# RISK AND REAL ESTATE INVESTMENT IN GHANA

**SAFIA TANKO IMRAN**

**(10442784)**

**THIS THESIS IS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF GHANA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE MASTER OF PHILOSOPHY DEGREE IN RISK MANAGEMENT AND INSURANCE**

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## DECLARATION

"I do hereby declare that this work is the result of my own original research and that no part of this has been presented by anyone for another degree in this university or anywhere else. All references used have been duly acknowledged."

…… ……

SAFIA TANKO IMRAN DATE

(10442784)

## CERTIFICATION

"We hereby declare that preparation and presentation of this thesis was in accordance with guidelines on supervision laid down by the University of Ghana"

…… ……

Dr. ALBERT GEMEGAH DATE

(FIRST SUPERVISOR)

…… ……

Dr. GYEKE- DAKO DATE

(SECOND SUPERVISOR)

## DEDICATION

This work is dedicated to our Heavenly Father and to my family.

**ACKNOWLEGEMENT**

To God be the glory for the great things He has done. I am indeed very grateful to the Almighty Allah for all He has done in my life and what He continues to do. This work could not have been completed without His care, guidance and protection.

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## ABSTRACT

Residential real estate, in recent times, has attracted a lot of attention due to its strong economic performance which is mainly as a result of increasing demand for housing and additional diversification benefits offered to investors in the region; making real estate investment extremely lucrative.

Nonetheless many investors have doubts about the prudence of investing in emerging markets. In particular it may be felt that the expected returns offered in the countries of the African region are not sufficient to compensate investors for the increased risks of investing in such markets. These risks can be categorized under four headings: credit risk, market risk, operational risk, and liquidity risk.

So in determining the extent to which systematic risks (those looked at in this work were GDP growth rate, Interest rate, Exchange rate, Inflation rate, Unemployment rate and Number of houses sold) influence investment returns in the Ghanaian housing market, this paper adopted a Vector Autoregressive Model where each of these risks were examined in turn to see if they were sufficiently large to deter real estate investment in the region in general.

From this the study it was found that shocks to the expected returns, the GDP growth rate, and the interest rate explained about 90% of the movement of the expected returns, indicating that these variables are good at transmitting the effects of shocks to the housing market.

This showed that investors would have to look at these areas as target areas when adopting risk management measures in order to maximize their returns.

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# CHAPTER ONE

## 1.0 BACKGROUND

One of the major drivers of economic growth could be said to be investment in housing. Provision of affordable housing could stimulate local economies through meeting critical housing needs; addressing monetary policy issues as well as fiscal shortfalls in the economy. Labor mobility within an economy could be facilitated by adequate housing; whilst the economies could be aided in their adjustment to adverse shocks. For example, in the United States over 25% of Gross Domestic Product (GDP) and two thirds of national wealth can be attributed to real estate; while it also triggers another 6% on average in downstream expenditures. Some experts would say that about 25% of the worth of publicly traded corporations could be attributed to their investments in real estate (Johnson, 2006).

Apart from sharing in such economic growth; real estate investment could provide an additional source of diversification to investors who are looking to expand their scope of activity and also benefit from higher expected returns which they would benefit from in the long run. Some works done have shown that considerable benefits can be obtained from diversification with real estate being part of one's portfolio (Lizerli et al, 1998).

It has also been seen that there is a higher probability of reduction of portfolio risk when such diversification occurs in emerging markets (Divecha et al, 1992). Some southeastern Asian countries such as China, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand; have come to be seen as areas of investment because of their huge growth potential, mainly as a result of high levels of housing demand, greater returns and portfolio diversification benefits.

An economy like the Ghanaian one is no different. The World Bank in 2011 predicted an increase in the income levels of Ghanaians ; enough to upgrade the country's socioeconomic status from low-income to lower middle-income ; this was seen in increased household spending by as much as 59% as at 2013(Ghana Statistical Service) .

Due to this shift in economic status and increase in household spending, many investors have shifted their concentration to high class residences and increased production volumes (Claussen, Jonsson, &Lagerwall, 2011) , at the detriment of the growing demand for affordable, middle class residences. This has resulted in low levels of supply of affordable homes (Ghana Home Groups 2013).

In determining the level of investment to be made; corporate and individual investors alike rely on current market situations and make speculations about the future based on these market trends. This in itself is extremely risky especially given the fact that factors such as exchange rate, inflation rate, and interest rate and government policies play a major role in real estate prices and activities. An astute investor must therefore tread carefully in order to maximize their return on investment.

It is therefore important to evaluate any evidence suggesting any forms of interaction between the real estate industry and the broader economy; in order to ascertain how one impacts on the other.

## 1.1 PROBLEM STATEMENT

Recent developments in the Ghanaian economy indicated a boom in the construction and housing sectors with more attention being focused on

property investment and development in the urban centres.Even with the obvious benefits of providing affordable housing, Ghana's housing sector is still in its infancy

In 2010, Real estate alone accounted for 1.78% of Ghana's GDP (Ghana Statistical Service, 2010); despite this, a limited amount of real estate transactions were recorded. This was mainly due to the fact there were/are impediments to the supply of housing in Ghana, making it very challenging. Various data suggest that Ghana requires a minimum annual delivery of about 190,000 units for the next 8 years to address the housing deficit. The national annual housing supply to demand ratio (for new housing) is estimated at about 35% (UN-HABITAT 2008). This inability of housing delivery system to meet effective demand over the years has created strain on the existing housing stock and infrastructure, especially in urban areas causing more attention to be taken to areas outside the city capital.

With the supply-demand dynamics somewhat out of kilter, there has been significant price pressure in the market while such price appreciation [by 25% as at 2013 (Housing Data Ghana)], should support the development of the secondary market; there has been limited resale activity in Ghana thus far. These recent rapid increases in home prices have raised concerns about whether home prices are susceptible to a steep decline which could have a severe impact on the broader economy.

The recent rapid increase in home prices, limited supply of housing as well increased and constant demand for affordable housing is a phenomenon which has attracted a lot of investor attention both foreign and local to this industry. This phenomenon interests scholars as well.

Given the many works that have been done on the real estate industry in Africa as well as works on those in Sub- Saharan Africa and Europe; relatively little is known about its risk - return

characteristics. This scarcity of empirical evidence cannot be attributed to the lack of interest or effort on the part of academics, but mostly due to the lack of available data on real estate operations. Most property level investment data are generally not accessible to academic researchers; therefore research relies on real estate indices for the analysis of the risk- return behavior of real estate. Data available in most cases are for commercial real estate (see Fuerst & Marcato, (2009) Geltner, (1989) Geltner & Goetzmann (2000) Goetzmann &Ibbotson, (1990) Ling & Naranjo, (2007) Pai&Geltner, (2007), Plazzi, Torous & Valkanov, (2008) among others).

Due to this phenomenon, much of the literature on Africa focuses on problems associated with real estate financing and its impact on the functioning of real estate industry; this study therefore aims to bridge the gap in literature between residential real estate and risk by bringing to the fore how risky market speculations can be especially if returns are based fully on them. An understanding of which will give investors a chance to take precautionary measures when investing in real estate.

Against this backdrop also, it would be useful to investigate how property markets and market forces (macroeconomic variables) interact with each other and impact on each other over time; this would provide a useful tool in the decision-making process which would have a strategic implication on real estate decision making and portfolio management.

The main focus of this work is residential real estate in Ghana since this area has a relatively higher level of demand due to the size of the housing deficit as compared to commercial real estate and thus attracts more investors in comparison too.

By understanding the various sources of risk such as those from macroeconomic variables (inflation rate, interest rate and exchange rate) investors would be able to implement risk

management systems that would be able to match current trends in the market; aiding them to identify areas where the most risk will be faced, mitigating these risk and thereby obtaining the highest returns as well. Emphasis will be moved from speculation about future market trends to better risk management techniques.

## 1.2 RESEARCH QUESTIONS

1. Do macroeconomic variables pose a great risk to investors?
2. What risk management measures should investors adopt in order to protect their investment?

## 1.3RESEARCH OBJECTIVES

1. Look at the various economic factors that have a correlation with the real estate industry in general in order to estimate their interaction with and impact on expected returns. The economic factors that will be looked at will be interest rate, inflation rate, exchange rate, GDP growth rate, unemployment rate, number of houses sold

2. Identify risk management techniques which can be adopted by investors to safeguard investment by concentrating on the areas (economic factors) which transmit the greatest shocks to the housing market; thereby increasing returns on investment.

## 1.4 SIGNIFICANCE OF STUDY

“Profit” is the cardinal objective of all investment undertakings; fortunately real estate development in Ghana is receiving great returns on investment. In spite of this, there should be significant focus on the risk factors that affect investment which would in turn affect the profitability of real estate development in the long run.

This research would contribute to existing literature by examining the Ghanaian residential real estate market – of which few studies exist -, drawing emphasis on the macroeconomic linkages to this market. This is only a first step, however, as it suffers from data availability.

In researching the gap between real estate investment and risk, this study will be of great interest to current as well as potential investors wishing to invest in the Ghanaian capital market in particular and Africa in general. With increasing investor interest in Africa, the need for such research is of paramount interest to all the stakeholders interested in Ghana's capital market.

## 1.5 RESEARCH LIMITATIONS

Though not exhaustive, the attempt by this research is to undertake an in depth analysis into the risks involved in real estate investment. As a result the limitations of this study should also be noted, which will lead to future studies.

Firstly, the study was limited in its scope to specific parts of Ghana, hindering generalization. Future studies may find it more appropriate to broaden the scope of work so that the results of this study can better be generalized. Secondly, factors other than those used in this work can affect real estate investment and development profitability; as such future research can focus on them in more detail. Thirdly, the nature of real estate contracts makes data collection especially difficult because there is no established body in Ghana that collects data on internal real estate transactions. Future scholars therefore should consider other approaches to obtain data, and implementing a method that would also raise the credibility of the work done.

## 1.6 CHAPTER OUTLINE

Chapter One introduces the research and comprises the research background, research problem, purpose, objectives of study, research questions, significance of research, limitations faced in research and the organization of the research.

Chapter Two presents a review of important and relevant literature of scholars who have looked at real estate investment and risk management. This forms the basis for the research study and acts as a form of framework upon which the research is built.

Chapter three looks at methodological approaches that were adopted in similar works and the method that was adopted for this study; which would highlight data description, model specification, research method and ethical issues in data collection

Chapter four would be concerned with presentation of data and the analysis of findings obtained.

Chapter five would look at drawing conclusions from the research undertaken, recommendations made and future research directions given.

Bibliography and Appendix follow

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 INTRODUCTION

In looking at investment into property markets, the investor would need to decide whether to invest directly in physical real estate or indirectly through managed funds. Investing directly in real estate would involve purchasing residential or commercial type property as an income-generating property or for resale at a future time. Nelson, (2006) explored the topic of direct real estate investing which in spite of its popularity and high profile, was still the most common avenue for individuals and institutions to add real estate exposure to their portfolios. Nelson (2006) also discussed the comparative advantages and problems of direct real estate investing Vis-a`-Vis indirect investing.

The risk-return dynamics of real estate markets is another major determinant of investment decisions both in property markets and in general financial activities. Here, '*Investment*' would imply that the client is a passive investor interested primarily in the potential profits and capital gains from ownership of the real asset as an investment, rather than the benefits of direct operation, use, or occupancy of the property (Bailley, 1984). For property; valuations, risk, and uncertainty in returns are the key areas of concern, since they are inherent parts of the process of investing in a property (Adair & Hutchison, 2005).

There are many benefits that can accrue from investment into real estate. At the investor level, the size and scale of the real estate operations would make it an attractive and lucrative market mainly due to the profit that would be received from future returns in compensation for the cost of forgoing present consumption and also the benefits resulting from capital income from

periodic income transfer, tax protection, protection against inflation, and gain in social status (Shim et al, 2006).

At the micro level, owning a house would mean that households have assets in hand and could convert it into cash when necessary, therefore, the increased price of a house would mean that the wealth of the household is also rising. Usually, with such increase in wealth, people would be able to enjoy more consumption and therefore create an expansion in the economy. Also, a house could be used as collateral when households need loans from the bank; therefore with the increase in house prices, there would be an associated increase in the value of collateral , allowing people to receive more credit from financial institutions and therefore have a higher ability to consume products.

In spite of these major developmental advantages , there is evidence from some developed countries that suggest that housing could be a threat to financial and macroeconomic stability; for example countries like USA and Ireland, had government bailouts from banks from the housing collapse in 2010 of up to 40 % of the country's GDP.

It can therefore be seen that all issues surrounding real estate investment would be of considerable interest to individual investors, institutional investors and even corporations who own real estate as part of their operations; therefore a well-functioning housing sector would be critical to the overall health of the economy; and as economies develop, one could expect a corresponding and deepening growth of housing markets.

Hence it is important to monitor current housing market developments to ensure that it is operating well.

## 2.1 THEORETICAL FRAMEWORK

The most important underlying factor that could influence real estate investment would be the *earning rate.* Return on investment could be said to be the profit expressed as a percentage of the initial investment. *Profit* on the other hand, would include income and capital gains while*risk* is simply the probability that an original investment would not grow as expected, or would even decline in value. It is therefore important to understand that all investments involve some level of risk, these risks would determine if a potential investment suited ones overall goals and circumstances.

Profitability and risk have a symmetrical relationship in real estate investment — meaning the higher the risk, the higher the demand for expected return (Shim et al, 2006). Such a relationship is called the ***offset relation*** between risk and profit. In this regard, profitability has a close relationship to investment behavior, which depends on the investment risk (Ross et al., 1995).

Two major factors that could significantly affect these returns would therefore be *income tax* and *inflation*. Income tax would reduce the amount of a return while inflation would reduce the value of one's return.

The graph below gives a simplified graphical representation of the relationship between risk and return:

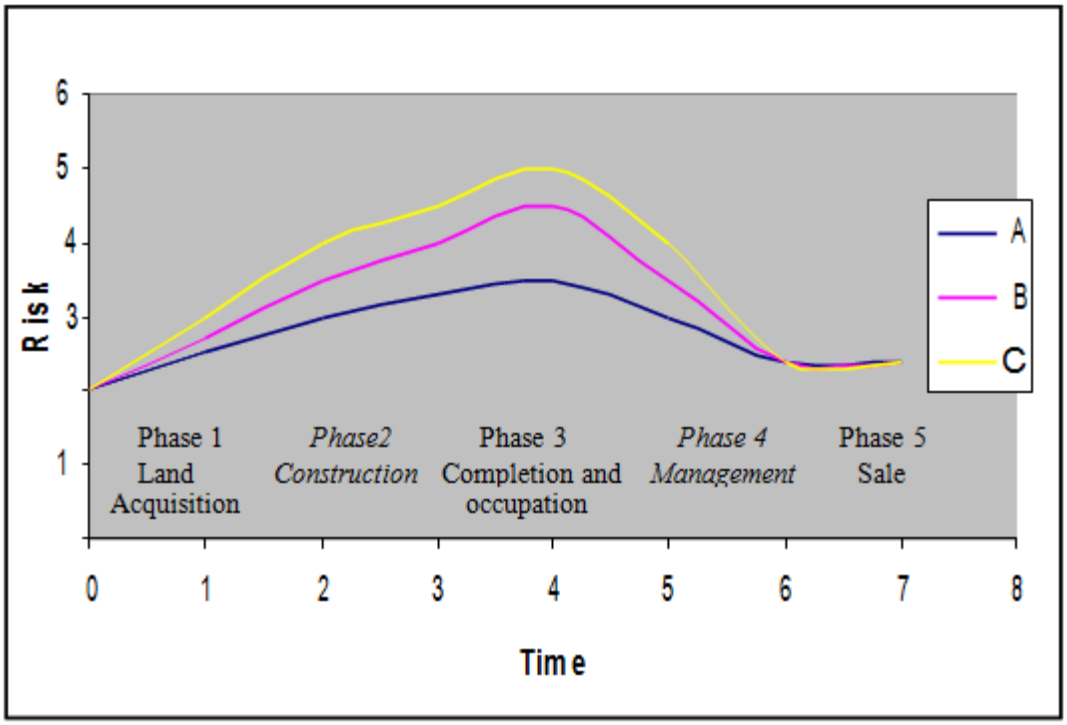
**FIGURE 1: RISK RETURN RELATIONSHIP**


The above relationship is based on the modern portfolio theory originally conceptualized by Markowitz, (1952) which says that the "*valuation of financial assets rests on two aspects of the assets, that is, **risk** and **return**".* In fact, Markowitz, (1952) sets the golden rule underlining the theory of investment that "*investors seek either to maximize returns at a given level of risk or to minimize risk at a given level of returns on their investment' (*Adu, 2012*).* In other words, in order for one to be willing to accept the risk that an investment could do poorly, investors would have to be compensated with a greater return. In retrospect also, with very safe, low-risk investments, the return would likely also be low.

For real estate, construction alone is a major source of risk since investor's funds would be "*tied up*" during that entire period, meaning the investment period would generally take a longer time for recovery. This could be mainly because the product development process from the

acquisition of land, through to the construction to leasing or eventual sale of the property usually takes a long time (18 months on average). The graph below gives a visual representation of the risk involved during the development stages. This is an oversimplified model to give an idea as to the areas that an investor would need to pay attention to when undertaking any real estate construction venture.

**FIGURE 2: RISKS AT PHASES OF CONTRUCTION**




Source: Brueggeman &Fisher, 2005

A - Lower than normal predevelopment leasing, completion behind schedule
B - Normal predevelopment leasing, completion on schedule
C - Greater than normal predevelopment leasing, completion ahead of schedule

The major areas of risks could be grouped under four main categories:

**TABLE 1: RISK CATEGORIZATION**

| CREDIT RISK | MARKET RISK | OPERATIONAL RISK | LIQUIDITY RISK |
|---|---|---|---|
| Consumer Credit | Interest rate | Operational risk management | Refinancing risk |
| Concentration risk | Currency risk | Legal risk | |
| Securitization | Equity risk | Political risk | |
| Credit derivative | Commodity risk | Valuation risk | |
| | Volatility risk | Reputational risk | |
| | | Settlement risk | |
| | | Profit risk | |
| | | Systemic risk | |

Source: Author's summary

## 2.2 RISK CATEGORIZATION

## 2.3 MARKET RISK

Market risk, which is also called ***systematic risk***, is the risk that could affect all securities in the same market in the same manner. It could also be said to be risk that is caused by some factors that could not be controlled by diversification, in most cases it is usually macroeconomic variables.

