constant at the bandwidth between 0.1 – 0.35 suggesting slightly undervalued assets in these asset markets as suggested by the Q theory.

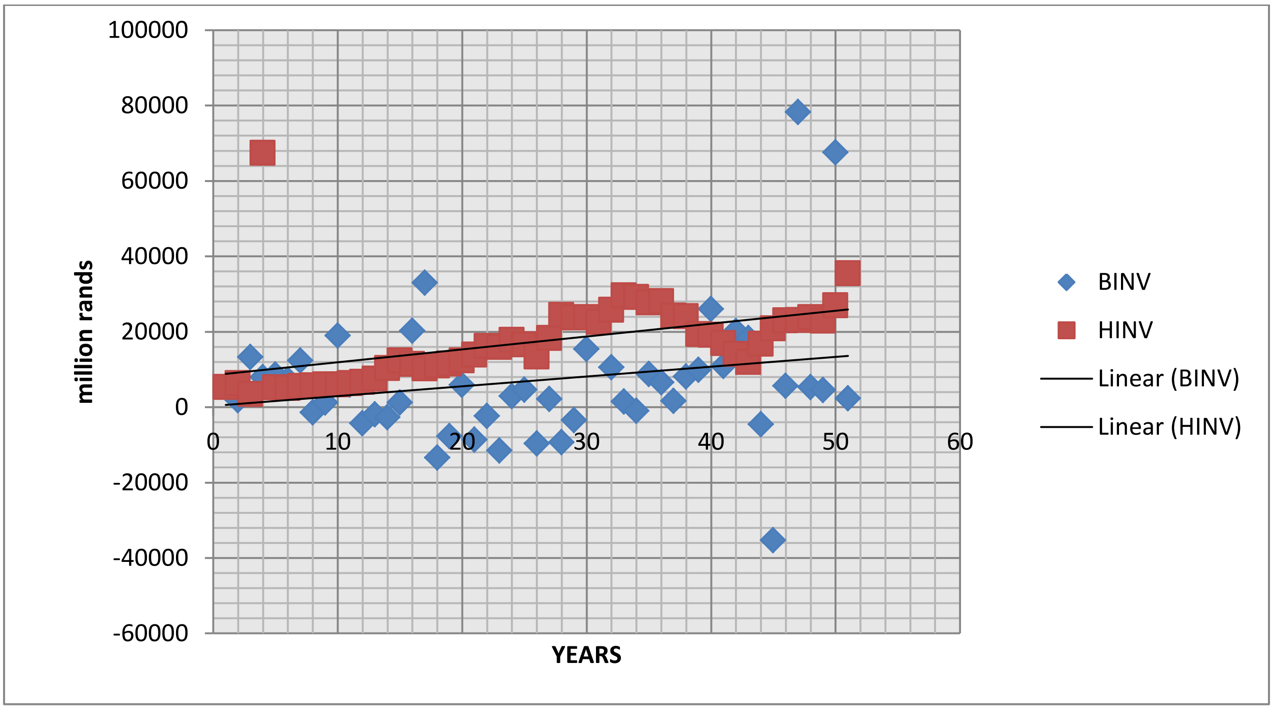
The dynamics in the Q figures can only be elucidated in relation to the levels of investment along with the amount of capital in each investment sector independently and their exposure to both systematic and unsystematic risks.

2.4 Housing (Residential) Investment (HINV) and Business (Equity) Investment (BINV) in South Africa

[3]A reader more interested on this can jump to chapter 3 of this study

The study now gaze into the dynamic trends and patterns in the selected sub sectors of investment. The study constructed a simple HINV and BINV, [4] in a bid to ensure that the dynamics in these investment markets are clearly exploded below to aid empirical investigation. The relationship between residential market investment and equity market investments in the South African data, 1960- 2010, is given as Figure 2.11 below. If the residential market is represented by the Housing Investment (HINV) and equity market is denoted by Business Investments (BINV), the following pattern is given below.

Figure 2.11 Housing Investment (HINV) and Business Investment (BINV) in South Africa, 1960- 2010



Data Source: IMF (2012), FNB (2012), World Bank Database (2012)

Once more, Figure 2.11 shows that business investment in South Africa is more volatile than the housing investment despite the capital adjustment in the data. The levels of business investment (BINV) from 1960- 1973 fluctuated around negative R 50 000- R100 000 million worth of business investment. This was followed by a surge in BINV figures in mid 1970s reaching its highest of excess R300 000 million in the late 1970s. This surge would have resulted from relative tax cuts, both personal taxes and corporate taxes which promoted investment in the fiscal policies of the period.

[4]These variables are constructed in chapter 4 of the study

The business investment plunged in the following year to negative R100 000 million fall in business investment, this would have been an effect of tax cuts in the previous periods which caused a huge government deficit in this period. The levels of BINV fluctuated within the margin of R 100 000- R100 000 million throughout the 1980s. BINV started to increase in the late 1980s through to early 2000s. This could have been an outcome of frugal spending and sound economic policies implemented in this period, which acted as an anchor to the stock market, hence business investment. The Business Investment (BINV) plunged to its lowest in the period between 2002- 2008; this could have been due to the rand crisis in 2002-2003 fiscal year and the sub- prime mortgage crisis in United States of America (USA).

Conversely, the residential investment figure remained in the positive range from 1960- 2010 sowing a stable trend in housing investment in South Africa. The South African housing investment figures gained momentum from the mid- 1980s to early 1990s reaching a peak of R30 000 million in 1996. This could have been a consequence of the favorable interest rates implemented by the then Reserve Bank governor Chris Stals, which supported housing investment in an attempt to ensure equity in the housing distribution in the post-apartheid era in South Africa.

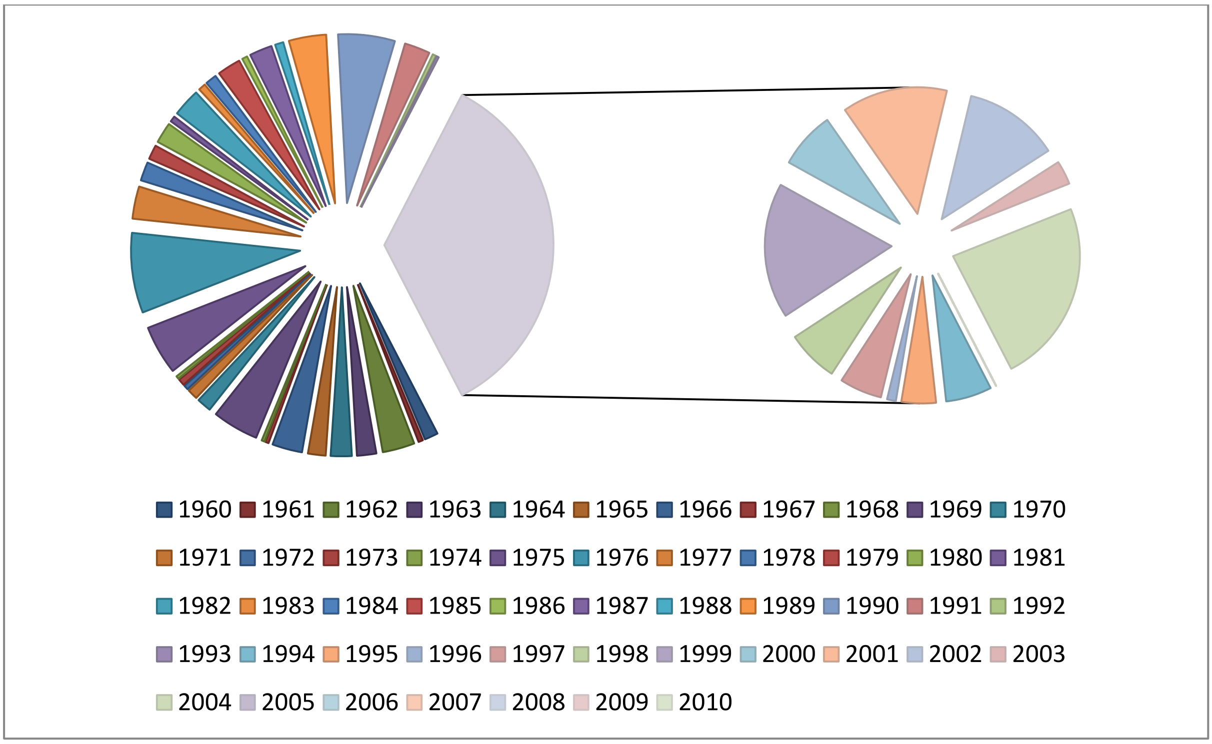
The HINV figures, started to fall at a decreasing rate from 1998 to 2002, to approximately R10 000 million in 2002; this fall could have been a product of the shift attention by the SARB under the new governor Tito Mboweni, in its bid to curb the inflation and the Asia crisis in 1998- 1999. Thereby causing relatively high mortgage prices and slow growth in the housing investment sector. This was also worsened by the rand crisis of 2002.

Figure 2.11 shows that the HINV performed better in the period of 2003- 2010 to reach a high of R25 000 million of housing investment. This recital would have resulted in a more government and SARB policies focused on individual housing investment such as the Rural Development Housing Programs (RDP) which increased the level of housing investment in the country. On the other hand, this increase in the housing investment could have been a consequence of the very lucrative housing prices in South Africa in this period (which was shown as ever increasing, in Figure 2.3 above).

2.5 The contribution of Residential investment (HINV) and Equity investment (BINV) towards the Total private net fixed investment (TINV) in South Africa

Both the BINV and HINV had different weight on their contribution on the total private net fixed investment (TINV). The pie chart given in Figure 2.12 below shows the individual contribution of both HINV and BINV in each year of the study.

Figure 2.12 The contribution of residential investments towards Total gross investments in South Africa, 1960- 2010



Data Source: IMF (2012), FNB (2012), World Bank Database (2012)

Business investment contributed a larger share of investment on aggregate, by contributing 65% towards the TINV; the contribution of the BINV was spread over a large number of years with most variables contributing fewer than 5% to the TINV. The highest contributors were in 1986 and 1987 contributing 5% and 8% respectively.

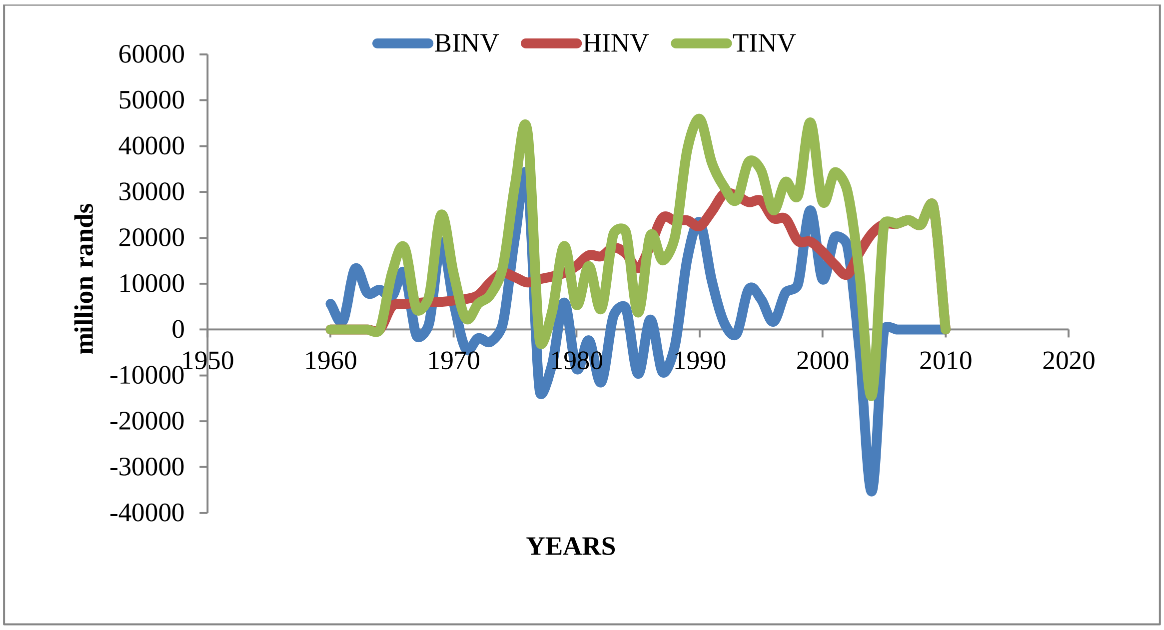
From the chart above, the HINV has 35 % influence of the total value of private sector investment with the years 1993, 1996, 2004, and 2007 contributing 6%, 4%, 5% and 8% respectively; being the biggest contributors to the TINV by residential investment.

Having realized the influence of each variable towards the total investment, the study goes on in the next section to expose the relationship between the major variables of the study below.

2.6 Total net private investment, Residential (housing) investment and Business (equity) investment in South Africa

This study now, tries to find the patterns, trends and dynamics of the major variables of this study. The study takes a glance at interaction as well as the in depth analysis in the relationship between TINV and its subsectors BINV and HINV. From the figure 2.12 above one can see that the TINV is clearly affected by the BINV and HINV volumes and the preceding analysis shows that there is a strong influence of the BINV and HINV towards the TINV.

Figure 2.13 Total net private investment, Residential (Housing) investment and Business (Equity) in South Africa, 1960- 2010



Data Source: IMF (2012), FNB (2012), World Bank Database (2012)

Figure 2.9 shows the three variables TINV, HINV and BINV. The figure shows a more volatile trend in the TINV which is illustrating a pattern that is closer to that of BINV. This relationship is not surprising since, Figure 2.13 above has clearly indicated that BINV have a more influence than HINV. From 1960 – 1970 TINV oscillated around R5 000 - R 200 000 million above both BINV and HINV. After a fall in TINV in the early 1970s TINV improved significantly to an all-time highs of R 500 000 million owing its major contributor being BINV. The general trend in TINV followed the general pattern of the BINV since the Business sector in South Africa is the major driver in total private investment, (thereby contributing 60 % to the TINV). Concluding a severe indication that there seems to be a strong positive correlation and endogeinty between HINV, BINV and TINV in the South African investment data.

2.7 Concluding remarks

This chapter analyzed the trends and patterns of the investment in South Africa. The chapter initiated with the analysis of the investment atmosphere along with investment figures as a percent of GDP, the study of carried a visual exposition of the Q in South African investment data and its determinants given thereafter. The chapter exposed a rather refreshing patterns in tends and patterns of the choice of variables TINV, BINV and HINV in the data. The study has shown that the prices in the housing prices have fluctuated with various social and political as well as economic patterns in South Africa. The next chapter looks at both theoretical and empirical literature underpinning the study.

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

In perspective, this chapter will provide a review of literature which exposes the relationship between asset prices and investments as well as other macroeconomic variable in the study. The first part reviews theoretical literature. The following theoretical theories are reviewed; Tobin Q theory of investment, the Solow Growth model and Arbitrage Pricing Theory of investment. The second part of this chapter will look at the empirical literature that attempted to investigate this relationship. It will be divided into three categories namely; empirical from developing as well as for developed economies and finally looks at empirical literature specifically for South Africa

3.1 Theoretical literature

A number of theoretical literatures have been brought forward to explain the determination of Investments, the general dynamics in the private investments and the variables that affect the private investment in South African asset market. This study reviews the following theoretical literature the Tobin's Q, the Robert Solow's growth model and the arbitrage pricing model.

3.1.1 The Tobin "Q" theory of investment

The Tobin Q- theory was first proposed by James Tobin and later advanced by Tobin and William Brainard. The Tobin Q- theory of investment looks at the microeconomic foundation of business and capital investments. This study underpins the literature of this theory from two angles, with the first angle being how the Q- theory of investment implies in business investments and how the Q- theory of investment can be applied on housing investments. According to the advanced Q- theory by Tobin and Brainard in Yoshikwa (1980) gives a summarized version of the Q- theory as;

"*The neoclassical theory of corporate investment is based on the assumption that the management seeks to maximize the present net worth of the company, the market value of the* *outstanding common shares. An investment project should be undertaken if and only if it increased the value of the shares. The securities markets appraise the project, its expected contributions to the future earnings of the company and its risks. If the value of the project as appraised by investors exceeds the cost, then the company's shares will appreciate to the benefit of existing stockholders. That is, the market will value the project more than the cash used to pay for it. If new debt or equity securities are issued to raise the cash, the prospectus leads to an increase of share prices."*[Tobin and Brainard, p. 242]

The study as mentioned above will review separately the Q- theory and how it has affected the financial assets markets particularly the stock market and the housing market. The study uses the assumption that a different objective function between the managers and shareholders and that the share price or asset price movements may not always reflect changes in 'fundamentals' (Blanchard et al., 1990),this rather contrary to the arbitrage pricing theory that reflects the concept of market fundamentals.

3.1.1.1The Tobin Q- theory on stock prices and investments

The major question that Tobin Q- theory of investment tries to answer in terms of business investment is; what level of investment will maximize the market value for the company share since individual firms do not have control of r and ε as mentioned by the arbitrage pricing model of investments. The Tobin neoclassical model assumes that the representative firm is a price taker furthermore, Cuthbert and Gasparo (1995) suggested that the firm will maximize the discounted present value of dividends subject to firstly, the production functions and secondly, an increasing and concave installation cost function for investment. The Tobin q- theory introduces a q variable that indicates the ratio between the market and the replacement cost of the firm's capital stock, K_t. Thus the market value of the company's shares are given by the identity $Vt \equiv q_t K_t$.The identity shows the direct relationship between stock prices, V_t and the q variable. The introduction of the q- variable into the equation assists in it helps the model to be tested empirically. Assuming that the firm communicates its investment plans to its investors or holders of the shareholders. The shareholders will be able to know the size of the capital stock in the next period; however the investors cannot be sure on the stock prices in the future. Further assuming that the firm finances all of its current investments spending I, through retained profits, moreover the increase in the firm's capital suggests that the higher the adjustment costs and replacement costs and these are denoted by c(I). The expected dividend for the period t will be equal to the expected profits in the period t, Π_t^e, less the part of profit that has been retained so as to finance the expected new investments. The function is given as the equation below:

$D_t^e = \Pi_t^e - I - c(I)$, $c(0) = 0$, $c' > 0$ .... (3.1)

If the level of investment is relatively low, the changes in the capital stock are small and can be accommodated without any significant changes in the firm's organization. Conversely if investment is high, the firm is likely to go through major changes. These changes can be captured by the functional form of

$c(I) = \frac{a}{2} I_t^2$ .... (3.2)

Where a is a positive constant, the above equation (3.2) implies $dc/dI_t = a(I)$, that is the marginal replacement cost increase proportional to the new level of investment.According to the q- theory of investment the firm will choose its level of level of gross investment I_t, so as to maximize the initial wealth of its owners (Sorensen andWhitta- Jacobsen, 2005:444). By taking the market's valuation of a unit of capital (q_t) this condition gives the first order condition $\delta V_t / \delta I_t = 0$, and this an important observation since it gives the solution to the market value maximization problem of the firm. The q- theory can be stated as follows:

$q_t = 1 + \frac{dc}{dI_t}$,... (3.3)

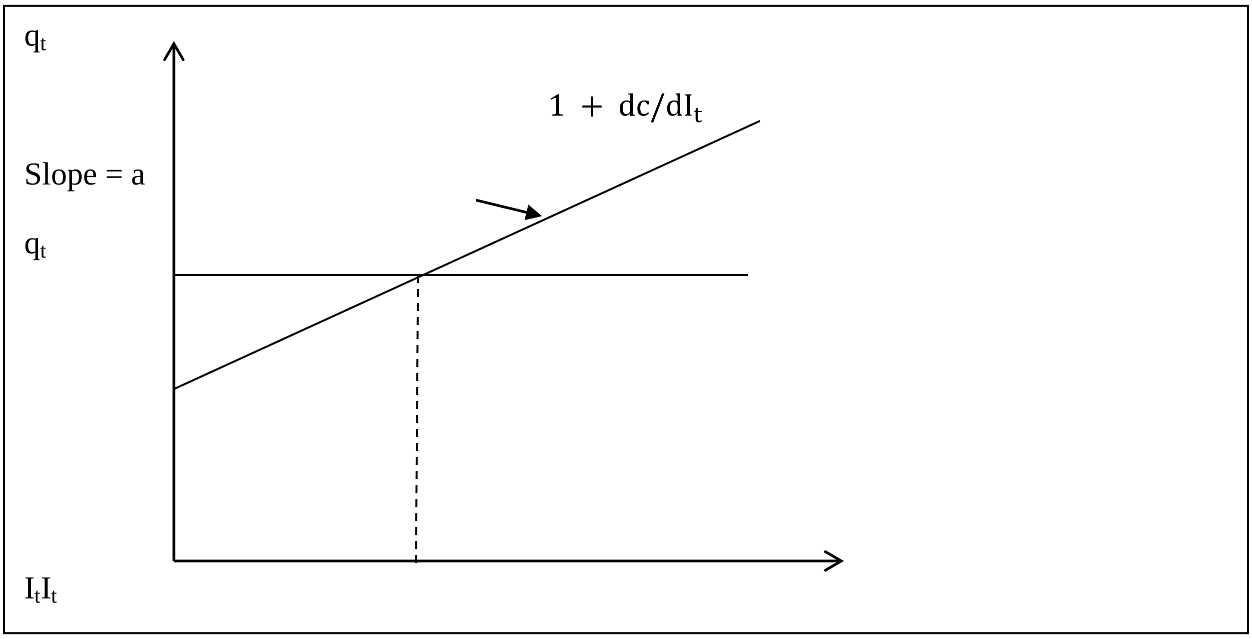
Then using $\frac{dc}{dI_t} = aI_t$:

Hence

$I_t = (q_t - 1)/a$ .... (3.4)

Using the equation (3.3) the left side shows the capital gains that the shareholder accrues on holding the shares and the left side shows the opportunity costs incurred of the dividend foregone. The investment rule given by equation (3.4) explains the financial cost in replacement of an extra unit of capital in the period t, therefore the firm must reduce its dividend payment by the amount equal to the replacement cost in the model. The graphical exposition of the above of the optimal level of investment is given below:

Figure 3.1 the optimal level of business investment



Source: Sorensen and Whitta- Jacobsen, 2010: 445

The above figure shows that at a higher value of a increases the slope of the investment curve $1 + dc/dI_t = 1 + aI_t$ thereby reducing the value- maximization level of investment where $1 + dc/dI_t = q_t$. The investment schedule (3.4) also holds when investment expenditures are financed by issuing shares and bonds rather than financing from retained profits. The above Tobin Q- theory of business is in conventional assumption that investment depends on real investment depends negatively with real interest rate and positively with stock prices. The stock prices adjust to keep the return on stocks in line with return on bonds and that the stock prices have a tendency of moving in line with the stock prices. According to the Q- theory expects the positive relationship between the profit rate and capital. The Q- theory suggest that business investment is a function of capital stock, K, income Y, real interest r, and the business confidence E. Thus:

$$I_t = f(Y, K, r, E) \qquad (3.5)$$

Where investment varies positively with both income Y and the business confidence index E and varies negatively with both capital stock and real interest rate.

