ANALYSIS OF SYSTEMIC RISK AMONG ASSET PRICES MOVEMENT, FINANCIAL SYSTEM AND THE REAL SECTOR ECONOMY IN KENYA

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DECLARATION

This thesis is my original work and has not been presented for a degree award in any other university

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DEDICATION

To my Mum and Dad who instilled the desire to pursue PhD from a tender age, I dedicate this to you. To my wife Serphine and my children Alice and Lawrence, your encouragement, support and love gave me the strength and motivation throughout my doctoral studies.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

APT	Arbitrage Pricing Theory
CBK	Central Bank of Kenya
CAPM	Capital Asset Pricing Model
CCAPM	Consumption Based Capital Asset Pricing Model
GDP	Gross Domestic Product
GMM	Generalized Methods of Moments
IPO	Initial Public Offer
IV	Instrumental Variable
MCR	Market Capitalization Ratio
NBFI's	Non-Bank Financial Institutions
NPL	Non-Performing Loans
NSE	Nairobi Securities Exchange
PD	Probability of Default
ROA	Return on Assets
ROE	Return on Equity
SDF	Stochastic Discount Factor
VAR	Vector Autoregressive Model

OPERATIONAL DEFINITON OF TERMS

Asset Prices movement: Refers to stock prices volatility. It is the change in prices of securities or other assets especially in the short term. Prices movement is the rise and fall of asset prices in over a short period of time for example daily, weekly, monthly or quarterly.

Brownian motion: A stochastic process representing variables that evolves over time.

Credit Risk: Financial risk associated with increase in default rate among creditors.

Consumer price stability: Refers to the concepts that price level of consumer goods and services are stable enough. It is also synonymous with inflation and 'price stability' as applied in this study.

Consumption credit: Credit awarded to household for consumption purposes.

Countercyclical: An economic or financial policy is called countercyclical if it works against the cyclical tendencies in the economy.

Durable consumption credit: Credit awarded to household for purchase of durable goods

Financial Risk: Refers to three main risks that financial institutions are exposed to. They include market risk, credit risk and operational risk.

Flight-to-quality: A financial phenomena where investors sell what they perceive to be high risk investment and purchase safer investment like treasury bills and bonds. It is synonymous with flight-to-safety and related to flight-to-liquidity.

Market risk: Financial risk associated with loss of investment or trading operations: Refers to losses due to changes in equity prices, interest rates, credit spreads, foreign exchange rates, and commodity indicators among other indicators exogenously determined by the market.

Financial Crisis: Disturbance of the financial markets associated with falling of asset prices and insolvency of among debtors and intermediaries which spreads to the real economy. Types of financial crises include debt crises, equity crises, banking crises.

Financial System: Composed of five main subsectors including Commercial banks, Insurance subsector, Security Market, Pension Fund and Financial Co-operatives.

Financial Stability: State where financial institutional system is resilient to economic shocks and effectively undertakes its basic intermediation functions.

Great moderation Period: A period of economic stability characterized by positive economic growth and sustained low inflation levels that commenced in mid-1980 to 2006 in developed countries. During this period, economists and scholars held the belief that the boom and burst cycle had been overcome. However, there was great volatility in financial and asset market.

Micro-prudential regulations: Firm-level oversight of financial regulation by regulators of financial institutions which monitor robustness of individual financial institution's balance sheet to financial shocks.

Macro-prudential regulations: Oversight of financial regulation which aims at monitoring the systemic risk and financial soundness of the whole financial system.

Real Sector of the economy: Also known as the 'real economy'. It is the sector of the economy that undertakes production and trade of actual goods and services.

Risk averse: Risk averse is a description of an investor who, when faced with two investments with a similar expected return (but different risks), will prefer the one with the lower risk. By definition rational economic investors are generally risk averse.

Speculative bubble: Refers to trade in the asset market at a price or price range that is strongly above the assets intrinsic value. The concept is similar to asset bubble or economic bubble.

Stochastic Discounting Factor: Refers to the concept that price of an asset can be estimated by discounting future cashflows using intertemporal consumption growth.

Systemic risk: The possibility that shocks emanating from one or more financial institution or from other economic sector can trigger severe instability in one or more sectors and eventually collapse of the entire financial system and/or the entire the economy. OR it is the build-up of widespread shocks within or without the financial system which may unravel and adversely impact financial system performance. Notably, this study uses systemic risk and systematic risk interchangeably.

ABSTRACT

The global economy enjoyed a period of low inflation and growth during the great moderation period in mid-1980 to 2006. However, prevalence of financial crises during and immediately after the great moderation period led to the realization that asset price movement was central to financial system stability. Second, it was discovered that pursuance of monetary policy does not guarantee financial stability. In this regard, there was great uncertainty as to the policy instrument needed to safeguard financial health in the economy. Safeguarding financial stability encompasses analysis of systemic risk factors that causes turmoil in the financial and real economic sectors. Systemic risks consist of all potential risk in the economic system that may negatively affect proper functioning of the economic system. In this regard, this study sought to analyze systemic risk among asset prices movement, financial system and the real economy. Specific objectives include: (i) to analyze the systemic risk in security asset prices movement in Kenya; (ii) to analyze the systemic risk in housing asset prices movement in Kenya; and (iii) to investigate the relationship among financial risk, asset prices movement and real sector economic variables in Kenya. To address the first and second objectives, three variants of consumption-based capital asset pricing model (CCAPM) are used. These include the standard CCAPM model, habit formation CCAPM model and Two-goods CCAPM model. To address the third objective, a macro-financial model was specified and included asset prices movement, credit risk and real economy variables. Quarterly time series data from 2001Q1 to 2017Q3 was used for analysis. The macro-financial model was estimated using VAR-X model. The main findings show that consumption risk factors such as changes consumption growth, habit formation and growth of durable goods were important in determination of security and housing asset prices movement. It was further established that while Kenyan investors make asset pricing decision with the objective of smoothening lifetime consumption, they exhibit low risk aversion behavior, and this was more pronounced in the housing market. However, there was evidence to show that risk aversion increases during bad economic times. Analysis of the relationship among financial risk, asset prices movement and the real sector confirmed existence of feedback loop between the asset market and real sector of the economy on one hand; and feedback effect between real sector variables and financial risk in the Kenyan economy on the other. It was further established that financial risk is was countercyclical to business cycles and tend to increase during recession and reduce during boom periods. Based on these findings, the study concluded that while low risk aversion maybe an indication of low systemic risk in the Kenyan market evidence of adjustment of risk during recession emphasizes the need for constant monitoring of systemic risk in the asset market. In addition, existence of feedback loops among macro-financial variables and enhances the need to adopt systemic risk management policies. The main study recommendation include designation of a macroprudential authority within Central bank with clear structures and mandate to constantly monitor systemic risk in the economy.

CHAPTER ONE

INTRODUCTION

1.1. Background

After the volatile period from 1970s to mid-1980s, the global economy embarked on fairly stable growth path referred to as the great moderation period which commenced from mid-1980's to 2006. Policy environment during this period focused on price stabilization policies as the most important monetary policy tool for achievement of inflation and output stability (Tymoigne, 2006; Somilano, 2009). Allen and Rogoff (2010) and Koivu (2014) explained that the general policy standpoint during the great moderation period purported that inflation stability would automatically enhance financial stability in the economy.

Despite the fact that efficacy of price stabilizing policies was widely been proven over the great moderation era, the global economy was characterized by unprecedented incidences of financial crises during and immediately after the period (Bernanke & Gertler, 2000; Allen & Rogoff, 2010; Koivu, 2014). Examples include the Asian crisis in the 1990's, dotcom bubble in 2001, the global financial crisis of 2008/2009 and the Europe debt crisis of 2014. Therefore, the nature, frequency and dynamics of financial crises raised pertinent question as to the efficacy of monetary and financial stability policies (Pouvelle, 2012; Seal *et al.,* 2013; Koivu, 2014).

Lessons learnt during and immediately after the great moderation period led to significant paradigm shift with regards to safeguarding financial stability. First, it was evident that pursuance of inflation and output stability objectives by the monetary authorities did not

guarantee financial stability (Tymoigne, 2006; Allen & Rogoff, 2010; Kasekende, 2011; Mwingi, 2015). For example, risk in financial asset market which manifest as large variation in boom and burst cycles have partly been attributed to relaxed monetary policy environment widely practiced during the great moderation period (Allen & Rogoff, 2010; Koivu, 2014).

Second, prevalence of financial crises led to the realization that financial asset market is central to safeguarding financial stability. Assets such as securities and real estate play a dual role both as productive assets and collateral for loans hence linking asset market and financial market. On the supply side, increase in asset prices enhances commercial bank's balance sheet position hence increasing the amount of loanable funds. On the demand side, increase in asset prices increase investors' confidence and wealth and ultimately improves their capacity to borrow (Tymoigne, 2006; Misati & Nyamongo, 2012; Pouvelle, 2012). These explain why asset prices burst may play a significant role in erosion of equity, real estate capital, credit losses and meltdown of real economic activity during Japan crisis in 1990's and the 2007/2008 global crisis (Allen & Rogoff, 2010; Pouvelle, 2012).

Third, there was great uncertainty as to the financial objectives to be pursued and the instruments needed to pursue these objectives (Allen & Rogoff, 2010; Seal *et al*., 2013). On one hand, policies geared towards management of risk associated with the asset market were vague at best. Notably, the use of micro-prudential instruments, such as financial risk indicators at the institutional level, failed to predict pending threats of banking crises in Europe, Asia and the United States (Kasekende, 2011; Allen & Rogoff, 2010). Furthermore, upsurge of financial innovation and development of financial sector limit the ability of conventional monetary policy instruments in management of systemic risk in the economy (Torre & Ize, 2009; Koivu, 2014).

Against this background, post crises literature confirms that systemic risk is central in management of financial stability objective. Systemic risk refers to disruption of the proper functioning of the financial system caused by an impairment of part or the entire financial system with the potential to cause significant adverse effect on the real economy. In this context, the term financial system does not mean the collection of financial institutions: It refers to the network of interrelated financial institutions which operate coherently in provision of financial intermediary services. Therefore, the banking system is composed of the collection, interaction and network of commercial banks with Central Bank at the center of the system (Zigrand, 2014).

Therefore, financial system is a working mechanism with independent dynamics from its individual constituents. This means that systemic risk management goes beyond regulating individual financial institution's health. Furthermore, systemic risk may emanate within and outside the financial system and therefore depends on the interplay among financial system, asset market and the real economy (Seal *et al*., 2013; Zigrand, 2014). Constant monitoring and management of systemic risk is vital in enhancing financial stability because despite their its origin, build-up of systemic risk is may evolve through snowballing effect into extreme outcomes to both the financial system and/or real economy (Gadanecz & Jayaram, 2008; Kliem, 2010; Zigrand, 2014).

1.2. The Effect of 2007/2008 Global Financial Crisis on Africa

The 2007/2008 global crisis which originated from housing market burst in the United States of America (USA) was fueled by lax in credit owing to low interest rate policy pursued by Federal Reserve Bank in USA. Housing market burst forced major banks to suffer significant

losses. This sent signals to international markets and led to disruptive consequences that culminated into financial crisis. Africa financial system generally proved resilient to 2007/2008 financial crisis (Griffith-Jones *et al*., 2013). As of 2008, African stock market accounted for only 2.09 percent of world capitalization. African banking assets only represented 0.87 percent of global banking asset (Kasekende *et al*., 2009; Griffith-Jones *et al*., 2013). In this regard, speculative attacks in the international capital market had minimal effect on financial system in Africa.

African economy recorded significant growth averaging five percent over the last two decades prior to the 2007/2008 global crisis. Growth was driven by high global demand for commodities, increased capital inflows, partly owing to China's strong growth and investment in Africa, and implementation of sound macroeconomic reforms (Kasekende *et al.,* 2009). The 2008 global financial crisis played a significant reviewing monetary policy stand on financial stability objective. It also provides important lessons of the adverse effect of financial crisis on developing countries in Africa.

This notwithstanding, there is enough evidence to support the argument that a highly liquid and vibrant financial market, integration and financial inclusion increase systemic risk in Africa (Misati & Nyamongo, 2013; Mwega, 2014; Mwingi, 2015). First, African financial sector was indirectly affected through contagion from international banks. Capital outflow by foreign investors led to overvaluation of stocks and consequently, dampened investment (Beck *et al*., 2010; Kasekende *et al*., 2009; Griffith-Jones *et al.,* 2013). Kasekende *et al*. (2009) reported that Nigerian and Egyptian investors recorded losses of half their wealth within six months of the wealth invested in mid-2008.

Second, the financial crisis had an adverse effect on the cost of Africa's sovereign debt. For example, average interest on sovereign debt increased by 250 basis points in emerging and developing countries (Kasekende *et al*., 2009). Increase in interest rate raised risk premium for majority of African countries forcing them to finance deficit from domestic sources at the expense of crowding out private investment in the economy.