### 2.3.1 VOLATILTY RISK

Like many assets, housing prices are quite volatile (Glaeser et al, 2008); house price volatility is worthy of careful study because it is related to more than just the transfer of large amounts of wealth between homeowners and buyers but also the impact of price volatility on the construction of new homes (Topel & Rosen, 1988).

Movements in house prices depend on two parts: *economic fundamentals* and *speculations* (Hu et al., 2006). When housing prices reflect fundamentals, those prices would help migrants make appropriate decisions about where to live. On the other hand if prices reflect the frothiness of irrational exuberance, then those prices might misdirect the migration decisions that collectively drive urban change. Economic fundamentals are usually a major source of risk for developing countries whose economy is mainly influenced by how these fundamentals behave.

The speculation part would explain why asset price bubbles have been studied by many researchers such as Case &Shiller (1989), Levin & Wright (1997), and Muellbauer &Murphy (1997).

### 2.3.2 INTEREST RATE RISK

High interest rates bring hardship given the fact that one's source of income and the income itself is a determining factor in acquiring a mortgage loan, making it very difficult to obtain a mortgage loan. The highest average annual household income in Ghana which tallied with the Greater Accra Region where the mortgage market is concentrated was GH¢335.60 or US$299.64 (GLSS 5). Therefore in cases where people collect loans from banks, the pressure of such a debt could be daunting especially when such a debt could lead to a foreclosure– where the property would be retrieved from the borrower when he is not able to pay his loan at the given time; this would usually occur if the borrower used his home as collateral when the loan was collected. In detail, only 5-8% of Ghanaians can afford a house from their own resource while 12% - 15% (which would comprise mainly top civil servants and staff of financial institutions) would have access to mortgage loans. For this reason, about 60% of the market participants were resident non-Ghanaians or non-resident Ghanaians (HFC Bank, 2009).

The same could also be true for the residential housing market, where higher interest rates might lead to weak housing sales, rising inventories of homes for sale, and falling housing prices. These in turn would make building houses less profitable, so builders would be less likely to construct new houses, creating an overall reduction in construction levels.

### 2.3.4 CURRENCY RISK

Real estate investors and advisers increasingly act in a global capacity with cross border activity shifting the focus from cash flow patterns—*changes in rents and capital values* – to the impact of currency movement. Incorporating exchange rate volatility into the analysis of international investment could substantially alter the expected return and risk characteristics of the investment (Sirmans &Worzala, 2003).

Exchange rate movements have major implications on the profitability of international real estate investments through the interplay of movements between the investor's home country currency and the foreign currency especially if most materials used during construction were imported meaning an increase in cost. Institutional investors would therefore display reluctance due to the possibility that they would impute "extra" risk on foreign investments, (French &Poterba, 1991)

### 2.3.5 LEGAL RISK

The World Bank estimated that registering for formal ownership/lease over a piece of unencumbered land in Ghana was the third longest registration process in the world (World Bank, 2004). Such problems which usually result from litigation problems come up when there is failure to correctly document, enforce or adhere to contractual arrangements; inadequate management of non-contractual rights; or failure to meet non-contractual obligations in land issues that could sometimes drag out real estate development. Such situations would result in risk of financial or reputational loss arising from regulatory or legal action (Whalley, 2011). Financial loss could also occur as a result of expenses of litigation to a company (Johnson &Swanson, 2007)

When such issues arise, the value of any such property would tend to fall. In such cases most investors would need look at the level of legal risk associated with any type of real estate property before investing in order to protect their returns.

### 2.3.6 POLITICAL RISK

Political risk is often defined as the risk of adverse consequences arising from unexpected political events (Root, 1972 and Kobrin, 1979). This definition is useful because it is the unexpected nature of the event that would increase uncertainty and also investment risk. In

addition the greater the political instability in such markets, the more likely it would to lead to greater fluctuations in exchange rates making these locally volatile returns even more volatile. This would also have a profound effect on the risk of international investment, as instability in a host country's government, or monetary and fiscal policy would result in more uncertain investment returns (Brewer, 1993). In summary investors frequently shun the politically unstable regions of the world in order to avoid political risk.

As a responsibility, it is imperative for a government to strive to create the ideal economic conditions necessary for the market to thrive (Karley, 2002)

## 2.4 OPERATIONAL RISK

### 2.4.1 OPERATIONAL RISK MANAGEMENT

Operational risk could be said to be the risk that a firm would face when it does not operate as it should or fails to prevent risk from arising in its business, usually because the firm lacks sufficient internal checks and balances. This could take the form of fraud, security, privacy protection or environmental risk which might come up when it attempts to operate within a given field or industry (Gregoriou, 2009).

Operational risk could therefore be said to be human in nature; the risk of business operations failing due to human error. With this, an entrepreneur could control and minimize the negative effects of human risk by adopting a suitable risk management strategy. In accepting the notion that the volatility of performance has some negative impact on the value of the firm, would lead managers to consider operational risk as one of the major sources of investment risk.

### 2.4.2 VALUATION RISK

This form of risk would usually arise when there is the possibility that a financial instrument, in this case real estate, would mature or is sold in the market at an amount less than what was anticipated by the seller (Albuquerque et al, 2012). This failing underlies virtually all modern asset-pricing puzzles.

The valuation of property and property-related assets is inherently subjective. Therefore there are no assurances that the valuation of the properties and property-related assets will reflect actual sale prices even in cases where such sales occur shortly after the relevant valuation date. This risk could therefore be of concern for investors, lenders, regulators and other people involved in the financial markets. Overvalued assets for instance could create losses for their owners and lead to reputational risks; potentially impacting credit ratings, funding costs and the management structures of financial institutions (Gregoriou, 2009). Moreover, all property valuations, including the valuation report, are made on assumptions which might not reflect the true position of the owner.

## 2.5. CREDIT RISK

This form of risk would usually come about when a borrower wants to use his borrowings to service interest payments; this might present the risk that the investor might be unable to service interest payments and principal repayments or comply with other requirements of its loans, thus rendering borrowings immediately repayable in whole or in part, together with any attendant cost. The investor might then be forced to sell some of his assets to meet such obligations, with the risk that borrowings would not be able to be refinanced or that the terms of such refinancing may be less favorable than the existing terms of borrowing.

### 2.5.1CONSUMER CREDIT RISK

Increase in the price of real estate may increase the economic value of bank capital to the extent that banks now own real estate. Such activities would also increase the value of loans collateralized by real estate companies and investors and might lead to a decline in the perceived risk of real estate lending. For all of these reasons, an increase in the price of real estate would increase the supply of credit to the real estate industry, which in turn would be likely to increase real estate prices and vice versa (Herring &Wachte, 1999). All this would occur only if the price of real estate increases.

### 2.5.3 SECURITIZATION

In order to avoid cluster risk and benefit from greater flexibility in terms of investments, investors have increasingly been directing their attention toward indirect real estate investments in recent years. That would mean investing in real estate stocks, funds or investment trusts. Investors' money would now not be tied up directly in bricks and mortar but rather be traded freely in the form of a security. One method therefore of investing indirectly in real estate which has enjoyed increased popularity in recent years is *securitization*. Real estate securitization – also known as *asset swaps* – involves contributing one's own real estate to a real estate investment vehicle in return for a unit certificate.

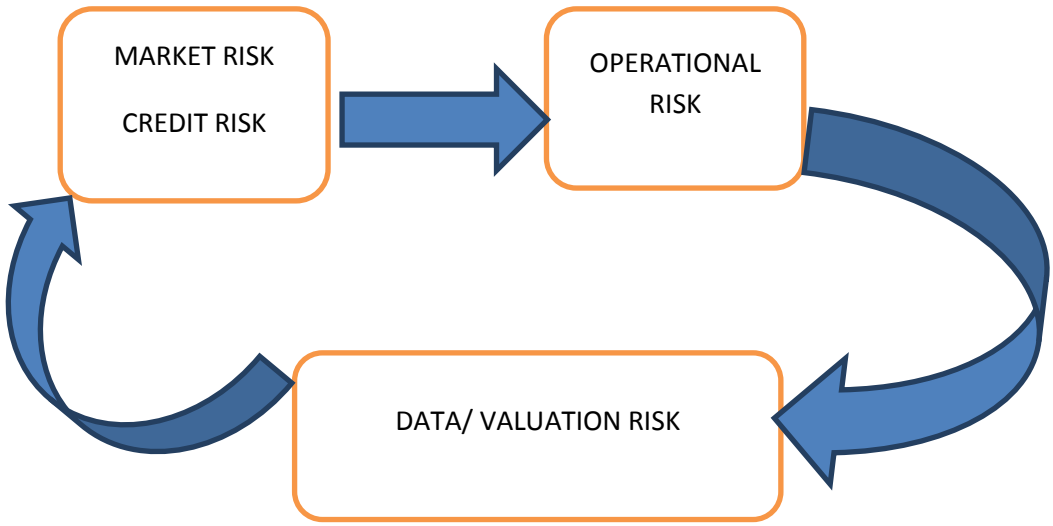
## 2.6 LIQUIDITY RISK

Real estate is a form of investment that takes considerable time to sell thereby making it illiquid, in cases where it is sold; the sale is usually below market value.

Such illiquidity might affect the investor's ability to vary his portfolio or liquidate part of his portfolio in a timely fashion and at satisfactory prices in response to changes in the economy, the

real estate market itself or other conditions. This could have adverse effect on the investor's financial position and on his operations, with a consequential adverse effect on the investor's ability to make expected distributions to his shareholders.

**FIGURE 3: LINKAGE BETWEEN TYPES OF RISK**




SOURCE: GARP Caribbean Chapter Meeting (2008)

The above graph shows that all these forms of risk are linked.

## 2.7 EMPIRICAL FRAMEWORK

There is evidence in literature to suggest that the housing market plays an important role in the macro economy and also how the performance of the economy could affect the housing market. As a result of this inter-relationship, it is therefore necessary to analyze this relationship between housing markets and the macro economy in a system which can assess the dynamic

interrelationship between housing and the relevant macroeconomic factors (Wei &Morley, 2007).

The importance of establishing this interrelationship to investors was seen in some empirical studies which tested these relationships , this was however done mainly on US data [ see Flanney & Protopadakis, (2002); Chen, 1991; Cheung & Ng, (1998), Humpe & Macmillan, (2007); and their results show that the changing values of these economic factors have the potential for explaining returns in the real estate markets.

Examination of existing empirical literature concerning the relationship between macroeconomic variables and property markets revealed a number of issues. First, many studies focused on the analysis of a single macroeconomic factor. Of these, a larger number were concerned with interest rates or inflation rates and few concerned themselves with the broader examination of the role of other macroeconomic variables in the return generation process [see Chan et al. (1990), McCue &Kling (1994), Bond &Seiler (1998), Quan &Titman (1999), Onder (2000), Brooks &Tsolacos (2001) and Liow et al. (2003)].

Also with few exceptions, most of these studies have been conducted in the United States. Some works have been done in the United Kingdom (Brooks &Tsolacos, 2001), Singapore (Liow, 2000; Liow et al., 2003), Turkey ( Onder, 2000) and Ireland (Stevenson & Murray, 1999), with a single contribution ( Okunev et al., 2002) in the Australian context.

Lastly, it was recognized that residential real estate returns are highly correlated with the changing demand fundamentals in the economic cycle, while commercial real estate returns are more closely aligned with changes in the liquidity cycle, reflecting the conduct of monetary

policy (Stringer, 2001). Finally, the manner in which market shocks are transmitted across time arouses interest in modeling the dynamics of the property return generation process.

For returns on property investments in Africa , macroeconomic factors have been seen to be a likely influence mainly due to the fact that most of the African economies are developing economies and as such very fragile and non-resilient to both internal and global shocks; therefore more responsive to the movement of economic variables. In this regard and consistent with the ability of investors to diversify, modern financial theory focused on the more common or systematic influences such as inflation, exchange rates, oil prices, interest rates among others as the likely sources of investment risk. The general conclusion of this theory therefore was macroeconomic variables present pervasive risks in any economy, which may not be rewarded through diversification. In such a market, firm or investor reward is positively correlated with amount of systematic risks that is borne. This means that in the long run, the return on individual asset reflect the influence of systematic economic fundamentals (Adu, 2012).

In view of these influences on African markets which are all mainly in transitional stages including that of Ghana, it would be in the interest of investors, government, academia, industry, regulatory bodies and many others to test the impact of macroeconomic variables on the real estate market, using a broader framework.

The idea that risk and uncertainty matter for demanded returns of an investment and those riskier investments should have a higher expected return than safer ones is quite intuitive (Damodaran, 2002).

## 2.8 OVERVIEW OF REAL ESTATE MARKET IN GHANA

The housing sector in Ghana has undergone fundamental changes since the 1990s. The Ghana Housing Corporation was set up by the then government in 1956 to build houses for people, especially those in the urban areas. During the Nkrumah regime, two main state bodies were formed to address the housing issue (i.e. the State Housing Corporation (SHC) and the Tema Development Corporation), with the special purpose of building residential units in the rapidly growing area of Accra and Tema respectively, as part of a major industrialization drive. A rural housing scheme was also initiated while the First Ghana Building Society - a quasi-government institution was set up to assist individuals through a mortgage scheme, to own houses.

Unfortunately these provisions had scarcely moved in tandem with demand especially with the growing population, leading to pockets of slums and communities that seemed to consist entirely of kiosks, containers and little communities that would end up on major roads or drainage systems. This situation caused the policy focus to shift away from direct state provision and move strongly towards active private sector participation in housing production, financing and production of building materials. In part, this was also due to the failure of public housing programs, dwindling state resources, unimpressive performance of state-owned enterprises, and recognition that the government alone was unable to solve the housing problem.

With the bulk of real estate provision being undertaken by the private sector who had determinedly been seeking to make up for the shortfall in the housing deficit by providing office blocks, shops, malls and other public buildings to address the housing, the Bank of Ghana, according to its 2007 statement on housing estimated that some 665,920 units would need to have been built in order to decrease the pressure on urban housing.

***TABLE 2: ESTIMATED AND PREDICTED HOUSING STOCK AND DEFCICT***

| YEAR | POPULATION | HOUSEHOLDS | ESTIMATED HOUSES REQUIRED | YEARLY REQUIREMENT |
|---|---|---|---|---|
| 2000 | 18,912,079 | 2,181,975 | 2,101,241 | 56,988 |
| 2001 | 19,422,705 | 3,808,374 | 2,240,220 | 58,896 |
| 2002 | 19,947,118 | 3,911,200 | 2,300,706 | 60,486 |
| 2003 | 20,485,690 | 4,016,802 | 2,362,825 | 62,119 |
| 2004 | 21,038,804 | 4,125,256 | 2,426,621 | 63,796 |
| 2005 | 21,606,852 | 4,236,638 | 2,492,140 | 65,519 |
| 2006 | 22,190,237 | 4,351,027 | 2,559,428 | 67,288 |
| 2007 | 22,789,373 | 4,468,505 | 2,628,532 | 69,105 |
| 2008 | 23,404,686 | 4,589,154 | 2,699,502 | 70,970 |
| 2009 | 24,036,613 | 4,713,061 | 2,772,389 | 72,887 |
| 2010 | 24,685,601 | 5,467,136 | 4,829,544 | 123,631 |
| 2011 | 25,324,611 | 5,614,749 | 4,959,942 | 126,970 |
| 2012 | 26,008,376 | 5,766,347 | 5,093,860 | 130,398 |
| 2013 | 26,710,602 | 5,922,038 | 5,231,395 | 133,918 |
| 2014 | 27,431,788 | 6,081,933 | 5,372,642 | 137,534 |
| 2015 | 28,172,446 | 6,246,145 | 5,517,704 | 141,248 |
| 2016 | 28,933,102 | 6,414,791 | 5,666,682 | 145,061 |
| 2017 | 29,714,296 | 6,587,991 | 5,819,682 | 148,978 |
| 2018 | 30,516,582 | 6,765,867 | 5,976,814 | 153,000 |
| 2019 | 31,340,530 | 6,948,545 | 6,138,188 | 157,131 |
| 2020 | 32,186,724 | 7,136,156 | 6,303,919 | 161,374 |

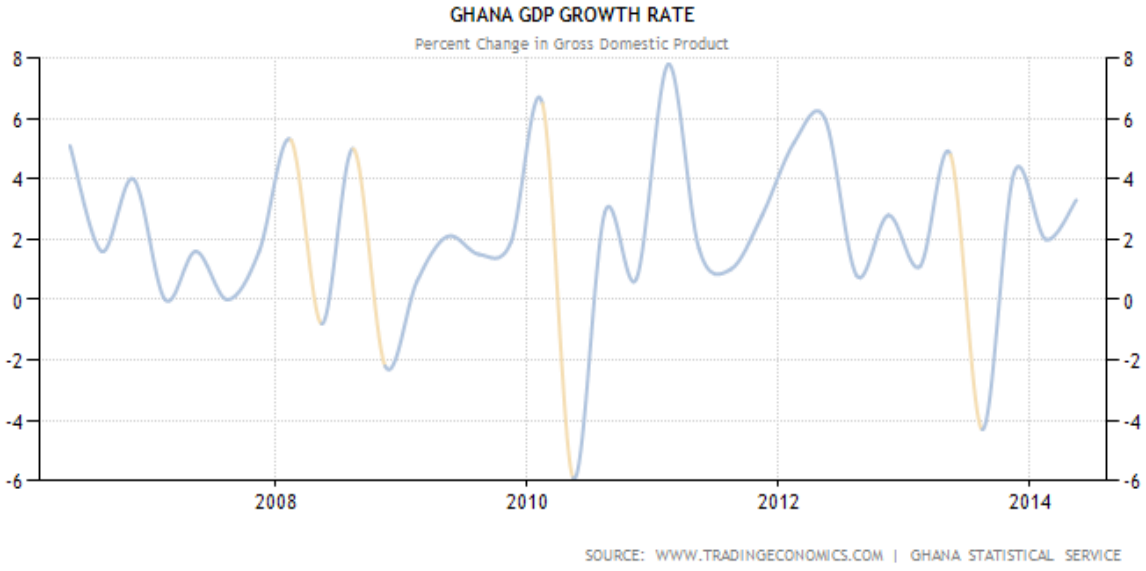
Source: Bank of Ghana 2007, Ansah &Ametepey (2013)

The above table shows that the population is expected to grow and with such an accompanying increase in household size; housing demand will also increase with a greater yearly requirement.