3.1.2.2 The Q- theory of housing investments

Wildasin (1984) suggested that the Tobin q theory can be examined for investments with many capital goods, while Sorensen and Whitta- Jacobsen (2005) also applied the q theory of investment and modified it to the q- theory of housing investment. Waldasin (1984) pointed that the Q- theory is a theory of the firm with an appealing behavioural hypothesis and value maximization. The earlier models of the Q- theory treated capital as a homogeneous good but rather, there are certain situations where it may be desirable or even essential to be able to study investment disaggregated by a type of good. In the general Q theory, the marginal q is basically shown as a determinant of investment because it shows how much increase in market value accompanied by a rand's worth of investment, while the actual stock market value of the firm reflects the profitability of existing total capital. In this regard, housing investment is an important component of the private investment and is highly volatile than business investment due to the fact that housing investments are durable, hence the fluctuations in prices of residential investments and assets plays a vital role in business cycles. Sorensen and Whitta-Jacobsen expanded the working q-theory of investment by extending the theory to formulate a hypothesis for housing market to explain the housing investments.

The Q- theory of housing investment is analogous with the Q- theory of business investments. The theory begins with formation of housing prices and identifies the factors such as housing capital that may tend to cause the fluctuations in the market value of the housing stock. Assuming the production function of the construction sector is given by the function below:

$I^H = A.X^{\beta}, \quad 0 < \ \beta < 1$ .... (3.6)

Where X is a composite input factor and A is a constant which depends on productivity capacity of the construction sector (Sorensen andWhitta- Jacobsen, 2005). With the assumption that the parameter β ranges from 1 to 0, shows that the production function is subject to the law of diminishing returns to scale. Further assuming that the construction firms use both the labor L and material Q in fixed proportions, if W is the wage and p^q is the price of materials then the price P (given as ‘ the construction index’) of a unit of the composite input Xis equal to

$$P = aW + bp^{Q} \quad (3.7)$$

If the p^H is the market price of a unit housing, the sales revenue of the representative construction firm will be $P^H I^H$, and the profits Π will be

$$\Pi = P^{H} I^{H} - PX - P(\frac{I^{H}}{A})^{1/\beta} \quad (3.8)$$

Taking the housing prices and the input price given, the construction firm will choose its level of activity I^H with the purpose of profit maximizing. By taking the first order differentiation of the above equation then the supply function is given as:

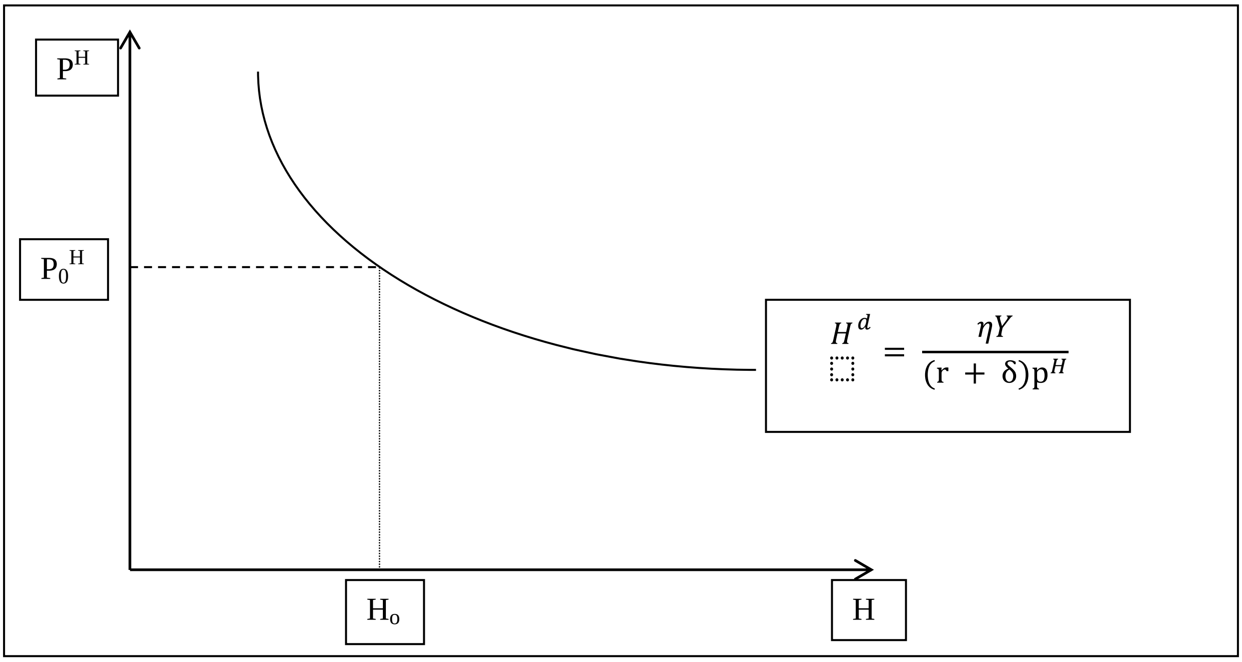
$$p^{H} - \frac{P}{\beta A}\left(\frac{I_t}{A}\right)^{(1-\beta)/\beta} = 0 \iff I^{H} = k.\left(\frac{I^{H}}{A}\right)^{\beta/(1-\beta)} \quad (3.9)$$

The relative price variable P^H/Pin the above equation (3.9) is similar to the Tobin’s q. Therefore, the higher the housing investment is higher the q- ratio of housing to the construction cost index. Approximately the housing theory varies negatively with interest rate and positively with total income just like the q- theory of business investment. It is of paramount importance to look at the housing demand in the housing demand in the residential market. Assuming the consumer has borrowed to acquire a housing stock H at a going market price p^H per housing unit and the mortgage debt is r. The consumer total cost of housing consumption is given by $(r + \delta)p^H$ where δp^H is the replacement cost. Given the choose between housing and non- durable expenditure the consumer will demand housing investment as long as the marginal rate of substitution between housing and non- durable expenditure is equal to the housing price. The consumer will demand the housing stock of;

$$H^{d} = \frac{\eta Y}{(r + \delta)p^{H}} \quad (3.10)$$

The housing demand H^d, shows the financial cost, r, which also looks at the opportunity cost that the consumer forgoes in investing his/ her savings in housing. And the cost of maintenance captured by the parameter δ. By inserting the conditions (15) and (16) the model comes up with the equilibrium condition of housing market $H^d = H$. This relationship is depicted graphically as below;

Figure 3.2 the short- run equilibrium in the housing market



Source: Sorensen and Whitta- Jacobsen, 2010: 452

Figure 2; above show how equilibrium the equilibrium price is determined in the residential market using the q- theory of investment. In the short run the supply of housing is given as a fixed level H_0. Holding all other things constant, a higher housing stock will imply a lower current price. On the demand side of the housing stock suggest that housing prices will be lower the real interest rate r and lower the level of income, Y. Therefore the housing function is given as:

$I^H = h\ (Y, H, r)$ .... (3.11)

In the above function housing investment varies negatively with real interest rate and housing stock but income varies positively with income. The Tobin Q- theory of housing investment does not address some problems faced by investors and suppliers of housing investment funding and houses. For example, there are demand problems in the demand for housing investments such as the "tilt" effect[5] this causes an availability problem for the home buyer. The supply function of the model fails to capture the presence of financial intermediaries and the strong influence of regulation in the construction industry. Regulations such as the regulation Q causes detrimental effect on the housing market.

[5] The 'tilt" effect is the problem of a fixed mortgage in an inflationary environment (see Claurette and Webb (1993: 83))

3.1.2 The Robert Solow Growth Model

In pursuit of understanding the dynamics of capital, employment, output and investments, Robert Solow (1956) examined the indispensable mechanisms as well as the contributions of various macroeconomics variables to economic growth; herein study Solow identified that in a basic economic model, economic agent (firms and/or Households) in several markets for output and investment; the supply conditions in most of these markets basically consist of the total output of firms while the demand in whichever output market is given by the sum of total consumption and total investment, in such circumstances output in numerous markets can either be consumed or it can be transformed into capital thereby making capital a pivotal component of aggregate investment, (Sorensen andWhitta- Jacobsen, 2010: 58). The housing market and the business market are not stella in this regard, the demand and supply of houses and business investment is reflected by number of houses and business stock that households hold, and consumption is reflected in the consumption and investment behavior in these markets.

Robert Solow’s dynamic growth model provides some useful information on the various sources of economic growth that explains a country’s growth performance. The Solow’s growth model examines how the economy in terms of its factors of production as it evolves over time.

In a continuous time framework the general Solow model is given as a process of seven equations below:

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha} \quad \ldots\ldots\ldots\ldots \text{(3.12)}$$

The first equation in Solow growth model shows the production function ith inputs inserted into the equation. The subsequent equation 3.13 shows the rental rates of the production function derived from marginal products of inputs.

$$r_t = \alpha\left(\frac{K_t}{A_t L_t}\right)^{\alpha-1} \quad \ldots\ldots\ldots\ldots \text{(3.13)}$$

Equations 3.14 to 3.17 give the functional income distribution assuming that there is not pure profit from the production. The equation 3.16 shows the fundamental capital accumulation equation in the production.

$$w_t = (1-\alpha)\left(\frac{K_t}{A_t L_t}\right)^{\alpha} A_t \quad \text{……………………………………………………………….. (3.14)}$$

$$S_t = sY_t \quad \text{……………………………………………………………………….. (3.15)}$$

Given the initial amount of capital and labor are given as K_o and L_0 respectively therefore

$$K_{t+1} - K_t = S_t - \delta K_{t,} \quad \text{………………………………………………………….. (3.16)}$$

$$L_{n+1} = (1+n)L_t, \quad \text{……………………………………………………………….. (3.17)}$$

The final equation of the Solow model is just the additional assumption of technological change.

$$A_{t+1} = (1+g)A_t \quad \text{…..……………………………………………………….. (3.18)}$$

In Solow's general growth model the steady state growth paths of the above parameters at initial values is achieved at:

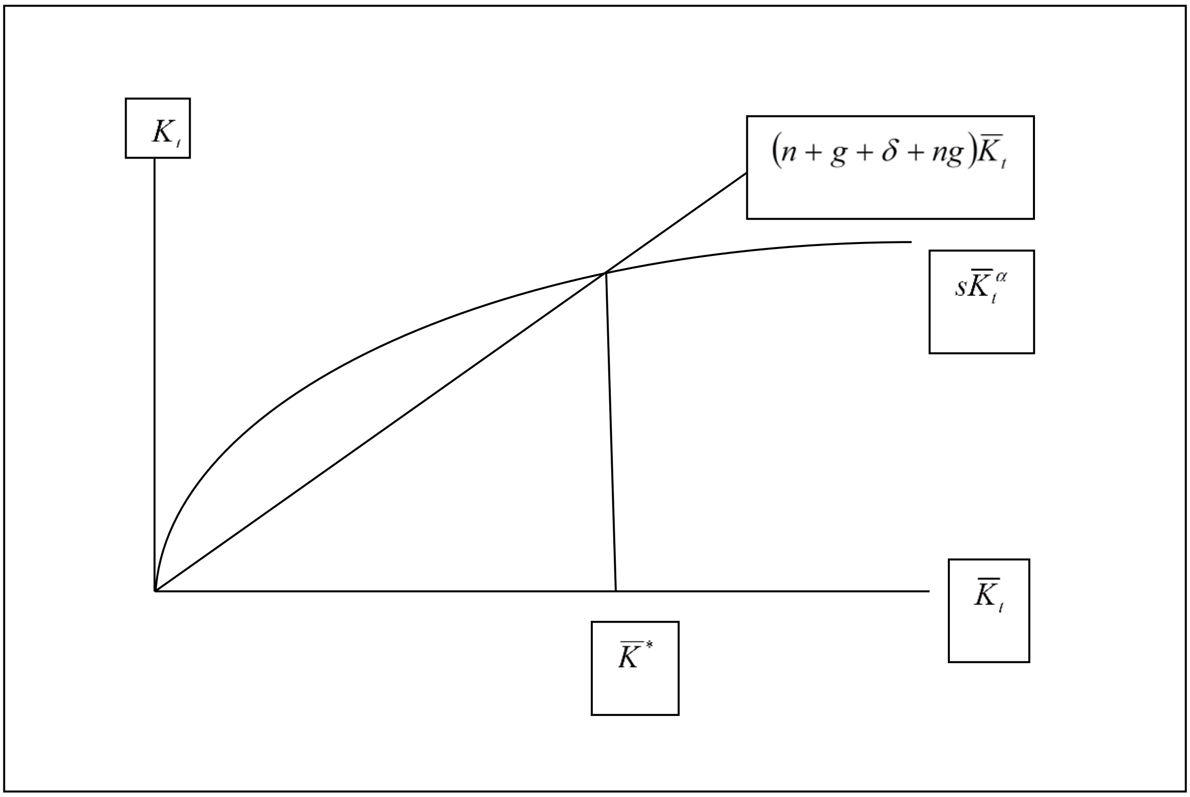
$$r^* = \alpha\left(\frac{s}{n+g+\delta+ng}\right)^{-1} \quad \text{……………………………………………………….. (3.19)}$$

Equation 3.19 shows the steady state of return on capital , where the equation 3.20 below shows the steady state of real wages at rate g.

$$w^* = A_t(1-\alpha)\left(\frac{s}{n+g+\delta+ng}\right)^{\frac{\alpha}{1-\alpha}} \quad \text{…………………………………………………… (3.20)}$$

The graphical exposition of the steady state in the general Solow model is given below as Figure 3.3 below.

Figure 3.3 The Solow Model Diagram



Source: Sorenson and Whitta Jacobsen 2010: 132

The Solow model was heavily criticized by Uzawa in 1969 what was basically popularly known as the Uzawa's Penrose effect. The major argument made by Uzawa's penrose effect was that, in classroom economics, a private- enterprise economy may be divided into two sectors; the household sector and the corporate sector. Decisions regarding the consumption of goods and services produced in the corporate sector are fundamentally done by the household which consecutively invested either in the business or housing investment. The household in turn provides labor and may from time to time possess assets and securities issued by the corporate sector (Uzawa, 1969).

On aggregate, if it assumed that if house owners and businesses plan the level of investment in order to maximizes the present value of expected future value of net cash flows, discounted by market interest rate (Uzawa, 1969). The desired level of investment per unit of real capital will be shown to depend on the expected rate of profit and market interest rate (Uzawa, 1969). If all households and corporate seek to maximize their rate of profit this implies that on aggregate the economy is likely to grow and enjoy a stable economic growth in both the housing and business sectors.

Despite all the criticism, the Solow model assists in understanding investments and how they influence economic growth. The next model to be examined in this study is the Arbitrage Pricing model on how investment asset prices affect the total investments. In this study's case how house prices affect housing investments in South Africa.

3.1.3 The arbitrage pricing theory (APT)

In a world filled with uncertainty, all assets would provide the same return which would be equal to the marginal productivity of capital (Lorie and Kimpton, 1985). The arbitrage pricing theory is an alternative philosophy of business investments to the Capital Asset Pricing Model (CAPM).

The APT suggest that the market value of shares in the firm must adjust to ensure that holding of shares is equally attractive as holding of bonds, thus the market value of listed companies should equal the fair value of similar corporate bonds in the bond market. The APT suggest that in the beginning of period t, the shareholder's dividend at the end of period t is given as D_t^e and the value of expected market value of shares by the shareholders at the beginning of the period t + 1 is given as V_{t+1}^e. The actual earning or market value of the share at the beginning of the period t is given as V_t. From the given information one can conclude that the capital gains that the shareholders gain from investing in the shares during this period t (capital gains during the period t) can be illustrated by the function $V_{t+1} - V_t$. This is basically the expected market value less the actual gain in stock market value at both the beginning and the end of the trading period. Shareholders are mainly concerned with the expected return on shareholding which is given as D_t^e $(V_{t+1} - V_t)$. This is where the expected dividends are multiplied by the capital gains (losses). The APT model also protracts that the capital market must and should be at equilibrium when the expected return on investment must equal the total required return on investment (shares). This capital market equilibrium is given by equation (1) below:

$$(r + \varepsilon)Vt = D_t^e + V_{t+1}^e - V_{t*} \quad \text{.......} (3.21)$$

The left side of the above equation (3.21) shows the function of the required return on holding shares as a form of private investment as compared to holding alternative investments such as holding a similar bond with similar indentures (for example holding a corporate bond). Were r is the real interest rate of holding the asset and ε is the risk premium of holding the stocks. The right side function gives the total expected return on shares. The required return function included a risk premium because stock prices and dividends are generally more volatile than bond price s and interest payment, thereby making share prices more risky than bond prices. The APT model further states that the total required return on shares must equal the arbitrage condition for capital (Sorensen andWhitta- Jacobsen, 2005: 436). Thus, if the prevailing market value V_t is so high that the required return on the left of equation (3.21) investors will sell off their shares in the firm in order to buy alternative investments such as bonds and the market value of the share V_t will drop. However if the current share prices in the firm promise a total of return in excess of (r + ε), investors will shift from bonds to shares thereby deriving up the current market prices V_t(Sorensen and Whitta- Jacobsen, 2005:436).

The behavior of investors is determined by the utility derived from their consumption possibilities this can be achieved by measuring all variables in the equation (1) in real terms. The value of the firm at the beginning of any period must be equated to the present value of that period's expected dividend plus the expected market value at the end of the period. Algebraically this can be achieved by rearranging equation (3.21) as follows:

$$V_t = D_t^e \frac{V_{t+1}^e}{1+ r+\varepsilon} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.22)$$

Since the main objective of firms with listed shares seeks maximize shareholder value by making sure that the share market value of their firm is high enough in excess of the total required rate of return. From the above analysis, this means that the company will discount its future value by r +ε, the firm will choose an investment policy which will maximize the value V_t therefore the firm's optimal investment policy must reflect such argument above. If the value of the firm at the beginning of any period equals the present values of that expected period's expected dividend plus the expected market value at the end of the period. Since the arbitrage conditions similar to (3.22) must hold for all subsequent periods, rational financial investors will expect that future stock prices will satisfy the relationship:

$$V_{t+1}^e = \frac{(D_{t+1}^e + V_{t+2}^e)}{(1+r+\varepsilon)},\ V_{t+2}^e = \frac{(D_{t+2}^e + V_{t+3}^e)}{(1+r+\varepsilon)},\ldots\ V_{t+n}^e = \frac{(D_{t+n}^e + V_{t+n+1}^e)}{(1+r+\varepsilon)} \ldots\ldots\ldots\ldots\ldots\ldots (3.23)$$

By successive substitution of the expression in (3.22) and (3.23), the expression can be given as below:

$$V_t = \frac{D_t^e}{1 + r + \varepsilon} + \frac{D_{t+1}^e}{(1 + r + \varepsilon)^2} + \frac{V_{t+2}^e}{(1 + r + \varepsilon)^2}$$

$$= \frac{D_t^e}{1 + r} + \frac{D_{t+1}^e}{(1 + r + \varepsilon)^2} + \frac{D_{t+2}^e}{(1 + r + \varepsilon)^3} + \frac{V_{t+2}^e}{(1 + r + \varepsilon)^3}$$

$$= \frac{D_t^e}{1+ r} + \frac{D_{t+1}^e}{(1+ r+\varepsilon)^2} + \frac{D_{t+2}^e}{(1+ r+\varepsilon)^3} + \frac{V_{t+2}^e}{(1+ r+\varepsilon)^3} + \cdots + \frac{V_{t+n}^e}{(1+ r+\varepsilon)^n} \quad \text{.......................................} (3.24)$$

From the equation (3.24) above, it can be reasonable to give the assumption that investors do not expect future real stock prices V_t^e to rise indefinitely at a rate faster than r + ε, thus, if the current price V_t, would become infinitely high according to the fact in equation (3.24), Hence the model assumes that;

$$\lim_{n\to\infty} \frac{V_{t+n}^e}{(1+ r+\varepsilon)^n} = 0 \quad \text{.......................................} (3.25)$$

With successive substitution of the assumption (3.25) above, this gives the following result:

$$V_t = \frac{D_t^e}{1+ r} + \frac{D_{t+1}^e}{(1+ r+\varepsilon)^2} + \frac{D_{t+2}^e}{(1+ r+\varepsilon)^3} + \frac{V_{t+2}^e}{(1+ r+\varepsilon)^3} + \cdots \quad \text{.......................................} (3.26)$$

The above observation shows the fundamental share price which is the basis at which firms maximize the present market value by stating that the market value of the shares in a firm equal the present discounted value of the expected future dividends paid out by the firm.

3.2Empirical analysis

Empirical studies on the relationship between housing investment and business investment have been vast, however, for some reasons the literature on housing investment and investment is relatively sparse and have been challenging. This difficulty arises from the fact that most researches in this market were conducted in the long run and using cross sectional data.

3.2.1 Empirical studies in developed economies

Cuthbert and Gasparo (1995) studied the importance of the Tobin's Q output and debt on fixed investment in UK manufacturing industry. The study implemented an intertemporal neoclassical investment framework to test the relationship, between fixed investments and the Tobin's Q using output and debt for each firm. The model uses some of the observations by Hayashi (1989) and Summer (1989), to model the present value of the firm as a maximizing function subject to its debt and output ratio. Herein in study Cuthbert and Gasparo (1995) used UK fixed investment sector annual data 1968- 1990. The study applied various econometric techniques to test the relationship by applying an error correction model along with co integration techniques such as the general to specific approach technique. The estimation results showed that the Tobin's Q is a sufficient statistic to explain the relationship between the tested variables furthermore the finding of the study where that investment depended on capital gearing and output. The study by Cuthbert and Gasparo (1995) suffered some drawbacks in terms of modeling a representative firm that is not demand constrained since some firms are demand constrained while other are in fact not demand constrained as suggested by Precious (1987). As usual the inherent problem, with the Tobin's Q is that data of the cost of replacement of an individual firm is rather scarce or nearly impossible to ascertain. On contrary, the study gave insightful information on how the Tobin's Q can be used to explain the investment behavior of each firm and the econometric estimation provides a strong basis of econometric inception of policy recommendation

Hasan and Taghavi (2002) studied the impact of residential investment and the macroeconomic in United Kingdom (UK). The study used annual data from 1968- 1999. The study implemented used both the historical decomposition (HDCs) and variance decompositions (VDCs) using a six Vector Autoregression (VAR) estimation technique. The results showed that the entire macroeconomic variables, fiscal policy variable is the most influential and significant impact on residential investment in the long run. The study also showed that the explanatory power of money during the period of study showed that it has depreciation and replacement. The findings of the study showed a strong confirmation of that deregulation measures in the UK in the early 80s had some significant alter the nature and strength of causal linkage between residential investment and macroeconomic variable.

Lettau and Ludvigson (2001) looked at the component of consumption, aggregate wealth and stock returns using US stock market quarterly data applying the co integration technique. The study founded that the fluctuations in the wealth ratio are strong predictors of both real stock movements and excess returns over a treasury rate; furthermore the study showed that the wealth- ratio is a good variable forecast for asset returns. In a similar study Lettau and Ludvigson (2004) looked at the link between wealth and consumption in understanding trend and cycle in asset in asset values. The findings of the study suggest that most macroeconomic models which make no allowance for transitory variation in wealth that is orthogonal to consumption are likely to misstate both the timing and magnitude of the consumption wealth linkage.