Third, significant decrease in commodity prices and revenue for primary exporting countries was partly attributed to the 2007/2008 financial crisis. For example, fiscal balance declined from a surplus of approximately 2 percent to a deficit of 4 percent in Sub-Saharan Africa. Overall export growth rate fell by approximately seven percent compared to decline in import growth rate of 4.7 percent (IMF, 2009). Therefore, the net effect of decline in commodity prices in the international market negatively affected African economy's terms of trade. The effect of 2007/2008 financial crisis proves that the origins of financial crises are often unpredictable, explosive and impact the other economies through contagion (Kose & Claessen, 2013; Seal *et al*., 2013).

1.3. The Kenyan Financial System

The Kenyan financial system is composed of five sectors which include Commercial Banks, Non-bank financial institutions, insurance sector, pension schemes and the Nairobi Security Exchange. The Kenyan banking sector is comprised of 42 commercial banks and one Mortgage Institution. The banking sector is the largest with total asset base of the banking sector was approximately KES 4 trillion, which represents 55.3 percent of the Kenyan GDP, as of 2017.

Kenya banking sector witnessed major policy reforms in the last three decades. These reforms include liberalization of interest rates in 1993, adoption of floating exchange rate regime, enactment of an autonomous Central Bank in 1996 and adoption of economic recovery strategy policy in 2003. The reforms created conducive atmosphere for development of both macroeconomic and financial sector in Kenya. In recent times, Kenya's financial system is characterized by an open and dynamic capital market and security exchange and growth of commercial banking. Emergence and growth of financial co-operatives (SACCO's) has also played a key role in enhancing financial inclusion (Republic of Kenya, 2003). Table 1.1 shows the trend of financial stability indicators in Kenya from 2006 to 2017.

Table 1.1: Financial Indicators (in percent): Selected years from 2006 to 2017

	2006	**2008**	**2011**	**2013**	**2015**	**2017**
Private sector credit as a ratio of GDP	22.7	25.3	30.4	31.7	34.9	29.3
Regulatory capital to risk weighted asset	16.5	18.9	19.4	19.4	18.7	21.4
Non-performing loans to gross loans	21.3	9.0	4.4	5.1	6.8	12.2
Return on Assets	2.8	2.8	3.3	4.7	2.9	2.7
Return on equity	28.6	28.6	32.2	28.9	23.9	20.3
Liquid assets to total assets	30.5	34.6	33.3	38.3	38.3	44.0

Source: CBK Banking Supervision reports, (Various Issues)

Table 1.1 shows that the financial indicator ratios have gradually improved from year 2006 to 2014. For example, Non-Performing loans (NPL) significantly reduced from 21.3 percent to 4.4 percent between 2006 and 2011 but increased from 2011 to 2015 by 2.4 percent. Returns on asset and return on equity increased within the same period and liquidity ratio stood at

34.6 percent in 2008 which is approximately 5 percent higher than the level in year 2000 (Beck *et al.,* 2010). Financial indicators show marked improvement. Beck *et al*, (2010) reported that an evaluation of financial stability revealed that majority of banks meet the statutory capital requirements. However, review of 2017 financial ratios shows that the banking sector's performance performed poorly relative to previous periods. This may be attributed to introduction of interest capping law in 2016 (CBK, 2018).

Despite significant growth of Kenya's financial system, several issues in the Kenyan financial system that enhance systemic risk; First, the structural composition of Kenya's financial system is characterized by large segmented financial market, dominance of few large banks and lack of effective interbank interaction across segments. Mwingi (2015) pointed out that the statistics mask a significant variation between the largest banks and the rest of the banks in Kenya. Failure or shocks to major banks can spill over across the sector culminating into a systemic financial crisis.

Second, private sector credit to GDP ratio averaged 30 percent over the period which shows dismal performance compared to developed economies where private sector credit to GDP is more than 100 percent. Limitation of private credit expansion is caused by high cost of credit. CBK (2014) reported that only 29 percent of adult population in Kenya has access to credit from commercial banks compared to 64 percent who have access to savings. Notably, high cost of credit is attributed to high risk associated with enforcement of collateral, low financial literacy, existence of a large informal sector and lack of effective competition.

Third, financial innovations such as introduction of mobile money transfer and agency banking have significantly improved intermediation and payment systems in the Kenyan

financial system (CBK, 2017). For example, value of transaction via mobile money transfer increased by approximately 65 percent from KES 2.3 trillion in 2014 to KES3.65 trillion in 2017. Financial innovation continues to a significant role in enhancement of financial inclusion and financial deepening in Kenya. However, rapid innovation introduces inherent risk to financial stability especially if innovation assimilation grows faster than formulation of policies needed to monitor such innovation (Tore & Ize, 2009).

1.4. The Kenyan Asset Market: Security and Real Estate Sector

According to CBK (2013), real estate and security market are two of the most significant asset markets that drive the Kenyan economy. First, the Nairobi Security Exchange (NSE) market is composed of 66 publicly listed firms with total outstanding shares valued at 40 percent of the Kenyan GDP. As of 2017, Market capitalization stood at KES 2.52 trillion which represents 32 percent of GDP (CBK, 2018). Figure 1.1 shows the trend of the Nairobi security exchange 20-Share index from the first quarter of 2001 to the fourth quarter of 2017.

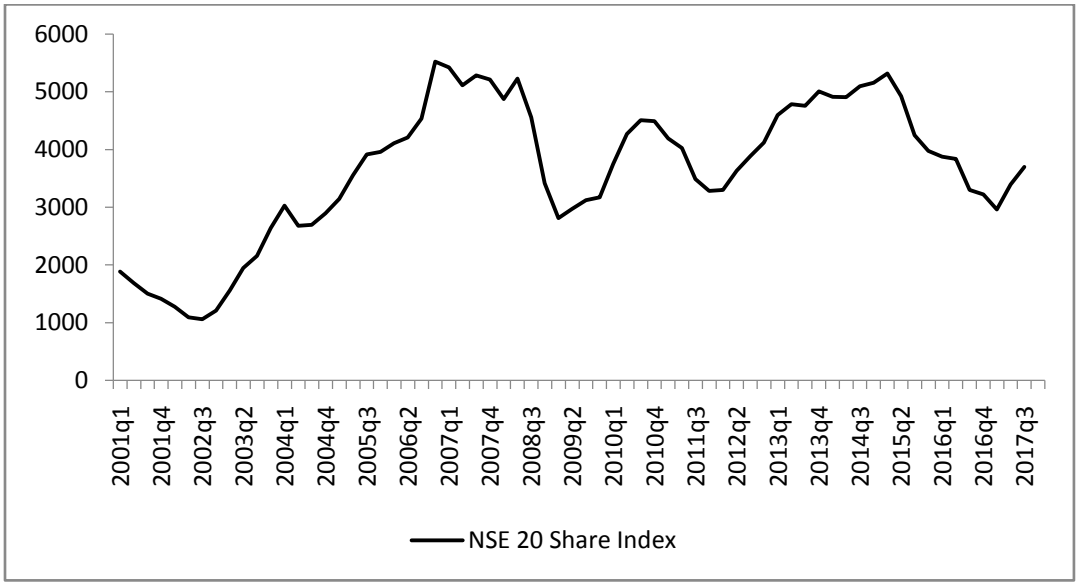

Figure 1.1: Trending NSE 20-Share Index from 2001Q1 to 2017Q3

Source of data: Nairobi Stock Exchange

Figure 1.1 shows that the NSE 20 share index generally increased over the 2001 to 2017 horizon. General growth of the stock market is attributed to sustained growth of the economy and low level of inflation. Trend analysis of NSE 20-Share index shows significant bearish tendency during periods where Kenyan economy experienced specific shocks. For example, sharp decrease in NSE index during the periods 2002, 2007 and 2013 may be attributed to political risk experienced during electioneering periods (Kimani & Olweny, 2011; CBK, 2013). According to CBK (2015) volatility and risk in security market may be explained by existence of speculators in the market, exchange rate fluctuations, security concerns and external shocks. Second, the real estate market has significantly grown over the last decade to account for 9.6 percent of real GDP as of 2017. Figure 1.2 shows the trend of real estate sector growth from the first quarter of 2010 to the fourth quarter of 2017

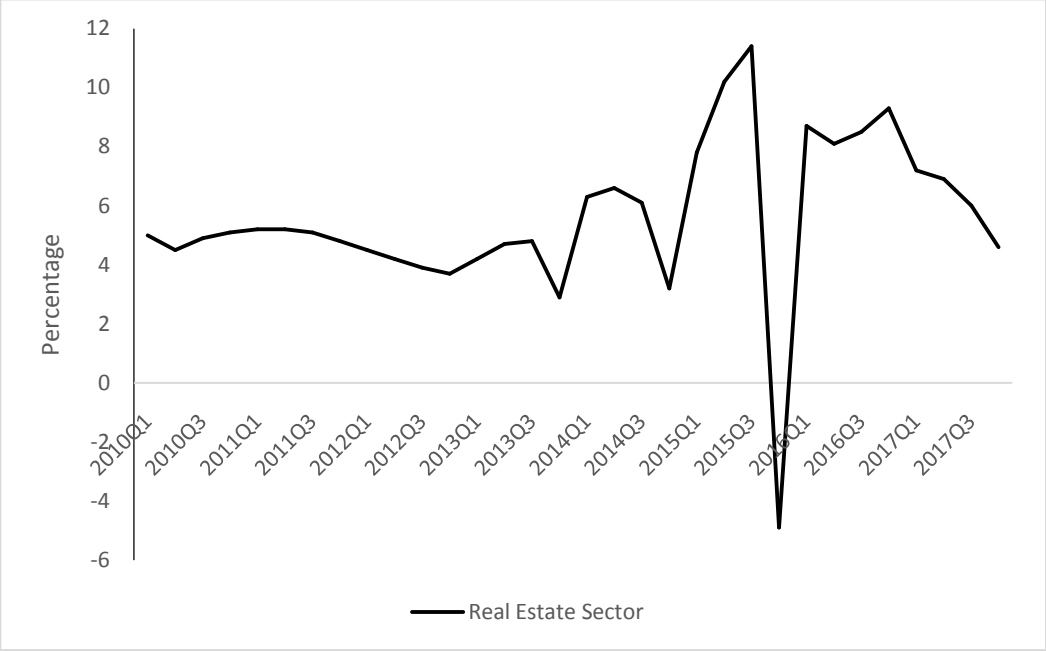

Figure 1.2: Trend in Real Estate Growth from 2010Q1 to 2017Q4

Source of data: Central Bank Database

Figure 1.2 shows real estate sector grew gradually by approximately 5 percent per quarter from 2010 to 2017. Real sector growth rate was measured using Hass Property Index. The figure shows that market the real sector market witnessed prolonged growth due to a steadily growing economy and rising middle class in urban areas (Miregi & Obere, 2014). However, significant changes were witnessed from 2015 with real estate growth declining to lows of -4.9 percent in the fourth quarter of 2015. CBK (2017) attributed changes from upswing to downswing trend observed from 2015/2016 period to cyclical behavior and market correction phenomena. Decline in real estate growth witnessed in major cities and their corresponding satellite towns was attributed to decline in housing demand and/or oversupply of housing due to increased asking price and increase in rental income. Notably, volatility in real estate market maybe an indication of asset market risk that results from mispricing of housing market in urban areas (CBK, 2018; Njaramba *et al*., 2018).

1.5. The Kenya Real Economy

The Kenya's Gross Domestic Product (GDP) has remained relatively stable averaging four percent per annum from 2000 to 2015. Financial services sector, wholesale and trade, and mining and quarrying were the main drivers of growth. The key sectors driving growth in the past (including agricultural and forestry, hotel and tourism) have contracted due to unreliable weather conditions and insecurity in the country. Though volatile, inflation levels have been relatively low from late 1990's to 2012. From 2010, inflation levels were within their medium target of five percent give or take 250 basis points. The low inflation is attributed to low global food and oil prices and sound monetary policies employed in Kenya (CBK, 2013; Mwega, 2014).

This notwithstanding, the Kenyan economy is still susceptible to both domestic and external macroeconomic shocks such as food shortages, fluctuation in commodity prices in the international market, high level of inflation among others. In addition, political risk attributed to elections and change in governance from central-based to county-based structure may have a profound effect on the real economy (CBK, 2014; Mwega, 2015).

Analysis of the Kenyan financial system, asset market and real economy have performed positively and generally remained resilient to shocks over the last three decades. However, presence of endogenous risk in each sector may be potential sources of systemic risk in the financial system. Kenya's policy environment focuses more on price stability relative to financial stability. The Central Bank of Kenya responds economic shocks by relaxing or tightening monetary policy (Misati & Nyamongo, 2012; Mwega, 2015).