In spite of the above growth in population and subsequent increase in demand for housing, Household Spending is forecasted to decrease in 2016 to -6.04 percent. In the long-term, the Household Spending in Ghana is projected to trend around -5.27, 28.65 and 21.65 percent in the years of 2020, 2030 and 2050 respectively. Household Spending in Ghana is reported by the Ghana Statistical Service

Housing is usually the second largest expenditure item in a family budget (GLSS 5) and also a significant contributor to the economy in general. In the case of Ghana, there are ways to observe how housing plays a role in economy through GDP. For instance, construction of housing would be included in the investment category of total economic spending. On average over the past ten years, new residential housing investment accounted for about 4.8% of real GDP (Ghana Statistical Service, 2010). However, this proportion varied from period to period because this type of investment, like the investment category as a whole, typically varied much more widely over the business cycle (periods of recession and expansion) than overall GDP. The wider cyclical swings in residential investment are shown in the Chart below, which compares real GDP (thin blue line) and real private residential investment (thick red line) over the past 40 years. Recessions, are shown as the gray bars in the chart (Ghana Statistical Service).

**FIGURE 4: GDP AND RESIDENTIAL REAL ESTATE INVESTMENT**




However increased housing expenditure could strain a family budget; constrain availability of resources for other household needs such as utilities, education, health care, transportation, saving for retirement and emergencies. High housing costs also drain the family budget of expendable income that might otherwise be spent in the local economy, reducing the expenditure linkages of the household (Bank of Ghana, 2007).

### 2.8.1LEGAL FRAMEWORK

a. The 1992 Constitution of the Republic of Ghana.

b. The Land Registry Act 1962 (Act 122). This Act provides for the registration of instruments affecting Land and not the title to land. The Act attempted to provide a form of compulsory registration of deeds by providing in section 24 that '***an instrument, other than a will or a judge's certificate, first executed after the commencement of this Act, shall not have effect until it is registered***.'

c. The Land Title Registration Law, 1986 (PNDCL 152).

d. The Rent Act (Act 220) of 1963

e. The Republic of Ghana as far as the Building Code regime is concerned is governed by the National Building Regulations L1 1630 (1996) derived out of Act 462 – The Local Government Act of 1993.

f. The Partnership Act 152.

g. The Business Name Act 1962.

h. The Companies Code 1963.

i. The Ghana Investment Promotion Act (Act 478).

## 2.9 CHAPTER SUMMARY

This chapter looked at the theoretical background of risk- return relationship, and the dynamics of real estate operations. The various types of risk were grouped under four main headings: market risk, operational risk, credit risk and liquidity risk. According to GARP Caribbean Chapter Meeting (2008), there is a linkage among these forms of risk.

For developing countries whose economic growth and movement depends heavily on the broader macro economy, the major sources of risk are systematic risk or market risk or the macroeconomic variables. The Ghanaian economy is no different.

Real estate in Ghana has undergone fundamental changes since the 1990s. Policy focus has shifted away from direct state provision and has moved strongly towards active private sector participation in housing production, financing and production of building materials. With the rapid population growth rate and growing demand for housing, investors are coming in regularly to partake in this industry.

# CHAPTER THREE

# DATA DESCRIPTION AND METHODOLOGY

## 3.0. INTRODUCTION

This chapter in describing the research design for this study begins by describing the data to be used, followed by a review of precedent research methodologies, this would aid in deriving the model specification that would follow. The techniques used for data analysis are finally outlined.

## 3.1 DATA DESCRIPTION

The sample for this research was the registered GREDA (Ghana Real Estate Developers Association) members in Accra who have the greater markets share. The macroeconomic variables that were used in this research were GDP growth rate, unemployment rate, exchange rate, inflation rate, interest rate and number of houses sold. Data on the macroeconomic variables were collected from Ghana Statistical Service, Bank of Ghana, International Labor Organization, World Bank and World Development Indicators.

The time period (2000 to 2014) was chosen to make accommodation for changes in government in order to determine if that would also have an underlying effect on the macro economy which would also have an effect on the real estate sector.

Quarterly data was used from 2000 to 2014, however data for unemployment rate from 2000 to date and that of GDP growth rate (prior to 2006) are annual in nature, therefore a disaggregation of annual data to quarterly data was necessary for these two variables. According to Jacobs, Kroonenbeg &Wansbeek, (1992) a disaggregation of annual data into quarterly data is possible; therefore in using Matlab. Annual GDP growth rate and unemployment rate were thus

disaggregated to find the quarterly values from 2000 to 2005 for GDP growth rate and from 2000 to 2014 for unemployment rate. Quarterly data was used for this study to show the short run transition path that was present in the macroeconomic variables used.

### 3.2 METHODOLOGY

The focus of this study is the relationship between expected returns on real estate investment and macroeconomic variables in Ghana.

Various asset pricing models have emerged over time out of which the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT) have tried to scientifically measure the potential for assets( in this case real estate) to generate a return or a loss. Both of them are based on the efficient market hypothesis, and are part of the modern portfolio theory (Jecheche 2006).

In spite of this common underlying factor, the CAPM differs from APT in that it is a model that believes that the investment horizon is a single period. This assumption is one in which all investors have the same probability of all the assets; suggesting that a security could be added to a portfolio based only on its systematic risk/beta; which are calculated using historical data (Hu, 2008). The beta is only priced by the market because all non-systematic risk is eliminated by diversification. The equation below looks at what goes into the computation of CAPM:

$$R_a = R_{f+} \beta_a (R_{m-} R_f)$$

Where:

$R_f$ is the risk free rate

$R_m$ is the expected market return

$\beta_a$ is the beta of the security

It could therefore be said that the general idea behind CAPM would be that investors need to be compensated in two ways: time value of money and risk. The time value of money is represented by the risk-free ($R_F$) rate as seen in the formula above; the compensation for this is achieved by placing money in any investment over a period of time. The other half of the formula would also represent the risk calculated as the amount of compensation the investor would need for taking on additional risk. This would be calculated by taking a risk measure (beta) that compares the returns of the asset to the market over a period of time and to the market premium (Rm-rf)

Another distinguishing factor between APT and CAPM is that APT rests on the hypothesis that the equity price is influenced by limited and non-correlated common factors and by a specific factor totally independent from the other factors (Jecheche 2006). The core idea of the APT would be that only a small number of systematic influences affect the long term average returns of securities.

In 1986, a single factor CAPM model was used in UK and found that tests of the single factor CAPM model were very disappointing and CAPM was rejected in favor of APT (Beenstock& Chan, 1986).

The major issue that might come up with the adoption of Arbitrage Pricing Theory would be it leaves it up to the investor to identify each of the factors on a particular stock. Therefore, the real challenge for the investor would be to identify three items: each of the factors affecting a particular stock in order to know the measures to be taken to protect against these factors, the expected returns for each of these factors to know how profitable they would be, the sensitivity of the stock to each of these factors and how they would affect productivity.

Identifying and quantifying each of these factors is no trivial matter, and is one of the reasons the Capital Asset Pricing Model remains the dominant theory to describe the relationship between a stock's risk and return.

In spite of this, the CAPM also has shortcomings that prevent it from being adopted in this research. One major reason why the CAPM will not be adopted in this research is CAPM explains the expected returns only by a single variable, the risk of an asset relative to the market. It is reasonable to assume that other factors influence the expected returns.

### 3.3 MODEL SPECIFICATION

Using 14 year (60 quarters) data on the six macroeconomic variables, a time series regression was ran under the broader framework of the Vector Autoregressive Model against Expected Returns of real estate firms.

The theoretical model assumed by this study is:

$$E(R)_t = \alpha + \beta_1 \log(IF)_t + \beta_2 log\,(IR_t) + \beta_3 \log(GDP_t) + \beta_4 \log(EXC_t) + \beta_5 \log(UMP_t) + \beta_6 NHS_t + \varepsilon_i$$

Where:

$E(R)_t$ = returns expected as a result of that asset's sensitivity to the common Factors

IF = Inflation rate

IR= Interest rate

GDP = Gross Domestic Product Growth rate

EXC= Exchange rate

UMP = Unemployment rate

NHS= number of houses supplied

$\beta_{it}$ = risk exposure or beta of asset i

$\varepsilon_i$ = is the returns that arise from asset-specific, or idiosyncratic events, assumed to be mutually independent over time and negligible for large numbers of assets (that is , the risk of change in expected return due to the unique circumstances of a specific security)

This study attempts to test the hypothesis that:

$H_0$: There is no relationship between Real estate returns and macroeconomic variables.

$H_1$: There is a relationship between Real estate returns and macroeconomic variables.

### 3.4 CHOICE OF VARIABLES

An approach for assessing the risk in residential real estate was outlined based on the premise that the most important source of risk is the market's fundamentals (Wheaton et al, 2001). These market fundamentals could be Gross Domestic Product, Inflation rate, Interest rate and Exchange rate; to mention a few. There has been evidence to suggest that the housing market plays an important role in the economy and also the performance of the economy could affect the housing market. As a result of this inter-relationship, it is more appropriate to analyze the relationship between housing markets and the macroeconomic variables in a system which can assess the dynamic interrelationship between housing and the relevant macroeconomic factors.

Ferson & Harvey (1991) found that the Treasury bill rate, interest rate term structure, and unexpected inflation rate affected the return on real estate. Watuwa & Scotia, (2008), concentrated on the effects of economic and financial factors on real estate investment, choosing property returns, the nominal interest rate, and growth rate of industrial production, unexpected

inflation, dividend yields and the interest rate spreads. The choice of variables used in the above works both have unexpected inflation and interest rate as factors that affect return on real estate. In addition to those, this study adopted GDP growth rate, Exchange rate, unemployment rate and number of houses sold as factors that affect return on real estate.

The sources of risk go beyond those mentioned in this study so further researches would have the opportunity to broaden the scope in order to add more knowledge to available literature.

### 3.4. 1 EXPECTED RETURNS (DEPENDENT VARIABLE)

Property level investment data are generally not accessible to academic researchers; most research relies on real estate indices to analyze the risk and returns of real estate investments; however the risk and return characteristics at the property level are not necessarily similar with the risk and returns of indices.

Therefore research should focus on *individual property investments*, instead of indexes, for the measure of actual risks taken and returns earned by residential real estate investors (Peng, 2010).Ghana does not have a body that calculates price indexes for the real estate sector; as such any method that adopts this approach will be faced with difficulty resulting from data unavailability.

The expected return from the sale of a residential property from quarter $t$ to $t$ +1 is calculated as either a percentage of capital or a percentage of the price of the property sold; for the purposes of this research, expected returns will be calculated as a weighted average of the returns made by the selected real estate companies (selection based on those with greater market share). This was mainly due to the data that was made available by the companies.

### 3.4.2 INFLATION

The relationship between inflation and property returns is a recurrent theme in the literature [see Hoesli (1994), Bond & Seiler (1998), Quan &Titman (1999), Stevenson & Murray (1999)]. Bond & Seiler (1998) justified this interest on the basis that financial assets, such as common stocks and bonds, have been found to be poor performers when inflation is higher than expected. Therefore if real estate is an effective hedge against expected inflation, then it should likely be included in efficient portfolios. Inflation affects the asset markets especially property markets because investors would require a higher risk premium when they believe there is a higher risk of future inflation. In the case of a family, inflation will affect individual consumption because if households expect future inflation they will increase their current consumption. The inflation rate is calculated by the percentage change of the Consumer Price Index (CPI), for the purposes of this research Non-Food CPI would be used.

### 3.4.3 INTEREST RATE

As a form of risk, the actions of interest rates can be seen in the residential housing market, where higher interest rates might lead to weak housing sales, rising inventories of homes for sale, and falling housing prices. These, in turn, would make building houses less profitable, and so builders would be less likely to construct more new houses, creating an overall reduction in residential construction. Interest rates could be considered as one of the good indicators of economic activity and are therefore deemed to contain information about property return movements. The main reason for this link would be the assumption that returns relate directly to the present and future state of the economy and that of business conditions; all these are in part governed by interest rates (Brooks &Tsolacos, 2001). Several empirical studies have also found that interest rates help explain a significant proportion of the variability in property returns [Chen

et al. (1986), Chan et al. (1991), McCue & Kling (1994), Liow (2000), Brooks &Tsolacos, (2001) and Liew et al., (2003)]. The 91-day Treasury bill would be used for its computation in this research.

### 3.4.3 UNEMPLOYMENT RATE

The contention that macro demand and supply conditions influence property returns has also been addressed by focusing on its link with real estate construction (Eppli et al., 1998), industrial production (Karolyi & Sanders, 1998), stock markets (Quan& Titman, 1997, 1999; Lizieri& Satchell, 1997), aggregate consumption (Ling & Naranjo 1997, 1998; Crone &Voith, 1999) and monetary policy (Johnson & Jenson, 1999). In this case, unemployment rates would act as a proxy for macro demand mainly because people who have either lost their job or fear losing their job would not be able to afford to move to a larger rental apartment or from a rental unit to purchase a residence whether it is a single family home, co-operative apartment or a condominium ;on the other hand also those who are gainfully employed would be able to increase their expenditure in terms of household spending thus influence property returns.

### 3.4.4 GDP GROWTH RATE

GDP (Gross Domestic Product) growth rate is a macro economic indicator of the strength of businesses, relative wealth of workers and the overall strength of the economy and is sometimes used by businesses and investors to determine how efficient capital deployment would be. Businesses use GDP numbers to also determine whether to increase or reduce employment and in addition evaluate business opportunities domestically in order to develop their cash deployment strategies. GDP growth rate can therefore be seen as a major source of risk to investors who are considering investing into an emerging market.

### 3.4.6 EXCHANGE RATE

Any financial activity that is cross border in nature would mean that focus would not only be on cash flow patterns—changes in rents and capital values in the case of real estate—but also on the impact of currency movement. Fluctuations in these currency values, whether the home currency or the foreign currency, can either enhance or reduce the returns associated with foreign investments. Exchange rate changes affect the prices of imported goods; mainly through changes in the demand for imports especially if building materials are imported. A real depreciation of the domestic currency makes building materials more expensive hence increasing the cost of construction.

Incorporating exchange rate volatility into the analysis of an investment can substantially alter the expected return and risk characteristics of the investment (Sirmans &Worzala, 2003). The impact of exchange rate volatility on the returns of foreign investments and currency risk management could be considered to be one of the important areas of risk management in international investment (Solnik, 1996), especially if the exchange rate exposure is significant. This presupposes that exchange rate volatility has a significant negative impact on foreign real estate investment returns. However, according to Addae-Dapaah & Hwee, 2007, this claim has not been conclusively proven.

### 3.4.7 NUMBER OF HOUSES SOLD

The investment duration of real estate is relatively long (18 quarters on average), so properties acquired near the end of the year are less likely to be resold by the next year and thus included in the sample. The number of houses sold would affect expected returns based on the revenue gained from the sale of each house, so the more the number of houses sold the higher the expected returns. The number of houses sold would be used as a proxy for industry supply. Due

to the fact that this research looks at risk and real estate investment, the individual deviations from the mean of all the variables mentioned above will be used in the analysis to measure risk.

### 3.5RESEARCH METHOD

The VAR (Vector Autoregressive) Model was proposed to be used in this present study mainly because it summarizes the dynamics of macroeconomic data (Canova 2007).

A VAR model is an n-equation; n-variable model which relates each variable in the system based on the premise that each variable is explained by its own lagged values plus current and past values of the other remaining *n-1* variables and works with the assumption that all the variables are endogenous. According to Brooks and Tsolacos (1999:143) a standard form VAR model with *p* equations is described as:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \cdots + \beta_p Y_{t-p+} \mu_t$$

Where:

Y = the set (or $p \times 1$ vector) of variables included in the system

$\beta$terms are the sets of coefficients ($\beta_0$is a $p \times 1$ vector of constants),

$\beta_1$ *to* $\beta_p$= $p \times p$ matrices of coefficients on lagged variables,

m = the number of lags of each variable in the equation

$\mu_t$ = a set of error terms which are assumed to be mutually uncorrelated and independent of the Ys.

VAR Models are used here to estimate the empirical evidence on the response of expected returns to various exogenous impulses (macroeconomic variables) in order to discriminate between alternative theoretical models of the economy. This simple framework provides a systematic way to capture rich dynamics in multiple time series.

The adoption of VAR model would provide the following advantages to this study

1. According to Sim, (1980) and McNees, (1986), VAR could give better forecasts as compared to structural simultaneous equations.
2. Vector autoregressive models also make it possible to approximate the actual process by arbitrarily choosing lagged variables.
3. The selection criteria for the appropriate lag length are used to avoid over parameterizing the model and produce a parsimonious model. Thereby, one can form economic variables into a time series model without any explicit theoretical idea of the dynamic relations (Fuss, 2008).

In the regression of time series macroeconomic data; the vast majority of which are non-stationary at their levels, on other non-stationary series it is most likely to generate spurious regression results. Therefore it is important that all the variables in the model are tested for stationarity using the Augmented Dickey-Fuller (1979) stationarity tests. The Augmented Dickey-Fuller (ADF) test is used in this study instead of the original DF-test because the ADF-test in terms of augmentation leads to empirical white noise residuals (Arthur, 1999).