Villalonga (2004) studied the impact of intangible assets such information technology, brand names, corporate culture and accumulated consumer information as well as the applicability of the Tobin's Q in these intangible resources to measure the assets intangibility and their impact on the sustainability of achieving a sustainable performance in terms of achieving a competitive advantage over other firms. The study implemented a hedonic q to show the relationship between these intangible assets and their impact on competitive impact on the company's performance. The study adopted a resource- based view of the firm (RBV) approach to capture the nested hypothesis of the study. Villalonga (2004), herein study used an Autoregressive AR (1) approach to estimate the model, using panel data from 161 US public companies. The study found that the predicted value from a hedonic regression of the Tobin's Q, despite of substantial variance across the industries, was consistent with other studies of similar nature and of all the intangible assets tested advertising was the most valuable asset in many industries. The study suffered some drawbacks in terms of ascertaining the value of the tangible assets and the replacement value of such assets since most of these assets are off balance sheet assets. The aggregation of data across industries may also have caused some biasness in the estimation of the model. However the study gave an insight on how the Tobin's Q can be extended to intangible assets and adds a great value to literature.

Jin and Zheng (2004) conducted a study on the US annual data to test the interaction of the residential investment and their asset prices in a multi- sector monetary business model. The study developed a three sector dynamic stochastic general equilibrium model which was estimated using the monte Carlo simulation. The study takes into account the salient business cycles properties in US that seem to be affecting the residential investment and house prices. In this study the model generated highly volatile and unstable properties of the residential market and hours worked to generate a residential good producing sector and the procyclicality of house prices. The study found that the model actually fitted very well in the data the lead- lag patterns of residential investment and house prices. The study also showed that both the monetary policy and the nominal interest rates play a vital role in the determination of house prices. Finally the study concluded that a monetary shock in the economy generates remarkably volatile residential investment and house prices.

In the study conducted by Arculus, Mitra and Srinivasan (2005), the study looked at the intertemporal relationship between the Tobin q (Q) and the return of investment (ROI), using the incidence of deferred tax incidence, intangibiles and non linearities in the Tobin's q and the ROI in firms. The study is line with a study conducted by Rapach and Wohar (2005) herein study used annual data ranging from 1872- 1997 examines the predictability of real stock prices based on price- dividend and price- earnings ratios using the MonteCarlo simulations and autoregressive model the study found that there is a significant evidence of increased long- horizons, and that current valuation ratios are uncorrelated with future stock prices. Rapach and Wohar (2006) the study employs the data mining technique on annual data to test the predictability of stock returns using the in- the sample and out- sample tests the results showed that there is little discrepancy between in sample and sample results. McMillian (2007) the study looks at the dynamics of stock price movements by applying both the present value and the asymmetric ESTR model on annual data of different countries. The study founded that the log dividend yield are characterized by an inner random walk regime, where the benefits of engaging in trade outweighs the costs and so the process moves randomly and prices rises greater than the level supported by dividends than price falls to dividends.

Gurkaynak (2006) conducted an econometric survey to test the presence of asset price bubbles. The study applied the bootstrap methodology and the Monte Carlo simulations modelling to compute the finite sample probability distribution of asymptotic test. The Bootstrap methodology was applied to the Nasdaq stock price and the Case- Shiller house price index. The data used in this study was monthly data from 1973 to 2010 for the Nasdaq data and monthly data from 1987 to 2010 for the Case- Shiller house price index. The study showed that there is evidence that the data fitted the data well without allowing for a bubble. The results of this study showed that the main reason for the upsurge in the asset price was mainly due to speculative behaviour. This study by Gurkaynak (2006) was built up from the study by Himmelberg, Mayer and Sinai (2005) in which the conducted a survey for house prices for 25 years in USA to test the conventional metrics like the growth rate of houses price, price to rent and price to income and the study found that it can be misleading because they fail to account for the time series patterns of real long- term interest rates and predictable difference in the long run of house price across local market.

Dia and Casalin (2009) investigated the impact of the aggregate investment, Tobin's q and external finance on economic policy. The study assumed a competitive analysis framework applied to the original Tobin's q and the neo classical investment framework, however the study assumed that the Tobin's q is not only an influence of the both aggregate investment and external finance but it is also an exogenous to the underlying market and its financing system. The study asked some inquisitive questions of the Tobin's q previous failure to explain the dynamics of the market in terms of its performance and high serial correlation in the white's noise test and the unit roots cannot reject the null of non stationarity of the q variable. Dia and Casalin (2009) came up with a truly ingenious explanation of the Tobin's q in terms of aggregated investment and considering capital flows of the investment decisions by the business and its sources of finances its business investments. The study showed that the q can be used to explain both investment behavior in terms of aggregate investment and external finance. The model was tested using a Vector Autoregression (VAR) and three stage least squared econometric procedures. The results showed that the q value had extremely low coefficients and high parameters of the adjusted cost function

Jones, Miller and Yeager (2011) conducted a survey to investigate, the charter value, Tobin Q and bank risk during the subprime financial crisis. The rational of the study was to ascertain the Tobin's Q as an approximation of the charter value to mitigate moral hazard and the financial risk in American banks. Using annual data of publicly traded holding of United States of American banks from 1988 to end of 2008, the study showed that there is a slight correlation between the Tobin's Q and the equity to asset ratio, the study gave the explanation that this relationship was due to Tobin's Q is a partially reflection of the high stock prices relative to other investments. Jones *et al* (2011) used a multivariate analysis with the modified Tobin Q as the dependent of market power, noninterest, GDP and the effective ratio, despite the statistically significant results of the variables, the model did not perform very well showing that the Tobin's Q is a poor measure of the cardinal measure of the charter value despite the fact it can be a good ordinal measure of the carter value of the moral hazard and investment behaviour in the banking environment. The poor performance of the Tobin Q is largely contributed to poor adjustments of the Tobin Q made, especially when the Q was measured in terms of constant Price- Earnings ratio and GDP, this may have caused some detrimental effects on the results, in that the GDP is an aggregated measure while P/E ratio is a disaggregate measure, moreso, the multivariate analysis used by the study did not explode the full non parametric measures in the study in terms of analyzing the Tobin Q with its ability to measure the moral hazardbehavior (Charter value).

Valcarcel (2012) studied the dynamic adjustments of stock prices to inflation disturbance the study used the two different structural auto regressions and the Markov chain Monte Carlo simulations, Using the United States data form 1980- 2008 and applying the two different VARs to estimate the data. The study findings were that there was a weakly negative correlation between stock prices and US inflation results from the disturbances to the demand of financial assets. The study also showed that the American investments in the private sector especially in the American stock market in the 2008 recession. The stock prices responded to inflationary shocks that came from money supply than shocks from money demand affecting investments.

Gupta, Miller and Van Wyk (2012) looked at how the US monetary policy, a federal funds rate shock, affect the dynamics of the US housing market and whether the financial market of the early 1980's influenced those dynamics, the analysis used the Bayesian vector autoregressive (BVAR) model over the periods 1968- 1982 and 1989- 2003. The findings of the study were that the monetary policy exerts negative effect on house prices at national level and the housing sector proves heterogeneous across regions.

Firth, Malatesta, Xin and Xu(2012) investigated the relationship between the internally generated cash flows and fixed asset investment of Chinese sing the dynamic panel GMM estimation technique. Using the monthly data from the Shanghai stock exchange market and a sampling sample from 1992- 2008.The study found that cash flow and investment are negatively related for low of cash flow but positively related for high levels of cash flow. The study showed that there is no significant evidence suggesting that access to finance and soft budget constraints explain the differences between investments and privately controlled listed companies.

Jansen, Andersen and Jansen (2012) studied the investment behavior in the non-transferable quota system of the Danish demersal North Sea Fisheries, the study used interest rates and capital stocks as the preliminary determinants of investment. The study implemented a logarithmic distributed lag econometric estimation technique using panel data from 1996- 2005 to estimate the model. The findings of the study are that the aggregated and disaggregated model yielded different results. More over the estimated parameters in the aggregated model were significantly higher in the aggregated data than in disaggregated models. The investigation showed that investments in the fisheries in the Danish North Sea investments in machinery, electronics and vessels are governed in the first lag while investment in gears was governed by present variables.

Basin, Gillian and Pearlman (2012) investigated the influence of inflation, human capital and the Tobin's q in the general monetary equilibrium. The model calibrated different aspects of the human capital and inflation by ascertaining the true values of the firm and endogenous growth in the economy though the monetary policy. Herein study, Basin*et al* (2012) deliberated a working model indicative of a representative household and firm, representing both decisions making made by the household and the firm to influence the Tobin's q. The model used the calculus variation as well as optimal control mathematical frameworks to calibrate the model to incorporate the levels of inflation in the country and how the monetary policy tend to affect the stock market along with investment in addition to sticky wages and inflation targeting. The model implemented a DSGE growth model applied to the Autoregressive econometric model, using quarterly US data from 1960 to 2007, the results showed that the AR(1) regressions of the quarterly seasonally adjusted money supply, confirmed that the average value of q was equivalent to 0.90, the simulations moreover showed that there is a strong positive correlation between inflation and human capital to the Tobin's q, the study also induced some shock parameters to the simulation in the model to back test and stress test the performance of the Human Capital and inflation outcomes, the study showed some ARCH effects furthermore GDP, currency supply and labour supply were statistically significant, however, consumption and investments fitted in the model so well. The model used investment as a constraint rather than an influence of the stock market value a contributing factor on the decision making part of each firm not inflation or human capital. The study suffered greatly in terms of generalisation because it is almost impossible to ascertain a representative "firm", let alone a representative "household". Over and above the study provides a great insight on the performance of the Tobin's q on the policy.

3.2.2 Empirical evidence from emerging countries

Oyama (1997) examined the relationship between the stock prices and macroeconomic variables in Zimbabwe. The study estimated this relationship using the revised return dividend model, error correction model, and the multi- factor re- generation model. The findings of the study were that the Zimbabwe stock exchange's rapid increase in stock was explained by the movements in money aggregates and market interest rates.

Phe (2002) conducted a study on the residential property analyzing the element of taxonology in Vietnam that has resulted from different residential investment strategies. The study used annual data from 1989-2000 of Hanoi central residential market. The study used a conceptualised dynamic stochastic residential model which was estimated using the VAR techniques, the results of the study showed that taxonology of home owners resulted in three types of investors: the improvers- consumerism, the improver- turned- dealer and the aspiring improvers.

Jongwanich and Kohnpaiboon (2008) examined the patterns as well as the determinants of private investments in the South Eastern Asia, using Thailand as a case study. The study seeks to understand why the South Eastern Asian economies never fully recovered from the 1998/1999 Asian crisis. The study estimates Thailand equation using annual time series data from 1960- 2005 by applying the ARDL estimation technique. The private investment equation found that capital shortages rather than existing capital extra capacity hinders short run investment recovery. On the other hand, the financial health of the Thailand investments institutions must be given continuous check and policy should give more attention to credit availability to ensure that a conducive investment climate.

Mykhayliv and Zauner (2012) looked at the relation that seems to exist between investment behavior and ownership structures in Ukraine. The study used a sampling range of Ukrainian firms' monthly data from 2003- 2007. The study used the Tobin Q as an endogenous variable to evaluate econometrically, the question whether government ownership is actually detrimental to the firms' performance and investments. The model estimation was conducted through the Ordinary Least Squares (OLS) and the Generalized Methods of Moments (GMM) econometric framework. The analysis showed that the proxy for marginal Q, the change in Tobin Q contains information about profitability of investment. The study also showed that government and foreign ownership structures suffer underinvestment due to private benefits control.

3.2.3 Empirical evidence from South Africa

Gupta, Jurgilas and Kabundi (2010) assessed the impact of the monetary policy on the real housing prices growth in South Africa suing a factor- augmented vector autoregressive (FAVAR), estimated using monthly data from 1980- 2006. The results of the finding showed that house prices inflation in South Africa responded negatively to the monetary policy shock.

Baciliar, Gupta and Shah (2010) tested whether house prices in South African market show signs of non- linearity based on smooth transition autoregressive (STAR) models estimated using quarterly data from 1990- 2009, the finds of the study showed an overwhelming evidence of non-linearity based on in- sample evaluation the linear and nonlinear models.

Gupta and Modise (2010) the study looked at the predictability of the valuations and stock prices in South Africa, the study used monthly South African data ranging from 1990- 2009 applying both the exponential smooth transition autoregressive ESTR and the non linear framework in explaining the patterns of stock predictability in the data the findings of the study where that the stock price predictability in the data does not show any promise both at short and long run horizons just like in the linear models. These general- to specific model shows that the valuation ratios showed that valuation ratios contains very useful information that explains that explains the behavior of the stock market.

Das, Gupta and Kanda (2011) tested for house bubbles in South African housing market and their impact on consumption basing on the unit root test and error correction models estimated using quarterly data 1969- 2009, the study found that consumption responded significantly to the house deceleration although there is no evidence of the effect being higher during the bubble period.

4. Concluding remarks

This chapter reviewed both the theoretical as well as the empirical literature that affect investments in residential investments. The following theoretical literatures were reviewed; the Tobin's Q theory of both business investments and housing investments. The chapter also considered the Solow Model of exogenous growth and the arbitrage pricing theory. The theoretical literature reviewed in the study showed that the Q theory can be interpreted in terms of different capital goods such as housing investments. The chapter also conducted a review of empirical literature, the study reviewed literatures from developed countries, developing countries and literatures particularly on South Africa. However the empirical literature reviewed in this study has also shown that the Q theory has not yielded conclusive results in interpreting both housing investment and business investment in South Africa and emerging markets. The next chapter will give the model specification from the reviewed literatures.

CHAPTER 4

RESEARCH METHODOLOGY

4.0 Introduction

The subsequent chapter examines both the theoretical and empirical literatures developed in the preceding chapters to formulate an empirical model of the study. The chapter is divided into three pristine sections, with the foremost section examining and constructing the model specification to allow the construction of variables to be estimated in the study. The second subdivision looks at the construction of variables and data source, lastly the final segment looks at different econometric techniques to be used in performing the model estimation of the study. The chapter closes with a comprehensive and summative conclusion.

4.1 Model specification

The study proposes a fairly standard investment model by Tobin and Barnaird (1962) along with the alternative neoclassical investment model by Jorgenson and Stephenson (1967) and which was later modified by Yoshikawa (1980), Hayashi (1982), Wildasin (1984), Cuthbertson and Gasparo (1993), Faria, Mollick, Sachsida and Wang (2012) the model recently have been extended by Sorensen and Whitta- Jacobsen (2005) and Dia andCaslin (2009) into other field of study such as residential market and external finance respectively. The study adopts the investment model by Dia and Caslin (2009). The empirical model of standard investment model is constrained by replacement and depreciation cost in both the residential market and stock market, which was explicitly introduced by the theoretical analysis in chapter three of this study.

Using the assumption, the objective of the firm is to maximize the present discounted value of the firm subject to technological constraints summarized by the production function (Wildasin (1984)), hence investors and firms in the economy tries to maximize this function, thus becomes the state variable of the study's optimal control in the economy. Since both the residential and stock market are highly competitive, the model also assumes that the product and factor market are competitive and efficient, more so, hypothetically, for the Tobin's marginal and average Q to be identified the empirical model assumes that the book value of capital are a correct measure of capital (Dia and Caslin (2009)). Furthermore, Hayashi (1982) assumes that the firm is a price taker in the factor market, and maximizes the value of the firm also subject to an increase and concave installation cost function for investment, Sorensen and Whitta- Jacobsen (2010) introduces the housing investment through the function of housing demand and housing supply, since the stock of housing capital is important in total household wealth. For these asset markets, the study adopts the following functional form equation of investment as:

$P_t^I I_t = HM_t + \alpha R_t$ .... (4.1a)

Where: $R_t = P_t^y(\text{F}\ (K_t, N_t) - w_t N_t$.. (4.1b)

The study notes to the reader, that the empirical model pays more attention to the time structure of investment process rather than the financing and tax considerations. In the above model, $R_t$is defined as the domestic private business investment in the business sector. $\alpha$is the share of the retained profits by companies in the stock market. I_t is the real investment, K_t is the stock of capital, N_t is the quantity of the variable input, w_t is the price of the variable input, P_t^I is the price of investment goods, P_t^y is the price of output, HM_t is the household market which is the equilibrium in the housing market, and the function (F(K_t, N_t) represents a standard investment function. At each moment in time all players and stakeholders in the business and the housing markets consists of complex decisions on the fixed factors of production and managerial skills or technological capabilities (Uzawa, 1960).Assuming a two agents model (that is, firms and households) and three commodities (output, Capital and labour) as first suggest by Solow (1956). The investment function of both housing market and the stock market can be defined the general optimal control function by Kamien and Muller (1976) and the subsequent investment as follows:

$$\int_0^T F(t, x(t), \mu(t))dt$$

Subject to

$\dot{x} = f(\big(t, x(t), \mu(t)\big), x(0) = x_0$... (4.2)

Thus the investment is modelled as:

$$\int_0^T F(t, I(t), H(t), \mu(t))dt$$

Subject to

$\dot{K} = \mathrm{I} - \delta K_t$

$K(0) = K_0.$

$I_{min} \leq I_t \leq I_{max}$

$L_t \geq 0, K_t \geq 0, and\ a\ given\ value\ of\ K_0$.. (4.3)

The above equation 4.3 state the show that the investments in these asset markets is constrained by the production function in each capital market, capital accumulation constraint $\dot{K} = \mathrm{I} - \delta K_t,\ 0 < \delta < 1$ given as the radioactive decay of capital where $L_t \geq 0, K_t \geq 0$, suggest the capital good continues to exist forever (Hayashi (1982), and Takayama (1997)). The volume of investment in both of these markets bounded by a competitive equilibrium condition that $I_{min} \leq I_t \leq I_{max}$ for all t and the study defines $I_{min} = 0\ and\ I_t \geq 0$ is the irreversibility of investments.

The maximized investment function is adjusted in real terms is given as,$H_t = HM_t/P_t^I$,$R_t = \frac{P_t^y}{P_t^I}$, $W_t = \frac{w_t}{P_t^I}$, are generally regard to be constant. The adjustments are in line with the remarks made by Takayama (1997) that, the firm takes the prices (P_t^y, w_t, P_t^I) which prevail at each t as given data and that, the firm knows all future pricesP_t^y, w_t, P_t^I.

While the original Tobin Q theory does not explicitly account for the housing market investment as much as it does in business investment. Some recent literatures[6] have shown that the theory can be used as theory of residential investment furthermore the Q theory can assist in explaining investment behavior in both the business as well as housing investment. This study notes that there has been no well-developed theory that links the Tobin's Q with both of these asset markets thus the theory (in the best of understanding of the study) has never been analyzed in terms of both the housing and business investment concurrently. Moreover, the basic specification of the theory did not take into consideration, the possibility

[6] In the findings of studies by Sorensen and Whitta- Jacobsen (2010), Madsen (2012) and Madsenand Carrington (2012) among others

of market prices of stocks and housing stock being relevant in order to generate investment induced economic growth.

4.1.1 The Langragian of the problem statement

If capital in these investment market is the state variable controlled by its derivative that is the model introduces the capital accumulation function as a constraint in the economy, which Hayashi (1982) gave as the first order condition of the capital stock, $\dot{K} = \mathrm{I} - \delta K_t$ to maximize the value to shareholders and residential property owners and δ is the exogenous rate of depreciation (Yoshikawa (1980)). The model completely assumes that personal taxes or corporate taxes and debt finance are absent[7]. Using the developments of nonlinear programming mathematical economics; formulating the problem explicitly as an optimal control problem, leads to the langrage of the problem statement in chapter 1 given as:

$$\boldsymbol{\ell}\,(\mathrm{I}, \mathrm{H}, \mathrm{K}, \mu, \lambda) = \sum_{t=0}^{\infty} \beta^t \{[P_t^y(\mathrm{F}(K_t, N_t) - \psi(I_t, K_t) - \emptyset(H_t, K_t)) - w_t N_t - P_t^I I_t - P_t^H H_t] - \lambda[K_t - K_{t-1}(1-\delta) - I_t] - \mu[H_t - I_t - \alpha(R_t\ F(K_t, N_t) - w_t N_t)]\}$$

.... (4.3)

For all $L_t \geq 0\ and\ I_t\ with\ I_{min} \leq I_t \leq I_{max}$

Where $\psi(I_t, K_t)$[8]and $\emptyset(H_t, K_t)$[9]are the adjusted cost function in each asset market. The study notes that the lower the, ψ and $\emptyset$ the more affordable the home or business ownership for an average buyer and the higher is the potential for business and house prices to increase and vice versa (Madsen, 2012). The rationale is that both the firm and household incur adjustment cost when undertaking investment, in both cases it is assumed to take the form either of lost output or waste of the good being invested (Wildasin, 1984). The study notes that there is no well-developed theory for the determinants of housing adjustment cost, which are given as$\emptyset$; this variable as noted by Madsen (2012) will depend on quite a number of things such as monetary policy, bank regulations, past house prices as well as economic prospects. To obtain the optimal level of capital stock the model adjust both the cost function in business

[7]As in the studies by Yoshikawa (1980), Hayashi (1982), and Wildasin (1984) furthermore investments are not always governed by profits.
[8] The justification of this interpretation is given in more detail in Gould (1968), Jorgenson and Stephenson (1968), Uzawa (1968) and Takayama (1997)
[9] Madsen (2012) gave a more concise definition of replacement cost for an average house buyer

investment and residential market, which can be defined under the assumption that output is exogenously given and the production function which is a convex polyhedral cone (Takayama, 1997; 22) and is linearly homogenous (Cuthbertson and Gasparo, 1993) showing units of both business invested lost from investing a given amount of capital (Wildasin, 1984)

By replacing equation 4.4 with the Arrow's condition

$$lim_{t>\infty}\mu_t = 0 \; and \; lim_{t>\infty}\mu_t \dot{K}_t = 0$$

Using the Kuhn- Tucker- Lagrange condition[10], to solve the maximization problem, subject to the adjustment cost of both the housing and business investment, the first order condition, to obtain the partial derivatives of the above the Quasi- saddle- point of the langrage/ Hamiltonian function for investment in asset markets is given as;

$$\partial\ell \backslash \partial I_t = \beta^t[-P_t^I I_t \psi' \, (I_t) + \lambda_t + \mu_{t+j}] = 0 \text{ .... (4.4a)}$$

$$\partial\ell \backslash \partial H_{t+j} = \beta^{t+j}\left[-P_t^y \emptyset'(H_t) - P_t^H - \mu_{t+j}\right] = 0 \text{ .... (4.4b)}$$

According to Dia and Caslin (2009)and using Euler condition, rearranging equation 4b, shows the langrage multiplier μ_{t+j} which means that the multiplier must be equal to the marginal cost in the residential market given by Sorensen and Whitta- Jacobsen (2005). Homothetic ally, this shows the marginal rate of substitution between housing investments and other types of investments relative of price of housing (Sorensen andWhitta- Jacobsen 2005; 453). By combining the necessary conditions and evaluating at optimal labor and capital at $(\dot{L}_t, \dot{K}_t)$ both equations 4b and 4b and the study comes up with following function;

$$\lambda_{t+j} = P_{t+j}^I + P_{t+j}^H + P_t^y \psi' \left(I_{t+j}\right) + P_t^y \emptyset'\left(H_{t+j}\right) \text{ .... (4.5)}$$

The above function (equation 5) signify a monotonic Boolean function which shows that "the value of the capital (the shadow value or the implicit rental price of investment[11]) equals the marginal industrial adjustment cost" (Dia and Caslin (2009)) plus the marginal cost of residential market (Sorensen andWhitta- Jacobsen (2005)) using the marginal productivity rule.