There are concerns whether monetary policy intervention can effectively address asset market turmoil and financial disruption in Kenya. For example, while monetary tightening reduced overall inflation, it also led to significant reduction in liquidity position of the financial sector prompting banks to liquidate their foreign asset holdings hence threatening financial stability in the economy (Misati & Nyamongo, 2012, Were, 2012).

In this regard, it can be argued that CBK overtly focuses on its principal role of maintaining stability of price levels. It is important to acknowledge that Article 4(2) of the Central Bank Act that states: "*the Bank shall foster the liquidity, solvency and proper functioning of a stable market-based financial system*" (CBK 2013). Remarkable improvements have been made with regards to micro-prudential policies. However, few if any macroprudential policies have been developed to effectively monitor and manage of systemic risk in the

Kenyan financial system. There is need for adoption of comprehensive system-based financial policies to safeguard both financial and overall macroeconomic stability in Kenya.

1.6. Statement of the Problem

The great moderation period policy environment identified macroeconomic stability with low inflation of consumer goods and services as opposed to financial instability (Somilano, 2010; Kose & Claessen, 2013; Allen &Rogoff, 2010). However, prevalence of financial crises including the 1997 Asian crisis, the dotcom bubble of 2001 in the U.S, the global financial crisis of 2007/2008 and the Europe debt crisis of 2014 has led to the realization that: First, asset price movements have a fundamental effect on the stability of the financial system and the real economy. Second, emphasis on consumer price stability is not sufficient to guarantee financial and by extension macroeconomic stability (Kose & Claessen, 2013; Somilano, 2010). Post financial crises environment acknowledges the need of introducing systemic risk measures to mitigate financial crises in developing economies because the cost of financial crises is colossal to the society (Koivu, 2014, Kose & Claessen, 2013).

Kenya's financial sector has witnessed robust growth and significant improvement in regulatory and development policies. This has contributed to financial deepening, improved efficiency and stability (Beck *et al.,* 2010). However, the banking system is still young and vulnerable to instability which may be caused by internal or external shocks and/or failure of major players in the industry (CBK, 2013; Mwega, 2015). Kenya's policy environment focuses more on price stability relative to financial stability. For example, while monetary tightening in 2011 led to reduced inflation, it also caused liquidity and enhanced risk in the financial sector (Were, 2012; CBK, 2014). Therefore, there is great uncertainty as to the

instruments needed to pursue financial stability objective. This prompts the review of the policy to ensure that proper mechanisms are put in place to safeguard financial stability in Kenya (Mwingi, 2015).

Safeguarding financial stability is a great concern that goes beyond securing monetary policy goals and management of individual financial institution's health. Systemic risks consist of all potential threats to proper functioning of the financial system that emanate from the part or the whole of financial system, asset markets and/or the real economy (Koivu, 2014 ; Zigrand, 2014). Lessons from previous financial crises have proven that without proper mechanism in place, build-up of systemic risk is often unpredictable, explosive and impact the other economic sectors through contagion (Kose & Claessen, 2013; Seal, *et al*., 2013).

Few studies have focused on systemic risk analysis of the Kenyan financial system. Becks *et al*. (2010) focused on bank stability and financial growth in Kenya, though insightful, the study did not evaluate systematic risk in the financial sector and the macroeconomy. Related studies focused on asset prices channel and monetary policy in Kenya (Misati & Nyamongo, 2013); or the effect of financial regulation on performance/stability of financial sector in the Kenyan economy (Kasekende, 2011; Mwega, 2014); or the dynamic relationship between housing prices and macroeconomic variables (Njaramba *et al*., 2018).

The principle argument of this study is that to achieve overall macroeconomic stability, there is need to pursue systemic risk management policies to complement price stability objective. This requires understanding the nature, dynamics and determinants of systemic risk among asset markets, financial system and the real sector of the economy (Misati & Nyamongo, 2012; Koivu, 2014; Zigrand, 2014).

1.7. Research Objectives

The general objective of this study is to analyze systemic risk among asset prices movement, financial system, and real sector of the Kenyan economy. Specific research objectives and research questions include the following:

i) To analyze systemic risk factors of security prices movement in Kenya.
ii) To analyze systemic risk factors of housing prices movement in Kenya.
iii) To evaluate the relationship among credit risks, asset prices and the real economic factors in Kenya.

1.8. Research Questions

i) What are the systemic risk factors of security prices movement in Kenya?
ii) What are the systemic risk factors of housing prices movement in Kenya?
iii) What is the relationship among credit risks, asset prices and real economic factors in Kenya?

1.9. Significance of the study

The uniqueness of this study is the robust investigation of systemic risk in the financial system in Kenya. Focus on financial stability objective was motivated by vagueness in policy and regulation of financial systems and the paradigm shift in policy and practices adopted to safeguard financial system health in both developed and developing economies after the global financial crisis that occurred in 2008. In this regard, the findings of this study are of vital importance to Central bank as the central authority responsible in formulation and implementation of systemic risk management and financial regulation in Kenya.

Secondly, the study focuses on asset market behavior and may therefore benefit Capital Market Authority and other players in the financial market. Lastly, as an umbrella body overseeing the Kenyan financial sector, the Ministry of Finance may benefit specifically in realigning all regulatory bodies to ensure policy harmonization and achievement of monetary, financial and overall macroeconomic stability in the Kenyan economy.

1.10. Scope and Organization of the Study

The policy environment that defined the scope and essence of this study was restricted to post-liberalization era which commenced in 1993. It was during the post liberalization period that financial market development rapidly evolved thus prompting the study. Quarterly time series data from the first quarter of 2001 to 2017 will be used for analysis. The rest of the study is organized as follows: Chapter two presents theoretical and empirical literature followed by the methodology in Chapter three. Chapter four provides the research findings. Finally, chapter five presents the summary, conclusions, policy recommendations and areas for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents literature review which is divided into theoretical and empirical literature. Theoretical and empirical literature will be structured thematically based on the study objective. The chapter concludes with the overview of the literature review and identification of the research gap.

2.2. Theoretical Literature on Asset Price Valuation

This section presents three major theories namely the capital asset pricing model, Arbitrage Pricing Model and Consumer based asset pricing model are presented.

2.2.1. Capital Asset Pricing Theory

Capital asset pricing theory (CAPM) is considered as one of the most prominent traditional models in asset pricing. This model was developed independently by Sharpe W. in 1964 and Linter J. in 1965. The model assumes that the objective of a rational investor is to maximize future returns and minimize risk. The theory specifies that total market risk is composed of unsystematic risk and systematic risk. Unsystematic risk can be eliminated by diversifying the portfolio mix. Systematic risk is the risk inherent in the aggregate market. Common sources of systematic risk are recessions, political conflict and any other shocks that may affect macroeconomic stability, Therefore, investors need to be compensated for systemic risk. This coefficient is estimated using the coefficient $\beta=\frac{Cov(R_i,R_m)}{Var(R_m)}$ measures the systematic

risk which cannot be minimized by diversification (see Appendix for derivation of β). The covariance risk captures the risk of an individual asset relative to market risk (Krause, 2001; Yogo, 2006; Pepin, 2014).

Despite the wide application of CAPM theory, critics argue that the models perform poorly in empirical investigations. Assumptions such as unrestricted borrowing at the risk free rate and homogeneity of investors are too simplistic and unrealistic. It is further argued that CAPM is a static model that assumes linearity between expected returns and systematic risk. This limits the application of the model with regards to capturing market dynamics and modeling nonlinear relationship. Of importance is the fact that it assumes that investment decisions are made exogenously with respect to consumption decisions (Krause, 2001; Yogo, 2006; Pepin, 2014).

2.2.2. Arbitrage Pricing Theory

Arbitrage pricing theory (APT) is an improvement of the CAPM model to the extent that it includes macroeconomic factors in estimating risk. Unlike CAPM which focuses on equilibrium by holding optimal portfolios, APT assumes that equilibrium is arrived at by ruling out arbitrage possibilities. It holds that asset prices are determined by a multiple number of random macroeconomic risk factors such as inflation, interest rates, industrial factors, growth of gross domestic product (GDP) and other political and economic events that may strongly affect asset returns (Krause, 2001).

Like CAP theory, APT assumes linearity between asset return and factor loadings. Factor loadings are macroeconomic variables used in estimation of APT model. APT also assumes that unsystematic risk is eliminated by diversification and therefore factor loadings capture

systematic risk. APT allows inclusion of multiple sources of risk, is less restrictive as it relaxes the assumption of homogeneity and can be applied as static and dynamic models (Krause, 2001; Kwan *et al*., 2014). The weakness of this model is that it is difficult to identify the risk factors to be included in the model as it does not have a strong economic foundation. Secondly, like the CAPM, assumption of linearity limits APT's application in nonlinear asset. Lastly, in its rudimentary form, the model does not systematically account for consumption decision (Krause, 2001; Hunter & Wu, 2008).

2.2.3. Consumption Capital Asset Pricing Model: Standard Model

Consumption based asset pricing model (CCAPM) was developed by Thomas Lucas and other economists in 1979. The CCAPM is an intertemporal model within which the investors maximize their expected lifetime utility (Kose & Claessens, 2013). This theory assumes that financial assets are used to smoothen lifetime consumption a concept referred to as stochastic discounting factor (SDF). Households sell assets during bad times and invest extra income during good times. This model associates systemic risk with macroeconomic factors and shows that those assets with high returns during bad times and low returns during goods times are considered as low risk premium asset (Yogo, 2006; Kose & Claessens, 2013).

The CCAPM model is flexible to the extent that different variations of CCAPM models can be applied in empirical investigation. The SDF approach to asset pricing holds that price of a security is estimated using expected future payoffs of a security discounted using the SDF. SDF therefore shows that investors consider macroeconomic risk through consumption risk factors when making investment decisions (Yogo, 2006; Kwan *et al*, 2014). The theoretical appeal of CCAPM model is the introduction of a dynamic and nonlinear model which is

deemed more realistic compared to previous models discussed in the preceding two sections (Yogo, 2006; Hunter & Wu, 2009; Kwan *et al*, 2014). Theoretical and empirical literature shows the importance of CCAPM as an asset valuation model. The CCAPM model is flexible to the extent that different variations of CCAPM models can be applied in empirical investigation (Kwan *et al*., 2014).

2.2.4. Consumption Capital Asset Pricing Model: Habit Formation Model

Yogo (2006), Hunter and Wu (2009) and Kwan *et al*. (2014) hold that empirical evidence has shown that the standard CCAPM model has little or no improvement over the CAPM model. Habit formation model is based on Relative Income Hypothesis theory which holds that people become accustomed to a way of living and as such form habits which persist over time. Therefore, consumption is not determined by the absolute level but also reacts to habit formation. Households will increase consumption above habit consumption level during good economic times when expected income is high. On the other hand, households reduce consumption to the habit level during bad economic times when expected income growth is zero or negative (Hunter & Wu, 2009).

In this regard, the price of asset is, therefore, countercyclical to habit such that when current consumption is close to the habit level, asset prices are low and consequently risk in the asset market is high. On the other hand, when current consumption is higher relative to habit level, asset prices are high as the asset market risk is perceived to be low by investors in the market. Yogo (2006) and Kwan *et al*. (2014) hold that habit formation CCAPM is nonlinear and cyclical to account for joint behavior of consumption/macroeconomic risk and asset returns.

2.2.5. Consumption Capital Asset Pricing Model: Two-Goods Model

According to Yogo (2006) and Kwan *et al*. (2014) the composition of durable and non-durable goods is also useful in explaining asset price movement. Consumers focus on smoothening non-durable goods such as food and utilities. On the other hand, durable consumption growth is procyclical to business cycle variation as it captures boom and recession trends. Yogo (2006) assumes that the intraperiod utility for a typical household is represented by constant elasticity of substitution between durable and non-durable goods. It follows that marginal utility of consumption is expected to increase when durable consumption falls or during recessionary periods. Consequently, investors must therefore be rewarded with high returns to hold on to risky assets. In this regard, the two-goods model introduces both the smoothening component of consumption and the effect of macroeconomic cycles in estimation of asset prices movement. In addition, this study uses APT as a basis of estimating augmented asset pricing models. These models are used to complement for consumption based asset pricing models.

2.3. Theoretical Arguments on Asset Prices and Financial Stability

There are no substantive theories that explain the dynamics of asset pricing movement and financial stability in the economy (Misati & Nyamongo, 2012; Choy, 2012; Yogo, 2006; Kwan *et al*., 2014). This section reviews and critiques the theoretical perspective that guide in policy formulation with respect to price stability, financial stability and formulation of monetary policy.