Failure to reject the null hypothesis that a series contains a unit root will lead to differencing the series until the variables are stationary for use in VAR. This is done before issues such as co-integration which helps to examine the long run relationship between economic variables are addressed.

In cases where co-integration is found to be present, an error correction mechanism which could help to capture both the long run and short run relationships among the variables would be used (Arthur, 1999). The advantage of the error correction model is that it does not put a priori restrictions on the model and separates long-run and short-run effect.

The next stage would be to assess the predictive power of the model; achieved through the application of the Error Variance Decomposition. This measure is constructed from a VAR/ VECM (Vector Error Correction Model) with orthogonal residuals (the percentage of the variance of the forecasted variable attributable to alternative right-band-side variables at different horizons) (Sims, 1972).

The variance decomposition of a VAR gives information about the relative importance of the various variables in explaining the variations in expected returns. The impulse response function would also be done to trace the response of an endogenous variable; in this case expected returns, to a change in one of the innovations (macroeconomic variables). Specifically, it would trace the effect on current and future values of the endogenous variable of one standard deviation shock to one of the innovations

## 3.6 ETHICAL ISSUES AND CONSIDERATIONS

Newman (2007) stated in the pursuit of knowledge, the researcher should balance his study with

1. Protection of rights of participants. Everyone who participates in the study should have freely consented to participation, without being coerced or unfairly pressurized. This means they should be well-informed about what participation entails, and reassured that declining will not affect any services they receive. While written consent may in some situations frighten the individuals, at the very least obtain verbal consent should be obtained.
2. Develop trusts with participants. The identity of the participants must be protected at all times during the data collection process and not be left lying around in notebooks or un-protected computer files.
3. Promote integrity. Questions will be presented in a manner such that it may not create distress during an interview, or emerge after.
4. Guard against misconduct in any form towards participants.

## 3.7 CHAPTER SUMMARY

This chapter in describing the research design for this study begun by reviewing the precedent research methodologies followed with a description of the nature of this research, its data collection method and sample used , followed by the model specification . The techniques used for data analysis were finally outlined.

Vector Autoregressive (VAR) Model was adopted in this present study, which works with the assumption that all the variables are endogenous. The variables used in the study were Expected returns, GDP growth rate, Exchange rate, Inflation rate, Interest rate, Unemployment rate and

Number of houses sold. These variables were chosen based on literature and interviewing the various real estate companies.

The individual deviations from the mean of these variables were used in their computations mainly because this study looks at risk, the weighted averages of the expected returns from the real estate companies were used to compute the expected returns. The real estate companies used were chosen based on their market share and only those with the greater market share were used since results from such areas would help in generalization.

# CHAPTER FOUR

# DATA PRESENTATION AND ANALYSIS

## 4.0. INTRODUCTION

The objectives of this chapter were to firstly investigate whether there was an interaction between returns from the property markets and macroeconomic variables, to which degree of variation in expected returns was explained by the macroeconomic variables and if these variables pose a great risk to expected returns. This would be done be first assuming that all the variables are endogenous and employ the VAR model; which would allow for the investigation of whether these variables have significant causal effects on each other. Secondly, it would also enable the determination of the size and nature of the impact of these variables on expected returns.

## 4.1LAG SELECTION

An important issue to consider in Vector Autoregressive Model is the estimation of the lag length; in order to avoid over parametization for a parsimonious model. Many lag length selection criteria have been employed in economic study to determine the lag length of time series variables; these include the Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SIC), Hannan-Quinn Criterion (HQC), Final Prediction Error (FPE), and Corrected version of AIC.

In many of these studies it was found that BIC was the best for large samples and useful for selecting true lag length in presence of regime shifts or shocks to the system (Asghar**,**Zahid & Irum, (2007). The Schwarz's Bayesian Information Criterion (SIC) was also

mainly recommended for quarterly data analyses that have a sample size of less than 120 observations (Ivanov & Kilian, 2001).

Liew (2004) found that Akaike's information criterion (AIC) and Final Prediction Error (FPE) were more superior to the other criteria in the case of smaller sample sizes (60 observations and below), in the manner that they minimized the chance of under estimation while maximizing the chance of recovering the true lag length. Also, AIC and FPE were found to produce the least probability of under estimation among all criteria (Liew, 2004).

With relatively large sample (120 or more observations), HQC was found to outdo the rest in correctly identifying the true lag length (Liew, 2004).

The sample size for this study is 60 quarters and as such AIC and FPE would be used as the lag length selection criteria. The table below shows the various lag selection criteria.

**TABLE 3: LAG SELECTION RESULTS**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -925.3698 | NA | 1250739. | 33.90436 | 34.15984 | 34.00315 |
| 1 | -640.7212 | 486.4902 | 240.9826 | 25.33532 | 27.37915* | 26.12568* |
| 2 | -602.9259 | 54.97511 | 394.1564 | 25.74276 | 29.57494 | 27.22469 |
| 3 | -558.5868 | 53.20688 | 588.8625 | 25.91225 | 31.53278 | 28.08575 |
| 4 | -507.0932 | 48.68481 | 883.2927 | 25.82157 | 33.23046 | 28.68665 |
| 5 | -388.0629 | 82.23915* | 183.3107* | 23.27501* | 32.47225 | 26.83166 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Author's Calculation

A five period lag was deemed appropriate for our analysis on the basis of Lag Selection Criteria results above, which is based on the minimum values of AIC and FPE (Hu, 2007).

The variables used in this study were Expected Returns (ER), Inflation rate (CPI), Interest rate (91D.TB), Exchange rate (EXC), Unemployment rate (UMP) and Number of houses sold (NHS), these have been written in a VAR framework as seen below:

$$(ER)_t = \beta_0 + \sum_{i=1}^{5}[\alpha_i (ER_{t-i}) + \beta'_i(X_{t-i}) + \mu_{t-i}]$$

$$CPI_t = \beta_0 + \sum_{i=1}^{5}[\alpha_i (CPI_{t-i}) + \beta'_i(X_{t-i}) + \mu_{t-i}]$$

$$91D.TB_t = \beta_0 + \sum_{i=1}^{5}[\alpha_i (91D.TB_{t-i}) + \beta'_i(X_{t-i}) + \mu_{t-i}]$$

$$EXC_t = \beta_0 + \sum_{i=1}^{5}[\alpha_i (EXC_{t-i}) + \beta_i'(X_{t-i}) + \mu_{t-i}]$$

$$UMP_t = \beta_0 + \sum_{i=1}^{5}[\alpha_i (UMP_{t-i}) + \beta'_i(X_{t-i}) + \mu_{t-i}]$$

$$GDP_t = \beta_0 + \sum_{i=1}^{5}[\alpha_i (GDP_{t-i}) + \beta'_i(X_{t-i}) + \mu_{t-i}]$$

$$NHS_t = \beta_0 + \sum_{i=1}^{5}[\alpha_i (NHS_{t-i}) + \beta'_i(X_{t-i}) + \mu_{t-i}]$$

Where:

$\beta_0$ is the vector of constants

$\alpha_i$ is the coefficient of the lagged dependent variables

$\beta'$ is the vector of coefficients of $X_t$,

$X_t$ the vector of lagged explanatory variables other than lagged dependent variable

$\mu_t$ error term

## 4.2 UNIT ROOT TESTS

A requirement for all variables that would be included in a VAR model is stationarity. Hence, all variables were subjected to Augmented Dickey—Fuller (ADF) tests. In the case where there was evidence that the log of the variables contained a unit root; these variables would be differenced until those variables became stable before being used in subsequent analysis. Any of the variables that led to the rejection of the null hypothesis of a unit root in the log-levels, were differenced.

The Augmented Dickey—Fuller (ADF) tests the hypothesis:

$H_o$ = There is unit root in the log-levels

$H_A$ = There is no unit root in the log levels

Below are the results of the unit root test

**Table 4: UNIT ROOT TESTS RESULTS**

| LEVELS | | | | | FIRST DIFFERENCE | | |
|---|---|---|---|---|---|---|---|
| Variables | T-stat | Critical values | P-value | Variables | T-stat | Critical values | P-value |
| E[R] | -3.789 | -3.547<br>-2.912<br>-2.593 | 0.0803 | | | | |
| GDP | -1.108 | -2.607<br>-1.947<br>-1.613 | 0.2740 | GDP | -5.755 | -4.467<br>-3.644<br>-3.261 | 0.0007 |
| EXC | 1.253 | -3.548<br>-2.913<br>-2.594 | 0.9982 | EXC | -4.756 | -4.394<br>-3.612<br>-3.243 | 0.0045 |
| CPI | -2.799 | -4.468<br>-3.645<br>-3.261 | 0.2125 | CPI | -5.179 | -4.416<br>-3.622<br>-3.248 | 0.0020 |
| 91 D.TB | -2.486 | -4.374<br>-3.603<br>-3.238 | 0.335 | 91D.TBIL | -5.229 | -4.394<br>-3.612<br>-3.243 | 0.0016 |
| UMP | -3.754 | -4.416<br>3.6220<br>-3.249 | 0.2387 | UMP | -8.014 | -4.441<br>-3.632<br>-3.254 | 0.0001 |
| NHS | -2.971 | -4.121<br>-3.488<br>-3.172 | 0.1490 | NHS | -6.728 | -4.416<br>-3.622<br>-3.248 | 0.0000 |

Source: Author's Calculation

Where;

ER is Expected Returns, EXC is Exchange Rate, GDP is GDP Growth Rate, CPI is the proxy for Inflation Rate, 91 D.TB is the proxy for Interest Rate, UMP is Unemployment Rate and NHS is the Number of Houses Sold.

The results from the test above indicate that all the variables except E[R] were non-stationary in levels. After first differences, the non- stationary variables were stationary; thus, we fail to reject the null hypothesis that each series is stationary.

We now move on to check if there is any co-integrating relationship between the variables, this would be done if each series is integrated of order I(1) but from the above it can be seen that one variable ( E[R]) is integrated of order I(0).

The three main methods for testing for co-integration are:

1. Engle–Granger Two-Step Method
2. Johansen Test
3. Phillips–Ouliaris Co-integration Test

For the purposes of this study the Johansen Test will be adopted; mainly because the Johansen test for co-integration that allows for more than one co integrating relationship, unlike the Engle–Granger method. Although Johansen's methodology is typically used in a setting where all variables in the system are I(1), having stationary variables in the system is theoretically not an issue and Johansen (1995) states that there is little need to pre-test the variables in the system to establish their order of integration. If a single variable is I (0) instead of I (1), this will reveal itself through a co-integrating vector whose space is spanned by the only stationary variable in the model (Österholm & Hjalmarsson 2007).

The Johansen Co-Integration Test tests the hypothesis

$H_o$ = There is no co-integration among variables
$H_A$ = There is Co-integration among variables

**Table 5:CO-INTEGRATION TESTS RESULTS**

Unrestricted Co-integration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.714244 | 231.1812 | 125.6154 | 0.0000 |
| At most 1 * | 0.592131 | 161.0347 | 95.75366 | 0.0000 |
| At most 2 * | 0.514565 | 110.8134 | 69.81889 | 0.0000 |
| At most 3 * | 0.410839 | 70.34162 | 47.85613 | 0.0001 |
| At most 4 * | 0.305921 | 40.71447 | 29.79707 | 0.0019 |
| At most 5 * | 0.236531 | 20.26501 | 15.49471 | 0.0088 |
| At most 6 * | 0.087888 | 5.151607 | 3.841466 | 0.0232 |

Trace test indicates 7 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.714244 | 70.14648 | 46.23142 | 0.0000 |
| At most 1 * | 0.592131 | 50.22134 | 40.07757 | 0.0026 |
| At most 2 * | 0.514565 | 40.47177 | 33.87687 | 0.0071 |
| At most 3 * | 0.410839 | 29.62715 | 27.58434 | 0.0270 |
| At most 4 | 0.305921 | 20.44946 | 21.13162 | 0.0621 |
| At most 5 | 0.236531 | 15.11340 | 14.26460 | 0.0366 |
| At most 6 * | 0.087888 | 5.151607 | 3.841466 | 0.0232 |

Max-eigenvalue test indicates 4 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's Calculation

According to the Johansen co-integration test above, both the maximum eigenvalue and the trace test rejected the null hypothesis of no co-integrating equation.

The trace test tests the null hypothesis of $r$ co-integrating vectors against the alternative hypothesis of $n$ co-integrating vectors. The maximum eigenvalue test, on the other hand, tests

the null hypothesis of $r$ co-integrating vectors against the alternative hypothesis of r + *1* co-integrating vectors (Österholm & Hjalmarsson 2007).

The maximum eigenvalue test result suggested that there were 4 co-integrating equations at the 5 percent significance level. The trace test also indicated that there were 7 co-integrating equations at 5 percent levels of significance. This shows there is long run association between the variables. It is not uncommon to find that both tests provide different number of co-integrating equations as was seen; however based on the works of Luutkepol at al, 2001, the results from the maximum eigenvalue test are selected. This is mainly because in the small sample size such as this one, trace test suffers from an excessive size distortion than the maximum eigenvalue tests (Luutkepol at al, 2001).

Due to the presence of co-integration as seen in the tables above, a Vector Error Correction Model (VECM) will be employed in place of a VAR model.

### 4.3 VECTOR ERROR CORRECTION MODEL (VECM)

**Table 6: VECTOR ERROR CORRECTION MODEL TABLE**

For the co-integration equation, the first lags of Expected returns, interest rate, inflation rate and exchange rate were present. There was a negative relationship between the first lag of expected return and present expected return, meaning if there was an increase in the past value then the next value would fall. The first lag of Exchange rate in the co-integration relationship had a positive relationship with expected returns, meaning an increase in the exchange rate would lead to an increase in the value of expected returns. The first lag of interest rate had a negative relation with expected returns; so as interest rate increases, expected returns falls. This follows from economic theory because as cost of boring of borrowing increases, firms will not be able to

invest into as many houses. The first lag of inflation rate has a negative relationship with expected returns which shows that as inflation rate increases then expected returns would fall. This also follows from economic theory because as cost of building products increase, cost of production would also increase resulting in an increase in the property prices. Not many people would be able to afford the new prices causing the firms to sell at a lower price which would result in a loss. This also confirms the general financial economics axiom that property is a hedge against inflation.

Where:

C1 to C4 are the coefficients of the co-integrated equations.

C5 to C39 are the coefficients of the lagged variables

C40 is the constant of the model.

| | Variables | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|---|
| **C(1)** | **D(ER(-1))** | **-2.481279** | **1.125569** | **-2.204466** | **0.0300** |
| **C(2)** | **D(91D.TB(-1))** | **-0.009635** | **0.004452** | **-2.164009** | **0.0331** |
| C(3) | D(CPI(-1)) | -0.000784 | 0.000634 | -1.236107 | 0.2196 |
| C(4) | **D(EXC(-1))** | **0.555744** | **0.194218** | **2.861444** | **0.0052** |
| C(5) | D(ER(-1)) | 0.265702 | 1.034814 | 0.256763 | 0.7979 |
| C(6) | D(ER(-2)) | -0.250556 | 0.927905 | -0.270024 | 0.7878 |
| C(7) | D(ER(-3)) | -0.455495 | 0.719034 | -0.633482 | 0.5280 |
| C(8) | D(ER(-4)) | -0.833204 | 0.462739 | -1.800591 | 0.0751 |
| C(9) | D(ER(-5) | -0.501896 | 0.322322 | -1.557126 | 0.1229 |
| C(10) | D(91D.TB(-1) | 0.006329 | 0.003967 | 1.595455 | 0.1141 |
| C(11) | D(91D.TB(-2) | 0.003364 | 0.003626 | 0.927650 | 0.3560 |
| C(12) | D(91D.TB(-3) | 0.002722 | 0.002699 | 1.008590 | 0.3158 |
| C(13) | D(91D.TB(-4) | 0.001208 | 0.001936 | 0.623926 | 0.5342 |
| C(14) | D(91D.TB(-5) | 0.002489 | 0.001279 | 1.946412 | 0.0547 |
| C(15) | D(CPI(-1) | 0.000450 | 0.000633 | 0.710810 | 0.4790 |
| C(16) | D(CPI(-2) | 0.000387 | 0.000643 | 0.601718 | 0.5489 |
| C(17) | D(CPI(-3)) | 0.000409 | 0.000679 | 0.602801 | 0.5481 |
| C(18) | D(CPI(-4) | 0.000389 | 0.000697 | 0.558808 | 0.5777 |
| C(19) | D(CPI(-5) | 0.000447 | 0.000704 | 0.635240 | 0.5269 |
| **C(20)** | **(EXC(-1)** | **-0.549238** | **0.184104** | **-2.983294** | **0.0037** |
| **C(21)** | **(EXC(-2)** | **-0.747967** | **0.194157** | **-3.852383** | **0.0002** |
| **C(22)** | **(EXC(-3)** | **-0.831958** | **0.194559** | **-4.276112** | **0.0000** |

| | | | | | |
|---|---|---|---|---|---|
| **C(23)** | **(EXC(-4)** | **-0.847882** | **0.222706** | **-3.807180** | **0.0003** |
| **C(24)** | **(EXC(-5)** | **-0.330500** | **0.137684** | **-2.400422** | **0.0184** |
| C(25) | D(GDP(-1) | -0.010359 | 0.009190 | -1.127238 | 0.2626 |
| C(26) | D(GDP(-2) | -0.009292 | 0.008590 | -1.081715 | 0.2822 |
| **C(27)** | **(GDP(-3)** | **-0.016960** | **0.008200** | **-2.068218** | **0.0415** |
| **C(28)** | **(GDP(-4)** | **-0.019296** | **0.007764** | **-2.485304** | **0.0148** |
| C(29) | D(GDP(-5) | -0.008025 | 0.004058 | -1.977671 | 0.0510 |
| **C(30)** | **(NHS(-1)** | **0.001890** | **0.000751** | **2.516710** | **0.0136** |
| **C(31)** | **(NHS(-2)** | **0.002283** | **0.000736** | **3.103374** | **0.0025** |
| **C(32)** | **(NHS(-3)** | **0.002573** | **0.000780** | **3.299225** | **0.0014** |
| **C(33)** | **(NHS(-4)** | **0.001636** | **0.000756** | **2.165350** | **0.0330** |
| C(34) | D(NHS(-5) | 0.000315 | 0.000419 | 0.751559 | 0.4543 |
| **C(35)** | **(UMP(-1)** | **-0.044263** | **0.014639** | **-3.023578** | **0.0032** |
| **C(36)** | **(UMP(-2)** | **-0.038107** | **0.011005** | **-3.462653** | **0.0008** |
| **C(37)** | **(UMP(-3)** | **-0.030535** | **0.009736** | **-3.136236** | **0.0023** |
| **C(38)** | **(UMP(-4)** | **-0.022931** | **0.008288** | **-2.766934** | **0.0069** |
| C(39) | D(UMP(-5) | -0.005873 | 0.005504 | -1.067018 | 0.2888 |
| **C(40)** | **Constant** | **0.022765** | **0.008920** | **2.552208** | **0.0124** |
| **Variables** | | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.** |

Source: Author's Calculation

The negative impact could be as a result of the country's inflation-targeting monetary policy. Thus as inflation rises, the market expects short-term interest rates to rise but in the long run inflation is captured in house prices.