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[10] (See Takayama A, 1997:90)
[11] Eisner and Nadiri (1968: 370)

When these condition hold, under the hypothesis of that the intertemporal preferences orderings are homothetic[12], Since the Tobin Q is delineated as the fraction of the market valuation of capital assets to their replacement costs (Faria *et al*, 2012), the first derivatives of both are linear in ratios I_t/K_t and H_t/K_t equation 5 becomes;

$$P^I_{t+j} + P^H_{t+j} + P^y_t\, \alpha \frac{I_t}{K_t} + P^y_{t+j} \gamma \frac{H_t}{K_t} + P^y_{t+j}\, k = \lambda_{t+j} \quad (4.6)$$

The eligible dynamic path for capital thus follows the mathematical definitions that:

$\dot{K}_t = I_{max} - \delta \dot{K}_t$ if $K_0 < K_t$

$\dot{K}_t = I_{min} - \delta \dot{K}_t$ if $K_0 > K_t$

$\dot{K}_t = K_t$ if $K_0 = K_t$

Where k is constant in both markets and using the assumption that both *I* represents investment in both investment markets; Since capital is an important component for the firms and house owners, decision making and ascertaining the value of the Tobin's Q is vital as well as necessary to compute the long run desired stock of capital before coming up with the disaggregated investment for both residential and business investment. Thus since the study assuming aggregated capital[13] then the study will tend to ignore the distinction of each investment thus at the end of the period (hypothetically) at point T* and T** (first and second derivative of time respectively).

$$K_t = K_0\, e^{-T*} + \frac{I_{max}}{\delta}(1 - e^{-\delta T*})$$

And

$$K_t = K_0\, e^{-T**}$$

In other words, in terms of T* and T** thus:

$T* = \frac{1}{\delta} \log \frac{I_{max} - \delta K_0}{I_{min} - \delta K_0} > 0$ for all t >T

[12]Uzawa (1969:23)

[13] Since capital is assumed to diverge in the long run with time (Uzawa's Penrose effect) and since long run capital capital is determined by the marginal productivity principle (Takayama 1997) .

$T ** = \frac{1}{\delta} \log \frac{K_0}{K_t} > 0$ for all t > T

Having shown the dynamic path of aggregated capital thus the study will construct the Q in disaggregated investment for both residential and business investment. Hayashi (1982) showed that the marginal and average Tobin's Q are equal when the returns to scale are constant. If capital is adjusted to the desired level instantaneously at the initial level time and is kept constant over the whole planning horizon gives rise to what Dia and Casalin (2009) suggested, as the parameter λ_{t+j}, measuring the marginal increase in the value of capital, becomes equal to the Tobin's Q which is given as

$$Q_{t+j} = \frac{\lambda_{t+j} - P^I_{t+j}}{P^y_{t+j}} = \alpha \frac{I_t}{K_t} + \gamma \frac{H_t}{K_t} + \delta \frac{P^H_{t+j}}{P^y_{t+j}} + k \qquad (4.7)$$

The function Q in the above equation is concave given that the preceding equations 4.5 and 4.6 are both sufficient as well as necessary for the optimal for the function $F(\mathrm{I}, \mathrm{H}, \mathrm{K}, \mu, \lambda)$. The variable Q_t measures the marginal Q [14](Dia and Casalin, 2009) in the Tobin Q, thus the measurement of a Rand in additional capital of the firm and additional capital invested in the housing market. Using proof by Wildasin (1984) both business investment and housing investment with their respective constraints can be tested using the investment ratios. If both housing and business investment are to be explained by the Tobin Q theory, then suppose the adjustment cost take the form of wasted output (Wildasin, 1984). Then the total investment can be written as a function of Q if and if only relative prices of both business investment and housing investment are fixed and that the weighted average marginal adjustment cost per Rand's worth in each capital good must depend on the total investment independently of the composition of investment and initial capital stock (Wildasin, 1984). Both housing and business investment can be tested empirically by equations (4.8a) and (4.8b) for business investment and housing investment respectively. Therefore assuming that total investment $I_{min} = 0$, the study can describe the optimal path of investment as follows:

$$\frac{I_{t+j}}{K_{t+j}} = \alpha_0 + \alpha_1 Q_{t+j} + \alpha_2 \frac{H_{t+j}}{K_{t+j}} + \alpha_3 \frac{P^H_{t+j}}{P^y_{t+j}} + \mu \qquad (4.8a)$$

[14]If Q is greater than one this can stimulate investments on the basis that capital is valued highly in the market, which is in line with the findings by Faria *et al* 2012.

$$\frac{H_{t+j}}{K_{t+j}} = \beta_0 + \beta_1 Q_{t+j} + \beta_2 \frac{I_{t+j}}{K_{t+j}} + \beta_3 \frac{P^H_{t+j}}{P^y_{t+j}} + \varepsilon \text{ ......} \quad (4.8b)$$

One can clearly see that there seem to be a parallel between the two cases in these sub sectors of investments is incomplete, it can be estimated with a single capital good. It is also clear that the left hand side of equation 4.8a and 4.8b are not, in general, equal to a monotonic function of $pI/_{pK}$ or any level of investment *pI*, in order to give the rate of investment can be inverted to give investment as a function of Q as this would give the derivation of the rate of investment as a function Q, thus:

$pI/pK = h(Q)$ For $\grave{h} > 0$ hence the rate of investment depends on Q where $pI/pK = h(\sum_j \emptyset'_j\,(I_j, K_j)w_j)$ where I define $\emptyset'_j(I_j, K_j) = \emptyset'_j(I_j, K_j, 1)$[15] hence;

$$pI = h\left(\sum_j \emptyset'_j\,, p_j, K_j\right) \text{......} (9)$$

The rational of the above definition of investments suggest that investments depend on a number of factors such as the different level of investment in different capital goods, output prices, capital good prices and the initial capital.

Using the conjecture:

> *There is a limit to the acceleration of capital formation of capital formation generated by arbitrage of such margins. Abnormally rapid accumulations of capital, exceptionally high rates of investments, impose extra costs on investing firms individually and on the economy collectively (Tobin, 1982: 179)*

The dynamic path of investment as function of capital aggregated and the Tobin's Q is given below:

[15]A more interested reader may refer Wildasin (1984)

Figure 4.1 The dynamic path of Kt and Tobin's Q

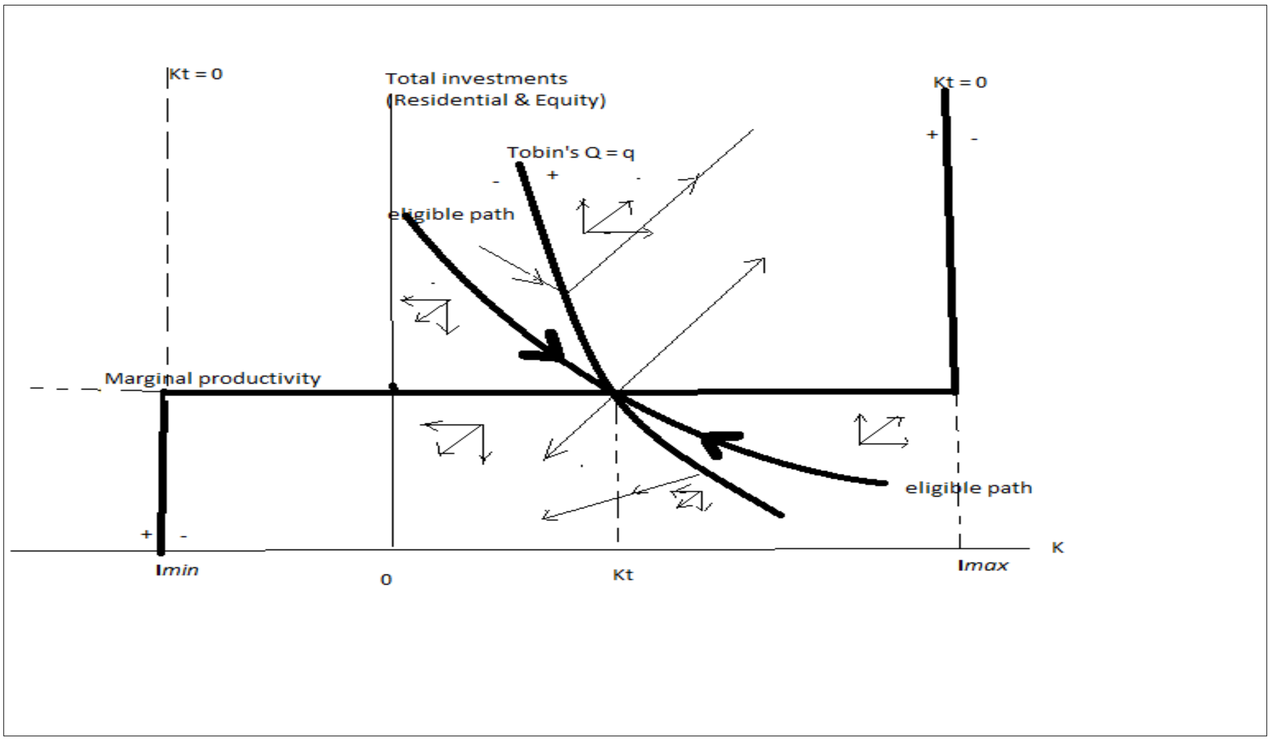


Figure 4-1 shows the alternative phase diagram for the optimal growth problem in the investment markets of the aggregated housing and business sectors, if capital is aggregated and the desired level of capital is optimized in the long run, the study propose two types of paths of $(\grave{K}, Tobin's\ Q)$ shown in Figure 4-1 showing that optimal capital and Q decreases over time as both $t \to \infty$. Clearly, only the second path is the only eligible,[16]since it does not violate the assumption that $\grave{K}_t \geq 0$ and gurantte the condition $\grave{I}\ \geq 0$ under the assumption $I_{min} < 0$ and that I_{max} is sufficiently large which implies that the Tobin's$Q_t > 0$.

In both residential and equity investment sectors, if capital index is given as a measure of the productive capacity of each sector, the capital index in both cases is likely to be a complex capital good endowment in each sector. In vernacular, if the capital index or the productive capacity of the sector independently increases then this might suggest an increase in the stock or the capacity of each sector to produce new investment. The system of equations above shows the interrelation of housing investment and business investment in the business cycles. Therefore the study has shown that the theories by early economists such as Uzawa (1968), Tobin (1962), Jorgenson(1968) and contemporary theories such as that of external finance (Dia and Casalin, 2009) can be used as well to explain the dynamics of business investment

[16]The path does not include prices of investments since as suggested by Takayama (1997) the crucial features of managerial and administrative resources are not usually bought or sold in the market; hence market prices of these resources do not exist [pp. 715]. This does not mean that the prices of the capital and labour is not important

and housing investment in relation to the Q theory of investment. The study also makes a crucial note that, a special case exist, in which the rate of the level of investment can be determined by a tax- adjusted Q, which lies outside the scope of this research.

4.2 MODEL DEVELOPMENT: DATA SOURCES AND VARIABLE CONSTRUCTION

The previous section of this chapter gave the model specification of the study. To empirically test the model specification the study adopts annual South African data from 1960- 2010. The study makes use of time series data since it gives an idea about the representation in economic dynamics and that some the variables, notably prices in asset markets move virtually continuously. The data has been adopted from the South African Reserve Bank (SARB), Penny World database, African Development Bank (ADB), World Bank, World Economic Report, Statistics South Africa (Satsa), the ABSA capital and FNB household survey for housing prices and indices, and the department of trade (the dti).

The dependent variable gross investment $I_t$and is specified by the Gross Domestic Fixed Investment (GDFI)with the base year 2000and the deflator of the real investment by the price of investment denoted asP_t^I and is given in constant rand. The variable P_t^y is the investment share of real GDP at constant prices with data from the Statistics South Africa (Satssa). The data for both the investment price and total household was obtained from the Penny World database. The study makes the assumption that the Gross Fixed Capital (GFC) embeds the fixed capital stock (Jorgenson and Siebert, 1968) and analogous the stock prices and housing market, hence,K_t is the gross fixed capital formation at constant 2005 prices. The data was retrieved from the South African Reserve Bank (SARB). The deflated housing stock and housing price H_t/P_t^H is the measured by the sales plus the change in inventory of the housing stock as the construction value added figures from the World Bank construction figures and the housing prices from the FNB annual prices, which is given in the data as the hedonic housing prices from the FNB household survey.

4.3 ESTIMATION ISSUES AND ECONOMETRIC ESTIMATION

Finally, from the above analysis the study now puts together the empirical dynamic behavioral framework of the simulation model in the model specification to formulate an aggregative dynamic model of investment behavioral patterns as well as to the investigation of both the short run and long run statistical processes. In order to convert the model specified above in the previous section into a practical econometric model, the study thus use the above data to construct variables to choose an efficient form based on the properties of the error term, in this regard the functional form is added to an error term(see Griffiths, *et al*, 1998). Thus the study will test various error correcting techniques as given in this section below.

To estimate the investment equation, the study uses basically two interrelated but dissimilar econometric procedures using an Auto regressive Distributed Lagged (ARDL) framework. Using the postulation that capital is regarded as a stock while investment is regarded as a flow. The first section of the empirical testing will largely test the theory of investment behavior in relation to the Tobin Q and changes in the demand for capital uses in addition to actual investment by testing the model stability and oscillations in the variables, and the subsequent section looks at the properties of the model behavior in terms of the multiplier effects and dynamic response of the model using the general- to- specific approach ARDL econometric technique and error correction model.

4.3.1 Avoiding spurious regressions: pre- testing unit roots and other tests

To avoid nonsense results the study will implement a broad spectrum of preliminary tests which includes the unit root tests, stationarity, cointegration, three Stage Least Squares (3SLS).

Unit root tests are carried out on individual variables in isolation; that is, the study will check for unit root tests because it does takes into account any relationship that may be there between the variables being tested and any other variables selected in the model (Cameron, 2005; 366).

4.3.2 Stationarity and Cointegration

The study will perform a preliminary test for both stationary and cointegration of the data to avoid spurious regressions and biasness.

4.3.2.1 Stationarity

"Stationarity of a stochastic process requires that the variance and auto- co variances are finite and independent of time," (Verbeek, 2000: 235). With autocorrelation, the study needs to assume and check if the stochastic process is stationary. A stationary time series can be defined as one with constant mean, constant variance and constant auto-covariance for each given lag (Granger and Newbold, 1974). Since the study will implement the 3 stage least squares and ARDL, it is important that the data should be stationary because stationarity in both three stage least squares and ARDL allows the model coefficient to be efficient and that they will exhibit error terms that will not be a down declining effect on the current value of the dependent variable (Brooks, 2008).As prearranged that the study will adopt the ARDL econometric technique and this technique requires stationary variables rather than their levels. For simplicity assuming the following autoregressive structure;

$y_t = \beta_0 + \beta_1 \Delta x_t + p\varepsilon_t + \mu_t$.. (4.9)

The study defines stationarity as, $\Delta y_t = y_{t-1} - y_t$, then the regression becomes as follows:

$\Delta y_t = \beta_0 + \beta_1 x_t + \mu_t$ .... (4.10)

In this regard, a regression model where a time series is non-stationary, the ARDL model would give rise to a spurious regression, biased t-ratios, incorrect inferences and the R-squared would be artificially high- close to 1. Generally, non-stationary variables might be transformed into stationary through differencing. As an example, if variable X is differenced, say d-times and get stationary series, it means that X, integrated of order d, denoted by X (1). The study will use both the Augmented Dickey- Fuller (ADF) and the Phillip- Peron (PP) unit root tests.

4.3.2.1.1 Phillip- Peron test

The Phillip Peron test (or Peron test) seems to be the main alternative stationarity test to the Augmented Dickey- Fuller type of test used by many researchers (Cameron, 2005: 371). The study will implement the Phillip- Peron test as a complementary to the Augmented Dickey-

Fuller (ADF) test to test for unit roots in the variables. The Phillip- Peron test deals with structural breaks in the time series. The most desirable element of the Phillip Peron test is that the structural breaks in the time series will be a bias towards acceptance of the null hypothesis of a unit root when the variable is stationary. This could be explained by saying that a sequence of two I (0) and I (1) series when there are treated as all one series with the same mean. Another great quality of the Phillip- Peron test allows the additive outlier type shift is the test simply adds a dummy to the equation.

After satisfying the unit roots condition it goes on to check long run association of the variables through various cointegration tests.

4.3.2.2 Cointegration

There are a number ways that one can use in order to obtain a dynamic model that has "sensible" long run properties. Cointegration helps researchers to deal with estimation problems that arise when the variables of interest have a stochastic trend (Cuthbertson and Gasparo, 1995). As a general rule non- stationary time series variables should not be used in regression models, to avoid the problem of spurious regressions (Hill, Griffiths and Lim, 2012: 488). The cointegration econometric property allows the study to check for any long run association of the variables of interest.

If investment in the model specification $\frac{I_{t+j}}{K_{t+j}}$ and its vector determining variables are both integrated of order 1 [that is, I(1)] then one test for cointegration is that the error terms (Cuthbertson and Gasparo, 1995). Assuming that the investment I_t and a vector of determining variables X_t are both cointegrated of order of 1, then a regression of I_t on X_t is stationary , that is integrated at order zero, I(0) (Cuthbertson and Gasparo, 1995) and the error term μ then;

$$I_t = \phi_I' X_t + \mu \qquad (4.11)$$

Stock (1987) proposed that the ordinary least squares (OLS) have flaws in explain a series with cointegration. Stock (1987) suggested that the OLS yields super consistent parameter estimate of ϕ_I' if the variables are cointegrated but the standard errors are asympotetically biased. Banerjee *et al* (1986) also suggested that the functional form of the above function would produce substantial biases in relatively small samples. To lessen the problem associated with problems of cointegration, the study propose the use of the Engle- Yow (1989) three stage procedure which gives the corrected long run parameter estimate of ϕ_I' and corrected standard errors (Cuthbertson and Gasparo, 1995). The corrected third stage long run parameter generates the corrected residual $\mu_t^*(= I_t - \phi_I' X_t)$ on which the study performs the unit root test for cointegration (Cuthbertson and Gasparo, 1995).

4.3.2.3 General- to Specific approach to co-integration of ARDL

After conducting a stationarity test and in the case where long run relations of interest are trend stationary, the accepted convection in econometrics when one is using a time series analysis is to de- trend the series and to model the de- trended series as stationary distributed lag or autoregressive distributed lag (ARDL) model (Pesaran and Shin, 1997). An alternative and widely used method to establish a valid dynamic model is to use the specific to general approach methodology by Hendry[17] (Cuthbertson and Gasparo, 1995). (Considering the following general simple ARDL (p,q) model:

$$I_t = \alpha_0 + \alpha_1 Q + \sum_{i=1}^{p} \phi_i I_{t-1} + \beta' X_t + \sum_{i=0}^{p-1} \beta_i^{*\prime} \Delta X_{t-1} + \mu_t \quad \text{(4.12a)}$$

$$\Delta X_t = P_1 \Delta X_{t-1} + P_2 \Delta X_{t-2} + \ldots\ldots\ldots\ldots + P_s \Delta X_{t-s} + \varepsilon_t \quad \text{(4.12b)}$$

Where I_t is the level of total investment and $X_t$is the vector of determining variables

4.4 TESTING THE MODEL BEHAVIOR: STABILITY AND OSCILLATIONS

The prime objective of this study so far has been able to test the ability of the structural model to assess the properties of the difference- equation simulated above, and oscillating behavior is very important in the model specified above, in that model is designed to explain the different market phenomena in the model. The structural properties of simulated model of a multi- equation system makes it rather obscure to analyze and evaluate the study will use the reduced form by the Hausman test below to allow a combined equations into a fundamental dynamic model[18] (Pindyck and Rubinfeld, 1998: 415). The oscillations and stability in the model is captured using variance analysis test, and the 3 Stage Least Squares (3SLS) given below.

[17]Developed by Hendry (1983)
[18]Which is given as a single- difference equation (Pindyck and Rubinfeld, 1998)

4.4.1 Analysis of Variance and Quadratic form

The mathematical framework of the model specification contains both fixed and random factors, the study before will have to perform one- way analysis of variance for random effects in the model (Rawling and Pantula, 1998: 591) and the mean square expectations to check for the components of random and systematic factors. This in turn, will assist determining any statistical influence and impact of the independent variables on the dependent variable prior to the econometric estimation. Since the study adopted a nonlinear functional form in the model specification it is important that the conducts a statistical inference on the analysis of variance to determine the volatility (standard deviation), correlation and covariance of variables chosen by the study. It is more so, vital to determine with clear certainty if the study has a quadratic function form in the variable as suggested by the model (Mukherjee, *et al*, 1998). The rational for the analysis of variance is to check whether the idempotent matrix and its trace are of the same to its order indicating the total (uncorrected) sum of squares has degrees of freedom equal to the number of elements in the vector (Rawlings and Pantula, 1998). The frame of variance analysis implemented in this study is basically the analysis of the correlations and the covariance of the variables. Assuming the covariance is given as below:

$$\boldsymbol{Cov}\left(Y_{ij}, Y_{st}\right) = \begin{cases} \delta_\alpha^2 & i = s, j \neq t \\ 0, & i \neq s \end{cases}$$

As suggested by Rawling *et al*, 1998; the one way analysis of variance and the mean square expectation for a random expectation for a random effect model is given by **Table 4.1** below as:

Table 4.1 One way analysis of variance and mean square expectations

<table>
<tr><th>Source</th><th>d.f</th><th>Sum of squares</th><th>Mean Squares</th><th>F for testing $H_0 = \delta_\alpha^2$</th></tr>
<tr><td>Regression (Reg)</td><td>$a = 1$</td><td>$n\sum_{i=1}^{a}(\bar{Y}_i - \bar{Y}_{...})^2$</td><td rowspan="2">$\delta^2 + \delta_\alpha^2$</td><td rowspan="2">MS (Reg)/ MS (Res)</td></tr>
<tr><td>Error (Res)</td><td>$a\ (n = 1)$</td><td>$\sum_{j=1}^{a}(Y_{ij} - \bar{Y}_i)^2$</td></tr>
</table>

4.4.2 Three stage least squares (3SLS)

The representation of economic problems as system of equations has always had strain on credibility however it is paramount that simultaneous equations systems are convenient representation of interdependence, mainly because it more persuasive to think of economic process that solve them as taking time than as working instantaneously (Tobin, 1982). The study implements the three stage least squares (3SLS) as a preliminary testing technique on the contemporaneous relationships among variables (Dia and Caslin, 2009) and the endogineity or exogineity of the error terms in the model. The three stage least squares is an estimation technique developed by Zellner and Theil (1962) on the background that the two stage least squares (2SLS) failed to account for the correlation between various equations in the system. The 3SLS has the advantage that it allows the structural equations to be correctly identified, reduces the problem of misspecification, omission of key variables, irrelevant variables and also it tries to address and eliminate the problem endogineity in the dependent variable of the study. The 2SLS has limited information on the method since it focus on a single equation (Toroj, 2012) and more so the 2SLS results in inefficiency of the results in the equation system. The 3SLS is implied if the structural disturbances that are not diagonal, that is, if the structural disturbances have nonzero contemporaneous co- variances (Zellner and Theil, 1962). The basic idea about the 3SLS is that it makes use of the 2SLS and then adds a third stage to account for the correlations in the disturb errors. The 2SLS is described below:

The 2SLS provides a very useful estimation procedure for obtaining the value of structural parameters in over- identified equations (Pindyck and Rubinfeld, 1998: 349). In estimating parameters and coefficients of a reduced form equation and structural equations researchers often counter problems of determining whether the structural equations are either under identified, exactly identified (just identified) and over- identified equations. Brooks (2008: 270) defined an unidentified equation as a structural equation that has structural coefficients that cannot be obtained from the reduced form estimates by any means. An equation can be said to be exactly identified if the unique structural coefficients estimates can be obtained from the reduced form equation by substitution (Brooks, 2008: 270). A structural equation is over identified when one or more set of structural coefficient can be obtained from the reduced form equation (Brooks, 2008: 270).