2.3.1. The Neoclassical Synthesis

The neoclassical synthesis was developed in the 1990's and fused into the neoclassical theory with new Keynesian theory. One of the main policy targets introduced by neoclassical theory is inflation targeting as the sole monetary objective. Goodfriend and King (1997) explained that inflation targeting framework is sufficient because: First, there is an optimal level of inflation that fuels macroeconomic stability and full employment level. Second, Schwartz hypothesis holds that Central Banks ought not to focus on financial stability unless there is an explicit threat to financial stability. Thirdly, Central Banks should focus on price stability and promote transparency and accountability (Tymoigne, 2006; Goodfriend & King, 1997).

Inflation targeting theory acknowledges the disruptive nature of financial imbalances on the economy but dismissed the level of asset prices as an inappropriate target. However, Central Banks should observe rapid growth in credit, investment and asset prices and respond to both inflation and financial imbalances using the interest rate approach (Tymoigne, 2006). This thesis supports the 'Greenspan principle' which holds that monetary policy should not try to 'lean against the wind' during a speculative bubble but respond after the burst to restore balance (Allen & Rogoff, 2010).

2.3.2. Post Keynesian Rebuttal to Neoclassical Perspective

Price stabilizing monetary instruments either target money supply or interest rates under the neo-classical assumption that money supply is exogenous. Post Keynesian theorists have shown that targeting either interest rates or monetary targets is flawed because money supply is endogenous. Financial sector has the ability to create credit and therefore circumvent monetary authorities' policy objectives (Palley, 2004; Kasekende, 2011). Targeting inflation

as the sole objective can lead to unforeseen instability in the financial sector as it may enhance balance sheet disorders without any immediate impact on inflation.

This problem is compounded by deregulation and innovation environment which has increased the capacity of financial sector to create credit. Even with relatively low and stable inflation, rapid changes in balance sheets and debt position within the financial sector may have significant impact on output and employment. Post Keynesian theorists hold that the Central bank has an indirect influence on inflation not only because it control money supply but also due to the fact that inflation is not purely a monetary phenomenon (Palley, 2004; Tymoigne, 2006).

2.3.3. Minsky Hypothesis

Minsky hypothesis holds that in a capitalistic system asset prices are inherently unstable since business cycles are endogenous in nature. Build up of systemic risk during good economic times means that there should be an active policy framework to promote economic stability and full employment (Tymoigne, 2006). Prolonged period of growth breeds optimism in the real and financial markets. Owing to excess liquidity, banks introduce less restrictive terms of lending leading to rapid credit growth which leads to increase in asset prices. Highly leveraged financial institutions rely on rising asset prices to repay debt (Ponzi games) and the market relies on speculation as opposed to fundamentals. If authorities introduce contractionary measures to curb impending inflation, the balance sheet position of leveraged firms worsens hence creating instability in the market (Palley, 2004; Tymoigne, 2006).

Therefore both Post Keynesian and Minsky Hypothesis dismiss the neoclassical assumption that instability can only be caused by overt negative shocks to the system. In this regard, post Keynesian and Minsky hypothesis do not negate Schwartz hypothesis but rather holds that causality between inflation and financial stability run both ways and recommend: First, Central Bank should focus on financial stability and leave full employment and economic growth objectives to other institutions. Second, Central bank should focus on financial matters both as a guide to influence expectations of private agents and as a regulator to promote financial development and stability. Thirdly, post Keynesian framework identify growth in credit, growth in asset prices and systemic changes to macroeconomic factors as important determinants of financial stability and recommends formulation of models that would enhance management of economic system by Central bank (Tymoinge, 2006; Palley, 2004 Seal *et al*., 2013).

2.4. Theoretical Rationale of Macroprudential regulation

Post Keynsian and Minsky Hypotheis clearly show that systemic risk cannot be effectively solved by price stability approach. Therefore, macroprudential regulations are important for systemic risk management. Well-designed macroprudential policies mitigate boom and burst cycles and thereby safeguard financial system. Generally, macroprudential policies have a significant impact in enhancing financial system stability and long term economic growth. The need for constant and consistent macroprudential policy regulation is threefold: The Principle-Agency problem, Externalities paradigm and Mood swings paradigm.

2.4.1. Principle-Agent Problem and Macroprudential Regulations

This argument is based on presence of information asymmetry in the market which leads to moral hazard problems. Moral hazard occurs when a party protected from risk behaves differently from the way it would have behaved if exposed to risk. Adverse selection encouraged originate-to-distribute model which encouraged banks to package loans into securities and sell them in the secondary security market as opposed to holding them to maturity. Torre and Ize (2009) argued that the agency paradigm create a self-propelled mechanism that enhance systemic risk. Banks' ability to shift risk under the originate-to-distribute framework, led them to predatory lending and exacerbate the moral hazard and adverse selection problem. For example, in the interest of making profits, banks' relaxed terms of lending and thereby attracting less risky borrowers. The agency paradigm enhances the buildup of structural vulnerabilities that contribute to systemic risk. Therefore, policies should introduce regulations that enhance financial transparency.

2.4.2. Externalities Paradigm

Externality is defined as the effect of one player's actions to the welfare of other players in the market. Generally, individual institutions make decisions based on the private benefits and cost criteria with little regard to the effect of their action to the whole society. Torre and Ize (2009) argued that one of the aspects that exacerbated the financial crises are existence of 'ready-to-run' investors in the market. Therefore, in an unregulated financial environment with incomplete information, existence of systemic externalities means that private institutions will not be ready to internalize the systemic risk during downturn periods. This

disapproves the neoclassical argument that financial sector can self-regulate and advocate for macroprudential policies.

2.4.3. Mood Swings Paradigm

Mood swings paradigm is based on the endogeneity nature of financial system and cyclical nature of the economy. Existence of upswings and downswings are often unpredictable because of rapid innovation in the financial sector. According to Tore and Ize, (2009 pg. 19):

"*This problem was compounded by a failure to fully comprehend the links between financial sector dynamics and the underlying asset price dynamics, and to adequately understand the feedback loop between rising asset prices and expanding credit."*

The feedback effect among the variables is caused by procyclical and countercyclical behavior in the economy. Changes in asset prices and leverage effect in the banking sector are procyclical and mutually reinforcing (Pouvelle, 2012; Choy, 2012). During upswings, optimism in the market enhances stability in both macroeconomy and financial markets. Expectations with regard to prices and market liquidity enhance procyclical effect between asset prices and credit growth and ultimately build-up systemic risk in the economy. Build-up of systemic risk during upswing eventually leads the economy to collapse on its own weight in presence of information asymmetry and predatory behavior in the banking industry (Torre &Ize, 2009).

Downswing period are characterized by reduction in asset prices and in turn worsens banks' leverage position forcing banks to restrict lending. This leads to contraction of investment and reduction of aggregate demand. Build-up of systemic risk during upswing period

manifests in the downswing period causing the economy to contract and further increasing default (Torre &Ize, 2009; Choy, 2012). Existence of mood swings justifies the imposition of regulation to mitigate buildup of credit risk, liquidity risk and market risk during the upswing periods. This can be done by preventing accumulation of leverage through setting minimum capital requirements and formulation of forward looking and stress testing models that can test systemic risk at the macro level (Torre &Ize, 2009).

2.5. Empirical Literature

This section reviews empirical literature in Kenya and selected studies around the world. Firstly, Wong *et al*., (2008) evaluated the credit risk model for stress testing banks financial stability in Hong Kong. The study used a system of equations with real GDP for Hong Kong and mainland China, credit risk (measured as probability of default rate), real property prices and real interest rates (proxied by Hong Kong interbank rate). The study used quarterly data from 1994Q4 to 2006Q1 and applied seemingly unrelated model. Using Monte-Carlo simulation to generate hypothetical scenarios, it was established that GDP, property prices, interest rates and exchange rate significantly influenced credit risk. The study showed that at 90 percent confidence interval, VaR was still favorable during the analysis period. This study identifies credit risk as an important aspect of measuring systemic risk and will therefore be instrumental in formulating financial stability model in the proposed study.

Hearn (2009) applied a multifactor time varying CAPM to study the effect of liquidity premium in valuation of stock assets in Uganda, Kenya, South Africa and London. The study found out that market size and liquidity are significant factors in explaining valuation of stock prices in Kenya and Uganda compared to South Africa and London. The study reported

that inclusion of market size and liquidity had a significant increase in explanatory power of the model compared to the standard, single factor CAPM. This study provides insight as to the importance of liquidity as a sensitivity factor in valuation of asset prices but failed to systematically model consumption as a macroeconomic risk factor.

Olena (2010) evaluated credit risk in South African bank using a single equation model. The study used loan loss provision as a proxy for credit risk and introduced property prices, interest rate, GDP and exchange rate as macroeconomic factors. Stress testing scenarios were created from worst historic scenarios experienced in South Africa It was established that South African banks were resilient to severe economic shocks. In addition, credit risk is sensitive to interest rates and property prices. The proposed study will borrow some of the explanatory variables applied in Olena (2010) which include loan loss provision, property price, GDP and exchange rate.

Vazquez *et al*., (2012) used a Vector Autoregressive model to test for interrelationship among asset prices, macroeconomic factors and credit growth and credit risk. A micro logit model and Value-at Risk procedure was used to evaluate credit risk of Brazilian banking sector. The study concluded that macroeconomic factors such as GDP and output gap were significant determinants of both credit growth and credit risk. The study used four hypothetical scenarios to generate adverse key macroeconomic conditions. Evaluation of stress testing scenarios shows that at 99 percent, value at risk was equivalent to 19 percent of the regulatory capital less provision for bad loans. These results show that Brazilian banking sector can cushion adverse shocks and were financially during the study period. This study will be useful to the proposed study as it will provide an anchor in formulation of adverse macroeconomic conditions in the stress testing vulnerability of Kenya's financial sector

Misati and Nyamongo (2012) used quarterly data from 1996 to 2009 to evaluate the relationship between asset prices, macroeconomic factors and monetary policy in Kenya. The main question addressed was whether Central Bank should pursue financial stability and price stability policies in equal measure. The study showed that there is a significant relationship between asset prices and monetary policy tools. The study concluded that Central Banks ought to provide for asset price movement when formulating monetary policy. This study did not account for financial instability. The proposed study modifies Misati and Nyamongo (2012) to include sectoral asset returns and use credit risk as the explanatory variable to account for financial stability

Pouvelle (2012) used bank level panel data with quarterly frequency from 1993 to 2010 to study the relationship among asset prices, credit demand factors (GDP, inflation, changes in lending rate) and credit supply factors (leverage, bank size, deposit) . The study used three stage least square method introduced financial instability index by estimating the model during instability period and stable period. The study established that security prices were a significant factor in determination of credit growth in both tranquil and financial instability periods. House prices were insignificant during tranquil period but significant and positive during financial instability period. Credit demand factors were significant during both periods. The study recommended that monetary policy should monitor asset prices due to their effect on credit growth and implementation of macro prudential policies to regulate interaction between growth of bank credit and asset price movements. The proposed study will improve on the methodology of capturing financial instability period by creating adverse scenarios since Kenya has not overtly experienced significant periods of financial instability.

Kwan *et al*, (2014) compared eight variations of CCAPM in an attempt to explain asset price movement in Hong Kong. The study established that generally, consumption based asset pricing models were relevant in explaining the dynamics of stock market returns and housing market returns in Hong Kong. Two-good model which incorporated durable and non-durable consumption was a better fit relative to other variants in explaining house prices returns relative to stock market returns. It was shown that composition risk was important in explaining house prices returns. This study will be useful in identifying variants of CCAPM model that will be used to evaluate asset pricing in Kenya.

Wambugu & Riro (2015) estimated the stock prices of eight companies trading under MIM in the NSE. The study employed the CAPM and Fama's three factor models in estimation, the study established that CAPM performed poorly but Fama's three factor model was a better fit. It was established that the size of the company and book to market ratio were significant factors in estimating asset prices. While the study focused on companies across all market segments in NSE, the main limitation was failure to include macroeconomic factors in modeling asset prices. The proposed study will improve on Wambugu and Riro (2015) by including macroeconomic factors in an attempt to capture factors that explain systemic risk in the financial sector.

Njaramba *et al.* (2018) investigated the relationship between housing prices and the Kenyan macroeconomy. The study employed VAR model with housing prices, house indebtedness, private capital inflows and household consumption as endogenous variables. The study findings indicate that the housing prices dynamically relate with the selected macroeconomic variables. Using annual data from 1960 to 2015, the study confirmed existence of mutually reinforcing relationship between the housing prices and consumption expenditure. Notably,

the study established that household prices granger cause house indebtedness but the converse is not true.