For the long run, results of our study showed that the growth in expected returns was influenced mainly by exchange rate(EXC), GDP growth rate(GDP), unemployment rate (UMP) and number of houses sold (NHS).

It could be seen that the lagged values of Exchange rate had a negative relationship with expected returns in the long run. Meaning as the exchange rate increased the value of expected returns fell in the long-run. The third and fourth lags of GDP growth rate had a negative relationship with expected returns.

The first four lags of number of houses sold had a positive relation with expected returns. So as the number of houses sold increased, the expected returns would be higher in the long run. Also, the first four lags of unemployment rate had a negative relationship with expected returns in the long run, so as the number of people who were unemployed increase, expected returns would also fall because unemployed people would not be able to increase their demand for houses in the long run.

The short run coefficients show lags of expected return, interest rate, inflation rate and the fifth lags of number of houses supplied and unemployment rate have a short run association with expected returns. The first second and fifth lags of GDP growth rate also have a short run association with expected returns.

The second third and fourth lags of expected returns showed a negative relationship between expected returns and its lags; while the first lag had a positive relationship with expected returns.

The lags of interest rate and inflation had a positive relationship with expected returns in the short run. This means that as both variables increased, there was also an associated increase in expected returns. The fifth lags of both unemployment rate and number of houses sold showed negative and positive relationship respectively with expected returns in the short run.

C1 is error correction term or speed of adjustment towards equilibrium (Aboubacar et al, 2014). Speed of adjustment is 200% meaning it is adjusting very fast towards long run equilibrium. C1 is significant at 5%.

All variables having their p-values being less than 5% are long run coefficients while those with their p-values being greater than 5%, are all short run coefficients. C19 is the constant which is also significant.

From appendix 4, it can be seen that R-squared is relatively high; error correction model can therefore be said to be statistically viable. F-statistic is significant; all independent variables can jointly influence the dependent variable.

**4.4VECGRANGER CAUSALITY TEST**

The Granger causality test is a statistical hypothesis test used for determining whether a one time series is useful in forecasting another. Ordinarily, regressions reflect "*mere*" correlations, but causality on the other hand could be used to test time series' ability to predict the future values of a time series using prior values of another time series. If a time series is a stationary process, the test is performed using the level values of the variables.

A multivariate generalization of granger causality, known as *block-causality*, was used to check whether the lags of one variable *granger cause* any of the variables in the system.

$H_o$ = Lags of excluded variables do not "Granger cause" the dependent variable

$H_A$ = Lags of excluded variables "Granger cause" the dependent variable

The table below shows granger causality tests for expected returns (E[R]).

**Table 7: Dependent variable (Differenced E[R])**

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(91D.TB) | 1.638309 | 2 | 0.4408 |
| D(CPI) | 2.439015 | 2 | 0.2954 |
| D(EXC) | 14.51593 | 2 | 0.0007 |
| D(GDP) | 4.934744 | 2 | 0.0848 |
| D(UMP) | 3.139527 | 2 | 0.2081 |
| D(NHS) | 1.507667 | 2 | 0.4706 |
| All | 30.80723 | 12 | 0.0021 |

Source: Author's Calculations

From the table above; the lags of exchange rate[D(EXC)]taken together "Granger cause" Expected returns[D(ER)], therefore they could predict future expected returns. We reject the null hypothesis that lags of Exchange rate do not "Granger cause" expected returns. Meaning there is causality running from exchange rate to expected returns. Interest rate [D (91D.TB)], inflation rate [D (CPI)], GDP growth rate [D (GDP)], unemployment rate [D (UMP)] and number of houses sold [D (NHS)] do not "Granger cause" Expected return, taken together they could not predict expected returns; we therefore accept the null hypothesis. On the other hand all the independent variables with their lags taken together can determine expected returns (Prob. 0.0021).

The Granger Causality tests above showed that jointly; all variables had an explanatory power for the property returns at 5 percent significant level. With expected return as the dependent variable, there was little evidence that the macroeconomic variables, individually, had causal effect on expected returns in the housing market in Ghana, which reflects similar results from a UK study by Brooks &Tsolacos, (1999).

Similar relationships were found in the equations with GDP growth rate and unemployment rate as the dependent variables but not in the remaining equations (see Appendix 4)

## 4.5 FORECAST ERROR VARIANCE DECOMPOSITION

In order to investigate the dynamic relationship between expected returns and other macroeconomic variables, the variance decomposition was employed. This is because it separates the variation in an endogenous variable into the component shocks to the VAR in order to assess whether the innovations in a variable (expected investment returns) could be attributed to its own shocks or shocks to other variables. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

In practice, it is usually observed that own series shocks explain most of the (forecast) error variance of the series in a VAR (Khan et al, 2001). The table below shows the variance decomposition for expected returns as explained by innovations in the other variables.

**Table 8: Variance Decomposition of Differenced (E[R])**

| Period | S.E. | D(ER) | D(91D.T) | D(CPI) | D(GDP) | D(EXC) | D(UMP) | D(NHS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.038938 | 100.0000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.042117 | 85.47882 | 5.048523 | 0.837084 | 7.969780 | 0.001636 | 0.625314 | 0.038838 |
| 3 | 0.047290 | 82.78044 | 4.767074 | 0.668380 | 6.619353 | 2.425170 | 2.708530 | 0.031049 |
| 4 | 0.049837 | 82.67371 | 4.349590 | 0.633560 | 7.411679 | 2.228807 | 2.644624 | 0.058034 |
| 5 | 0.055562 | 75.74032 | 4.877013 | 2.321090 | 11.98692 | 2.136740 | 2.848308 | 0.089603 |
| 6 | 0.057174 | 74.60331 | 5.180996 | 2.261771 | 11.97177 | 3.075368 | 2.699140 | 0.207649 |
| 7 | 0.060963 | 74.76000 | 5.282472 | 2.411572 | 10.59806 | 3.220917 | 3.437175 | 0.289811 |
| 8 | 0.062456 | 75.59709 | 5.268557 | 2.330794 | 10.16100 | 3.079669 | 3.286768 | 0.276126 |
| 9 | 0.064698 | 75.15332 | 5.669173 | 2.575754 | 10.02848 | 2.869924 | 3.427306 | 0.276049 |
| 10 | 0.066770 | 75.81064 | 5.584196 | 2.470473 | 9.522032 | 3.036564 | 3.294057 | 0.282042 |

Source: Author's Calculation

Shock to the lags of expected returns accounted for 75.8% of the variation in the expected return; the shock to the 91 day Tbill accounted for 5.58% of the variation in the expected return while the GDP growth rate explained 9.52% of the variation in expected return as at the $10^{th}$ quarter. This suggests, shocks to the expected investment return, the GDP growth rate, and the interest rate explained about 90% of the movement of the expected investment return, indicating that these variables are good at transmitting the effects of the shocks to the housing market. The shocks to investment return accounts for the biggest proportion of the variation in the property return, indicating that the expected return series was a useful source of information for predicting the movement of returns in the housing market.

Shocks to CPI, Exchange rate and Number of houses sold have been relatively small from quarter to quarter, making their percentage of variation in Expected returns small.

The shock to the number of houses sold fell after the second quarter, while shocks to CPI and Unemployment rate have been minimal from quarter to quarter, the same can be said for Expected returns; making their percentage of variation as a share in interest rate small. (See Appendix 6 for variance decomposition of the other variables)

### 4.6 IMPULSE RESPONSE

The importance of adding an impulse response function to a VECM is it traces the response of an endogenous variable; in this case expected returns, to a change in one of the innovations (macroeconomic variables). Specifically, it traces the effect on current and future values of the endogenous variable of one standard deviation shock to one of the innovations. This aids investors to know how E[R] responds to shocks in the macroeconomic variables. Below is the tabular representation of the impulse response of expected returns to innovations in the other variables.

**Table 9: Response of E[R]**

| Period | **E_R_** | 91D.TB | CPI | EXC | GDP | UMP | NHS |
|---|---|---|---|---|---|---|---|
| 1 | **0.025448** | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | **0.002435** | -0.009369 | -0.001989 | -0.002623 | 0.008242 | 0.003124 | 0.003479 |
| 3 | **0.001416** | -0.009846 | -0.004507 | -0.015991 | 0.009395 | -0.004879 | -0.000349 |
| 4 | **-0.003622** | -0.011601 | -0.003673 | -0.005813 | 0.001077 | -6.14E-05 | -0.002345 |
| 5 | **0.000356** | -0.011599 | -0.002118 | 0.009082 | 0.003233 | 0.000619 | -0.002630 |
| 6 | **-0.001807** | -0.009884 | -0.009566 | 0.009328 | -0.000945 | 0.000146 | 0.001250 |
| 7 | **0.004832** | -0.006094 | -0.012482 | 0.009660 | 0.002467 | -0.005999 | -0.000627 |
| 8 | **0.005155** | -0.004965 | -0.015039 | 0.015918 | 0.000539 | -0.005222 | -0.002156 |
| 9 | **0.005600** | -0.004954 | -0.013564 | 0.018966 | 0.002175 | -0.008078 | -0.001667 |
| 10 | **0.004821** | -0.004369 | -0.015204 | 0.017641 | -9.15E-05 | -0.008518 | -9.01E-05 |

Source: Author's Calculation

Expected returns were positive in the first quarter and also at its highest when there were no shocks from the other variables. In the second quarter on the other hand; expected returns still responded positively to shocks in interest rate, inflation rate and exchange rate (negative shocks),GDP growth rate, unemployment rate number of houses sold ( positive shocks) even though expected returns fell from 0.025 to 0.0024.

In the third quarter; expected returns responded positively to a unit shock on interest rate, inflation rate and unemployment rate, number of houses sold , exchange rate(negative unit shocks for these variables)and GDP growth rate (positive unit shock). Expected returns however still fell from 0.0024 to 0.0014.

In the fourth quarter expected returns responded negatively to shocks in interest rate inflation rate exchange rate and number of houses sold (all negative unit shocks) and GDP growth rate (positive unit shock). Expected returns here were negative

In the fifth quarter, expected returns responded positively to unit shocks in the variables with exchange rate having a greater positive unit shock. Expected returns increased from -0.0036 to 0.0035.

The sixth quarter showed that expected returns responded negatively to unit shocks in the variables with exchange rate still accounting for most of this response. Expected returns fell from 0.0035 to -0.0017. From the seventh quarter to the tenth quarter, expected responded positively to unit shocks in the variables. Expected return increased marginally but fell in the tenth quarter.

See Appendix 7 for the graphs showing all the impulse responses of all the variables.

## 4.7 CHAPTER SUMMARY

The objectives of this chapter were to firstly investigate whether there was an interaction between returns from the property markets and macroeconomic variables, to which degree of variation in expected returns was explained by the macroeconomic variable and how great a risk these variables pose to expected returns. This was done by first assuming that all the variables were endogenous and employing the VAR model; which allowed for the investigation of whether these variables had significant causal effects on each other. Secondly, the VAR enabled the determination of the size and nature of the impact of these variables on expected returns.

The sample size for this study was 60 quarters and as such AIC and FPE was used as the lag length selection criteria; from this selection criteria a five period lag length was deemed appropriate for our analysis. The results from unit root test indicated that all the variables except E[R] were non-stationary in levels and stationary after first differencing; thus, we failed to reject the null hypothesis that each series was stationary. A necessary condition for co-integration was integration of order I (1) and the non- stationary variables were integrated of order I (1), we tested for possible co-integration in the sequence using the Johansen (1991) co-integration test, which showed that a co-integration relationship existed among the variables.

The Vector Error Correction model was then adopted, followed by the Granger causality to test for causality among the variables, variance decomposition to assess whether the innovations in expected investment returns could be attributed to its own shocks or shocks to other variables followed. The impulse response tables which traced the response of the variables to a change in one of the innovations (macroeconomic variables) were done after this.

The diagnostic tests were run to test for hetroscedasticity, serial correlation and normality. This was to ensure that results obtained from impulse response and variance decomposition were

valid. From the results of the tests, it was seen that there was no hetrosceasticity and serial correlation but the residuals were not normally distributed. This could have been mainly due to the presence of outliers or structural breaks in data and as such an ADF test had to be done to rectify this situation. Refer to Appendix 3 for Diagnostic test results.

# CHAPTER FIVE

# SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

## 5.0 INTRODUCTION

Houses can be said to be a major component of household wealth, especially for low to middle - income households, and no doubt, housing wealth is increasingly gaining importance to most Ghanaians evidenced by the surge in demand for ownership. For many, houses themselves are a very important form of savings as homeownership is considered a source of protection for wealth against inflation in the long run. In environments where inflation is relatively high, investors would move away from money markets to the goods market as a form of hedge against inflation. Some schools of thought have argued that housing has the potential of becoming an engine of economic growth because of its high yield on invested resources, a high multiplier effect and a host of beneficial forward and backward linkages in an economy (Bank of Ghana, 2007). Housing equally serves as collateral for borrowing by homeowners, generating funds for other investment and wealth creation. Thus, housing becomes both a 'cultivator' and 'protector' of wealth (Xiao, 2001).

Residential housing investment has a relatively higher level of risk mainly because unlike commercial real estate which generates capital on a daily basis, capital on residential real estate is based on the level of income earned by the owner/ tenant; so if there is a break or drop in that cash flow the tenant or buyer would not be able to afford the house. This may explain why a lot of completed houses for sale/ rent are still vacant in the city capital. This would imply also that owners would either keep their property vacant in which case they would have to pay the cost of

maintenance or sell/ rent at a lower price. This is a risk that a lot of would-be owners and investors would need to consider.

The analysis done by this research therefore allowed us to look at residential real estate investment in order to determine the extent to which systematic risks influence investment returns in the Ghanaian housing market.

The rationale for this study came from two interconnected issues. There was a general recognition of the importance of the real estate markets and housing construction in various economies which served as an engine of growth. Secondly, despite speedy growth in financial liberalization, supply of residential real estate was still nowhere near the required level to satisfy the growing demand for housing; which resulted in an influx of investors wanting to benefit from this sector.

The findings from this paper would help investors to estimate and manage the risk exposure more effectively by being able to identify the sources of risk both in the long run and short run. Investors would furthermore be able to estimate their cost of equity more precisely and might better be able to pick stocks for time varying investment strategies.

## 5.1 SUMMARY OF FINDINGS

A Vector Autoregressive Model was employed in this study in order to examine the factors – with emphasis on macroeconomic variables – that affect residential real estate markets in Ghana. A large number of variables were examined and some excluded. Others were found to have a relatively little impact.

The key variable was expected returns in which the expected returns to be gained from investment in homes for the middle class. Each series except E[R] was integrated of order I (1) albeit with there being the presence of co-integrating relationship which showed that there was a long run association between the variables.

The presence of long run relationship led to the adoption of the Vector Error Correction Model. From this co-integration equation, the first lags of Expected returns, interest rate, inflation rate and exchange rate were present. There was a negative relationship between the first lag of expected return and expected return, meaning if there was an increase in the past value of expected return then the next value of expected return will fall. The first lag of Exchange rate in the co-integration relationship had a positive relationship with expected returns, meaning as exchange rate increased there would be an increase in the value of expected returns.

The results of the study showed that both GDP growth rate and unemployment rate have a negative impact on expected returns which was seen in the long run and short run , even though that of unemployment was minimal. Number of houses sold on the other hand had a positive impact on expected returns both in the short run and long run (albeit a small positive impact). Variations in interest rate had a little impact on expected returns in the short run which was in line with existing literature. This confirmed that market expectations about interest rates fitted with lagged values of property which was in line with literature (Sibanda & Mhlanga, 2013).Finally, inflation rate which played a small role in expected returns, impacted positively in the short run. This was also in line with general financial axiom that property is a hedge against inflation. Thus as inflation rose, the market would expect interest rates to rise but long run inflation was captured in property prices (Sibanda & Mhlanga 2013 ).

Some of these results concur with Ling and Naranjo's (1997) conclusion that "*the term structure of interest rates and unexpected inflation do not carry statistically significant risk premiums in the fixed- coefficient model but are significant when sensitivities and risk premia are allowed to vary over time*" . Brooks and Tsolacos (1999) also found "…*some evidence that the interest rate term structure and unexpected inflation have a contemporaneous effect on property returns*".

## 5.2 CONCLUSION

This analysis looked at Residential real estate based on the premise that the most important sources of risk were the market's fundamentals( those used in this study were GDP growth rate , Exchange rate, Interest rate, Inflation rate, Unemployment rate and number of houses sold).

From table8, shocks to the expected investment return, the GDP growth rate, and the interest rate explained about 90% of the movement of the expected investment return, indicating that these variables were good at transmitting the effects of the shocks to the housing market. The shocks to investment return accounted for the biggest proportion of the variation in property returns, indicating that the expected return series was a useful source of information for predicting the movement of returns in the housing market. These areas were therefore great sources of risk to the investor.