Intuitively, 2SLS basically involves two stages; the first stage estimates the reduced form equation using the OLS. This first stage, allows the researcher to construct a variable which is linearly related to the predetermined model variables and which is plunged of any correlation with the error term in structural equation (Pindyck and Rubinfeld, 1998: 350). The second stage, regresses the structural model is estimated by replacing the variable s with the first stage fitted variables (Pindyck and Rubinfeld, 1998: 350). The use of OLS in the second stage will yield a consistent estimator of the parameters (Pindyck and Rubinfeld, 1998: 350). If the additional predetermined variables appeared in the structural equation, 2SLS would also estimate those parameters consistently (Pindyck and Rubinfeld, 1998: 350).

Usually a system of equation often has exogineity of dependent variables, a Hausman test is conducted and it explained below in this chapter.

4.4.2.1 Testing of exogineity and endogineity in the structural equation

Since the study is conducting the 3SLS technique as a preliminary diagnostic tests for variables. More often than not, the 3SLS has a problem of erogeneity (that is, the dependent variables are not endogenous), the study will adopt the Hausman test for exogineity[19].

4.4.2.1 The Hausman test

To determine whether the dependent variables really need to be treated as an endogenous or not, the study performs a Hausman test to check whether the empirical model suggest that there should be a two way relationship between two or more variables. The Hausman is applied for this empirical model as follows:

$$\frac{I_{t+j}}{K_{t+j}} = \alpha_0 + \alpha_1 Q_{t+j} + \alpha_2 \frac{H_{t+j}}{K_{t+j}} + \alpha_3 \frac{P_{t+j}^B}{P_{t+j}^y} + \mu \quad \text{.......} \quad (4.12)$$

$$\frac{H_{t+j}}{K_{t+j}} = \beta_0 + \beta_1 Q_{t+j} + \beta_2 \frac{I_{t+j}}{K_{t+j}} + \beta_3 \frac{P_{t+j}^H}{P_{t+j}^y} + \varepsilon \quad \text{.......} \quad (4.13)$$

If $\mathrm{BINV_t} = \frac{I_{t+j}}{K_{t+j}}$, $HINV_t = \frac{H_{t+j}}{K_{t+j}}$ and $AP_t = \frac{P_{t+j}^H}{P_{t+j}^y}$ then system of equations is given as follows;

$$\mathrm{BINV_t} = \alpha_0 + \alpha_1 Q_n + \alpha_2 HINV_t + \alpha_3 AP_t + \mu \quad \text{.......} \quad (4.14)$$

[19] Justification for the use of the Hausman test is found in the study by Dia and Casalin, (2009). For the application, See Brooks (2008) and Greene (2012)

$$HINV_t = \beta_0 + \beta_1 Q_{t+j} + \beta_2 \mathrm{BINV_t} + \beta_3 AP_t + \varepsilon \text{ .... } (4.15)$$

If preliminary model of the empirical study is given as a function Total Investment (TINV) in the model is defined as:

$$TINV_t = \gamma_0 + \gamma_1 \mathrm{BINV_t} + \gamma_2 HINV_t + \gamma_3 AP_t + \gamma_4 Q_n + \eta_t \text{ .... } (4.16)$$

Assuming that the following equations are exactly indentified system of equations of the model:

$$\mathrm{BINV_t} = \alpha_0 + \alpha_1 HINV_t + \alpha_2 BP_t + \mu \text{ .... } (4.17a)$$

$$HINV_t = \beta_0 + \beta_2 \mathrm{BINV_t} + \varepsilon \text{ .... } (4.17b)$$

To obtain the reduced form equations of the above equations is given above. The reduced form equations of the system of the simultaneous equation are obtained as follows:

$$\mathrm{BINV_t} = \alpha_0 + \alpha_1(\beta_0 + \beta_2 \mathrm{BINV_t} + \varepsilon) + \alpha_2 AP_t + \mu \text{ .... } (4.18)$$

$$\mathrm{BINV_t} = \alpha_0 + \alpha_1(\beta_0) + \alpha_1\beta_2 \mathrm{BINV_t} + \alpha_1\varepsilon) + \alpha_2 AP_t + \mu \text{ .... } (4.19)$$

$$\mathrm{BINV_t}(1 - \alpha_1\beta_1) = (\alpha_0 + \alpha_1\beta_0) + \alpha_1\beta_1 \mathrm{BINV_t} + \alpha_1\varepsilon + \alpha_2 AP_t + \mu \text{ .... } (4.20)$$

$$\mathrm{BINV_t} = \frac{(\alpha_0 + \alpha_1\beta_0)}{(1 - \alpha_1\beta_1)} + \frac{\alpha_2 BP_t}{(1 - \alpha_1\beta_1)} + \frac{\alpha_1\varepsilon + \mu}{(1 - \alpha_1\beta_1)} \text{.. } (4.21)$$

The above equation (4.21) is the reduced form equation for Business Investment (BINV), since there are no endogenous variables on the Right Hand Side (RHS). Substituting in equation (4.16) of TINV for BINV, this gives:

$$TINV_t = \gamma_0 + \gamma_1 \mathrm{BINV_t} + \gamma_2(\beta_0 + \beta_2 \mathrm{BINV_t} + \varepsilon) + \gamma_3 AP_t + \gamma_4 Q_n + \eta_t \text{ .... } (4.22)$$

$$TINV_t = \gamma_0 + \gamma_1 \mathrm{BINV_t} + \gamma_2\beta_0 + \gamma_2\beta_2 \mathrm{BINV_t} + \gamma_2\varepsilon + \gamma_3 AP_t + \gamma_4 Q_n + \eta_t \text{ .... } (4.23)$$

$$TINV_t = (\gamma_0 + \gamma_3\beta_0) + (\gamma_1 + \gamma_3\beta_1)\mathrm{BINV_t} + \gamma_3 AP_t + \gamma_4 Q_n + (\eta_t + \alpha_1\varepsilon) \text{.............. } (4.24)$$

Substituting the above equation (4.24) to find HINV from equation (4.21):

$$TINV_t = (\gamma_0 + \gamma_3\beta_0) + (\gamma_1 + \gamma_3\beta_1)\left(\frac{(\alpha_0 + \alpha_1\beta_0)}{(1 - \alpha_1\beta_1)} + \frac{\alpha_2 BP_t}{(1 - \alpha_1\beta_1)} + \frac{\alpha_1\varepsilon + \mu}{(1 - \alpha_1\beta_1)}\right) + \gamma_3 AP_t + \gamma_4 Q_n + (\eta_t + \alpha_1\varepsilon) \text{ .... } (4.25)$$

$TINV_t =$

$\left(\gamma_0 + \gamma_3\beta_0 + (\gamma_1 + \gamma_3\beta_1)\frac{(\alpha_0+\alpha_1\beta_0)}{(1-\alpha_1\beta_1)}\right) + \left(\frac{(\gamma_1+\gamma_3\beta_1)\alpha_1}{(1-\alpha_1\beta_1)}\alpha_4\right) AP_t + \frac{(\gamma_1+\gamma_3\beta_1)((\alpha_1\varepsilon+\mu))}{(1-\alpha_1\beta_1)} +$

$\alpha_4\ AP_t + \gamma_5 Q_n + (\eta_t + \alpha_1\varepsilon)$ .... (4.26)

$TINV_t = \left(\gamma_0 + \gamma_3\beta_0 + (\gamma_1 + \gamma_3\beta_1)\frac{(\alpha_0+\alpha_1\beta_0)}{(1-\alpha_1\beta_1)}\right) + \left(\frac{(\gamma_1+\gamma_3\beta_1)\alpha_1}{(1-\alpha_1\beta_1)} + \gamma_4\right) AP_t + \gamma_5 Q_n +$

$(\frac{(\gamma_1+\gamma_3\beta_1)(\alpha_1\varepsilon+\mu)}{(1-\alpha_1\beta_1)}) + (\eta_t + \alpha_1\varepsilon))$ .... (4.27)

Equation (4.26) gives the reduced form for TINV. Finally the reduced form of HINV can be obtained by substituting for BINV as given below:

$HINV_t = \beta_0 + \frac{\beta_1(\alpha_0+\alpha_1\beta_0)}{(1-\alpha_1\beta_1)} + \frac{\alpha_2\beta_1\ AP_t}{(1-\alpha_1\beta_1)} + (\frac{\beta_1(\alpha_1\varepsilon+\mu)}{(1-\alpha_1\beta_1)} + \varepsilon)$ .... (4.29)

These three equations can be expressed in terms of π_{ij} and the structural equations can be given as:

$TINV_t = \pi_{10} + \pi_{11}\mathrm{AP_t} + \pi_{12}Q_n + v_1$.. (4.30)

$BINV_t = \pi_{20} + \pi_{21}\mathrm{AP_t} + v_2$... (4.31)

$HINV_t = \pi_{30} + \pi_{31}\mathrm{AP_t} + v_3$... (4.32)

The Hausman test suggest that the reduced equations must be run using OLS to obtain the fitted values of $\widehat{TINV}, \widehat{BINV}, \widehat{HINV}$. The next step in the Hausman test is to regress the corresponding structural equation using OLS and forgetting the problem of simultaneity (Brooks, 2008: 275). The final stage of this procedure is to use the F test to test that the restrictionsβ_2 *and* $\beta_3 = 0$. The rule of thumb is that if the null hypothesis is rejected then BINV and HINV should be treated as endogenous. If the β_2 *and* $\beta_3$are significantly different from zero, there is extra important information for modelling TINV from the reduced form equations (Brooks, 2008: 275). Alternatively, if the null hypothesis is not rejected then BINV and HINV can be treated as exogenous for TINV, and there is no useful additional information available for TINV from modelling BINV and HINV as endogenous (Brooks, 2008: 275).

4.5 TESTING MODEL BEHAVIOR: MULTIPLIER AND DYNAMIC RESPONSE

Since the investment market in the model build up is to predict how a change in one variable is likely to affect other variable over time, it is imperative that the study makes a fundamental analysis on the dynamic response of the model and be able to quantify the response by being able to calculate and examine the multipliers associated with the original model's exogenous variable (Pindyck and Rubinfeld, 1998: 429).

4.5.1 Auto- Regressive Distributed lag (ARDL) Model

In order to test both the theoretical as well as the empirical underpinnings of the study; the study uses an Autoregressive distributed lag model. The ARDL model enables the study to test the dynamic econometric analysis of the long run relations of the variables in the model. The ARDL are dynamic models that consist of distributed lag models and autoregressive models. The study adopted the ARDL model for a number of reasons such as that since investment portrays the time path of the dependent variables (that is, investment) relation to its past variables (Gujarati, 2004). The incorporation of the distributed lag model in the study is the increased importance of lags in econometric models. These lags may arise from both technological and institutional factors as a way of an example, suppose the price of capital relative to investment or adjustment cost, thus making investment feasible (Greene, 2012). If a drop in price of capital is expected to be temporary, firms may not rush to substitute capital or investments (Gujarati, 2004). Some institutional factors that might affect business and housing investment are contractual obligations that may prevent firms from switching from one source of capital or raw materials to another (Gujarati, 2004). The study then performs most of its analysis making use of Auto-Regressive Distributed Lagged (ARDL) techniques; ARs, in fact, have two major advantages. First, all the variables can be treated as endogenous. Second, it becomes possible, under certain conditions, to model at the same time both stationary and non-stationary series.

The study employs the ARDL to capture the different fundamental parts to the dynamic model. The econometric estimation uses the general to specific ARDL technique.

4.5.1.1 The General to specific ARDL Approach

If the investment behavior is imbedded in behavior in capital, in turn, which given as stock, then the relationship between actual investment and the changes in capital services uses can be shown through the decision making by the agents in both of these markets. Given that capital and investment expenditures require time to completion then the study assumes that there is no lag between the claim of old investment goods and the purchase of new investment.

After a preliminary test of exogeneity and endogenity in the structural system of equations, the model then implements a general- to- specific ARDL model to empirically test under the assumption that BINV and HINV are endogenous while the Q in the Tobin Q is treated as exogenous for investment, thus housing and business asset markets directly affect aggregate investment

$$I_t = \alpha_0 + \alpha_1 Q + \sum_{i=1}^{p} \phi_i I_{t-1} + \beta' X_t + \sum_{i=0}^{p-1} \beta_i^{*\prime} \Delta X_{t-1} + \mu_t \text{.......................................} (4.20)$$

Where I_t is the level of total investment and $X_t$is the vector of determining variables, thus the study will estimate the General- to- Specific (*Gets*) ARDL model specified below:

$$TINV = \alpha_0 + \alpha_1 TNV_{t-1} + \alpha_2 BINV_{t-1} + \alpha_3 HINV_{t-I} + \alpha_4 Q_{t-1} + \alpha_5 AP_{t-1} + \varepsilon_t \text{ .... } (4.21)$$

As revealed throughout this thesis, the Q is delineated as the portion of the market valuation of capital assets to their replacement costs (Faria *et al,* 2012) the following study variables are constructed to test empirically the model:

TINV: the gross private investment in South Africa is given as an instrumental value; of the Gross Domestic Fixed Investment (GDFI) to avoid the problem of endogenity and spurious regressions as highlighted by chapter 2 of this study.

BINV: is the variable representing net private business investment given in the model specification as the ratio of the level of investment indexed to productive capital stock $\frac{I_t}{K_t}$ in period t were t is the time frame of the study.

HINV: is the net private housing investment given as the level of housing investment indexed to the productive capital in the economy $\frac{H_t}{K_t}$ in the period t.

AP: is the variable representing the adjusted prices given as the ratio of housing prices and business prices $\frac{P_t^H}{P_t^y}$. Where P_t^H andP_t^y are the housing prices and business prices respectively in the economy.

Q: is Tobin’s average Q to explain the business and housing investment. Q ratio is given as defined by the mathematical modeling as the ratio of the market value to its replacement cost.

The main advantage of this (nonlinear) parameterization is that it gets direct estimates of the long run and short- run parameters (Cuthbertson and Gasparo, 1995). The model can then easily be estimated recursively to examine parameter stability and statistical significance of the long run and short run parameters (Cuthbertson and Gasparo, 1995). The major disadvantage of this approach (*Gets* approach) is that it is possible to get the absence of a cointegrating vector implicit in the set of variables in the ARDL and hence in the final the study tends to perform final parsimonious error correction model (ECM) (Cuthbertson and Gasparo, 1995).

4.5.1.1.1 Advantages of the General to specific (*Gets*) ARDL

Aggregation entails that no loss of information, since the study in the model specification has a marginalized the parameters with respect to disaggregates from the investment markets was retained and has therefore retained the set of statistical information for the error term as suggested by Hendry (2000). Data partition allows the simulation to form a basis on which decisions about which variables to omit or to include, which is the most fundamental of determinant of the success or failure of any empirical modeling. Parameter constancy, implicitly relates to invariance as constancy across interventions which affect the marginal process (Hendry, 2000).

4.5.1.1.2 Limits of the *Gets* model

The main problem with *Gets* model just like any other structural multivariate estimation, is the problem of the goal of fitting a parsimonious model which is in most cases over-parameterized model and the possibility of inclusion of large but significant coefficients which in turn add variability to the model forecast (Enders, 1995: 291). The other problem with the *Gets* model is that in some cases can have no feedback effect. To combat these estimation issues the study will implement other estimation techniques to help in the minimizing of the limitations above.

4.5.1 Error Correction Model (ECM)

After conducting the *gets* ARDL methodology the study finally conducts the ECM technique for a number of reasons. To approximate the parameters of the Auto regressive distributed lag for the model an error term must be added to the final form of the ARDL technique. Since the

ARDL does not take into account the absence of a cointegrating vectors in the set of variables. To insure a stable and dynamic complete long run model the study employees the ECM model. The ECM model is a very popular econometric modeling technique because it allows the regression equation to test for underlying or fundamental link between variables (in vernacular, the long run relationship) as well as the short run adjustments or the rate of change in the model (Hill *et al*, 2012:49). Cointegration implies that y_t and x_t share similar stochastic trends and since the difference e_t is stationary, there never diverges too far from each other (Hill *et al*, 2012: 488). For simplicity, in the above model the following model:

$$DTINV = \beta_1 + \beta_2 DHINV + \beta_3 DBINV + \beta_4 DAP + \beta_5 DQ + \varepsilon \text{ .... (4.22)}$$

The ECM model has a number of favorable characteristics that impelled the study to use it for instance; the ECM is a convenient model for measuring the correction from disequilibrium of the previous period in which this has a very good economic implication (Asteriou and Hall, 2007: 311). More so, the ECM has the benefit that if the variables in question have cointegration ECMs are formulated in terms of first order of differences which in turn eliminates trends from variables involved, hence the problem of spurious regression is restricted (Asteriou and Hall, 2007: 311). Furthermore, ECM is an easy method that one can fit with the general- to- specific approach to economic modeling. Finally, the disequilibrium error term is a stationary variable this implies that there is some adjustment process in the error term (Asteriou and Hall, 2007: 311).

4.6 DIAGNOSTIC TESTS

A significant role for hypothesis testing in econometrics involves diagnostic checking (King, Zhang and Akran, 2007). To test the model constructed in the earlier section of this chapter, the study adopts a typical test procedure involves the use of a test statistic and critical values in order to control the probability of wrongly rejecting the null hypothesis (King, *et al*, 2007). The study acknowledge the major problem of any econometric procedure on how best to control the overall probability of rejecting the model when its true and multiple test statistics are used. The study adopts various diagnostic test on the coefficient, residual and stability diagnostics on the model as well as to test endogeinty on the error term in the simultaneous equations. The proposed testing procedure of applied econometric tests is applied to test for serial correlation in an observed time series, for normality, and significance of coefficient in a dynamic regression model (King, *et al*, 2007).

4.6.1 Testing the significance of serial correlations

Gujarati (2004) defined autocorrelation or serial correlation as the correlation between members of series of observation in time. In other terms correlation is the observed relationship that exists between the disturbance terms in relation to any observed parameter in the model. The presents of autocorrelation can be shown as $cov\left(\mu_i, \mu_j\right) \neq 0$ for all $i \neq j$. In empirical literature, a frequently encountered problem is to test the null hypothesis that a time series is white noise, (King, *et al*, 2007). That is to say the first level differenced serial correlation of a time series are zero. Basic econometric procedures such as the use of lagged values of variables in the regression though the constructing a series of lagged values and first differences. The process of lagged values can be constructed by shifting all the observation one period in a spreadsheet (Brooks, 2008: 143). Another popular but not formal way to test correlation is the use of the graphical exploration of the sample error term and the plotted error term of the previous period over time.

4.6.1.1 The Portmanteu test

This is a relatively important diagnostic test in the General to specific (Gets) ARDL analysis since the test allows both the test for fit as well as the test if the residuals in the model are white noise or to check if there are any serial correlations. The Portmanteu model was first proposed by Box and Pierce and was later modified as the Ljuing- Box statistic, Li McLeod's Q and finally as Monti's Q. The first proposal was given as below:

$$Q_{BP} = n\sum_{k=1}^{m}\hat{r}_k^2$$

Where $\hat{r}_k^2$ is the sample correlation of order k of the residual. While Q_{BP} is the distributed x^2 with (m-n-p) degrees of freedom. The null hypothesis is set at no serial autocorrelation, if the autocorrelations are very small; the portmateau test shows that the model does exhibit lack of fit.

4.6.1.2The Durbin- Watson test

Using the graphical exposition can be difficult to interpret and to complement these informal procedures the study adopts several formal procedures to dictate the presence of autocorrelation. The first way to test for serial correlation the study adopts the Durbin-Watson (DW) test. The DW technique is a test used to test for first order autocorrelation- that is, the DW test only test for any relationship between an error and its immediately previous values (Brooks, 2008:144). To test for serial correlation under the DW test, the null hypothesis, the error s at time t-1 and t are independent of one independent of one another (Brooks 2008:144). if this null hypothesis is to be rejected. Then the study can conclude that there is evidence of a relationship between successive residuals. The DW test is given as follows:

$$DW = \frac{\sum_{t=2}^{T}(\hat{\mu}_t - \hat{\mu}_{t-1})}{\sum_{t=2}^{T}\hat{\mu}_t^{\,2}} \quad \text{.......} (4.23)$$

The rule of thumb of the DW test must be limited to $0 < DW < 4$. The null hypothesis would not be rejected if the DW is near 2 this means that the data has little evidence of autocorrelation in the residuals. If the DW is equal to 0, then the data shows a positive autocorrelation in residuals and DW of 4 shows a negative autocorrelation in residuals.

4.6.1.3 The Breusch- Godfrey Test

Since the DW test rest on many restrictive assumptions such as that; for DW test to be effectively applied the regression must have a constant and the regressors must be stochastic, furthermore, there must be no lags of dependent variable (Brooks, 2008:145). The study performs a Breusch- Godfrey test for serial correlation, the Breusch- Godfrey test is more general approach to test for autocorrelation and it test to the r *th* order. It is also referred to as the Langrange Multiplier (LM) test[20]. The Breusch- Godfrey test involves basically three stages; the first stage requires the study to estimate the linear regression using OLS and obtain the residual of the error term $\hat{\mu}_t$ (Brooks, 2008: 149). The next stage requires the study to regress the residual $\hat{\mu}_t$ on all of the regressors, thus giving:

$$\hat{\mu}_t = \gamma_1 + \gamma_2 x_{2t} + \gamma_3 x_{3t} + \rho_1\hat{\mu}_{t-1} + \rho_2\hat{\mu}_{t-2} + \rho_3\hat{\mu}_{t-3} + \ldots + \rho_r\hat{\mu}_{t-r} + \mu, \varepsilon \sim N(0, \delta^2)$$

[20] See Gujarati, 2004:473

To obtain the R- squared from the auxiliary regression (Brooks, 2008: 149).The final stage of the Breusch- Godfrey test is to let T denote the number of observations, and then the test statistic of the Breusch- Godfrey test is then given as:

$(T-r)R^2 \sim \mathcal{X}^2 r$ .... (4.24)

With the Breusch- Godfrey test, unlike the DW test, only one part of the null hypothesis of no autocorrelation has to be rejected to lead to the rejection of the hypothesis as a whole (Brooks, 2008:149).