2.4. Overview

Theoretical literature revealed that compared to traditional models, CCAPM is more appealing theoretically because it links consumption and macroeconomic risk with asset price movement. This study adopts Post-Keynesian school of thought which holds that pursuance of consumer price stability may not necessarily safeguard financial stability. Notably, build up of systemic risk may occur during both good times and bad times and maybe propagated by externalities paradigm, principle-agency problem and mood swings phenomena that are inherent in capitalistic markets. This theory recommends formulation of models that would enhance management of systemic risk to safeguard financial stability

Review of empirical literature has shown that traditional methods of asset valuation such as CAPM and APT have performed poorly in explaining asset price movement. Analysis of the interrelationship among asset prices, financial sector and the macroeconomy show that the interrelationship is significant and may explain feedback loop between asset market, financial systems and the real economy. It was also established that the dynamics of these markets differs considerably during periods of financial stability and periods of instability.

2.5. Research Gap

Despite the paradigm shift and reinvention of financial regulation towards management of financial systems, analysis on systemic risk profile in developing countries (particularly in Africa) is still non-existent. This study aims at filling this gap by: First, exploring systemic

risk in the housing and security markets given their central role in management of systemic risk. Second, the study explores the interrelationship among asset market conditions, financial system and dynamics in the real economy in an attempt to explore the nature of systemic risk build-up in the Kenyan economy.

CHAPTER THREE

METHODOLOGY

3.1. Introduction

This chapter presents the methodology used to address the objectives specified in the study and was organized as follows: Firstly, research design was presented. Thereafter, theoretical framework and empirical model specification are presented thematically based on the study objectives. The later part of the chapter provides description and measurement of variables and the sources of data.

3.2. Research Design

The study adopted non-experimental time series research design. Given the scope and nature of the study, quarterly time series data from the first quarter of 2001 to the third quarter of 2017 was used for analysis. The dataset was collected from various secondary sources. Econometrics models were specified and estimated using several specified models.

3.3. Theoretical Framework

This section provided theoretical underpinning for the asset pricing model. The study applied Consumption based Capital asset pricing model (CCAPM). The CCAPM model originated from Von-Neuman-Morgenstern utility theory by Sharpe (1970), Linter (1979) and Merton (1990) as quoted in Krause (2001). This model assumes that a representative household aims at maximizing lifetime utility subject to total wealth. The household problem is specified as:

$$Max\ U(C_t, C_{t+1}) = U(C_t) + \beta(E(U(C_{t+1})) \quad (3.1)$$

Subject to: $W_t = C_t + P_t A_t$ (3.2)

$$C_{t+1} = W_{t+1} + (P_{t+1} + D_{t+1})A_t \quad (3.3)$$

Equation (3.1) is the objective function which augments current consumption (C_t) utility and the present value of expected utility from future consumption ($E(U(C_{t+1}))$ (Yogo, 2006). Equations (3.2) and (3.3) represent resource endowment and allocation at time t and t+1 respectively. At time t, the investors' total wealth is W_t and is allocated between consumption (C_t) and asset whose price is P_t. The total wealth at time t+1 are consumed and Wealth (W_{t+1}) is estimated as value of Price per asset (P_{it}) plus amount of dividend per unit of asset (D_{t+1}) multiplied by number of asset A purchased at period t.

The limitation of the wealth composition in (3.2) and (3.3) is that it assumed a single asset portfolio (A_t). This study assumes that the market dynamics, risk profile and preference for different assets fundamentally differ. Therefore, this study introduces asset portfolios such that:

$$A_t = \sum_i^n A_{it} \text{ where } \quad i = 1,2 \dots, n \quad (3.4)$$

Each asset, A_{it} has corresponding price, *Pit* and return Ri_t. Therefore, the constraint in (3.2) and (3.3) may now, respectively, be expressed as:

$$W_t = C_t + \sum_{i=1}^n P_{it}\, A_{it} \quad (3.5)$$

$$C_{t+1} = W_{t+1} + \sum_{i=1}^n (P_{it+1} + R_{it+1})A_{it} \quad (3.6)$$

Therefore, making C_t and C_{t+1} from equation (3.5) and (3.6) respectively the subject and substituting them into equation (3.1) yields:

$$U(C_t, C_{t+1}) = U(W_t - \sum_{i=1}^n P_{it}\, A_{it}) + \beta(E(U(W_{t+1} + \sum_{i=1}^n (P_{it+1} + D_{it+1})A_{it})) \quad (3.7)$$

Maximizing the unconstrained function in equation (3.7) with respect to A_{it} yields:

$$-U'(C_t)P_{it} + \beta(E\big(U'(C_{it+1})(P_{it+1} + D_{it+1})\big) = 0 \tag{3.8}$$

Making the $U'(C_t)P_{it}$ the subject and thereafter dividing through by $U'(C_t)P_{it}$ yields:

$$E\left[\beta \frac{U'(C_{t+1})}{U'(C_t)} \frac{(P_{it+1}+D_{it+1})}{P_{it}}\right] = 1 \tag{3.9}$$

Equation (3.9) is the first order Euler condition. Note that $\frac{(Pi_{t+1}+D_{it+1})}{P_{it}}$ represent gross rate of return$(1 + R_{i,t+1})$ which explicitly captures changes in assets prices. The term $\frac{U'(C_{t+1})}{U'(C_t)}$ gives the intertemporal elasticity of substitution (IES). The first order Euler condition (equation (3.9)) for each of the asset can be represented as:

$$E\big[M_{t+1}(1 + R_{i,t+1})\big] = 1 \; \forall i \tag{3.10}$$

Where i represent the type of asset and $[M_{t+1}] = \left[\beta \frac{U'(C_{t+1})}{U'(C_t)}\right]$ is the stochastic discounting factor (SDF). SDF refers to the rate at which investors are willing to sacrifice consumption at time *t+1* for consumption at time *t.* Assuming that the difference between expected returns of two assets is equal to zero, it follows that the expectation of excess returns $E(R^e_{it+1})$ for asset *i* (R_i) over risk free asset *f* (R_f) is given as:

$$E\big[\big(1 + R_{i,t+1}\big) - (1 + R_{f,t+1})\big] = E\big(R_{i,t+1} - R_{f,t+1}\big) = 0 \; \forall i \tag{3.11}$$

Based on equation 3.11, the excess asset returns measure the level of risk in the asset market such that the higher the returns (synonymous with low asset prices), the higher the level of risk in the asset market. From equation (3.11), it follows that the SDF for excess return is:

$$E\left[M_{t+1}\left(R_{i,t+1} - R_{f,t+1}\right)\right] = E(M_{t+1}R^{e}_{it+1}) = 0 \quad (3.12)$$

This study assumes that a household's intertemporal consumption behavior is defined as a power utility model $\left[U(C_t) = \frac{{C_t}^{1-\gamma}-1}{1-\gamma}\right]$ as proposed by Campbell and Cochrane (2000), Yogo (2006), Mehra (2012) and Kwan *et al*. (2014). The SDF given power utility orientation is:

$$M_{t+1} = \beta \frac{U^{'}(C_{t+1})}{U^{'}(C_t)} = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \quad (3.13)$$

Given the SDF specification in (3.13) the CCAPM model is given as:

$$E(M_{t+1}R^{e}_{it+1}) = E\left[\beta \left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} R^{e}_{it+1}\right] = 0 \quad (3.14)$$

From equation (3.14), two parameters of interest include subjective discount factor (β) and risk aversion coefficient(γ). First, β is the parameter capturing subjective time preference factor. Low levels of β suggests that representative agents prefer spending wealth at present time relative to the future. On a priori ground β is bounded such that $0 < \beta < 1$.

Second, γ is the risk aversion coefficient. It measures the investor's tolerance towards risk. Risk aversion adjustment is determined by volatility of consumption growth as measured by consumption variance. Campbell and Cochrane (2000) holds that CCAPM model factors in systemic risk from the real using consumption variance (see derivation of CCAPM in Appendix A(1) through A(7)). In this regard, increase in systemic risk leads to asset prices volatility and prompts investors to be more risk averse. On apriori values of γ range from zero to ten (0 to 10) such that risk aversion is greater than five ($\gamma > 5$) imply high levels of risk aversion (Yogo 2006; Kwan *et al*., 2014).

3.3.2. Empirical Model Specification

Empirical model specification is composed of two sections. First, equation (3.12) is used as a basis of estimating asset pricing behavior. Risk aversion coefficient estimates will be used to assess the level of systemic risk associated with respective asset markets. Based on the theoretical framework in (3.3.1), estimation of CCAPM model generally used SDF model. The general SDF model is given power utility orientation as

$$f(\emptyset) = (E_t[M_t(R_t^e)]I_t) \tag{3.15}$$

Where M_t is the general SDF which measures intertemporal marginal rate of substitution.

I_t is the vector of control variables containing information at period t

R_t^e is the excess return estimated as asset return less the risk free rate. That is

$R_t^e = R_t^m - R_t^f$

R_t^m is the asset return at period t

R_t^f is the risk free rate at period t

$\emptyset$ is the variable of interest

For the purpose of this study, assets portfolio at period t (A_t) include two assets (n=2) namely real estate, A_{1t} and securities A_{2t}. This study compared three risk averse household agents whose consumption behavior is determined by standard utility function, habit formation function and 'Two- Goods' utility function specifications.

Model I: Standard SDF Model

The SDF in equation (3.14) is introduced in the model under the assumption that the error term is multiplicative to the joint distribution of consumption and log normal returns. The log-linear standard linear approximation model given as:

$$R_{it}^{e} = -\log\beta + \gamma log\left[\frac{C_{t+1}}{C_t}\right] + \varepsilon_{1t} \tag{3.16}$$

Asset prices movement (that is security and housing) will be used to estimate excess returns($R_{it}^{e} = R_{it}^{m} - R_{t}^{f}$) in separate models. Estimation of equation 3.16 is estimated using models that are consistent with endogeneity of key variables. In this regard, Yogo (2006), Hearn (2009), Hunter and Wu (2009) and Kwan *et al.,* (2014) identified lagged values of consumption growth and state of the economy variables as valid instruments for consumption decision.

Model II: Habit formation Models

The habit formation CCAPM as specified by Hunter and Wu (2009) which assumes that habit formation is non separable but exogenous. This implies that consumption decisions are made jointly with household's habits. Therefore the power utility function is given as:

$$U(C_t, H_t) = \frac{(C_t - X_t)^{1-\gamma} - 1}{1-\gamma} \qquad \text{where } C_t > X_t \tag{3.17}$$

Where X_t represents external habit formation at period t. As specified, Engsted *et al* (2009), hold that consumption is above habit at all times. In this regard, surplus consumption ratio is introduced such that $S_t = \frac{C_t - X_t}{C_t}$ which captures business cycle variations. This implies that

surplus consumption above the habit level is high during economic booms (good times) and low during economic recessions (bad times). Hunter and Wu (2009) and Kwan *et al.* (2014), The SDF representing habit formation can be presented as:

$$M_{t+1} = \beta \frac{U^{'}(C_{t+1})}{U^{'}(C_t)} = \beta \left(\frac{C_{t+1}}{C_t}\frac{S_{t+1}}{S_t}\right)^{-\gamma} \tag{3.18}$$

This study adopts surplus consumption ratio to capture habit formation. Based on the SDF model specified in equation (3.18), the habit formation linear approximation model estimated as:

$$R_{it}^{e} = -\log\beta + \gamma log\left[\frac{C_t}{C_{t-1}}\right] + \rho log\left[\frac{S_t}{S_{t-1}}\right] + \varepsilon_{2t} \tag{3.19}$$

The subjective discounting factor β captures the implicit intertemporal discounting factor associated with habit formation. Therefore, three parameters of interest which include discount factor (β), relative risk aversion (γ) and coefficient of habit formation(ρ) are estimted. On apriori ground α and γ and are expected to be positive while ρ is expected to be negative.