There are many other influences on expected returns other than those mentioned such as sales earnings and debt measures as well various changes in the economy itself. The diligent investor would have to keep an eye on all indicators, economic and otherwise, that could signal a change in the market. The variables used in this study were just some of the economic variables that could be used to provide a picture of the economy. Further study would deem it necessary to look into those areas as well.

## 5.3 RECOMMENDATIONS

### 5.3. 1 THE GOVERNMENT

Unavailability of data on property sales and land values have resulted in transaction on the market being isolated mainly due to poor coordination between land development and the provision of infrastructure ; thus hampering activities in the property market. The government could therefore set up a body that would be in charge of gathering all information pertaining to the activities of real estate industry. The Ghana Institution of Surveyors also proposed a Survey Council Bill in 2010 to improve the activities of estate agents in the market; this law is still outstanding. Efforts should be made to reexamine this bill so that it could be implemented.

### 5.3.2 REAL ESTATE INDUSTRY

Owners and contractors could help bring an end to the high degree of informality in the property market by making transactions in the industry more transparent through the provision of information on their activities in order to reduce the of death of adequate and reliable records on activities in the market. . In particular, the proper enforcement of these measures would reduce costs in the long term, although this would entail considerable change in industry's operations.

### 5.3.3. INVESTORS

In looking at the results from table 8, the areas that served as high level of risk to the investor were; GDP growth rate, interest rate and expected returns. An investor would therefore have to look at other sources of capital other than banks in order to address issues of interest rate, broaden the scope of his portfolio in such a way as to protect his investment from the sporadic movements of the economy and also ensure that he finds more innovative ways in terms of selecting areas of real estate investment that would continue to have high levels of demand. All

these are just some measure that investors can take in terms of risk management techniques that would help to maximize his returns.

### 5.3.4. LEGAL PRACTICTIONERS

Those in the legal profession could also provide statistics on real estate transactions since most of these businesses go through them. These statistics can then be given to either the Ministry of Finance or any governmental body set up to gather data on real estate operations and transactions. This could then be made available to academia or investors and stakeholders in real estate.

### 5.3.5 ACADEMIA

It is also recommended that a further study should be made into this field since the sources of risk to real estate investment are more than those used in this analysis and may also have different impacts on the investor.

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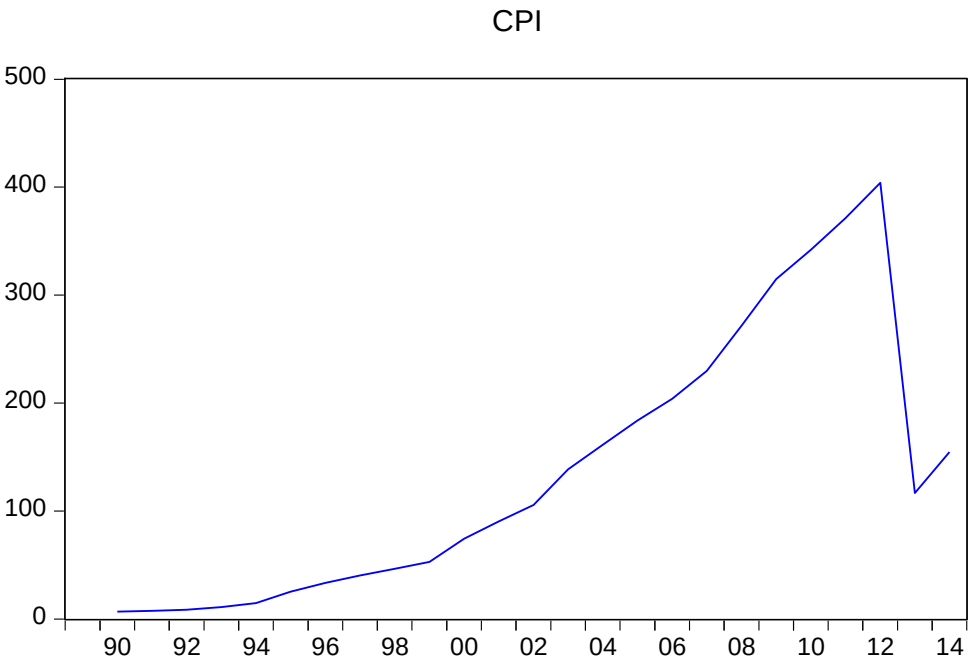
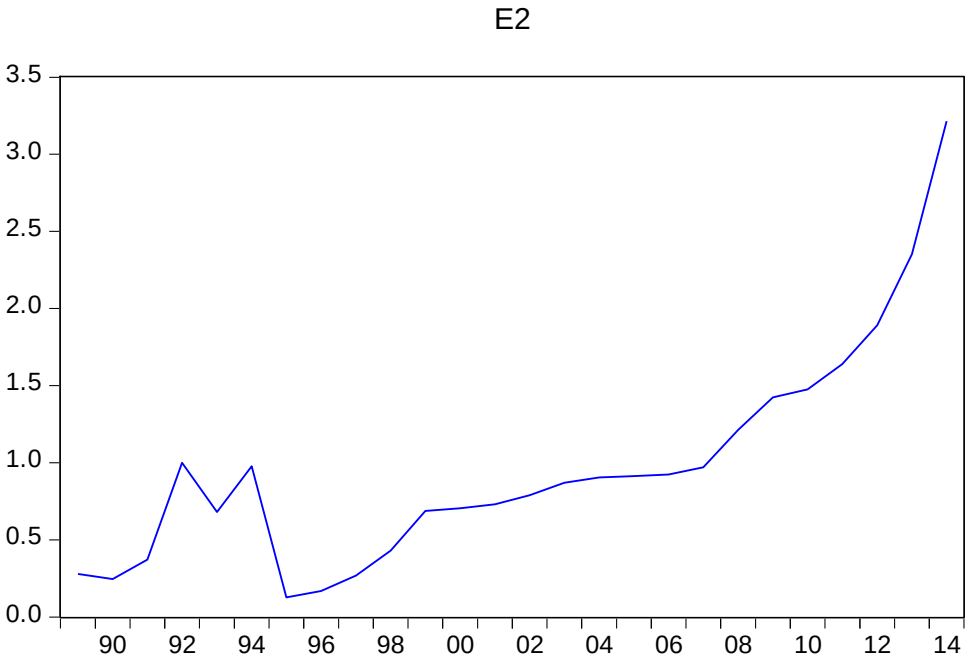
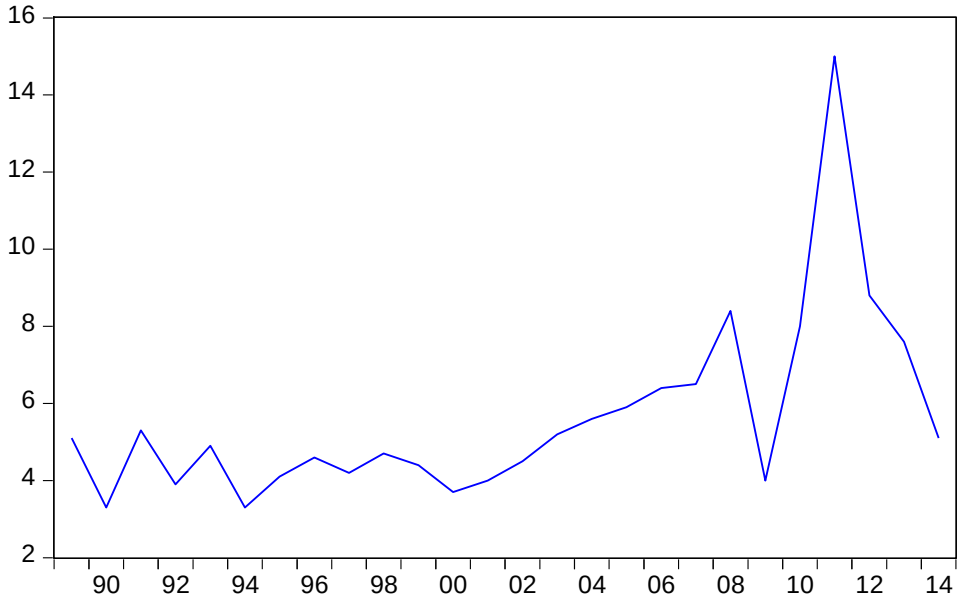
## APPENDIX 1: NON STATIONARITY OF DATA

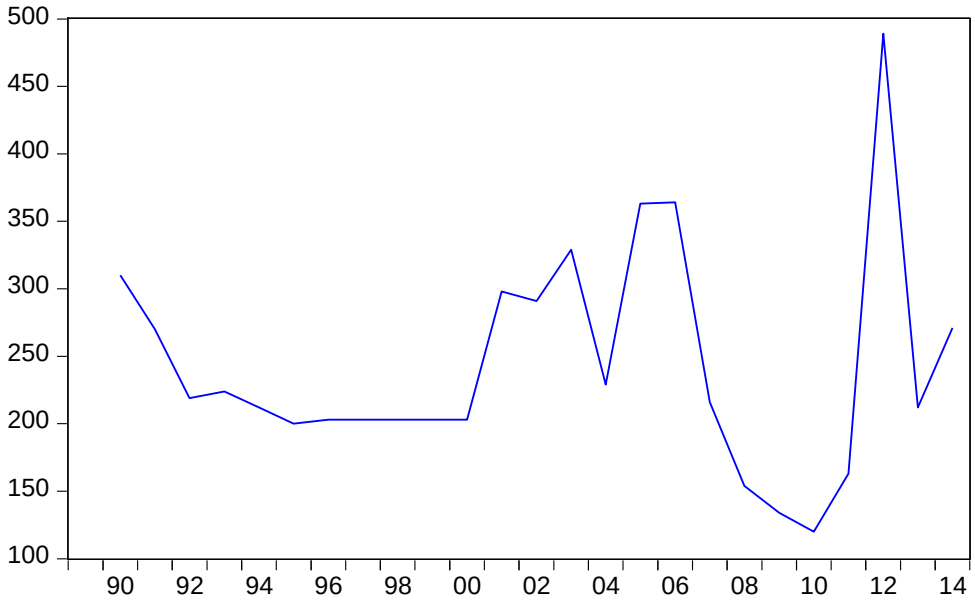


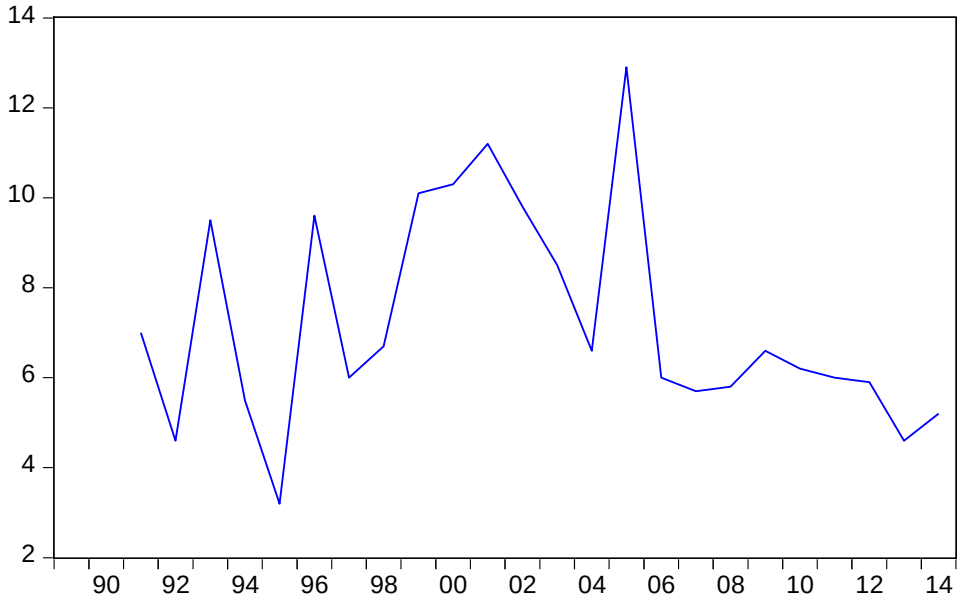
GDP



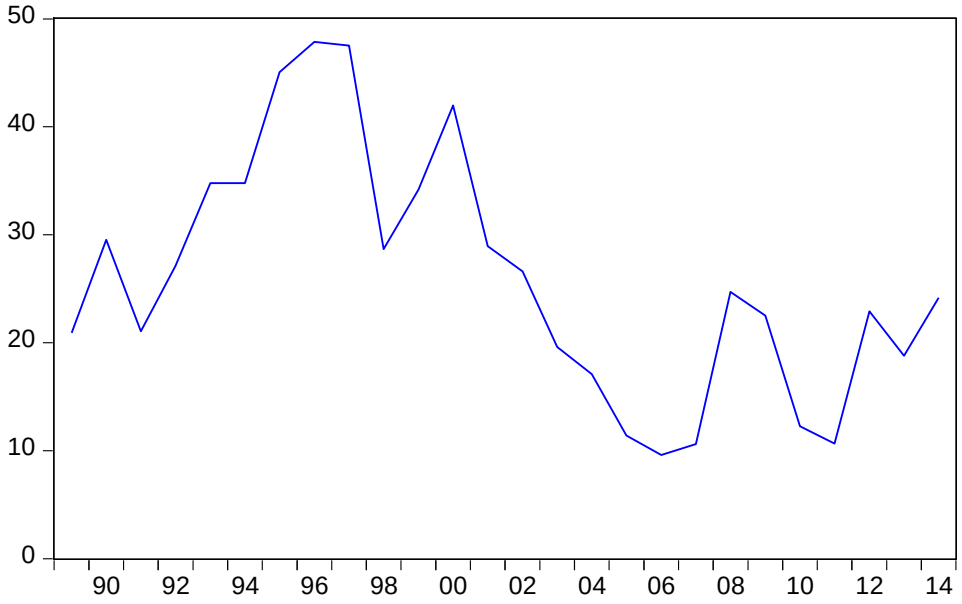

N1



U1




91-DAY TBIL



## APPENDIX 2: DESCRIPTIVE STATISTICS

| | *E[R]* | *CPI* | *91D.TB* | *GDPGR* | *UMP* | *NHS* | *EXC* |
|---|---|---|---|---|---|---|---|
| Mean | 0.2184 | 233.681 | 21.239 | 3.423 | 7.5425 | 65.1 | 1.2859 |
| Standard Error | 0.0050 | 17.355 | 1.277 | 0.255 | 0.2858 | 3.386 | 0.0829 |
| Median | 0.2075 | 193.1 | 21.645 | 3.8625 | 6.4 | 62 | 0.916 |
| Mode | 0.2 | 131.4 | 9.6 | 1.6 | 6 | 75 | 0.9 |
| Standard Deviation | 0.0388 | 134.437 | 9.890 | 1.9789 | 2.2144 | 26.232 | 0.642 |
| Range | 0.187 | 486.28 | 37.59 | 9.4 | 8.3 | 118 | 2.5895 |
| Minimum | 0.123 | 53.42 | 9.41 | -0.5 | 4.6 | 17 | 0.703 |
| Maximum | 0.31 | 539.7 | 47 | 8.9 | 12.9 | 135 | 3.2925 |
| Sum | 13.1062 | 14020.89 | 1274.381 | 205.42 | 452.55 | 3906 | 77.154 |
| Count | 60 | 60 | 60 | 60 | 60 | 60 | 60 |

## APPENDIX 3: DIAGNOSTIC TESTS

HETEROSKEDASTICITY

$H_o$ = There is no hetrosedasticity among the residuals

$H_A$ = There is hetroscedasticity among the residuals

| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| F-statistic | 1.311972 | Prob. F(21,35) | 0.2331 |
| Obs*R-squared | 25.10623 | Prob. Chi-Square(21) | 0.2426 |
| Scaled explained SS | 9.302841 | Prob. Chi-Square(21) | 0.9866 |

We do not reject the null hypothesis of no hetroscedasticity because 0.2426 is greater than 0.05.

Therefore there is no hetroscedasticity (meaning residuals are homoscedastic) which is desirable.