4.6.1.4 The Cochrane- Orcutt procedure of correcting serial correlation

Auto correlation has serious implication on the data since it gives inefficient parameters in dynamic econometrics models. In the case of any serious autocorrelation in the regression the study will conduct a Cochrane- Orcutt test to remedy any serial correlation. The procedure involves running the residual obtained from the OLS to obtain a more efficient residual given as;$\hat{\mu}_t = \rho_r \hat{\mu}_{t-r} + \varepsilon_t$ the next process is to obtain $\hat{\rho}_t$ and construct y^* using the value of $\hat{\rho}_t$ and run the Generalized Least Squares (GLS) regression (Brooks, 2008: 151).

4.6.2 Testing for Normality

Empirical findings have shown that many researchers have often assumed random variables to be normally distributed. Therefore, this study acknowledges that testing for normality is a vital issue. The study will conduct a Jarque- Bera test as well as the modified version of the Jarque- Bera (MJB).

4.6.2.1 Jarque- Bera (JB) test

The Jarque- Bera test has been used by many researchers to check for normality in the regression analysis. The assumption that the sample must the error term is normality distributed thus $\mu_t \sim N(0, \delta^2)$ is essential in order to apply as well as conduct a single or joint hypothesis(Brooks, 2008: 161).

The Jarque – Bera test combines information from the skewness. Kurtosis generally given as $\sqrt{b_1}$ and b_1 respectively(King, Zhang andAkran, 2007); the simplest construction of the Jarque- Bera is given as:

$$JB = T[\frac{(\sqrt{b_1} + b_1)^2}{6} + \frac{(b_1 - 3)^2}{24}] \quad (4.25)$$

The Kurtosis for a normally distributed regression should be equal to three and the residual should be symmetric about the mean. The coefficient of skewness and the coefficient of excess Kurtosis must be jointly zero (Brooks, 2008: 163). The null hypothesis is of normality, and this could be rejected if the residuals from the model were either significantly skewed or leptokurtic/ platykurtic (or both) (Brooks, 2008: 163).

4.6.2.2 Modified Jarque- Bera (MJB) test

Urzua (1996) in King, Zhang andAkran (2007) proposed the modified Jarque- Bera given as:

$$MJB = T[\frac{(\sqrt{b_1})^2}{Var(\sqrt{b_1})} + \frac{(b_2 - E(b_2))^2}{Var(b_2)}] \quad (4.26)$$

This procedure is almost similar to the JB test but instead of constructing a test statistic of skweness and kurtosis the MJB is a testing procedure that is focused on estimating the joint density of the skewness and kurtosis measures through the montecarlo simulations(King, Zhang andAkran, 2007). The criteria for rejection of the MJB test is when the null hypothesis of the probability of values of rejecting thenull hypothesis can be approximated the relative frequencies of the m- bivarate vectors of skewness and kurtosis obtained in the MJB test.

4.6.3Testing for significance of regression coefficients

It is imperative that the study explores the statistical properties of the model. It is a common practice that the study conducts various test statics of the coefficients.

4.6.3.1 Test statistics

Since the study uses the ARDL model to test the parameters. One of the conventional tests for the significance of the regression coefficient in an AR *(d)* model is the conducted through the F- static (King, Zhang andAkran, 2007), given by:

$$F = \frac{SRR/d}{SSE/(n-d-1)} \quad (4.27)$$

Where SSR is the sum of squares due to the regression and SSE is the sum of squared residuals.

4.6.4 Testing for Heteroscedasticity

In order to get consistent standard errors, the study will need to get a model that is dynamically complete. Essentially, this means that the model has to have white noise error. It is imperative that the study conducts tests for the presence of heterodasticity in the tested variables. To dictate heteroscedasticity the study adopts various techniques of dictating as well as for correcting this heteroscedasticty. The following tests are considered in this study.

4.6.4.1 Glesjer Test

The Glesjer test is one of the earliest as well as the simplest proposed technique for dictating heteroscedasticity. The Glesjer test regress the absolute values of $\widehat{\mu}_i$ on the X variables that are thought to be closely associated with δ_i^2 (Gujarati, 2004: 405). A classical example of the Glesjer methodology is given by:

$|\widehat{\mu}_i| = \beta_1 + \beta_2 X_i + v_i$ .... (4.28)

Where v_i is the error term, however, the study notes that this technique has been heavily criticized for being too simple and GoldfeldandQuandt suggested that the error term v_i have the problem in that its expected value is a nonzero. The study will adopt other techniques to compliment the Glesjer test.

4.6.4.2 Goldfeld- Quandt Test

This is a relatively popular test for heteroscedasticity, the test basically is a three stage procedure. The Goldfeld- Quandt test assumes that the variance δ_i^2 is proportional to the square of the X variable (Gujarati, 2004: 406). If given a simple regression equation below:

$Y_i = \beta_1 + \beta_2 X_i + v_i$ .... (4.29)

Suppose δ_i^2 is positively related to X_i as;

$\delta_i^2 = \delta^2 X_i$ .... (4.30)

Where δ^2 is a constant, the above assumption suggest that δ_i^2 is propositional to the square of the X variable. The Goldfeld- Quandt test postulate that δ_i^2 is larger as the value of X becomes large. If that turns out to be the case, heteroscedasticity is likely to be present (Gujarati, 2004: 406).

4.6.4.3 Breusch- Pagan- Godfrey (BPG) test

Despite the success of theGoldfeld- Quandt test in terms of empirical studies. The Goldfeld-Quandt test depended on the value of the intercept but also it indentifies the correct X variable with which to order the observations (Gujarati, 2004: 411). The basic idea behind the BPG test is given as follows; consider the k- variable linear regression (Gujarati, 2004: 411):

$Y_i = \beta_1 + \beta_2 X_{2i} + \cdots \dots \dots . + \beta_k X_{ki} + u_i$ .... (4.31)

Assume that the error variance δ_i^2 is described (Gujarati, 2004: 411) as:

$\delta_i^2 = f\ (\alpha_1 + \alpha_2 Z_{2i} + \dots + \alpha_m Z_{mi})$.. (4.32)

That is, δ_i^2 is some function of the non- stochastic variableZ_i's, some or all of the X's can serve as Z's, (Gujarati, 2004: 411) specifically:

$\delta_i^2 = \alpha_1 + \alpha_2 Z_{2i} + \dots + \alpha_m Z_{mi}$.. (4.33)

Assume that δ_i^2 is some function of Z's. If $\alpha_1 = \alpha_2 = \alpha_m = 0$, $\delta_i^2 = \alpha_i$, which is a constant; One can test the hypothesis $\alpha_1 = \alpha_2 = \alpha_m = 0$ using the BPG test (Gujarati, 2004: 411).

4.6.4.4 White's General Heteroscedasticity Test

The main advantage of the white's test does not rely on the normality assumption and is easy to use. Assuming that the following standard regression model is estimated (Gujarati, 2004: 413):

$Y_i = \beta_1 + \beta_2 X_2 + \beta_3 X_3 + u_i$ .... (4.34)

The White's test suggestsrunning the following auxiliary regression (Brooks, 2008: 135):

$\widehat{\mu}_i{}^2 = \alpha_1 + \alpha_2 x_{2i} + \alpha_3 x_{3i}{}^2 + \alpha_4 x_{4i}{}^2 + v_i$ .... (4.35)

The test is one of the joint null hypothesis that $\alpha_1 = 0$ and $\alpha_2 = 0$ and $\alpha_3 = 0$ and$\alpha_4 = 0$. For the LM test, if the $\mathcal{X}^2$- test is greater than the corresponding value in the statistical tables then reject the null hypothesis that the errors are homoscedastic (Brooks, 2008: 135).

4.7 Concluding Remarks

This chapter examined both the model specification as well as the economic framework that the model is going to apply in an attempt to expose empirically the relationship within the variables of interest. The various mathematical and econometric exposition reviewed in this chapter will assist in the exploration of the statistical and econometric patterns of the variables of interest and hypothesis testing. Both the ARDL and the error correction techniques will allow the econometric inception of the Q theory. The chapter sets a background to the estimation and presentation of results of the study given in the subsequent chapter.

CHAPTER 5

PRESENTATION OF EMPIRICAL FINDINGS

5.0 Introduction

The preceding chapter exposed the model estimation techniques to be used in this study. This chapter augments and gives the empirical analysis of the tested results. The study applied the ARDL framework and its analytical techniques proposed on the annual South African data covering the period 1960 to 2010. The data was computed using different statistical and econometric analysis software, basically eviews 7, and Stata 12 for better and reliable output, depending on the different level econometric technique that is required and necessitated to be captured by the study. The first section of the chapter will look at the elements of stationarity and co integration in the variables of interest, followed by the estimation results of the model behavior in terms of model stability and oscillations as the preliminary test of endogenity. The subsequent section of this chapter reports the results of model multipliers and dynamic response of the working empirical model together with the results of necessary diagnostic tests of the model.

5.1 Unit roots/ Stationarity Results

To avoid spurious regression and since the study uses a ARDL modeling technique which necessitates stationarity (Koop, 2000: 149) therefore the study requires a stationary time series analysis. This section explores both the graphical exposition and a formal analysis of each and every variable in the data to check for stationarity. Figure 5.1 below shows the graphical exposition of the variables at default. The variables of the annual data from 1960-2010, show that TINV and BINV are stationary variables at default, although AP, HINV and Q are not stationary at level. Figure 5.2 shows that all the variables are stationary at first level.

Figure 5.1 before Differencing

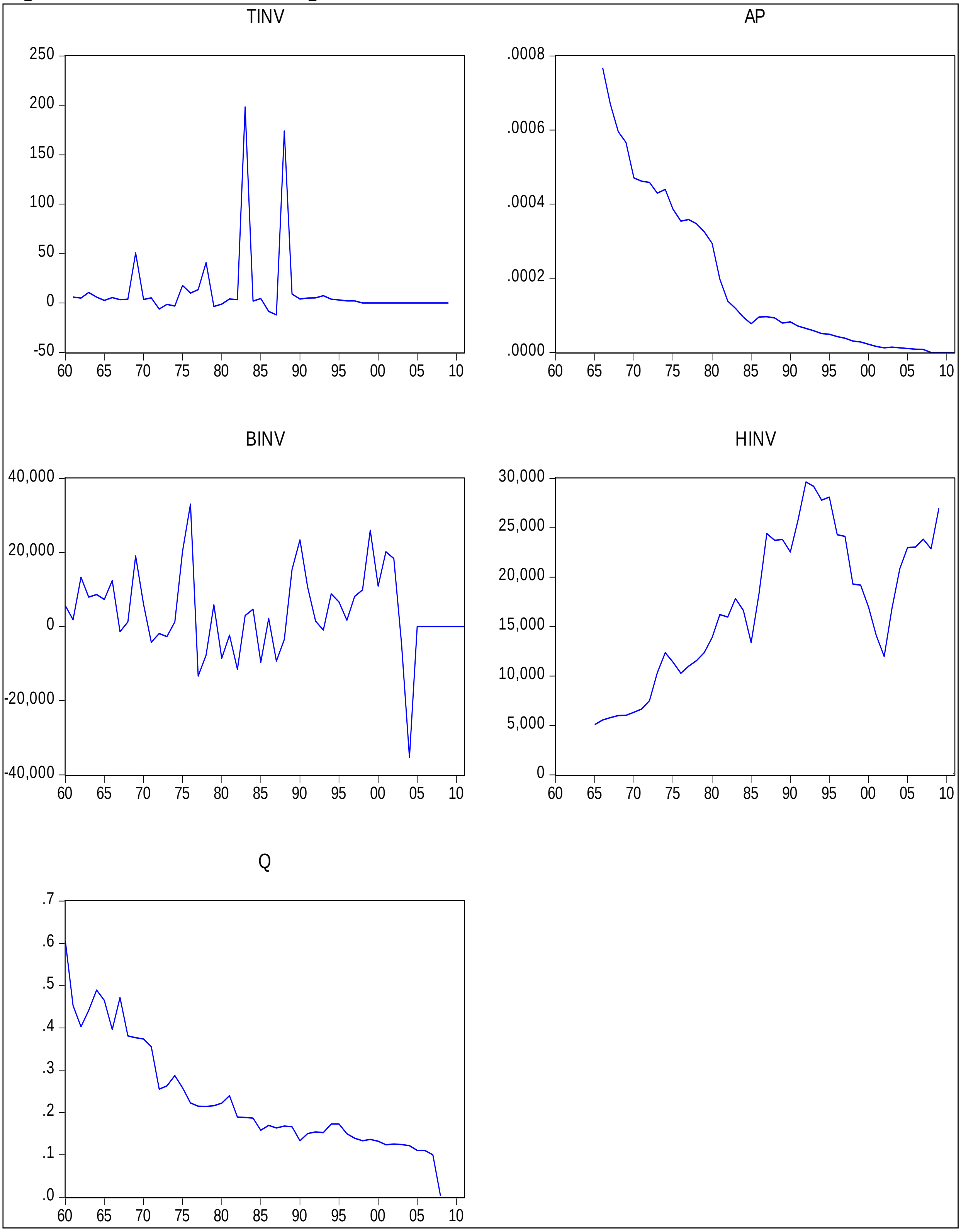
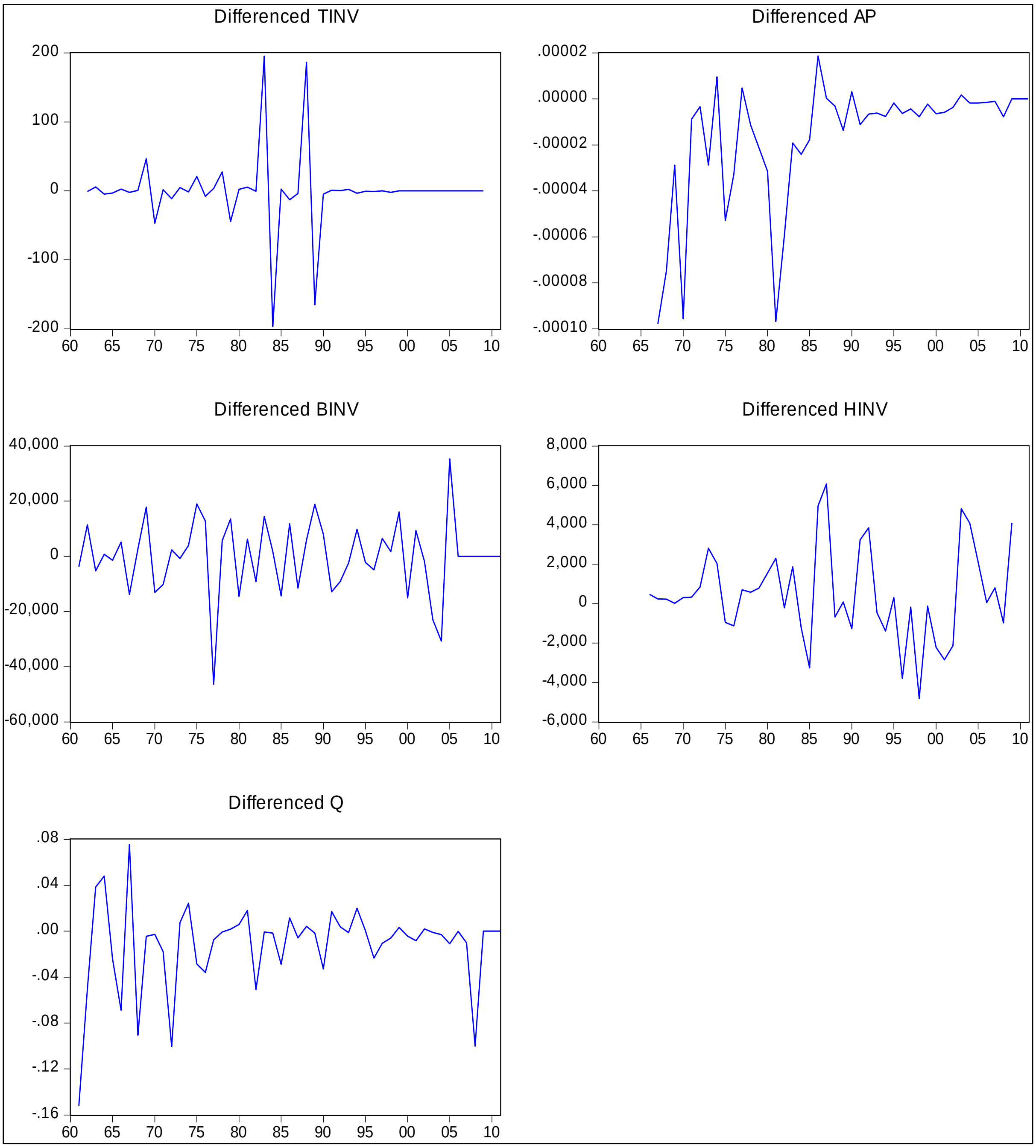


Figure 5.14 after Differencing



The study performs a more formal analysis of stationarity using both the Augmented Dickey-Fuller (ADF) test and the Phillip- Peron (PP) test as a compliment to the graphical representations given in Figure 5.1 and Figure 5.2 above. The results of the Augmented Dickey- Fuller test are shown in Table 5.1 below:

Table 5.1 Results of the Augmented Dickey- Fuller Unit Root Test

Augmented Dickey- Fuller Test						
Level				**First Difference**		
Variables	Constant	Trend and Constant	None	Constant	Trend and Constant	None
DTINV	-7.276179*	-7.249060*	-1.437145*	-9.766281*	-9.696666*	-9.889024*
DBINV	-5.167815*	-5.157125*	-4.829637*	-8.045755*	-7.955903*	-8.128443*
DHINV	-1.241387	-1.665570	0.782544	-4.999056*	-4.922240*	-4.862568*
DAP	-3.201001	-1.891112	-3.904090*	-4.736234*	-5.543542*	-4.212546*
DQ	-2.529351	-4.191240*	-3.323333*	-9.071331*	-8.940723*	-8.535418*
CV (5%)	-2.919952	-3.500495	-1.947381	-2.919952	-3.500495	-1.947381
CV (1%)	-3.565430	-4.148465	-2.611094	-3.565430	-4.148465	-2.611094

Notes

(1) The null hypothesis, H0 = Variables have a unit root.

(2) *, and ** represent a stationary variable at 1% and 5% level respectively.

(3) The critical values are obtained from MacKinnon (1996) one-sided p-value.

(4) The appropriate lag lengths are selected by Akaike information Criteria and E-views program automatically selected the appropriate lag length.

(5) CV stands for Critical Values

Table 5.1 shows that DTINV and DBINV are stationary both at level and first difference at both 5% and 1% critical values. DHIV was non- stationary at level and showed a drift and random walk at level, however the variable was stationary after differencing at first level and was stationary at trend, and at trend and constant. DAP was stationary at none showing that the variable had a random walk at level showing a deterministic trend however, after differencing the variable showed a stochastic trend and was stationary at trend, trend and constant and at none. DQ was non- stationary at trend but it was stationary at trend and constant as well as at none. After differencing at first difference DQ showed a stochastic trend and the variable was stationary.

Table 5.2 Results of the Phillip- Peron Unit Root Test

Phillip- Peron Test Results						
Level				**First Difference**		
Variables	Constant	Trend and Constant	None	Constant	Trend and Constant	None
DTINV	-7.31325*	-7.26321*	-6.68015*	-28.56453*	-29.4934*	-28.93068*
DBINV	-5.08430*	-5.06907*	-4.87232*	-28.13252*	-28.2868*	-28.25909*
DHINV	-1.338395	-1.665570	0.627585	-4.884535*	-4.795827*	-4.777543*
DAP	-5.03574*	-2.849096	-6.87735*	-4.713270*	-5.52811*	-4.187484*
DQ	-2.682600	-4.20230*	-4.50968*	-10.63441*	-10.4874*	-9.067313*
CV (5%)	-2.919952	-4.148465	-1.947381	-2.921175	-3.502373	-1.947520
CV (1%)	-3.565430	-3.500495	-2.611094	-3.568308	-4.152511	-2.612033

Notes

(1) The null hypothesis, H0 = Variables have a unit root.

(2) *and ** represent a stationary variable at 1% and 5% level respectively.

(3) The critical values are obtained from MacKinnon (1996) one-sided p-value.

(4) The appropriate lag lengths are selected by Akaike information Criteria and Eviews programme automatically selected the appropriate lag length.

(5) CV stands for Critical Values

The Phillip- Peron (PP) test showed similar results to the Augmented Dickey- Fuller test. Table 5.2 above showed that both DTINV and DBINV were stationary at level. However, DHINV, DAP, and DQ were non- stationary at level but were stationary at first differenced thereby complementing both the results of the Augmented Dickey- Fuller test and the graphical representations above.

5.2 Results using the ARDL Approach to Co- integration

The study tested co integration among the variable to substantiate for any long run association. This was conducted through the ARDL approach to co integration. The regression conferred the following results:

Table 5.3 Results of the ARDL Approach to Co- integration

Variable	Constant	@TREND	BINV	HINV	AP	Q
Coefficient	-2.664086	- 5.257527	- 7.0004	- 4.0049	- 7.0049	-10.0049
Error	*0.311*	*1.4075*	*1.4725*	*1.00083*	*-0.6377*	*2.606046*
t- statistic	-8.56617	-3.73536	-4.75409	-4.00158	10.98467	-3.83912

The given that both the trend and constant in the regression equation were statistically significant in the model, the study included the trend element as well as the constant element. The ARDL (1,1) tested the long run parameters of the model to check for any long run dynamics in the model and the study showed long run parameters in TINV, and BINV, were statistically significant at 5%. Table 5.3 above showed that HINV, AP, and Q do not have any long run association with TINV. The study went on to perform a Wald test for independency in the coefficients of TINV, BINV, HINV, AP and Q. Thus, assuming that the coefficients are equal to zero and the results showed that the Wald test had a *p*- value of 1.62% which is below 5%. The study rejected the null hypothesis and concluded that the coefficients are not equal to zero. Using the Pesaran and Pesaran (1997) tables, the F critic was equal to 4 which was above the F value of 3.737 in the Wald test and concluded that atleast two co -integrating equations are possible in the model.