According to Campbell and Cochrane (2000), the standard CCAPM model fails to capture cyclical variation and propose the use of habit level consumption as a measure of business cycle variation. Hunter and Wu (2009) and Kwan *et al.* (2014), introduces surplus consumption ratio (SCR) to capture habit formation. Increase in surplus consumption ratio over the habit level is expected during good economic times while surplus consumption level close to habit level is expected during bad economic times. Notably, same instruments

identified in the standard models are used in estimation of habit formation including lagged values of surplus consumption

Model III: Two-Goods Model

This model holds that the composition of consumption at any given period is important in asset price determination (Piazessi *et al*., 2007; Yogo 2006). Assuming two consumption goods namely durable (D) and non-durable goods (nD), constant elasticity of substitution utility model (CES) allows ease of substitution between durable and non-durable goods for a given period. Yogo (2006) contends that the dynamics of durable consumption relative to non-durable consumption risk are different and this explains why the use of aggregate consumption fails to capture the effect of cyclical variation on equity premium. Therefore, intra-period on consumption decisions given a two-good model is given as:

$$U(nD, D) = [(1-\alpha)nD^{\rho} + \alpha D^{\rho}]^{\frac{1}{\rho}}. \tag{3.20}$$

Where α is the relative weight, γ is the coefficient of relative risk aversion and ρ is the constant elasticity of substitution between nD and D. The intertemporal marginal rate of substitution (derivation presented in the Appendix equations 9 through 14) is given as

$$M_{t+1} = \beta \frac{U'(nD_{t+1}, D_{t+1})}{U'(nD_t, D_t)} = \beta \left(\frac{n_{Dt+1}}{nD_t}\right)^{-\gamma} \left(\frac{D_{t+1}}{D_t}\right)^{1-\gamma-\rho} \tag{3.21}$$

The SDF model specified in equation (3.21) provides the basis of estimation of two goods model using a log-linear approximation model such that:

$$R_t^e = -\log\beta + \delta_1 log\left[\frac{nD_t}{nD_{t-1}}\right] + \delta_2 log\left[\frac{D_t}{D_{t-1}}\right] + \varepsilon_t \tag{3.22}$$

Based on the SDF in (3.21) three parameters of interest include discount factor (β), and the coefficients of relative risk aversion associated with non-durable goods (δ_1) and durable goods (δ_2) respectively. On apriori grounds β, and δ_1 are expected to be positive while δ_2 is expected to be negative. This implies that the coefficients of the discounting factors in the respective models (captured by $-\log\beta$ in the linearized log models) are expected to be positive. The same instruments identified in the standard models are used in estimation of standard formation CCAPM include lagged values of growth of durable and non-durable goods.

3.4. Relationship among Credit risk, Asset Prices and the Real Economy

3.4.1. Theoretical Framework

This theoretical framework provides an anchor for the third objective. Economic theory holds that links financial risk, asset prices and macroeconomic variables. Robert Merton's model, published in 1974, provides the grounds of linking default behavior and risk to macroeconomic conditions. Thus, it provides the basis of assessing the relationship between default behavior, assets and macroeconomic conditions and analyzing default behavior given stress scenarios (Rowles & Simons, 2009; Johansson & Bromsen 2011). Merton's model is based on the balance sheet equation which holds that the value of asset at time t (A_t) is equal to the sum of equity (E_t) and debt (D_t) such that:

$$A_t = E_t + D_t \tag{3.23}$$

Assuming that the firm can only default when debt matures (at time T) and that the value of asset is zero $t = 0$, then shareholder's objective is to maximize:

$$E_T = Max(0, A_T - \widehat{D}) \tag{3.24}$$

If the company cannot pay debt or dividend between $0 < t < T$, default will be observed if the value of its assets are less than debt $A_T < \widehat{D}$. If at maturity $A_T > \widehat{D}$ then shareholders will be left with $A_T - \widehat{D}$. For simplicity, assume that D_t is a zero-rated debt with face value of $\widehat{D}$ and matures at time T and assets follow a stochastic process which is given by a geometric brownian motion such that:

$$\partial A = \mu A \partial t + \sigma A \partial W \quad \rightarrow \quad \frac{\partial A}{A} = \mu \partial t + \sigma \partial W \tag{3.25}$$

Equation (3.25) implies that change in asset is driven by random drift ($\mu A \partial t$) and volatility of assets $\sigma A \partial W$ multiplied by the brownian motion ∂W (Rowles & Simons, 2009; Johansson & Bromsen 2011). The integral of equation (3.25) is given as:

$$\int \frac{\partial A}{A} = \ln(A_t) = \mu t + \sigma_A W_t \tag{3.26}$$

Note that W is the standard Brownian motion $W_T \sim N(0, T)$ which evolves over time (T). Dividing this process by its standard deviation ($\sqrt{T}$) yields a standard normal distribution $\frac{W_T}{\sqrt{T}} = Z \sim N(0,1)$. This implies that W_T can be expressed in terms of the standard normal variable $W_T = \sqrt{T}Z$. Hence, the integral in (3.26) can be presented as:

$$\ln(A_t) = \mu t + \sigma_A \sqrt{T} Z \tag{3.27}$$

Recall that a firm defaults if $A_T < \widehat{D}$; the probability that a firm defaults is:

$$P\left[\ln(A_t) < \ln(\widehat{D})\right] = P\left[\mu t + \sigma_A \sqrt{T} Z < \ln(\widehat{D})\right] \tag{3.28}$$

$$= P\left[\sigma_A \sqrt{T} Z < \ln(\widehat{D}) - \mu t\right] = P\left[Z < \frac{\ln(\widehat{D}) - \mu t}{\sigma_A \sqrt{T}}\right] \tag{3.29}$$

$$= P\left(A_T < \widehat{D}\right) = \Phi\left[\frac{\ln(\widehat{D}) - \mu t}{\sigma_A \sqrt{T}}\right] \quad (3.30)$$

Where Φ represent the standard normal distribution function. Equation (3.30) forms the basis of macro-financial model. Probability of default increases with debt $(\widehat{D})$ and is negatively related to asset volatility as measured by σ_A and asset volatility is influences by macroeconomic factors. Given that $\widehat{D} = A_T - E_T$ this means that asset value is positively related to default rate and equity is negatively related to default rate (Rowles & Simons, 2009; Johansson & Bromsen 2011).

3.4.2. Empirical Model Specification

This section provides empirical specification for the financial- macroeconomic model which is hinged on the theoretical framework developed in section 3.4.1. Credit risk is used to measure financial risk build-up in the financial sector. The choice of credit risk as a representative measure of financial risk (instability) was informed by the dominance and the role of Kenya's commercial banks in the financial sector (Johhanson & Bromsen, 2011; Choy, 2012). Commercial Banking is one of the five main subsectors in the financial system in Kenya. Merton's model links default rate and financial market indicators such as asset returns.

Wong *et al.,* (2008) and Choy (2012) hold that effective analysis of the relationship among asset prices, financial sector and the macroeconomy should incorporate the feedback between assets, which act as banks collateral, and systemic risk in the financial system and real sector economy (Tore & Ize, 2009; Kawata *et al.,* 2013). The system variables can be summarized in a vector of endogenous variables (Y) as:

$$Y = \{CR, A, RE\} \tag{3.31}$$

Where CR, represent credit risk as measured by probability of default and is bounded [0, 1] (Virolainen, 2004; Wong *et al.*, 2008). A represent asset portfolio (That is; Housing market returns (HMR) and security market returns (SMR)). RE represent real sector economy. Therefore, the model that links financial risk asset prices movement and real sector variables is specified as:

$$CR_t = \alpha_1 + \sum_{i=1}^{\rho} \theta_{1i} CR_{t-i} + \sum_{j=1}^{q} \beta_{1j} HMR_{t-j} + \sum_{k=1}^{K} \gamma_{1k} SMR_{t-k} + \sum_{l=1}^{L} \varphi_{1l} GDP_{t-l} + \sum_{m=1}^{M} \tau_{1m} Inf_{t-m} + \sum_{n=0}^{N} \delta_{1n} X_{t-n} + \mu_{1t} \tag{3.32a}$$

$$HMR_t = \alpha_2 + \sum_{i=1}^{\rho} \theta_{2i} CR_{t-i} + \sum_{j=1}^{q} \beta_{2j} HMR_{t-j} + \sum_{k=1}^{K} \gamma_{2k} SMR_{t-k} + \sum_{l=1}^{L} \varphi_{2l} GDP_{t-l} + \sum_{m=1}^{M} \tau_{2m} Inf_{t-m} + \sum_{n=0}^{N} \delta_{2n} X_{t-n} + \mu_{2t} \tag{3.32b}$$

$$SMR_t = \alpha_4 + \sum_{i=1}^{\rho} \theta_{3i} CR_{t-i} + \sum_{j=1}^{q} \beta_{3j} HMR_{t-j} + \sum_{k=1}^{K} \gamma_{3k} SMR_{t-k} + \sum_{l=1}^{L} \varphi_{3l} GDP_{t-l} + \sum_{m=1}^{M} \tau_{3m} Inf_{t-m} + \sum_{n=0}^{N} \delta_{3n} X_{t-n} + \mu_{3t} \tag{3.32c}$$

$$GDP_t = \alpha_4 + \sum_{i=1}^{\rho} \theta_{4i} CR_{t-i} + \sum_{j=1}^{q} \beta_{4j} HMR_{t-j} + \sum_{k=1}^{K} \gamma_{4k} SMR_{t-k} + \sum_{l=1}^{L} \varphi_{4l} GDP_{t-l} + \sum_{m=1}^{M} \tau_{4m} Inf_{t-m} + \sum_{n=0}^{N} \delta_{4n} X_{t-n} + \mu_{4t} \tag{3.32d}$$

$$Inf_t = \alpha_5 + \sum_{i=1}^{\rho} \theta_{5i} CR_{t-i} + \sum_{j=1}^{q} \beta_{5j} HMR_{t-j} + \sum_{k=1}^{K} \gamma_{5k} SMR_{t-k} + \sum_{l=1}^{L} \varphi_{5l} GDP_{t-l} + \sum_{m=1}^{M} \tau_{5m} Inf_{t-m} + \sum_{n=0}^{N} \delta_{5n} X_{t-n} + \mu_{5t} \tag{3.32e}$$

Therefore, equation (3.32a to 3.32e) is composed of endogenous variables which included credit risk (CR), as a proxy of financial risk, asset returns portfolios, which include security market returns (SMR) and housing market returns (HMR). RE represent real sector variables which include GDP growth and inflation. Credit risk was measured by probability of loan default (default rate) in the commercial banking sector. Lending rate and interbank rate were introduced as exogenous variables (X) to control for the effect of interest rates in the economy. The lag variables are introduced to capture dynamic effect of endogenous variables on the system.

3.5 Model Estimation

This section presents the estimation procedure used to address each objective. To address the first and second objectives, three models specified in (3.16), (3.19) and (3.22) were used to estimate asset returns in real estate market and security market separately. To further understand asset behavior and evaluate the predictive power of CCAPM approach, this study estimated and reported augmented regressions. Excess security and housing returns were regressed against macroeconomic variables including GDP growth, inflation, exchange rate and lending rates. Choice of explanatory variables is based on popular approach presented in empirical literature.

The Ordinary Least Squares (OLS) and/or Instrumental Variable method (IV) estimators were used as deemed appropriate. IV estimator was to be used to account for possible endogeneity problem since feedback effect between consumption and asset movement is expected. In this regard, the following procedure was used to address the first objective. First, IV method was estimated and subjected to heteroskedasticity and autocorrelation tests. To

test for Heteroskedasticity, Breusch-Pagan test was used under the assumption of constant variable (homoscedasticity). To test for autocorrelation, Breusch-Godfrey test was used under the assumption that there is no autocorrelation. Two-Stage-Least Squares (2SLS) was to be used in the event that residuals are homoskedastic and absence of autocorrelation. However, if heteroskedasticity and/or autocorrelation are established, GMM estimator was used as it is robust for autocorrelation and/or presence of autocorrelation (Greene, 2002; Stock & Yogo, 2005).

Second, the results were be subjected to endogeneity test. GMM-Distance test was deemed appropriate because it is robust to violation of conditional homoskedasticity and presence of autocorrelation. The null hypothesis stated that instruments are exogenous. Wooldridge (2002) holds that if regressors are exogenous, Ordinary Least Squares (OLS) yields consistent results for a well specified model with homoskedastic and non-autocorrelation residuals are exogenous.

Third, Wald F-test was used to test for weak instruments because it is robust to violation of heteroskedasticity and/or autocorrelation. The null hypothesis stated that the instruments are weak. According to Stock and Yogo (2005) Limited Information Likelihood (LIML) estimator is consistent results even in presence of weak instruments. However, if rejected, then GMM estimator and/or 2SLS will be used as deemed appropriate. Lastly, Sargan test were used to check for overidentification of the set of all instruments. The null hypotheses stated that the models are correctly specified.

To address the third objective, theoretical literature identified macro-financial model that link asset market, financial risk and the real economy as important in analyzing joint evolution of

systemic risk in the economy. Therefore, analysis of the relationship between credit risk and asset prices was based on the model specified in equation (3.32a through 3.32e) in Chapter. The relationships among these variables are analyzed using system of equations presented in the vector autoregressive (VAR) model. The VAR model was chosen because it captures the linear interdependence among financial risk, asset prices movement and real sector variables. The study follows from Ocampo and Rodriguez (2012) in using VAR-X model which provides for inclusion of exogenous variables. The VAR-X model is estimated using the maximum likelihood estimation (MLE).

According to the literature the individual coefficients in the VAR model do not have economic interpretation. Therefore, the relationship among the variables of interest can be analysis through (i) the impulse response functions (IRF) and forecasted error variance decomposition analysis. The impulse responses capture the effect of a shock to a specific variable on the adjustment path of the variables. The IRF also captures the feedback effect and possible linkage between markets and maybe important in explaining systemic risk among macro-financial variables. Variance decomposition is also used in analysis to complement the IRF results. The variance decomposition indicates the proportion of variance in the left-hand side variable due to the variance of other variables in the system.