SERIAL CORRELATION

$H_o$: there is no serial correlation among the residual

$H_A$: there is serial correlation among the residuals

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 1.599993 | Prob. F(2,15) | 0.2345 |
| Obs*R-squared | 4.218312 | Prob. Chi-Square(2) | 0.1213 |

In this case we accept the null hypothesis that there is no serial correlation because 0.1213 is greater than 0.05

## APPENDIX 4: VEC GRANGER CAUSALITY TEST RESULTS

**Dependent variable (D [91D.TB])**

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(E_R_) | 2.463000 | 2 | 0.2919 |
| D(CPI__NF) | 4.146382 | 2 | 0.1258 |
| D(EXC) | 3.246578 | 2 | 0.1972 |
| D(G2) | 0.692807 | 2 | 0.7072 |
| D(UMP) | 1.816215 | 2 | 0.4033 |
| D(NHS) | 4.309253 | 2 | 0.1159 |
| All | 19.36242 | 12 | 0.0801 |

**Dependent variable (D [CPI])**

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(E_R_) | 0.553396 | 2 | 0.7583 |
| D(91D.TB) | 0.273194 | 2 | 0.8723 |
| D(EXC) | 0.809132 | 2 | 0.6673 |
| D(GDP) | 0.121344 | 2 | 0.9411 |
| D(UMP) | 1.546245 | 2 | 0.4616 |
| D(NHS) | 7.652824 | 2 | 0.0218 |
| All | 10.71065 | 12 | 0.5539 |

**Dependent variable (D [EXC])**

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(E_R_) | 2.047436 | 2 | 0.3593 |
| D(TBR_91_DAY) | 0.768363 | 2 | 0.6810 |
| D(CPI__NF) | 3.571823 | 2 | 0.1676 |
| D(G2) | 0.408119 | 2 | 0.8154 |
| D(UMP) | 0.352888 | 2 | 0.8382 |
| D(NHS) | 0.492751 | 2 | 0.7816 |
| All | 8.171868 | 12 | 0.7716 |

**Dependent variable (D [GDP])**

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(E_R_) | 15.89880 | 2 | 0.0004 |
| D(91D.TB) | 4.070722 | 2 | 0.1306 |
| D(CPI) | 4.740850 | 2 | 0.0934 |
| D(EXC) | 1.516751 | 2 | 0.4684 |
| D(UMP) | 2.361656 | 2 | 0.3070 |
| D(NHS) | 0.921187 | 2 | 0.6309 |
| All | 26.76010 | 12 | 0.0084 |

**Dependent variable (D [UMP])**

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(E_R_) | 6.797608 | 2 | 0.0334 |
| D(91D.TB) | 3.589820 | 2 | 0.1661 |
| D(CPI) | 5.497317 | 2 | 0.0640 |
| D(EXC) | 7.983517 | 2 | 0.0185 |
| D(GDP) | 0.931994 | 2 | 0.6275 |
| D(NHS) | 2.822759 | 2 | 0.2438 |
| All | 23.13283 | 12 | 0.0266 |

**Dependent variable (D [NHS])**

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D(E_R_) | 4.453669 | 2 | 0.1079 |
| D(TBR_91_DAY) | 0.998258 | 2 | 0.6071 |
| D(CPI__NF) | 1.266007 | 2 | 0.5310 |
| D(EXC) | 3.193218 | 2 | 0.2026 |
| D(G2) | 0.572780 | 2 | 0.7510 |
| D(UMP) | 1.818673 | 2 | 0.4028 |
| All | 10.97597 | 12 | 0.5310 |

**APPENDIX 5: VECTOR ERROR CORRECTION MODEL**

Sample (adjusted): 2001Q4 2014Q4

Included observations: 53 after adjustments

Standard errors in ( ) & t-statistics in [ ]

| Cointegrating Eq: | CointEq1 | CointEq2 | CointEq3 | CointEq4 |
|---|---|---|---|---|
| D(E_R_(-1)) | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| D(91D.TB(-1)) | 0.000000 | 1.000000 | 0.000000 | 0.000000 |
| D(CPI(-1)) | 0.000000 | 0.000000 | 1.000000 | 0.000000 |
| D(EXC(-1)) | 0.000000 | 0.000000 | 0.000000 | 1.000000 |
| D(GDP(-1)) | -0.025506 | -7.550940 | -77.22117 | -0.338656 |
| | (0.00942) | (7.00252) | (52.8659) | (0.22147) |
| | [-2.70899] | [-1.07832] | [-1.46070] | [-1.52911] |
| D(NHS(-1)) | 0.001981 | 1.703047 | 12.53137 | 0.052663 |
| | (0.00056) | (0.41797) | (3.15547) | (0.01322) |
| | [ 3.52572] | [ 4.07458] | [ 3.97132] | [ 3.98378] |
| D(UMP(-1)) | 0.046505 | 18.36177 | 193.6328 | 0.714599 |
| | (0.01289) | (9.58859) | (72.3895) | (0.30326) |
| | [ 3.60715] | [ 1.91496] | [ 2.67487] | [ 2.35636] |
| C | 0.003800 | 2.627258 | 21.42607 | 0.034251 |

| Error Correction: | D(ER,2) | D(91DT,2) | D(CPI,2) | D(EXC,2) | D(GDP,2) | D(NHS,2) | D(UMP,2) |
|---|---|---|---|---|---|---|---|
| CointEq1 | -2.481279 | -273.9212 | -2495.504 | -2.487182 | 161.3458 | -1856.086 | 74.49759 |
| | (1.12557) | (150.197) | (1723.25) | (1.29605) | (81.6898) | (933.985) | (61.3644) |
| | [-2.20447] | [-1.82374] | [-1.44814] | [-1.91905] | [ 1.97510] | [-1.98728] | [ 1.21402] |
| CointEq2 | -0.009635 | -0.755158 | -7.709210 | 0.009715 | 0.088946 | -9.532740 | 0.266891 |
| | (0.00445) | (0.59413) | (6.81661) | (0.00513) | (0.32314) | (3.69454) | (0.24274) |
| | [-2.16401] | [-1.27103] | [-1.13094] | [ 1.89487] | [ 0.27526] | [-2.58022] | [ 1.09950] |
| CointEq3 | -0.000784 | 0.238741 | 2.244422 | 0.005153 | -0.107137 | 0.801967 | -0.043603 |
| | (0.00063) | (0.08462) | (0.97081) | (0.00073) | (0.04602) | (0.52617) | (0.03457) |
| | [-1.23611] | [ 2.82149] | [ 2.31191] | [ 7.05697] | [-2.32802] | [ 1.52416] | [-1.26130] |
| CointEq4 | 0.555744 | -20.81928 | -201.9627 | -1.471520 | 15.35606 | 165.5106 | -1.033392 |
| | (0.19422) | (25.9167) | (297.348) | (0.22363) | (14.0957) | (161.160) | (10.5885) |
| | [ 2.86144] | [-0.80332] | [-0.67921] | [-6.58002] | [ 1.08942] | [ 1.02700] | [-0.09760] |
| D(E_R_(-1),2) | 0.265702 | 331.1342 | 3262.123 | 2.633175 | -157.1863 | 1675.795 | -52.02715 |
| | (1.03481) | (138.087) | (1584.30) | (1.19155) | (75.1032) | (858.677) | (56.4166) |
| | [ 0.25676] | [ 2.39802] | [ 2.05903] | [ 2.20987] | [-2.09294] | [ 1.95160] | [-0.92220] |
| D(E_R_(-2),2) | -0.250556 | 295.4060 | 3739.993 | 2.956755 | -100.8513 | 1560.110 | -34.52562 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | (0.92790) | (123.821) | (1420.62) | (1.06845) | (67.3441) | (769.965) | (50.5880) |
| | [-0.27002] | [ 2.38576] | [ 2.63264] | [ 2.76734] | [-1.49755] | [ 2.02621] | [-0.68249] |
| D(E_R_(-3),2) | -0.455495 | 206.8147 | 2262.024 | 3.403675 | -37.60243 | 1440.893 | -31.02003 |
| | (0.71903) | (95.9486) | (1100.84) | (0.82794) | (52.1849) | (596.646) | (39.2007) |
| | [-0.63348] | [ 2.15547] | [ 2.05481] | [ 4.11102] | [-0.72056] | [ 2.41499] | [-0.79131] |
| D(E_R_(-4),2) | -0.833204 | 173.1690 | 1552.954 | 1.597892 | -6.817586 | 960.3632 | -0.327953 |
| | (0.46274) | (61.7484) | (708.454) | (0.53283) | (33.5840) | (383.976) | (25.2279) |
| | [-1.80059] | [ 2.80443] | [ 2.19203] | [ 2.99890] | [-0.20300] | [ 2.50110] | [-0.01300] |
| D(E_R_(-5),2) | -0.501896 | 145.0499 | 1668.754 | 0.581091 | -3.980071 | 153.0757 | 3.447270 |
| | (0.32232) | (43.0110) | (493.476) | (0.37114) | (23.3930) | (267.459) | (17.5725) |
| | [-1.55713] | [ 3.37239] | [ 3.38163] | [ 1.56569] | [-0.17014] | [ 0.57233] | [ 0.19617] |
| D(91D.TB(-1),2) | 0.006329 | 0.362391 | 8.395395 | 0.001033 | -0.043757 | 8.746421 | -0.324361 |
| | (0.00397) | (0.52939) | (6.07380) | (0.00457) | (0.28793) | (3.29194) | (0.21629) |
| | [ 1.59545] | [ 0.68455] | [ 1.38223] | [ 0.22618] | [-0.15197] | [ 2.65692] | [-1.49968] |
| D(91D.TB(-2),2) | 0.003364 | 0.168390 | 4.796845 | -6.09E-05 | 0.022449 | 8.996620 | -0.075294 |
| | (0.00363) | (0.48390) | (5.55195) | (0.00418) | (0.26319) | (3.00911) | (0.19770) |
| | [ 0.92765] | [ 0.34798] | [ 0.86399] | [-0.01460] | [ 0.08530] | [ 2.98980] | [-0.38084] |
| D(91D.TB(-3),2) | 0.002722 | 0.679394 | 7.013754 | 0.002559 | -0.116936 | 2.393351 | -0.141226 |
| | (0.00270) | (0.36018) | (4.13241) | (0.00311) | (0.19590) | (2.23973) | (0.14715) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | [ 1.00859] | [ 1.88627] | [ 1.69726] | [ 0.82338] | [-0.59693] | [ 1.06859] | [-0.95972] |
| D(91D.TB(-4),2) | 0.001208 | 0.140974 | 2.532640 | 0.004729 | 0.146751 | 5.250326 | -0.024159 |
| | (0.00194) | (0.25838) | (2.96446) | (0.00223) | (0.14053) | (1.60671) | (0.10556) |
| | [ 0.62393] | [ 0.54560] | [ 0.85433] | [ 2.12113] | [ 1.04427] | [ 3.26775] | [-0.22886] |
| D(91D,TB(-5),2) | 0.002489 | 0.144441 | 0.487762 | 0.000386 | -0.084868 | 0.517019 | -0.067475 |
| | (0.00128) | (0.17062) | (1.95755) | (0.00147) | (0.09280) | (1.06097) | (0.06971) |
| | [ 1.94641] | [ 0.84657] | [ 0.24917] | [ 0.26199] | [-0.91455] | [ 0.48731] | [-0.96797] |
| D(CPI(-1),2) | 0.000450 | -0.185416 | -2.998698 | -0.006053 | 0.102338 | -0.849752 | 0.054240 |
| | (0.00063) | (0.08440) | (0.96836) | (0.00073) | (0.04590) | (0.52484) | (0.03448) |
| | [ 0.71081] | [-2.19684] | [-3.09668] | [-8.31052] | [ 2.22937] | [-1.61906] | [ 1.57295] |
| D(CPI(-2),2) | 0.000387 | -0.189808 | -2.624915 | -0.006762 | 0.116818 | -0.790669 | 0.055140 |
| | (0.00064) | (0.08576) | (0.98396) | (0.00074) | (0.04664) | (0.53330) | (0.03504) |
| | [ 0.60172] | [-2.21320] | [-2.66769] | [-9.13720] | [ 2.50443] | [-1.48260] | [ 1.57368] |
| D(CPI(-3),2) | 0.000409 | -0.208374 | -2.596237 | -0.007249 | 0.129164 | -0.635592 | 0.050878 |
| | (0.00068) | (0.09063) | (1.03982) | (0.00078) | (0.04929) | (0.56357) | (0.03703) |
| | [ 0.60280] | [-2.29916] | [-2.49681] | [-9.26976] | [ 2.62037] | [-1.12779] | [ 1.37406] |
| D(CPI(-4),2) | 0.000389 | -0.198742 | -2.165161 | -0.007483 | 0.121843 | -0.488766 | 0.048541 |
| | (0.00070) | (0.09300) | (1.06696) | (0.00080) | (0.05058) | (0.57828) | (0.03799) |
| | [ 0.55881] | [-2.13712] | [-2.02929] | [-9.32529] | [ 2.40898] | [-0.84521] | [ 1.27760] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D(CPI(-5),2) | 0.000447 | -0.185494 | -2.076219 | -0.006616 | 0.128951 | -0.498794 | 0.038523 |
| | (0.00070) | (0.09400) | (1.07849) | (0.00081) | (0.05113) | (0.58453) | (0.03840) |
| | [ 0.63524] | [-1.97333] | [-1.92512] | [-8.15623] | [ 2.52226] | [-0.85332] | [ 1.00309] |
| D(EXC(-1),2) | -0.549238 | 24.75154 | 351.6477 | 0.746910 | -22.78068 | -8.062317 | -2.079997 |
| | (0.18410) | (24.5671) | (281.864) | (0.21199) | (13.3617) | (152.768) | (10.0371) |
| | [-2.98329] | [ 1.00751] | [ 1.24758] | [ 3.52334] | [-1.70493] | [-0.05277] | [-0.20723] |
| D(EXC(-2),2) | -0.747967 | 59.15055 | 415.6209 | 0.939369 | -17.02495 | 62.11006 | -8.194824 |
| | (0.19416) | (25.9085) | (297.254) | (0.22356) | (14.0912) | (161.109) | (10.5851) |
| | [-3.85238] | [ 2.28306] | [ 1.39820] | [ 4.20179] | [-1.20820] | [ 0.38552] | [-0.77418] |
| D(EXC(-3),2) | -0.831958 | 44.72421 | 203.4020 | 0.461212 | -11.54387 | 79.83191 | -2.293859 |
| | (0.19456) | (25.9622) | (297.871) | (0.22403) | (14.1204) | (161.443) | (10.6071) |
| | [-4.27611] | [ 1.72266] | [ 0.68285] | [ 2.05873] | [-0.81753] | [ 0.49449] | [-0.21626] |
| D(EXC(-4),2) | -0.847882 | 57.99182 | 700.9971 | 0.357750 | 3.588782 | 0.137044 | -2.580360 |
| | (0.22271) | (29.7181) | (340.963) | (0.25644) | (16.1632) | (184.799) | (12.1416) |
| | [-3.80718] | [ 1.95140] | [ 2.05593] | [ 1.39508] | [ 0.22203] | [ 0.00074] | [-0.21252] |
| D(EXC(-5),2) | -0.330500 | 17.29840 | 238.2949 | 0.794002 | 15.84650 | 159.7372 | 0.232584 |
| | (0.13768) | (18.3727) | (210.795) | (0.15854) | (9.99263) | (114.249) | (7.50634) |
| | [-2.40042] | [ 0.94153] | [ 1.13046] | [ 5.00827] | [ 1.58582] | [ 1.39815] | [ 0.03099] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D(GDP(-1),2) | -0.010359 | 0.069018 | 1.349351 | -0.059657 | 0.197092 | 0.685468 | 0.118656 |
| | (0.00919) | (1.22631) | (14.0698) | (0.01058) | (0.66697) | (7.62568) | (0.50102) |
| | [-1.12724] | [ 0.05628] | [ 0.09590] | [-5.63767] | [ 0.29550] | [ 0.08989] | [ 0.23683] |
| D(GDP(-2),2) | -0.009292 | 0.429782 | -3.671059 | -0.032312 | 0.238829 | 2.425566 | -0.032226 |
| | (0.00859) | (1.14627) | (13.1514) | (0.00989) | (0.62344) | (7.12794) | (0.46832) |
| | [-1.08172] | [ 0.37494] | [-0.27914] | [-3.26677] | [ 0.38308] | [ 0.34029] | [-0.06881] |
| D(GDP(-3),2) | -0.016960 | 1.232563 | -12.65178 | -0.034590 | 0.349899 | 1.691018 | 0.089776 |
| | (0.00820) | (1.09424) | (12.5545) | (0.00944) | (0.59514) | (6.80442) | (0.44706) |
| | [-2.06822] | [ 1.12641] | [-1.00775] | [-3.66331] | [ 0.58793] | [ 0.24852] | [ 0.20081] |
| D(G2(-4),2) | -0.019296 | 2.828660 | 6.732242 | -0.027803 | 0.297649 | -2.087128 | 0.370135 |
| | (0.00776) | (1.03604) | (11.8867) | (0.00894) | (0.56349) | (6.44250) | (0.42328) |
| | [-2.48530] | [ 2.73026] | [ 0.56637] | [-3.10997] | [ 0.52823] | [-0.32396] | [ 0.87444] |
| D(G2(-5),2) | -0.008025 | 1.664305 | 11.89924 | -0.019922 | -0.020123 | -3.288107 | 0.219609 |
| | (0.00406) | (0.54151) | (6.21285) | (0.00467) | (0.29452) | (3.36731) | (0.22124) |
| | [-1.97767] | [ 3.07346] | [ 1.91526] | [-4.26350] | [-0.06833] | [-0.97648] | [ 0.99264] |
| D(NHS(-1),2) | 0.001890 | -0.100755 | 0.212261 | 0.000286 | 0.065847 | 0.134218 | 0.006102 |
| | (0.00075) | (0.10023) | (1.14998) | (0.00086) | (0.05451) | (0.62328) | (0.04095) |
| | [ 2.51671] | [-1.00522] | [ 0.18458] | [ 0.33109] | [ 1.20788] | [ 0.21534] | [ 0.14902] |
| D(NHS(-2),2) | 0.002283 | -0.156203 | 1.081381 | -0.000590 | 0.028170 | 0.279266 | 0.007881 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | (0.00074) | (0.09815) | (1.12607) | (0.00085) | (0.05338) | (0.61032) | (0.04010) |
| | [ 3.10337] | [-1.59152] | [ 0.96032] | [-0.69661] | [ 0.52773] | [ 0.45757] | [ 0.19654] |
| D(NHS(-3),2) | 0.002573 | -0.196782 | 1.812422 | 0.000424 | -0.009946 | 0.159296 | -0.012220 |
| | (0.00078) | (0.10406) | (1.19391) | (0.00090) | (0.05660) | (0.64709) | (0.04251) |
| | [ 3.29923] | [-1.89104] | [ 1.51806] | [ 0.47180] | [-0.17574] | [ 0.24617] | [-0.28742] |
| D(NHS(-4),2) | 0.001636 | -0.166635 | 1.541293 | 0.001696 | -0.004783 | 0.342636 | -0.035068 |
| | (0.00076) | (0.10084) | (1.15700) | (0.00087) | (0.05485) | (0.62709) | (0.04120) |
| | [ 2.16535] | [-1.65240] | [ 1.33214] | [ 1.94890] | [-0.08720] | [ 0.54639] | [-0.85114] |
| D(NHS(-5),2) | 0.000315 | -0.090044 | 0.724646 | 0.000926 | -0.001625 | 0.240422 | -0.023230 |
| | (0.00042) | (0.05596) | (0.64200) | (0.00048) | (0.03043) | (0.34796) | (0.02286) |
| | [ 0.75156] | [-1.60919] | [ 1.12874] | [ 1.91786] | [-0.05338] | [ 0.69095] | [-1.01611] |
| D(UMP(-1),2) | 0.044263 | -5.607079 | -49.06005 | -0.033516 | 0.566859 | -4.064781 | 0.047500 |
| | (0.01464) | (1.95347) | (22.4127) | (0.01686) | (1.06246) | (12.1475) | (0.79811) |
| | [ 3.02358] | [-2.87031] | [-2.18894] | [-1.98832] | [ 0.53353] | [-0.33462] | [ 0.05952] |
| D(UMP(-2),2) | 0.038107 | -3.124924 | -24.34913 | -0.029927 | -0.525480 | -7.595948 | -0.170206 |
| | (0.01101) | (1.46855) | (16.8490) | (0.01267) | (0.79872) | (9.13199) | (0.59999) |
| | [ 3.46265] | [-2.12790] | [-1.44514] | [-2.36168] | [-0.65790] | [-0.83180] | [-0.28368] |
| D(UMP(-3),2) | 0.030535 | -2.843238 | -9.330024 | -0.010688 | -0.193963 | -0.521704 | -0.045659 |
| | (0.00974) | (1.29922) | (14.9063) | (0.01121) | (0.70663) | (8.07909) | (0.53081) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | [ 3.13624] | [-2.18841] | [-0.62591] | [-0.95339] | [-0.27449] | [-0.06457] | [-0.08602] |
| D(UMP(-4),2) | 0.022931 | -2.518198 | -10.88629 | 0.000100 | -0.267423 | 5.522787 | -0.542344 |
| | (0.00829) | (1.10589) | (12.6882) | (0.00954) | (0.60148) | (6.87688) | (0.45182) |
| | [ 2.76693] | [-2.27707] | [-0.85799] | [ 0.01049] | [-0.44461] | [ 0.80309] | [-1.20035] |
| D(UMP(-5),2) | 0.005873 | -1.817517 | -13.08664 | -0.005673 | 0.385204 | 12.88025 | -0.273272 |
| | (0.00550) | (0.73452) | (8.42736) | (0.00634) | (0.39950) | (4.56755) | (0.30010) |
| | [ 1.06702] | [-2.47442] | [-1.55288] | [-0.89503] | [ 0.96423] | [ 2.81995] | [-0.91062] |
| C | 0.022765 | -2.302713 | -26.01443 | -0.071886 | 1.142951 | -3.796079 | 0.375670 |
| | (0.00892) | (1.19027) | (13.6563) | (0.01027) | (0.64737) | (7.40156) | (0.48630) |
| | [ 2.55221] | [-1.93461] | [-1.90495] | [-6.99900] | [ 1.76553] | [-0.51288] | [ 0.77251] |
| R-squared | 0.972351 | 0.863976 | 0.964431 | 0.977716 | 0.965826 | 0.910267 | 0.805294 |
| Adj. R-squared | 0.889404 | 0.455904 | 0.857724 | 0.910864 | 0.863303 | 0.641067 | 0.221175 |
| Sum sq. resids | 0.005970 | 106.3070 | 13993.74 | 0.007916 | 31.44666 | 4110.719 | 17.74480 |
| S.E. equation | 0.021430 | 2.859626 | 32.80917 | 0.024676 | 1.555305 | 17.78227 | 1.168326 |
| F-statistic | 11.72253 | 2.117216 | 9.038121 | 14.62512 | 9.420583 | 3.381382 | 1.378648 |
| Log likelihood | 165.7152 | -93.64878 | -222.9697 | 158.2405 | -61.37076 | -190.5069 | -46.20746 |
| Akaike AIC | -4.743970 | 5.043350 | 9.923384 | -4.461905 | 3.825312 | 8.698372 | 3.253112 |
| Schwarz SC | -3.256957 | 6.530363 | 11.41040 | -2.974893 | 5.312325 | 10.18539 | 4.740124 |
| Mean dependent | 0.000717 | 0.187849 | 0.126415 | -0.001396 | -0.027844 | 0.377358 | 0.009434 |
| S.D. dependent | 0.064439 | 3.876784 | 86.98199 | 0.082650 | 4.206644 | 29.68114 | 1.323866 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 0.116885 |
| Determinant resid covariance | 6.24E-06 |
| Log likelihood | -208.8511 |
| Akaike information criterion | 19.50382 |
| Schwarz criterion | 30.95381 |