5.3 RESULTS OF THE MODEL BEHAVIOR: STABILITY AND OSCILLATIONS

A pre- analysis of variance was conducted by the study to ascertain the distribution of the variable to allow a correct estimation technique, to achieve this; the study implemented a simple multivariate analysis to check the dispersion and volatility of each variable in question. The results from the estimation are given as **Table 5.4** and **Table 5.5** below:

Table 5.4 Results of analysis of means, standard deviation, correlation and covariance

Variable	Mean	S.D	Correlations				
			1	2	3	4	5
TINV (1)	12.557	36.781	1				
BINV (2)	7091.17	17554.279	-0.058	1			
HINV (3)	17370.29	10838.49	0.032	0.092	1		
AP (4)	0.00	0.01	-0.037	0.004	-0.124	1	
Q (5)	0.23	0.13	-0.041	-0.112	-0.420	0.4490	1
N = 56 for all variables							

Table 5.4 gives the means, standard deviations and the correlation of the variables of interest, the results shows that BINV and HINV have a higher means and standard deviation this is attributed to the GFC deflators used to compute the variables, while TINV, AP and Q have a lower means and the standard deviations, particularly the adjusted prices since the prices tend to diverge with the replacement cost in the long run. In order to examine the influence of each variable on the other the study thus performed a correlation test given by the correlation matrix above. The correlation matrix shows that most of the data to weakly correlated with the exception of $r_{\mathrm{Q,AP}}$ and $r_{\mathrm{Q,HINV}}$ this may, perhaps be because of the fact that Q is particularly important in the Residential and asserting prices in each market. The correlation matrix also shows that multicollinearity is not a problem in this analysis. The covariance in the variables is as below:

Table 5.5 Covariance Matrix

	TINV	*BINV*	*HINV*	*AP*	*Q*
TINV	1326.34				
BINV	-36468.44	302110506.3			
HINV	12341.25	17158771.62	115169396.1		
AP	-0.0070	0.3813	-6.937	2.71E-05	
Q	-0.185	-242.95	-562.552	0.000292	0.0156

The results of the analysis of variance given in Table 5.5 shows that both the residual has a more variance in the model than that given by the regression analysis, the results are shown below:

Table 5.6 Analysis of variance summary for regression analysis

Source of variation	*Df*	*SS*	*MS*	*F*	*Significance F*
Regression	4	425.14619	106.286	0.072735	0.9900542
Residual	46	67218.386	1461.269		
Total	50	67643.532			

5.3.1 The 3 Stage Least Squares

The study implements a preliminary assessment of any contemporaneous relationship among the tested variables in the model. The preliminary test is conducted by a means of a Three Stage Least (3SLS) to test for any endogeinty in the variables before applying the *Gets* ARDL technique. To check for any endogeinty in the variables, the study used the lags of BINV and HIV to avoid endogeinty with the explanatory variable TINV. Table 5.7 below shows the results of the 3SLS test results conducted and the results showed that Table 5.7

Table 5.7 Results of the 3SLS of Simultaneous Equations

TINV = BINV + HINV + AP + Q			
	Coefficient	t- statistic	Probability
C(1)	7817.338	2.813414	0.0061
C (2)	-22184535	-2.718462	0.0080
C(3)	-160.1677	-0.009098	0.9928
C(4)	21550.43	9.764757	0.0000
BINV = C(1) + C(2)*AP + C(3)*Q			
R-squared			0.186737
Adjusted R-squared			0.244626
S.E. of regression			13460.23
Durbin-Watson stat			1.202747
HINV = C(4) + C(2)*AP + C(3)*Q			
R-squared			0.650297
Adjusted R-Squared			0.633238
S.E. of regression			4412.137
Durbin-Watson stat			1.333920

The results showed that BINV, HINV and AP are all statistically significant at 5% in any of the two regressions. This shows that we accept the null hypothesis and reject the alternative and conclude that the variables are endogenously determined. The Hausman test suggested that there is no evidence of simultaneity for any of the endogenous variables. The Q coefficient shows that Q is in actually exogenously determined in the model even if the study employees lagged values of the BINV and HINV as instruments. The 3 stage least squares satisfies both the objective and problem statement of the study.

The 3SLS technique was subject to some diagnostics to check on the accuracy of the test for endogeinty in this model. The study conducted a Ljung- Box Q test or the residual Portmanteu test for autocorrelation in the model and the results are given by the **Table 5.8** below, Both the Q- stat and the Adjusted Q- statistic had a p- value equal to zero suggesting that the study should accept the null of no autocorrelation in group statistic and conclude that the group residuals are different from zero.

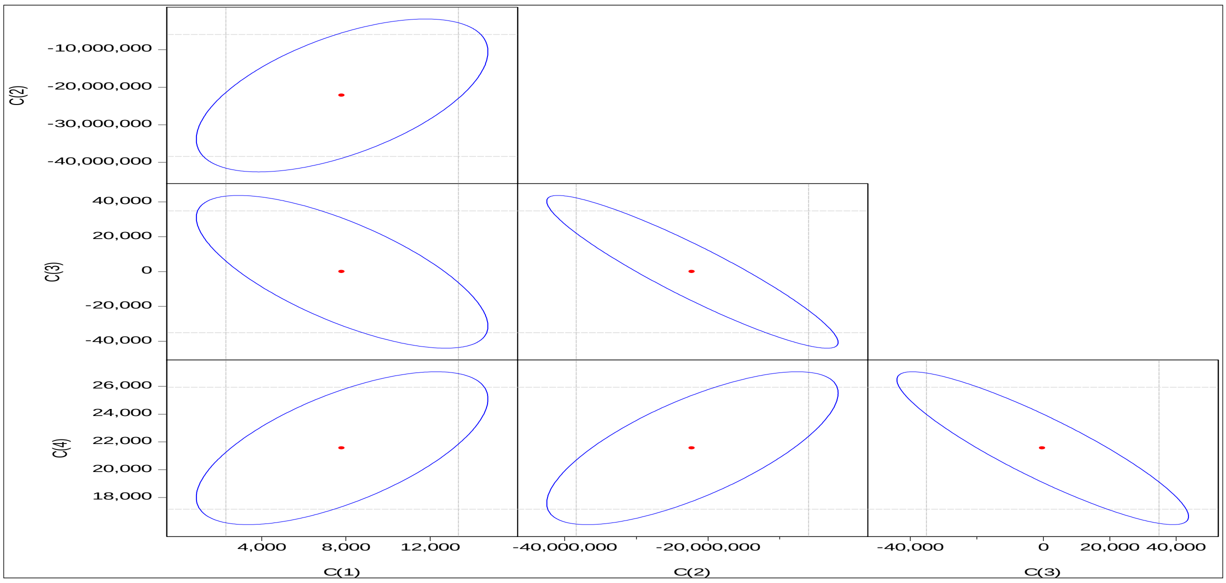
Table 5.8 Ljung- Box Q Tests for Autocorrelations

Lags	Q- stat	Probability	Adjusted- Q stat	Probability
1	7.48109	0.8675	8.35274	0.8567
2	16.34272	0.6767	17.35064	0.7563
3	24.11524	0.0489	28.05774	0.0376
4	68.64710	0.0387	73.04278	0.0276
5	81.18206	0.0127	84.90273	0.0056
6	85.15764	0.0000	89.50603	0.0000
7	91.32439	0.0000	96.83947	0.0000
8	97.68844	0.0000	104.6178	0.0000
9	109.2080	0.0000	119.0994	0.0000
10	120.6121	0.0000	133.8577	0.0000
11	129.3485	0.0000	145.5062	0.0000
12	135.9228	0.0000	154.5460	0.0000

The test showed that the correct number of lagged to be included by the ARDL model is supposed to be 2 since m> 2 in the Monte Carlo simulated Portmateu test, suggests model adequacy. The Q- test helps in checking if the residual time series are actually not equal to zero. The null hypothesis was set at no autocorrelation up to lag h.

The study tests for correlation among the variables in the 3SLS by adopting a visual analysis of correlation using the confidence ellipse approach. Basically, the confidence ellipse approach is a visual indicator of correlation that complements the correlation matrix. The correlation ellipse use the fact that variables are diagonally correlated between 1 and -1 hence, the more circular the two variables the more the variables are uncorrelated. The results are given by Figure 5.3 below:

Figure 5.3 Coefficient diagnostics: confidence ellipse of the 3SLS



The confidence ellipse in **Figure 5.3** of the following coefficients Q, AP, and HINV can be interpreted at 95% confidence interval to be uncorrelated against BINV, this shown by the near circular appearance of the confidence ellipse. In the plot of HINV vs. Q shows a somewhat elongated confidence ellipse indicating a slightly higher correlation thereby suggesting the erogeneity of Q.

5.4 RESULTS OF MODEL BEHAVIOR: MULTIPLIER AND DYNAMIC RESPONSE

The study after an inspection for co integration in the variables, the study implemented a general to specific approach econometric modeling technique to the annual data to perform the General- to Specific (*Gets*) ARDL model, and the error correction of the model which gave the following long run and short run dynamics given by the following sub sections below.

5.4.1 The ARDL model using the general- to- specific Approach results

The study after an inspection for co integration in the variables, the study implemented a general to specific approach econometric modeling technique to the annual data to perform the ARDL (2, 2) model. A final parsimonious ARDL model with its long- run elasticities calculated from the steady- state solutions given in parenthesis. The estimation of Equation below using the ARDL model is reported in chapter 4 of this study. Using Hendry's general-to-specific method, the model gave the following long run and short run dynamics given by the following equation below (See **Appendix C** for tabulated results):

$$
\begin{array}{cccccccc}
\Delta TINV_{t-1} = & C & -@TREND- & AP_t & + \ TINV_{t-1} & +TINV_{t-2}+ & BINV_{t-2} \\
-2.0756 & 21.184 & 4.8916 & 0.3446 & 0.7235 & 0.3858 & 0.00067 \\
 & (0.00979) & (0.4330) & (0.1419) & (-0.5464) & (0.187) & (-0.5091)
\end{array}
$$

$$
\begin{array}{ccc}
+\ HIV_{t-2} & +\ AP_{t-2} & -\ Q_{t-1} \\
0.00671 & 5.12998 & 3.9533 \\
(0.1012) & (-0.1306) & (0.1297)
\end{array}
$$

The ARDL (2, 2) model showed that a one percent shock in the Average Housing and Private Business investments prices results in a 14.19 percent decrease in total gross investments in South Africa in the long run. The variable AP shows that prices of the asset prices as a considerable influence on the total gross investment in South Africa. This is in line with economic theory, since most economic literature dictate that there is a negative relation between asset prices and the stock of keeping these assets. The long run relationship between TINV and AP suggest that the economic transmission of prices in these asset markets has a long run effect on the behavior of investors since the investors do not necessarily act on current information.

The short run partial coefficient of net private business investment (BINV) in the second lag suggest that for every one percent increase in the net business investment (BINV) results in approximately 50 percent increase in total gross investments (TINV) response in South African Asset market. The transmission of business investments in the second lag means that at least in the short run investments in the stock market takes two years to transmit into the economy to affect total gross investments.

The short run coefficient of Average prices (AP) also affect Total investments (TINV) in the second period of the model suggesting that a 13 percent increase in Total gross investments in South African investments will be as a result of a one percent short run change in average prices in these two asset markets. The ARDL results suggest that in the short run the transmission of Asset prices affect the TINV in a two year period lag system. Analogously, to the long run AP. The short run variable of AP, exhibit the same negative relationship between TINV and AP suggesting that an increase in price of assets in the residential or the stock market results in a decrease in holding these assets.

The short run coefficient on the ‘levels term’ the Tobin’s Q and gross investment in the first lag suggest that, the Tobin’s Q only affect the total gross investment only in the short run and at its first lag. Suggesting that the Tobin Q accounts for only 12 percent increase in total investment, thus for every one percent change in the Tobin Q, total investment (TINV) decrease by 12 percent which is in line with economic theory which suggest that a higher Q value suggest that capital assets are overpriced and most investors will not hold these assets. It should be noted that the Tobin’s Q actually performed well in this model exhibiting some levels of stability, however it should be noted that the Tobin’s Q only affect in the short run and there seem to be no significant long run relationship between the Tobin’s Q and TINV in the South African data modeled therein.

Mutually the long run and the second lag of the short run coefficient of TINV affected itself in a statistically significant way. A one percent change in TINV in the current period is a result of 54 and 18 percent change in TINV in the long run and second lag of the previous period. In the long run period, an increase in Total gross investment (TINV) results in a decrease in TINV in the current period but in the short run, the second lag showed that there is a positive relationship in TINV and its second lag. This makes economic sense in that the transmission of investments in South Africa is not direct in the long run, and that an increase in total investments is influenced by other exogenous factors such as the Tobin Q or government policies. On the other hand, there seem to be a direct transmission in the mechanism that affects total gross investments.

The ARDL included a trend and a constant in the time series to cater for lag weights, in the selected lag criteria. Both the Constant and Trend were significant at 5% showing that both the trend and the constant affect the ARDL model. The ARDL model shows that all the four variables excluding the Tobin Q (which so far has been treated as exogenous) to be showing some degree of overshooting since these variables in this dynamic model shows that the adjustment completes after three – six years.

5.4.2 Error Correction Model (ECM)

After exploring the *Gets* ARDL the study conducts a parsimonious error correction model (ECM) to test both the co integration as well as the rate of adjustment of errors in the long run model[21]. This is done as complementary procedure to verify the results of the general- to-specific ARDL given above and also to give a dynamic response for the ARDL technique. The ECM showed the following results:

Table 5.9 ECM Results, Annual data: 1960- 2010

Variable	Coefficient	t- statistic	Probability
D(BINV)	0.000548	1.213779	0.8416
D(HINV)	0.000541	0.201196	0.2323
D(AP)	-3415.906	-0.014978	0.9881
U(-1)	-1.109593	-6.889488	0.0000
R-squared			0.559864
Adjusted R-squared			0.513533
F-statistic			12.08422
Prob(F-statistic)			0.00000
Durbin-Watson stat			2.003613

$$DTINV = -0.283 + 0.005DHINV + 0.005DBINV - 3415DAP - 1.1096ECM$$

$$\begin{array}{ccccc} (7.66) & (0.002) & (0.0004) & (2.280) & (0.161) \\ [-0.037] & [0.201] & [1.213] & [-0.0149] & [-6.889] \end{array}$$

The ECM model shown in Table 5.9 above shows the one period lag of the residual that is, the equilibrium error term of one period in the dynamic model. This error correction term, thus, act as a guideline to the variables in the system to restore back the long run equilibrium. The coefficient of the error term of the error term has been -1.109593 meaning that the system corrects its previous disequilibrium at a speed of 111% annually. Moreover, the error term is negative and significant indicating validity of the long relationship between variables. Never- the- less, in this ECM model the short run variables are not significant. The ECM fit the ARDL model over the whole period of the study.

5.5 THE DIAGNOSTIC CHECKS RESULTS

[21] Justification of this can be found in the study by Cuthbert and Gasparo (1995)

Gujarati (2004:516) argues that diagnostic tests should be performed so that the model finally chosen is a good model in the sense that all the estimated coefficients have the right signs, they are statistically significant on the basis of the *t* and *F* tests, the R- Squared value is reasonably high and the Durbin-Watson *d* and *h* has acceptable value (approximately around 2). In this regard, this study employs a consortium of tests such as, the Histogram and Normality test, Correlogram of Squared Residual Test, the Heteroscedasticity test and the Ramsey RESET test among others.

The R- squared and the Adjusted R- Squared of the ARDL model were 0.799411 and 0.741175 suggesting that at least 79.99 % of the data is explained in this model and the model correctly ‘fits’ the data. The Durbin- Watson was 2.210579 suggesting a good model in terms of no serial correlation and no spurious regressions. However, the Durbin Watson h test needs to be constructed

The study conducted a Lagrange Multiplier (LM) test to check for serial correlation in the ARDL model. The null hypothesis was set that there is no serial autocorrelation up to the lag 6, as selected by the lag length criterion. Using the calculated Breusch- Godfrey (BG) test, the BG statistic was 4.458512 which exceeds the critical value of the $\mathcal{X}^2{}_c$ (6) of 3.84. The study does not reject the null hypothesis of no serial correlation in the model up to the lag order of 6 at 95 percent confidence interval. In the LM test the probability of the Obs* R-squared statistic of 0.5217 suggest that the study should not reject the null hypothesis of serial correction up to lag order of 6 at the 95% confidence interval level.

The study performed a normality test to check if the data 90odeled was normally distributed a Jarque- Bera test was conducted. The null hypothesis suggests that there is the data is not normally distributed. The Jarque- Bera(BJ) statistic was 3.56 and a $\mathcal{X}^2{}_c$ of 6.0 this suggest that the residuals in the data were clearly normally distributed.

The study performed various tests for heteroscadesticity of in the residual. The first test was the Engle’s autoregressive conditional heteroscadesticity ARCH test to test for any presence of heteroscedasticity in the regressions. The null hypothesis was set at that there is evidence of ARCH process and the alternative there is no ARCH, the results of the ARCH (6) was equal to 0.0191 at p value of 0.8305 suggesting no evidence of heteroscedasticity hence the study rejects the null hypothesis and accept the alternative of no ARCH process in the ARDL.

The study also conducted the Breusch- Pagan- Godfrey test (BPG) and the White's test of heteroscedasticy and the study found that the BPG statistic was 0.8965 and White's test 0.7259 showed that the data did not exhibit any heteroscedasticity hence the data showed homoscedaticity.The Ramsey Reset test for functional form misspecification and the Reset test showed that there is no evidence of misspecification in the data, the RAM (6) was equal to 2.8 at $\mathcal{X}^2{}_c$=7.8.finally the study conducted the Hendry Forecast (HF) test with the t-statistic of 6.098 was given as 10.78 at $\mathcal{X}^2{}_c$ equal to 7.8 this suggest that the study does not reject the null hypothesis of parameter constancy in the periods of failure predictive ability. A summary of some of these diagnostic results are given in **Table 5.10**below:

Table 5.10 Summary of diagnostic results

Test	Null Hypothesis	t- statistic	$\mathcal{X}^2{}_c$
JB	There is no normal distribution	3.56	6.0
ARCH (6)	There is ARCH process	0.0191	8.3
BPG	presence of heteroscedasticity	0.8965	5.8
RAM (6)	evidence of misspecification	2.8	7.8
HF	parameter constancy	6.098	10.78
LM	No serial correlation	4.4585	3.84

The study conducted a Chow test for any structural breaks in the South African data 1960-2010. The First Chow test (Chow 1) showed some elements of predictive failure in the dynamic model (that is, out- of- sample forecasting ability) of the ARDL model in the period of 1982- 1984, since this period was the peak of political turmoil and the worst industrial relations[22] ever in the recorded history of South Africa. This is also evidenced by the recursive residual graph below. The second Chow (2) break was in the period of 1993- 1994, to test the ability of the ARDL to predict the out- of- sample period of 1993- 1994 to forecast the dependent in this period. Chow (1), F (1, 22) was equal to 0.91 at the p- value of 0.46 showing that the model correctly predicted the crisis. More so, the Chow (2) F (9, 20) was estimated to be 0.46 at p- value of 0.88 thereby again suggesting a correct predictability of the model to estimate the out- of- sample recursive tests. The recursive coefficient test of the ARDL model is given below:

[22]See a book by Howe G (1984). **Industrial relations in South Africa, 1982- 1984: A Comparative review of statistics and trends.** Centre for Applied Social Sciences. University of Natal

Figure 5.4 Recursive coefficient of the ARDL

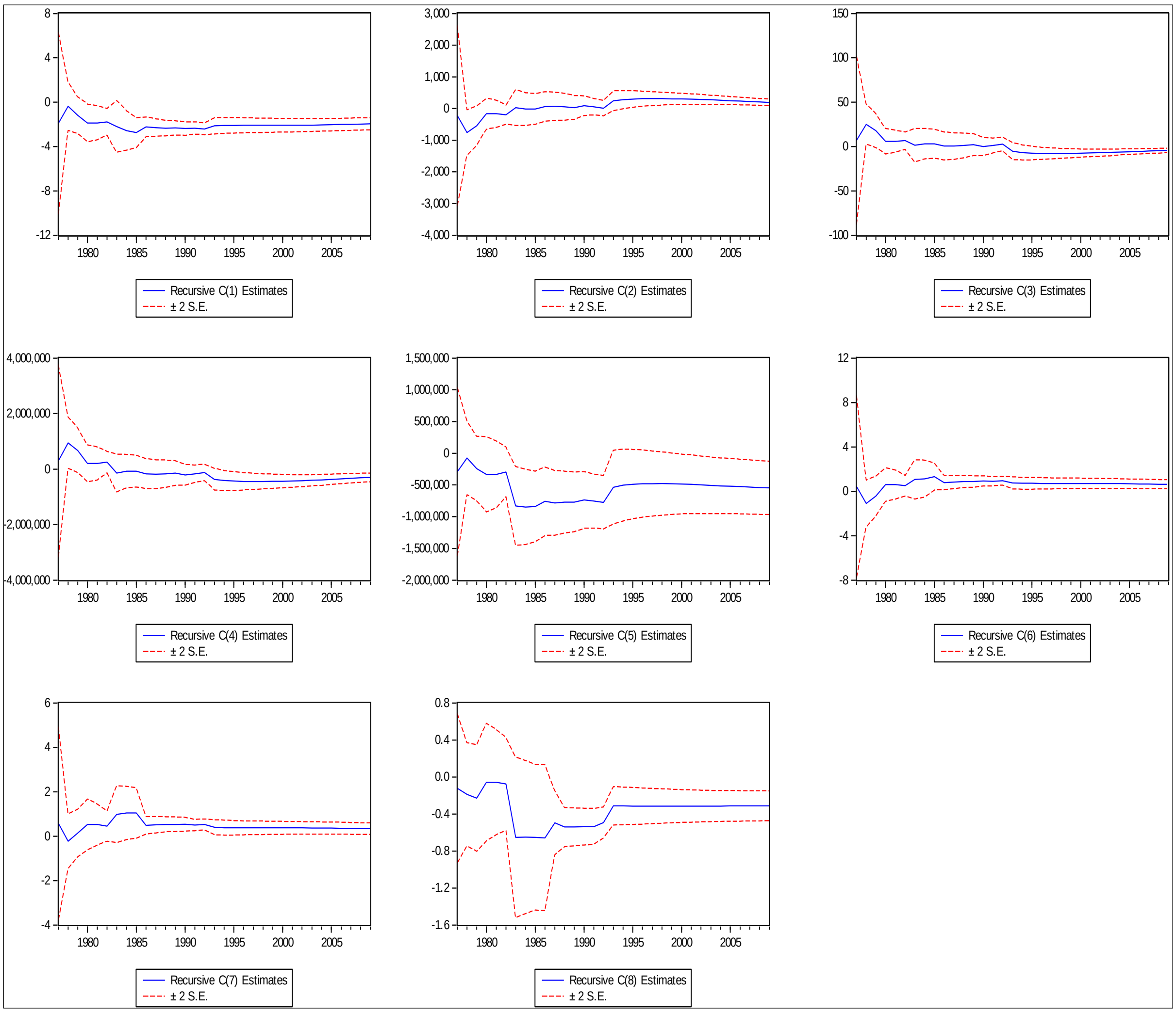
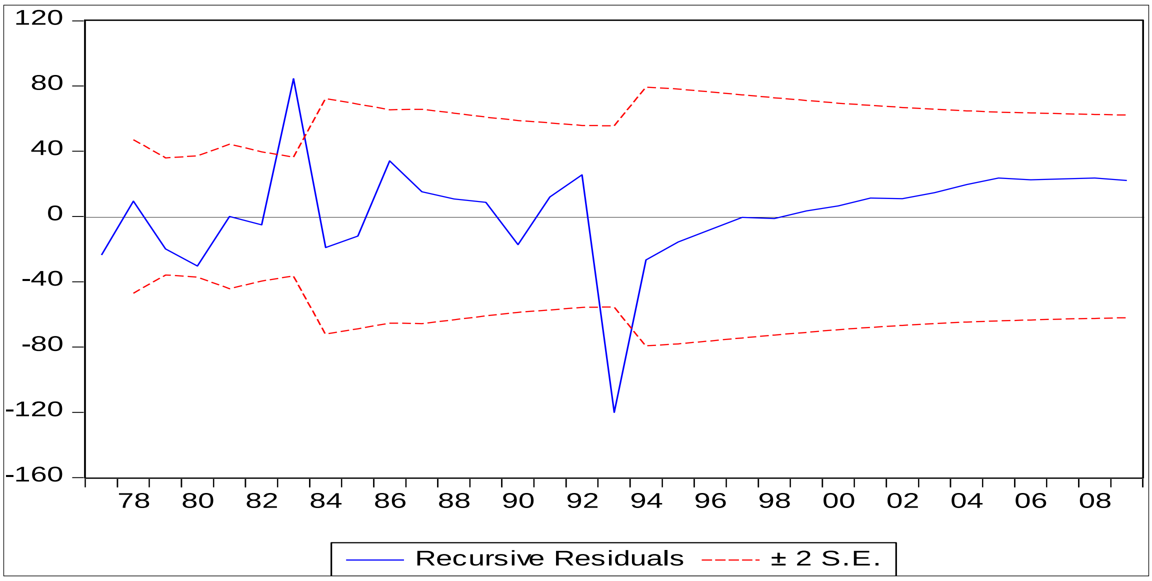