The following diagnostic were tested to evaluate the appropriateness of the VAR-X model: Firstly, Likelihood ratio, Akaike information criteria among other tests were used to determine the appropriate number of lags that one lag model was the most appropriate. Secondly, stability condition of the VAR-X model was tested using Eigen roots analysis. The null hypothesis stated that the VAR is stable and all roots lie inside the unit circle. Third, autocorrelation was tested using the LM tests under the null hypothesis of no serial

correlation. Lastly, Heteroskedasticity test was conducted using White test. The null hypothesis stated that there is no heteroskedasticity.

3.6. Source of Data

For the purpose of investigations, secondary macroeconomic data is applied for analysis. Given the high frequency nature of financial time series data, quarterly time series data from 2001Q1 to 2017Q3 were used for analysis. Note that monthly data are likely to be dominated by white noise but quarterly data is presumed to be suitable in picking up both cyclical variations and real economic signals. Consumption credit, Non-performing loans, Lending rate, interbank rate and Inflation rate data was sourced from Central Bank of Kenya. Housing Prices data was sources from Hass consultant limited. 20 share Nairobi Security Index was sources from Nairobi Security Exchange (NSE), Gross Domestic Product was sources from World Bank database. Table 3.1 specifies the source of data for each of the variables used for analysis.

3.7. Description and Measurement of Variables

Table 3.1: Description and Measurement of Variables

Variable	Definition	Measurement
Security Market returns	The proportion of changes in prices of the NSE 20 share index. NSE 20 share index is the weight prices of 20 public listed companies in Nairobi Securities Exchange	Estimated as the natural log of the ratio of current period and previous period NSE 20-share index
Housing Market returns	The proportion of changes in prices of the Hass Property index. Hass Property index refers to the weighted average of asking prices from 320 suburbs and towns in Kenya	Estimated as the natural log of the ratio of current period and previous period Hass Property Index
Risk Free rate	The theoretical rate of return of an investment with zero risk	Risk free rate is measured by the 91-Day Treasury bill rate auctioned by CBK
Excess Security Returns	Excess rate of returns of securities traded in capital asset over the risk free rate.	Estimated as the difference between identified Security Market returns and 91-days Treasury bills rate
Excess Housing Returns	Excess rate of returns of housing returns over the risk free rate.	Estimated as the difference between identified Housing market returns and 91-days Treasury bills rate
Real GDP growth	The rate of change of a country's Gross Domestic Product from one period to another after adjusting for inflation	Estimated as the percentage difference in quarterly real GDP
Average Consumption growth	The rate of change of a country's aggregate consumption from one period to another after adjusting for inflation	Estimated as the natural log of the ratio of current period and previous period aggregate consumption
Surplus	Used as a proxy for habit formation. Surplus consumption	Estimated natural log of the ratio of the

Consumption ratio	ratio captures cyclical behavior of consumption above the habit formation level	difference between current period consumption and minimum value of consumption for the period under study and current period consumption
Durable goods consumption growth	This refers to consumer goods that have a useful life of more than one year. Example includes automobile, furniture, books, electronics among others. Consumer durable credit is used as a proxy of consumer durable	Estimated as the natural log of the ratio of current period and previous period consumer durable credit
Non-durable goods consumption growth	These are consumer goods that have a useful life of less than one year. The difference between total private consumption credit and consumer durable credit is used as a proxy of Non-durable consumer goods	Estimated as the natural log of the ratio of current period and previous period non-durable consumption credit
Interbank rate	The average rate of interest charged on short term loans between commercial banks	Measured as the average rate of interest charged between banks
Lending rate	This is the amount charged as interest on loan over and above the principal loan	Measured as the interest rate chargeable on loan as a percentage of the principal sum.
Inflation rate	Refers to increase in Consumer Price Index (CPI). CPI refers to weighted average prices of different household goods	Measured as the percentage change in CPI compared to the same period in the previous quarter.
Credit Risk	Refers to commercial bank exposure to loan Default where default is captured by value of non-performing loans.	Estimated as the proportion of non-performing loans as a ratio of total loans incurred in a specific period
Change in Real Exchange rate	Exchange rate between KES and USD was used for analysis	Estimated difference between current and previous period exchange rate.

Source: Author's Compilation

CHAPTER FOUR

EMPIRICAL FINDINGS

4.1. Introduction

This chapter presents the empirical findings of the study. The first part presents descriptive statistics and trends of key variables used in the model. Descriptive analysis consists of estimation of pairwise correlation coefficients between variables included in the model and stationarity tests for all the variables, where applicable. Finally, presentation and discussion of results of the model estimation were provided at the later part of the chapter.

4.2. Descriptive Analysis

Descriptive statistics were calculated which include the measures of central tendency, dispersion and pairwise correlation analysis of the variables used in the study. In addition, trend analysis of selected variables was presented for in-depth analysis of variable dynamics. Table 4.1 summarizes the various statistics of the variables used in the study.

Excess security returns and excess housing returns refer to assets returns above the risk free rate as defined in Table 3.7. In Table 4.1 the excess security returns and excess housing returns had a mean of 05 percent and -7 percent, respectively. Notably, excess security returns had a relatively high coefficient of variation of 120 percent. This is expected due to the highly volatile nature of financial assets. However, excess housing returns was less volatile with coefficient of variation of 54 percent.

Table 4.1: Descriptive Statistics of Variables Used in the Study

	Mean (%)	Med (%)	Max (%)	Min (%)	Std (%)	C.V (%)	Obs
Excess Security Returns	5.0	4.0	0.21	-0.18	6.1	120	67
Excess Housing Returns	-7.0	-6.0	0.018	-0.18	3.8	54	50
Aggregate Cons growth	5.22	4.4	20.69	-18.6	6.2	82.25	66
Durable Cons. Growth	0.12	-0.56	29.2	-35.8	10.3	0.0	66
Non-durable Cons. Growth	5.1	4.7	30.5	-21.7	7.65	0.66	66
Surplus Cons ratio	7.7	0.89	0.97	0	2.66	34.5	67
Default Rate	16.84	12.8	36.50	5.37	0.97	5.76	67
Housing Market Returns	1.09	1.50	1.05	0.969	.02	51.5	50
Security Market Returns	1.02	1.1	25.39	-28.80	10.6	106	67
GDP Growth	4.80	5.35	8.40	2.32	2.09	43.5	67
Inflation	8.09	7.02	19.18	1.23	4.44	0.54	67
Lending Rate	15.61	14.8	12.20	20.21	2.37	6.6	67
Treasury Bills	8.02	8.19	19.40	1.18	3.40	2.36	67
Interbank rate	7.15	7.16	21.87	0.47	4.12	1.73	67

Source: Author's Calculations

Aggregate consumption growth and non-durable consumption growth were approximately 5 percent while durable consumption growth was approximately 1 percent during the period. This implies that aggregate consumption is driven by non-durable consumption compared to durable consumption. Default rate, representing credit risk, had a mean value of 16.8 percent and a standard deviation of approximately 1 percent. Macroeconomic indicators show that GDP grew at an average of 4.8 percent and the average inflation rate was approximately 8.09 percent respectively during the period.

The security market returns and housing market returns are different from excess assets (security and housing) returns. Security market returns is the proportion of changes in prices of the NSE 20 share index as defined in Table 3.7. In the same table, housing market returns is defined as the proportion of change in prices of the Hass Property Index. Figure 4.1 shows

the trends of security market returns from the first quarter of 2001Q1 to the third quarter of 2017Q3 and housing market returns from 2005Q1 to 2017Q3.

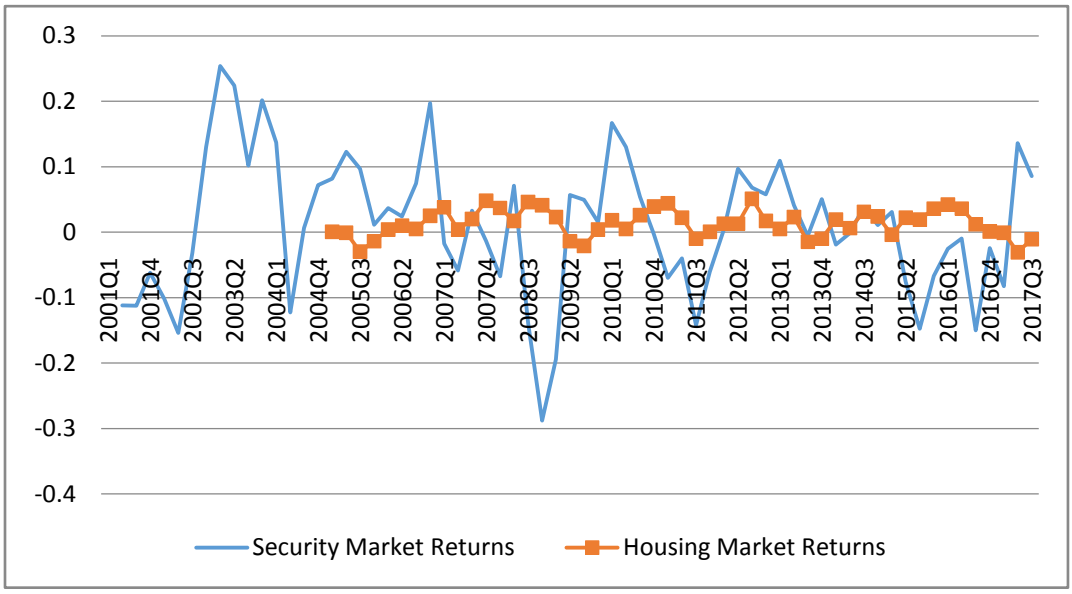

Figure 4.1: Security Market Returns and Housing Market Returns

Figure 4.1 confirms that both assets are relatively volatile, have no trend and mimic a normal distribution with zero mean and relatively constant variance. These characteristics are typical of financial assets observed in the capital market. Notably, security market returns are more volatile compared to housing market returns. This suggests that housing prices movement are fairly stable compared to security market returns.

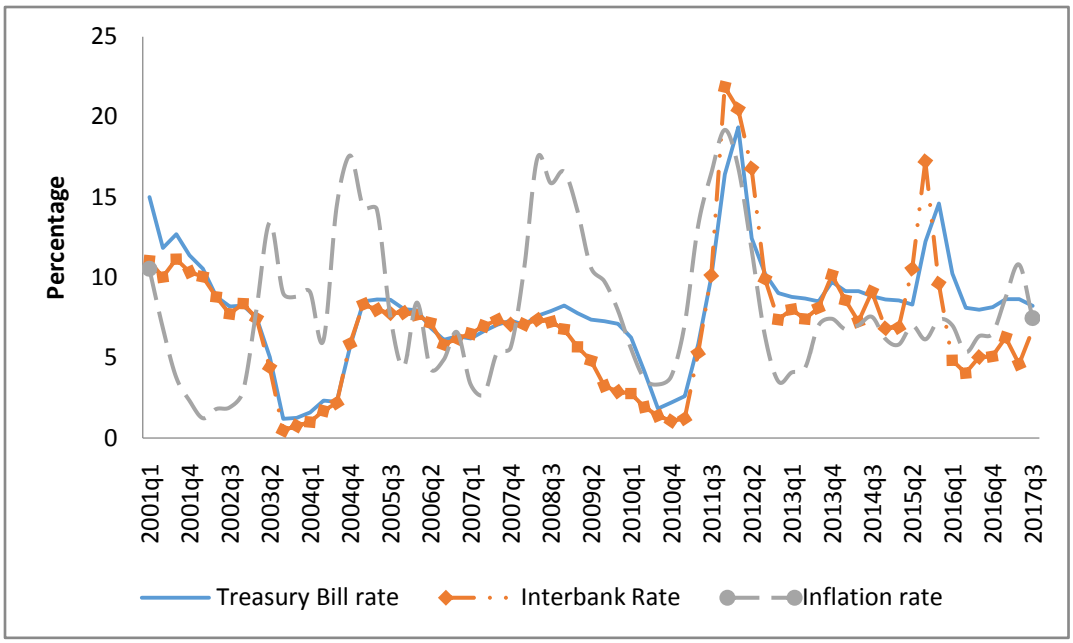

Figure 4.2: Trending Interbank, Treasury Bills and Inflation

Figure 4.2 presented strategic policy variables that influence the financial system in Kenya. The figure shows that there is a strong co-movement between interbank rate and treasury bills rates. This may suggest that interbank rate strongly respond to monetary policy signals. Meanwhile, inflation rate is relatively volatile compared to interbank rate and treasury bills rate. However, inflation responds to both interbank and treasury bills rate indicating that monetary policy signals targeting treasury bills rate and interbank rate are transmitted to the market through inflation.