## APPENDIX 6: VARIANCE DECOMPOSITION OF VARIABLES

### Variance Decomposition of D [91 D.TB]

| Period | S.E. | D(ER) | D(91D.T) | D(CPI) | D(GDP) | D(EXC) | D(UMP) | D(NHS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.515573 | 0.258771 | 99.74123 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 4.999592 | 0.610013 | 92.71681 | 1.627460 | 0.197714 | 1.724004 | 0.147632 | 2.976363 |
| 3 | 6.093277 | 1.778664 | 79.73020 | 2.579241 | 3.409215 | 10.28180 | 0.170312 | 2.050568 |
| 4 | 6.749285 | 1.841814 | 80.01788 | 2.110058 | 3.510231 | 10.62469 | 0.140215 | 1.755111 |
| 5 | 7.358245 | 1.550365 | 82.56507 | 1.813401 | 2.972612 | 9.232091 | 0.129329 | 1.737132 |
| 6 | 7.972597 | 1.320866 | 81.72312 | 1.791422 | 4.045977 | 9.298063 | 0.157847 | 1.662701 |
| 7 | 8.558402 | 1.175697 | 81.65784 | 1.747923 | 3.639793 | 9.885228 | 0.188504 | 1.705015 |
| 8 | 9.130494 | 1.081044 | 81.56941 | 1.607709 | 3.804109 | 10.25396 | 0.177019 | 1.506744 |
| 9 | 9.583194 | 0.987673 | 82.11905 | 1.493121 | 3.783595 | 10.03263 | 0.164807 | 1.419123 |
| 10 | 9.996157 | 0.908693 | 82.38789 | 1.411044 | 3.771728 | 9.829869 | 0.182767 | 1.508012 |

### Variance Decomposition of D [CPI]

| Period | S.E. | D(ER) | D(91D.T) | D(CPI) | D(GDP) | D(EXC) | D(UMP) | D(NHS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 67.93049 | 12.69981 | 5.159905 | 82.14029 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 71.26961 | 15.18320 | 6.314320 | 74.70255 | 1.644822 | 0.853804 | 0.359448 | 0.941857 |
| 3 | 75.20430 | 14.53898 | 5.931930 | 69.03466 | 2.374869 | 1.979288 | 0.331505 | 5.808764 |
| 4 | 80.21953 | 16.02451 | 9.618131 | 63.39785 | 2.581173 | 1.747150 | 0.318150 | 6.313033 |
| 5 | 85.80062 | 15.97750 | 11.38748 | 59.09122 | 5.020732 | 2.457573 | 0.535131 | 5.530372 |
| 6 | 89.39800 | 17.06529 | 11.35808 | 58.21633 | 5.017688 | 2.270047 | 0.558715 | 5.513853 |
| 7 | 92.55518 | 17.25586 | 11.89066 | 56.86230 | 5.548091 | 2.524210 | 0.544283 | 5.374590 |
| 8 | 95.49634 | 18.09808 | 12.73671 | 54.48619 | 5.732878 | 2.405797 | 0.636669 | 5.903674 |
| 9 | 99.14402 | 18.38738 | 13.34080 | 53.14510 | 6.326860 | 2.382483 | 0.612659 | 5.804725 |
| 10 | 102.3406 | 18.60656 | 14.06763 | 52.27065 | 6.633309 | 2.256744 | 0.673188 | 5.491918 |

**Variance Decomposition of D [GDP]**

| | S.E. | D(ER) | D(91D.T) | D(CPI) | D(GGR) | D(EXC) | D(UMP) | D(NHS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.284268 | 8.633272 | 2.735470 | 5.757316 | 82.87394 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 2.637179 | 23.84811 | 2.099406 | 4.321590 | 66.89689 | 0.871700 | 1.640420 | 0.321882 |
| 3 | 2.931878 | 19.65230 | 1.704702 | 13.95479 | 59.41820 | 1.376139 | 1.523803 | 2.370057 |
| 4 | 3.242097 | 23.69561 | 2.078539 | 13.41348 | 53.89024 | 1.241524 | 3.076233 | 2.604379 |
| 5 | 3.428582 | 24.57731 | 3.351886 | 13.77542 | 50.13933 | 2.383094 | 3.247466 | 2.525489 |
| 6 | 3.470363 | 24.80016 | 3.346821 | 13.84788 | 48.94747 | 2.631375 | 3.764826 | 2.661466 |
| 7 | 3.755770 | 23.99905 | 3.236522 | 15.68143 | 48.63180 | 2.591417 | 3.295393 | 2.564386 |
| 8 | 3.876617 | 25.10678 | 3.254206 | 15.82761 | 46.56766 | 2.549389 | 3.260135 | 3.434225 |
| 9 | 3.977413 | 25.15500 | 3.370544 | 16.91276 | 45.07510 | 2.960220 | 3.097075 | 3.429297 |
| 10 | 4.077876 | 25.65771 | 3.344438 | 17.02596 | 44.60186 | 2.907267 | 3.072215 | 3.390538 |

**Variance Decomposition of D [EXC]**

| Period | S.E. | D(ER) | D(91D.T) | D(CPI) | D(GDP) | D(EXC) | D(UMP) | D(NHS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.082510 | 0.037480 | 3.672180 | 4.364663 | 26.95560 | 64.97008 | 0.000000 | 0.000000 |
| 2 | 0.108249 | 0.071704 | 3.967098 | 5.413036 | 36.65495 | 52.95051 | 0.011945 | 0.930753 |
| 3 | 0.121296 | 0.093779 | 4.999431 | 9.425191 | 35.32041 | 48.24173 | 0.204869 | 1.714593 |
| 4 | 0.144023 | 0.090950 | 5.095275 | 12.71586 | 33.74279 | 45.37828 | 0.179508 | 2.797331 |
| 5 | 0.164171 | 0.106927 | 5.402894 | 11.82084 | 33.87260 | 46.05311 | 0.150399 | 2.593238 |
| 6 | 0.178014 | 0.095978 | 5.596565 | 11.54620 | 34.16890 | 46.12543 | 0.142821 | 2.324101 |
| 7 | 0.189427 | 0.085053 | 5.608852 | 12.16305 | 34.36505 | 45.08784 | 0.167519 | 2.522632 |
| 8 | 0.202379 | 0.083744 | 5.602985 | 12.84981 | 34.38081 | 44.14440 | 0.161760 | 2.776487 |
| 9 | 0.215559 | 0.075491 | 5.752733 | 12.96410 | 34.10001 | 44.22459 | 0.142986 | 2.740095 |
| 10 | 0.227023 | 0.068903 | 5.838042 | 12.72405 | 34.16335 | 44.41811 | 0.132546 | 2.654998 |

**Variance Decomposition of D [UMP]**

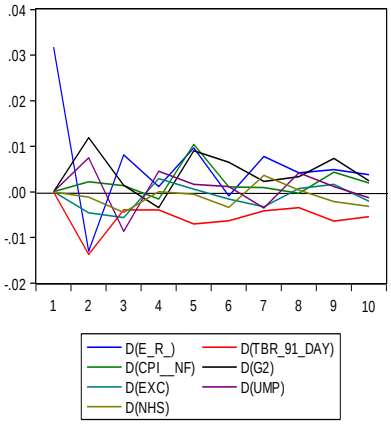
| Period | S.E. | D(ER) | D(91D.T) | D(CPI) | D(GDP) | D(EXC) | D(UMP) | D(NHS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.184198 | 1.129453 | 3.072684 | 0.184967 | 9.794904 | 10.26289 | 75.55510 | 0.000000 |
| 2 | 1.343751 | 2.655145 | 2.440669 | 0.771710 | 12.36017 | 10.74266 | 70.25297 | 0.776681 |
| 3 | 1.488176 | 4.533292 | 6.071225 | 0.645043 | 10.91943 | 12.44440 | 64.69239 | 0.694215 |
| 4 | 1.645568 | 3.714338 | 5.676766 | 0.649755 | 11.82687 | 12.11974 | 65.01480 | 0.997735 |
| 5 | 1.769387 | 3.932528 | 5.478626 | 0.565466 | 12.15685 | 11.26864 | 65.73488 | 0.863013 |
| 6 | 1.898467 | 4.412816 | 5.779206 | 0.682482 | 11.97558 | 11.36975 | 65.02880 | 0.751366 |
| 7 | 2.009317 | 4.231981 | 5.650204 | 0.763251 | 12.20697 | 12.34305 | 64.00412 | 0.800421 |
| 8 | 2.112515 | 4.124540 | 5.702245 | 0.723287 | 12.11263 | 12.44273 | 64.14449 | 0.750078 |
| 9 | 2.216617 | 4.289808 | 5.814817 | 0.708042 | 12.17063 | 12.01599 | 64.27867 | 0.722040 |
| 10 | 2.314639 | 4.239691 | 5.865031 | 0.782358 | 12.39523 | 11.92160 | 64.13305 | 0.663037 |

**Variance Decomposition of D [NHS]**

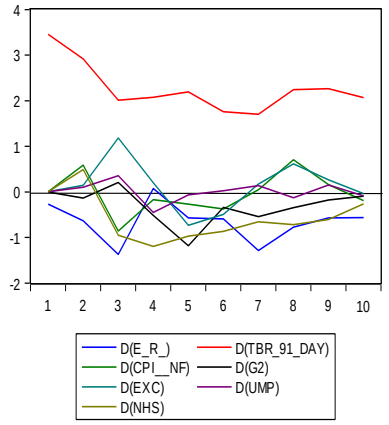
| Period | S.E. | D(ER) | D(91D.T) | D(CPI) | D(GDP) | D(EXC) | D(UMP) | D(NHS) |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.47399 | 0.669251 | 0.242296 | 0.052130 | 2.914425 | 1.144314 | 0.590029 | 94.38755 |
| 2 | 27.87790 | 3.066078 | 4.218584 | 2.262806 | 14.80546 | 12.51657 | 0.941250 | 62.18925 |
| 3 | 31.81738 | 2.840889 | 3.570111 | 1.806789 | 13.80836 | 18.23864 | 1.097647 | 58.63757 |
| 4 | 33.86981 | 2.681375 | 3.461695 | 2.268940 | 14.23281 | 17.98639 | 1.113797 | 58.25499 |
| 5 | 36.41017 | 2.321909 | 3.269781 | 3.334550 | 17.38456 | 17.28716 | 0.985919 | 55.41612 |
| 6 | 39.32596 | 2.129775 | 2.972509 | 3.268115 | 15.76092 | 17.38227 | 0.891248 | 57.59516 |
| 7 | 41.76588 | 1.935938 | 3.505087 | 2.899984 | 17.12106 | 19.66007 | 0.792574 | 54.08529 |
| 8 | 43.77723 | 1.871523 | 3.371947 | 2.700851 | 17.87028 | 20.28367 | 0.851226 | 53.05050 |
| 9 | 45.51846 | 1.745022 | 3.180715 | 2.537694 | 17.97565 | 19.87574 | 0.834689 | 53.85049 |
| 10 | 47.33707 | 1.613516 | 3.366443 | 2.697881 | 17.86762 | 19.99904 | 0.817197 | 53.63830 |

# APPENDIX 7: IMPULSE RESPONSE GRAPHS

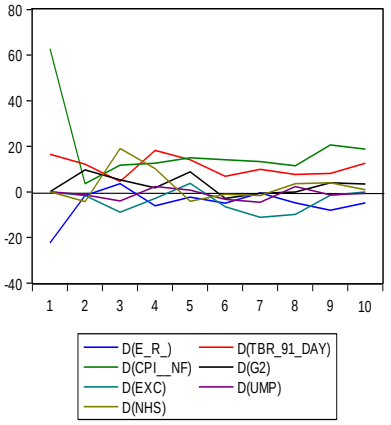
Response of D(E_R_) to Cholesky
One S.D. Innovations



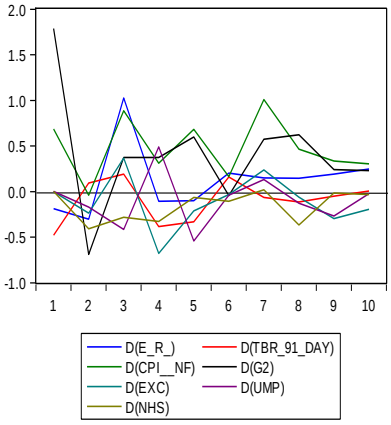

Response of D(TBR_91_DAY) to Cholesky
One S.D. Innovations



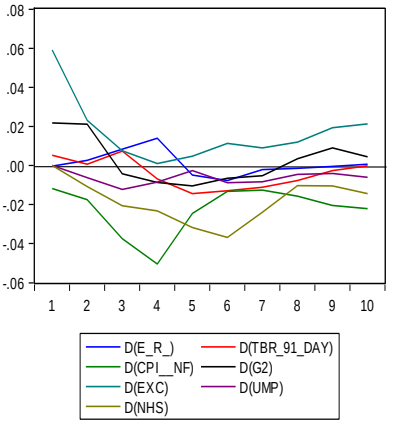

Response of D(CPI__NF) to Cholesky
One S.D. Innovations



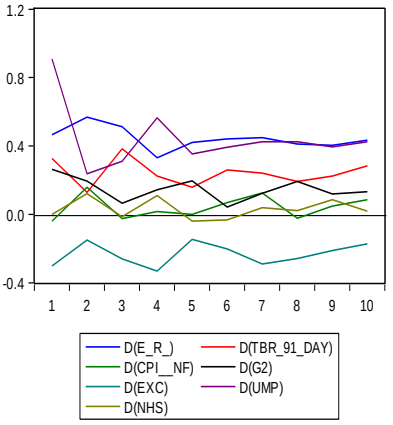

Response of D(G2) to Cholesky
One S.D. Innovations




Response of D(EXC) to Cholesky
One S.D. Innovations




Response of D(UMP) to Cholesky
One S.D. Innovations




Response of D(NHS) to Cholesky
One S.D. Innovations