Figure 5.4 above shows the graph of the recursive coefficient tests and the test showed that all the six coefficient of the were correctly estimated at the modulus of 2SE showing that the parameters in the model are stable, this means that in the long run, the ARDL model is stable and the coefficients are relatively statistically significant broadly remain unchanged. The recursive stability test is given by Figure 5.5 below:

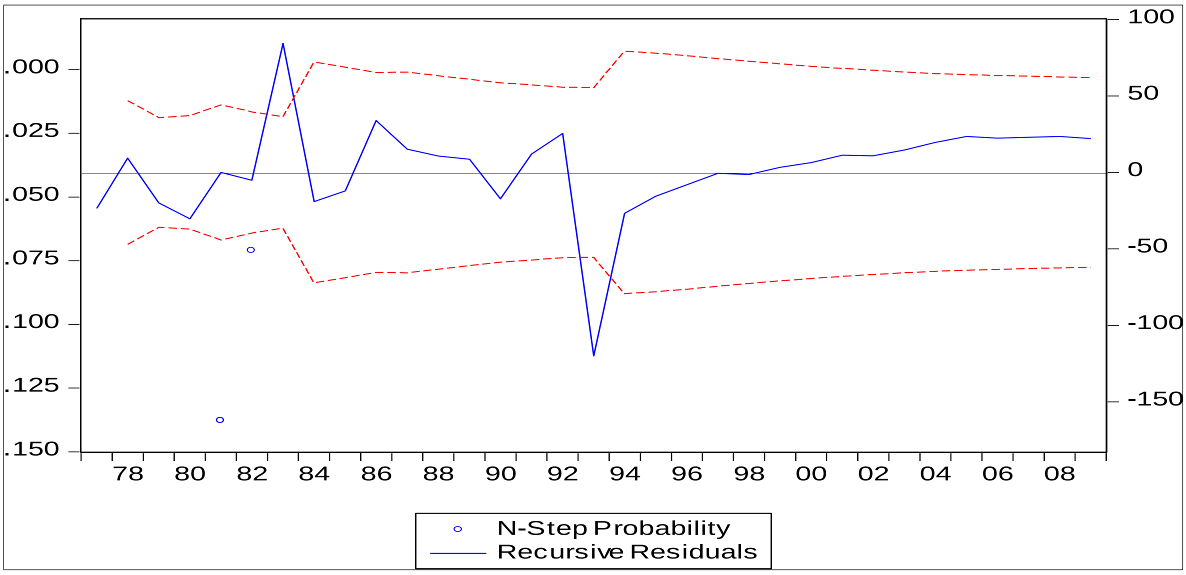
Figure 5.5 Recursive residuals stability test



The Recursive residual test in the structural break in the recursive graph showed that the residuals were not constancy in period of 1982- 1984 and also 1993- 1994 this shows that there were some structural breaks in these periods as also evidenced by the chow structural breaks in these periods[23]. The periods of 1982- 1984 was mainly a period of political turmoil in South Africa and this in turn affected investment in these years hence the error shows a structural break, moreover, the period between 1993- 1994 is consistent with the country's history as South Africa's transition period from apartheid to free South Africa, a lot of investors panicked and hence affected investments in this period. Finally, the study implemented the 'N- increasing Chow test'by (Hendry (1990) the results are shown below in Figure 5.6:

[23]This is shown by the Chow 1 and Chow 2 tests given above

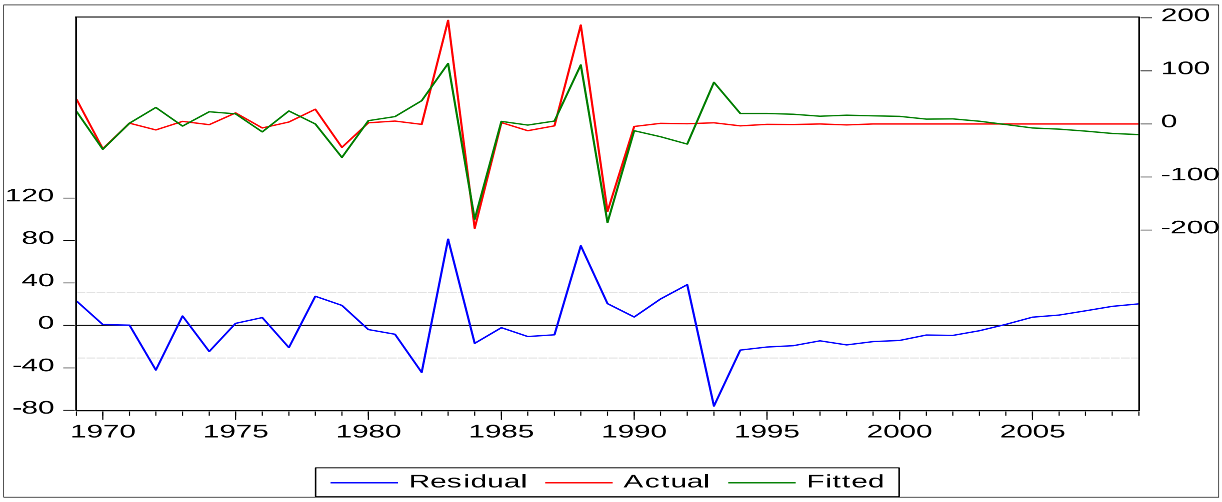
Figure 5.6 N-increasing Chow test



The N-increasing indicate that the overall statistical parameter consistency. Despite the out-of- sample periods in the structural breaks. This is in line with the economic theory.

The actual and fitted graph below shows how the model fits the data as well as its standard errors.

Figure 5.7 Actual, fitted, residual graph of the gets ARDL



The ARDL model traces out the data efficiently through the time frame of the study with minimum errors. Figure 5.7 above shows the leveraged plot of the Total gross Investment (TINV) against its independent variables and the test showed that the intertemporal (across time) the data fitted the regression with exception of the years 1982-1984 due to the structural breaks as shown by the other stability tests.

Figure 5.8 the Actual, fitted, Residual graph for the ECM model

The actual, fitted, residual graph of the ECM model shows that the Error Correction Model correctly traces out the data with minimum errors of the endogenous dynamic model. However the Figure 5.8 below shows that the ECM does not fully fit the data in periods between 1982 up to 1994 due to some structural breaks in the data.

5.8 Concluding Remarks

This chapter gave the empirical results of the econometric model adopted in chapter 4. The results have shown that the model has statistical properties that can be tested in a real economic situation using data. In this chapter the results have shown that the econometric inception used in this study managed to capture the statistical as well as the econometric properties of the Q theory. The results have shown that the Q theory is statistically significant in the South African housing industry. The following chapter gives the policy inference and recommendations based on these results reported in this chapter.

CHAPTER SIX

RECOMMENDATIONS AND POLICY INFERENCES

6.1 Summary

As suggested by Curthbertson (2005), Dia and Casalin (2009), and Sorensen and Whitta-Jacobsen (2010) this study opted to study the relationship between financial flows in asset prices and real investment in the subsector residential investment without taking any a priori stance on the causality relationships occurring among the variables under analysis even though the theoretical literature of the study suggested a priori. The study intercepted with a concise background and literature review. The study then constructed a simple theoretical model which permits the choice of the macroeconomic variables at work on a theoretical foundation.

The study then performs most of its analysis making use of Auto-Regression Distributed Lagged (ARDL) techniques, the study uses aggregate data for the South African economy that are available for a long time span, from 1960- 2010. This analysis covered different business cycles, and has made it possible to allow capturing of the long-run dynamics of the variables. Moreover, since the analysis makes extensive use of the general- to- specific ARDL model, which have low power, longer time-series enhance the statistical reliability of the tests. The obvious cost was the loss of cross-firms heterogeneity. The study, thus regard the empirical evidence provided by the Error Correction Model as complementary to that obtained by means of micro-level data, and show that the results are compatible with other similar studies.

In the long run, Gross investment in South Africa is mainly affected by the average asset prices in both the residential and the business investment. The other long run variable that seem to affect the level of it's the variable net business investment which might have been triggered by the ever increasing business opportunities in South Africa and that the South African market is virtually the economic harbor of the African economy as a whole. It is actually saddening that, the performance of the Tobin Q is not satisfactory in affecting the Long run investments in South Africa

6.2 Policy implications and recommendation

The study showed a statistically significant relationship between the levels of investment and its sub sectors such as the business investment and residential investment in South Africa. The study has shown that the investment behavior in both of these markets is policy relevant. The South African government through institutional arrangements should intervene in the residential market in order to influence the total gross investment in South Africa. The study has revealed that residential investments are equally important as business investment since both are equally largest contributor to the total gross investment, thereby making it a very influential variable in the economy. More than 40 percent of private residential investments in South Africa have been used as replacement cost than capacity building in the last 15 years, this is shown by the ARDL model and the dynamics shown in chapter two of the study. This could raise concern in the South African economy, since this have a huge impact on the growth objective of the country.

The short run coefficients of the ARDL model showed that investment determinants such as the lagged variables such as BINV, HINV, AP and the exogenous Q were the most important determinants of the short run shocks in the gross investments. This might have been due to the recent aggressive growth policies implemented by the South African government such as Accelerated and Shared Growth Initiative for South Africa (ASIGSA), industrial policy Action Plan (IPAP2), Growth Employment, and Redistribution (GEAR), New Growth Policy (GNP). The performance of the Tobin Q was rather sufficient though not conclusive in the short run.

In South Africa, government intervention in the asset markets especially in enhancing availability credit condition to ensure high capital structures of private firms and households; this consecutively can have a positive as well as huge impact on enhancing both short- run and long run investments in these two asset markets. As an alternative, the role of government can be through creating business opportunities as well as providing policies such as low interest bearing loans to investors in both of these markets.

6.3 Limitations of the study

The study, faced some hindrances in carrying out the analysis, the most fundamental limitation of the study, was the classic assumption of "homogeneity" in the capital structure of the capital data of both asset markets since it was aggregated. This aggregation of capital data could have resulted in the loss of across industry and sub market differentials, thereby distorting the structural and institutional features which could have affected the investment behavior in South Africa.

The nature and quality of data available might also have an effect on the analysis since the data used in this study was mainly data from secondary sources and instrumental variables were used in the analysis.

Another problematic limitation of the study is that the model formulation was based on the Tobin Q which has very limited empirical success, this in turn, has affected the functional form of the dynamic model of the study. However, for the sack of the analysis and for the in-depth analysis the study has to adopt the functional form in order to produce efficient results.

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APPENDICES AND CROSS-REFERENCES

Appendix

Table A1 South African annual time series data 1960- 2010

Year	TINV	BINV	HINV	AP	Q
1960	6.256783	5607.768	5345.654	0.00345	0.605319
1961	5.934335	1856.455	6345.543	0.00675	0.453191
1962	4.929539	13273.99	3487.354	0.003452	0.402717
1963	10.59924	7965.407	67432.98	0.00639	0.441204
1964	5.807707	8665.304	5234.434	0.03681	0.489189
1965	2.649778	7290.4	5063.82	0.000563	0.465132
1966	5.320877	12393.27	5539.468	0.000768	0.396346
1967	3.210149	-1415.51	5776.779	0.00067	0.471753
1968	3.755623	1236.713	6002.605	0.000595	0.381056
1969	50.48002	19023.37	6024.68	0.000566	0.376584
1970	3.583333	5960.211	6331.044	0.000471	0.373735
1971	5.116582	-4251.6	6657.577	0.000462	0.355991
1972	-6.13225	-1891.89	7505.945	0.000459	0.255556
1973	-1.48076	-2684.23	10312.34	0.00043	0.262891
1974	-3.1116	1255.618	12345.55	0.000439	0.287156
1975	17.70493	20278.37	11397.59	0.000387	0.258528
1976	9.975258	33020.89	10271.68	0.000354	0.222673
1977	13.4424	-13359.7	10977.79	0.000358	0.215108
1978	40.9223	-7715.83	11557.22	0.000347	0.214444
1979	-3.44525	5884.261	12345.84	0.000326	0.216163
1980	-1.27203	-8571.61	13896.97	0.000294	0.222003
1981	4.060797	-2358.09	16196.63	0.000197	0.239972
1982	3.35078	-11505.9	15977.75	0.000138	0.189174
1983	198.4214	2962.191	17844.16	0.000119	0.188496
1984	1.864048	4674.18	16620.39	9.47E-05	0.186807
1985	4.463311	-9662.62	13358.66	7.7E-05	0.157971
1986	-8.44756	2176.546	18323.54	9.56E-05	0.169505
1987	-12.1748	-9333.04	24402.75	9.59E-05	0.163674
1988	174.0138	-3452.12	23727.36	9.27E-05	0.167963
1989	8.944706	15403.04	23815.67	7.9E-05	0.166261
1990	4.096238	23405.54	22546	8.22E-05	0.133333
1991	4.990745	10583.3	25784.03	7.1E-05	0.150385
1992	5.177358	1461.526	29629.1	6.44E-05	0.154158
1993	7.426936	-960.405	29175.15	5.83E-05	0.152857
1994	3.853973	8817.136	27782.11	5.07E-05	0.17283
1995	3.151119	6604.767	28091.61	4.89E-05	0.173254
1996	2.103797	1689.751	24300.06	4.25E-05	0.149844
1997	2.077047	8126.588	24114.47	3.82E-05	0.139291
1998	3.24539	9899.221	19305.69	3.05E-05	0.133286
1999	4.56243	26003.39	19176.99	2.82E-05	0.136489

2000	7.45637	10926.36	16956.04	2.17E-05	0.132206
2001	7.3454	20198.58	14109.08	1.58E-05	0.123857
2002	6.4534	18331.87	11981.18	1.22E-05	0.125691
2003	5.34526	-4570.76	16793.68	1.39E-05	0.124561
2004	3.5645	-35300.8	20870.24	1.21E-05	0.121532
2005	3.5467	5626.734	22989.35	1.03E-05	0.1105
2006	3.256473	78242.65	23045.25	8.76E-06	0.110259
2007	3.56748	5345.27	23841.48	7.76E-06	0.1
2008	2.4537u58	4563.456	22869.52	6.68E-06	0.122
2009	2.45463	67583.23	26967.79	5.64E-06	0.112
2010	5.53657	2346.374	35436.27	2.23E-06	0.111

Appendix B

Table B1: South African Annual Data, 1960- 2010

Year	investment share of real Gdp constant prices	price level of investments	GDFI base (2005)	Housing prices	GFC	Change in stocks, private sector (current US$)	GDP (current US$)	Construction, value added (current US$)
1960	11.38	72.47	18.8		49539	2.78E+08	7.34E+09	..
1961	8.52	80.77	18.8		49585	92052343	7.72E+09	..
1962	7.41	89.41	18.4		48434	6.43E+08	8.25E+09	..
1963	9.53	95.86	21.6		57081	4.55E+08	9.15E+09	..
1964	12.67	84.13	25.9		68304	5.92E+08	1E+10	..
1965	14.14	87.92	30.4		80223	5.85E+08	1.1E+10	4.06E+08
1966	11.93	87.7	30.1	114197.5	79311	9.83E+08	1.2E+10	4.39E+08
1967	14.53	90.85	30.8	135572.1	81357	-1.2E+08	1.33E+10	4.7E+08
1968	12.27	84.34	32.2	141691.2	85040	1.05E+08	1.44E+10	5.1E+08
1969	13.67	89.53	36.3	158066.5	95699	1.82E+09	1.62E+10	5.77E+08
1970	15.51	85.23	41.5	181015.2	109356	6.52E+08	1.79E+10	6.92E+08
1971	16.34	89.51	45.9	193725	121178	-5.2E+08	1.98E+10	8.07E+08
1972	12.42	93.74	48.6	204403.1	128258	-2.4E+08	2.06E+10	9.63E+08
1973	13.46	101.3	51.2	235656.2	134955	-3.6E+08	2.84E+10	1.39E+09
1974	15.65	112.12	54.5	255136.8	143768	1.81E+08	3.57E+10	1.77E+09
1975	15.46	107.57	59.8	278314	157796	3.2E+09	3.69E+10	1.8E+09
1976	13.16	104.39	59.1	295149.1	155846	5.15E+09	3.55E+10	1.6E+09
1977	11.96	107.79	55.6	300715.1	146555	-2E+09	3.94E+10	1.61E+09
1978	11.58	108.89	54	313765.4	142491	-1.1E+09	4.53E+10	1.65E+09
1979	12.17	114.46	56.3	351366.5	148430	8.73E+08	5.59E+10	1.83E+09
1980	14.63	128.04	65.9	435096.5	173779	-1.5E+09	8.07E+10	2.42E+09

1981	17.23	118.83	71.8	601716.9	189340	-4.5E+08	8.68E+10	3.07E+09
1982	13.28	99.9	70.2	723390.9	185270	-2.1E+09	8.01E+10	2.96E+09
1983	12.78	103.43	67.8	870067.2	178709	5.29E+08	8.6E+10	3.19E+09
1984	12.46	89.87	66.7	948576.7	176047	8.23E+08	8.52E+10	2.93E+09
1985	9.81	67.43	62.1	875670.7	163678	-1.6E+09	6.71E+10	2.19E+09
1986	8.56	80.41	50.5	840936.6	133275	2.9E+08	7.95E+10	2.44E+09
1987	7.84	88.46	47.9	922734	126456	-1.2E+09	1.04E+11	3.09E+09
1988	9.07	98.5	54	1062034	142368	-4.9E+08	1.15E+11	3.38E+09
1989	9.56	96.19	57.5	1217615	151628	2.34E+09	1.25E+11	3.61E+09
1990	7.48	114.8	56.1	1397320	148079	3.47E+09	1.12E+11	3.34E+09
1991	7.82	112.56	52	1584379	137139	1.45E+09	1.2E+11	3.54E+09
1992	7.6	106.59	49.3	1653899	129925	1.9E+08	1.31E+11	3.85E+09
1993	7.49	101.21	49	1735913	129205	-1.2E+08	1.3E+11	3.77E+09
1994	9.16	97.38	53	1921356	139860	1.23E+09	1.36E+11	3.89E+09
1995	10.17	101.12	58.7	2067317	154813	1.02E+09	1.51E+11	4.35E+09
1996	9.59	91.11	64	2141827	168759	2.85E+08	1.44E+11	4.1E+09
1997	9.43	89.15	67.7	2333223	178449	1.45E+09	1.49E+11	4.3E+09
1998	9.45	80.92	70.9	2655405	186953	1.85E+09	1.34E+11	3.61E+09
1999	8.94	78.57	65.5	2785528	172753	4.49E+09	1.33E+11	3.31E+09
2000	8.99	70.9	68	3262355	179431	1.96E+09	1.33E+11	3.04E+09
2001	8.67	59.05	70	3728221	184543	3.73E+09	1.18E+11	2.6E+09
2002	9.1	52.41	72.4	4297585	190988	3.5E+09	1.11E+11	2.29E+09
2003	9.94	72.26	79.8	5207633	210540	-9.6E+08	1.68E+11	3.54E+09
2004	10.95	83.3	90.1	6886494	237651	-8.4E+09	2.19E+11	4.96E+09
2005	11.05	86.81	100	8450696	263754		2.47E+11	6.06E+09
2006	12.36	85.4	112.1	9744766	29578		2.61E+1	6.82E+09

					6		1	
2007	12.78	86.66	127.8	11162311	337092		2.86E+11	8.04E+09
2008			144.8	11613287	381850		2.75E+11	8.73E+09
2009			140.1	11574087	369558		2.83E+11	9.97E+09
2010			137.9	12396918	363611		3.64E+11	..
2011			143.9	12660981	379617			

Appendix C

Table C1: ARDL general to specific Approach Results

ARDL general to specific Approach				
Variable	Coefficient	t- statistic	Standard error	Probability
C	211.8482	3.986839	53.13688	0.0004
@TREND	-4.891698	-3.801684	1.286719	0.0006
TINV(-1)	-2.075615	-7.574325	0.274033	0.0000
AP(-1)	-344639.3	-4.188778	82276.81	0.0002
D(BINV(-2))	0.00677	1.949626	0.000347	0.0603
D(HINV(-2))	0.006701	3.072645	0.002181	0.0044
D(AP(-2))	-5.12998.0	-2.317496	221358.7	0.0172
D(Q(-1))	-0.395.3838	-2.062126	191.7360	0.0477
D(TINV(-1))	0.723567	3.410551	0.212155	0.0018
D(TINV(-2))	0.385847	2.863591	0.134742	0.0074
R-squared		0.799411		
Adjusted R-squared		0.741175		
S.E. of regression		30.80286		
Sum squared resid		29413.30		
Log likelihood		-192.9769		
F-statistic		13.72719		
Prob(F-statistic)		0.000000		
Durbin-Watson stat		2.210579		

Appendix D

Table D1: Descriptive Statistic

Covariance matrix					
	TINV	*BINV*	*HINV*	*AP*	*Q*
TINV	1326.34				
BINV	-36468.44	302110506.3			
HINV	12341.25	17158771.62	115169396.1		
AP	-0.0070	0.3813	-6.937	2.71E-05	
Q	-0.185	-242.95	-562.552	0.000292	0.0156

Correlation matrix					
	TINV	*BINV*	*HINV*	*AP*	*Q*
TINV	1				
BINV	-0.058	1			
HINV	0.032	0.092	1		
AP	-0.037	0.004	-0.124	1	
Q	-0.041	-0.112	-0.420	0.4490	1

Descriptive statistics					
	TINV	*BINV*	*HINV*	*AP*	*Q*
Mean	12.557	7091.17	17370.29	0.00	0.23
Standard Error	5.150	2458.091	1517.69	0.00	0.02
Median	4.096	5345.27	16620.39	0.00	0.17
Standard Deviation	36.781	17554.279	10838.49	0.01	0.13
Sample Variance	1352.87	308152716.4	117472784.04	0.00	0.02
Kurtosis	19.935	7.17613	7.80	43.71	0.44
Skewness	4.452	1.933303627	1.96	6.44	1.18
Range	210.60	113543.45	63945.63	0.04	0.51
Minimum	-12.17	-35300.8	3487.35	0.00	0.10
Maximum	198.42	78242.65	67432.98	0.04	0.61
Sum	640.41	361649.622	885884.86	0.07	11.79
Count	51	51	51	51	51
Largest(1)	198.4	78242.65	67432.98	0.037	0.605
Smallest(1)	-12.17	-35300.8	3487.354	0.000	0.100
Confidence Level(95.0%)	10.345	4937.220472	3048.373318	0.001	0.035