Notably, comparison between the asset returns presented in Figure 4.1 and monetary policy variables in Figure 4.2 shows that the economy experienced structural shocks experienced during electioneering periods. These periods include 2002/2003, 2007/2008 and 20011/2012 periods. Consumption was identified as a fundamental variable that captures systemic risk associated with asset prices movement in the economy. This study used consumption credit

was used as a proxy for the economy's consumption pattern. Figure 4.3 shows the trend of consumption credit growth.

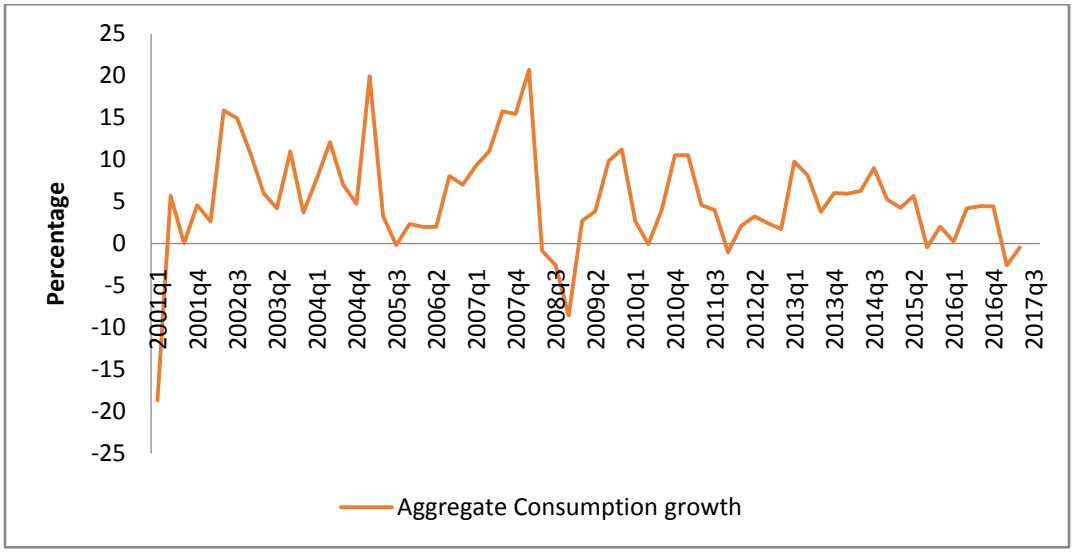

Figure 4.3: Trending growth in Consumption over the study period.

Figure 4.3 shows that consumption growth has generally been fairly stable, oscillating between mean of approximately 5 percent growth. Volatile nature of consumption credit may reflect the use of credit to smoothen consumption and may therefore be important in explaining asset pricing decisions. For the purpose of this study, consumption was decomposed to durable and non-durable consumption components. Figure 4.4 plots durable and non-durable consumption growth.

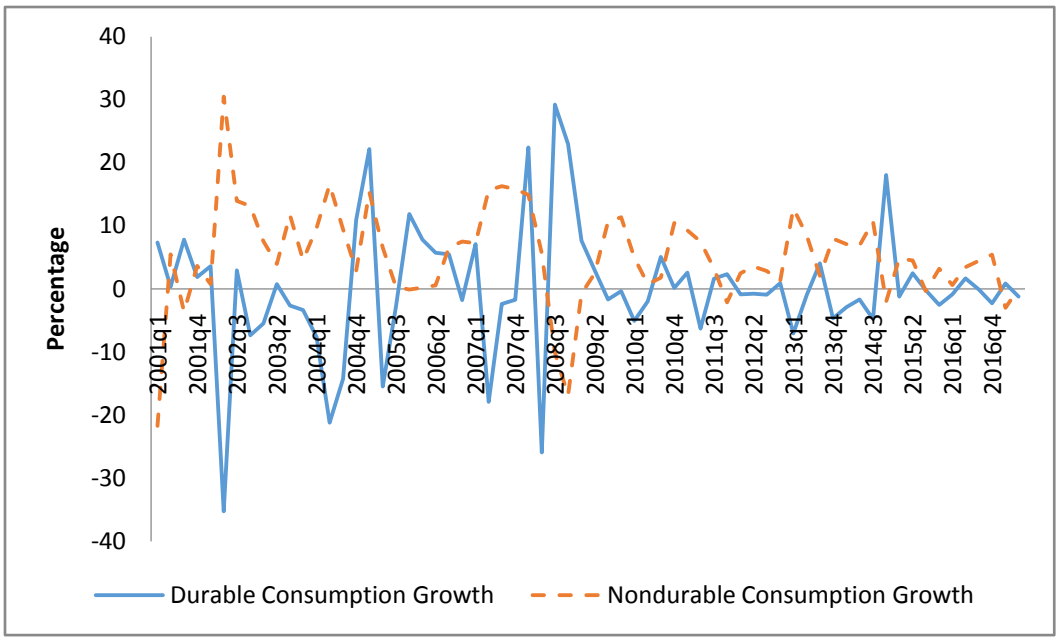

Figure 4.4: Trending Durable and Non-durable Consumption Growth

Figure 4.4 plots the growth rates of durable and non-durable consumption. Firstly, it is evident that durable and non-durable consumption growth rates have similar trend. However, growth of non-durable consumption appears to be countercyclical to non-durable consumption growth such that when durable consumption registers high growth rates, non-durable consumption growth moves in the opposite direction. This is expected since the two goods are considered to be perfect substitutes. Figure 4.5 captures the trend of GDP growth and durable consumption growth.

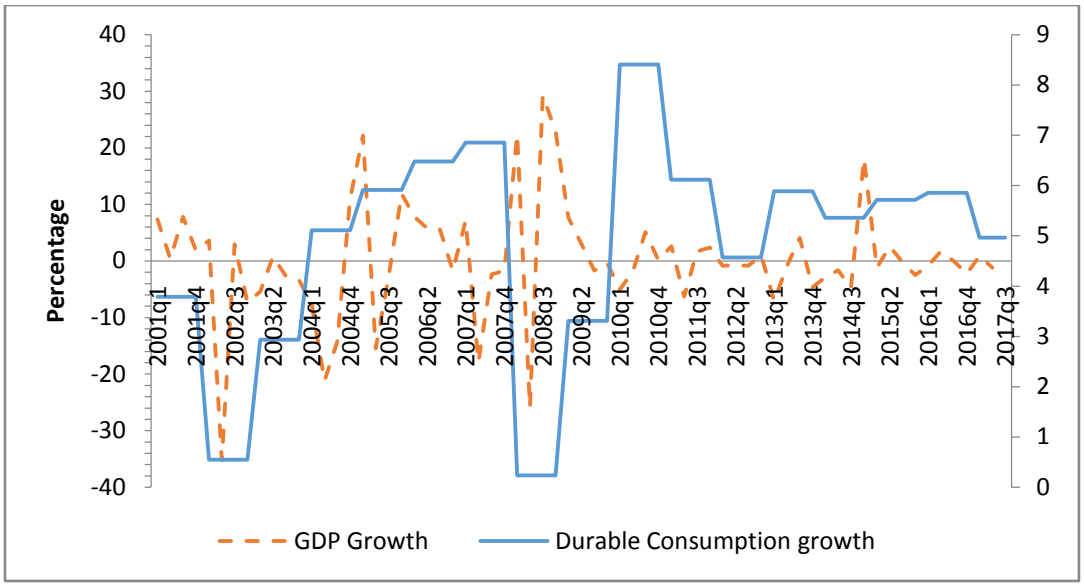

Figure 4.5: Trending GDP Growth rate and Durable Consumption Growth

Figure 4.5 introduces a secondary axis on the right hand side to accommodate significance difference in data range between the two variables. GDP growth trends business cycle variations and therefore captures recessions and boom cycles over the study period. Figure 4.5 show that significant decreases in durable consumption growth observed during recession periods, that is around 2002/2003 and 2007/2008. This indicates that durable consumption growth is procyclical as it declines during recession periods and increases during boom periods.

Estimation of pairwise correlation coefficients and tests of stationarity were also conducted to analyze important characteristic pertinent to estimation. The pairwise correlation coefficients for variables used in the study are presented in Tables B.1 and B.2 of Appendix B. The acronyms used in Table B.1 are defined as follows: CONSCRE represents growth of total consumption credit; LDURSDF growth of durable consumption credit; LNDURSDF represents growth of Non-durable consumption credit; SURPLUS represents Surplus-

Consumption ratio; EXHPI represents Excess Housing returns; NSEXC represents Excess NSE security returns; and GDPGMP represents GDP.

The Table B.1 shows that aggregate consumption was strongly correlated with consumption credit with a correlation coefficient of 0.95. In this regard, total consumption credit was used as a proxy of aggregate consumption because consumption credit can be decomposed to durable and non-durable consumption credit. Table B.1 shows that correlation coefficient of non-durable consumption growth is highly correlated with aggregate consumption growth while durable consumption growth has a significantly low correlation coefficient of 0.038.

This asserts the assumption that aggregate consumption growth is driven by non-durable component relative to durable consumption (Yogo, 2006). Notably, correlation coefficients of key variables were significantly low which a priori suggest that multicollinearity among dependent variables are within acceptable limits. To test the time series properties of the variables used in the study, the Augmented Dickey Fuller (ADF) test and Kwiatkowski-Phillips-Schimdt-Shin (KPSS) test for stationarity were used. The test results are presented in Table C.1 in Appendix C. Table C.1 shows that all the variables are stationary at level. It is worth noting that KPSS tests deemed credit risk non-stationary at five percent.

4.3. Empirical Findings

This section presents the empirical findings of the study. As mentioned earlier, the general objective of this study is to analyze systemic risk in asset prices movement, financial system and the real sector variables in order to evaluate the financial stability in Kenya. To address the broad objective, three specific objectives were introduced, and the results presented thematically based on each specific objective. In each of the succeeding sections, analyses of

the estimated results and model diagnostic tests are presented. The discussions of the empirical findings and inferences which may be used to formulate future policy are also included in this section.

4.3.1 Systemic Risk Factors in Security Prices Movement in Kenya

The first objective sought to evaluate the systemic risk factors in security prices movement in Kenya. To achieve this objective, different specifications of the Consumption Capital based asset pricing models (CCAPM) were estimated. Risk aversion coefficient was used to evaluate systemic risks factors associated with security prices movement. The CCAPM model is based on the theory that identifies consumption as the fundamental source of systemic risk that explains security prices behavior.

As mentioned in Chapter 3, excess security returns was identified as dependent variables capturing systemic risk in the security market. A high level of excess security returns is synonymous with asset price volatility which represents high level of risk in the financial asset market. For robust analysis, various specifications of the models were estimated. The study introduced three variants of the CCAPM models.

The first specification, referred to as the standard CCAPM, was based on equation (3.16) in Chapter 3. This model identified aggregate consumption growth as the main source of systemic risk. The second CCAPM model based on equation (3.19), introduced habit formation as an additional independent variable in the model. Habit formation variable is introduced to evaluate the effect of business cycle movement. Finally, the third model refers to as the 'Two-goods CCAPM' model was based on equation (3.22) developed in Chapter 3. This model decomposed consumption into durable and non-durable consumption growth.

As discussed in Chapter 3, the variables in the regression models were transformed into logarithm since the underlying relationship between excess security returns and consumption variables is multiplicative. The excess security returns models were estimated using instrumental variable approach to account for possible endogeneity between excess security returns and consumption factors. Selection of number of lags of consumption growth variables were introduced based on Akaike Information criteria.

Seven lags of consumption growth were introduced in the standard CCAPM model. Seven lags of consumption growth and seven lags of Surplus-consumption ratio were introduced in the habit formation model. Seven lags of non-durable consumption growth and seven lags of durable consumption growth were introduced in the two-Good CCAPM model. The estimated results and the model diagnostic tests results are presented in Table 4.2a and Table 4.2b respectively.

Table 4.2a: Regression Results for Excess Security Returns Models

Dependent Variable: Excess Security Returns	**Standard CCAPM**	**Habit CCAPM**	**Two-Goods CCAPM**
Constant (-Log β)	-0.14 (-4.02)***	-0.18 (-6.06)***	-0.091 (-6.52)***
Gross consumption growth (γ)	1.34 (2.36)**	1.49 (2.76)**	
Surplus Consumption ratio (ρ)		-0.27 (-3.38)***	
Non-durable Consumption growth (δ_1)			0.623 (5.66)***
Durable Consumption growth (δ_2)			-0.277 (-3.22)***
No. Of Observations	56	55	59
Diagnostic Tests			
Goodness of fit: Adjusted R-Square	19.8	25.58	31.56
Notes: t-statistics in parentheses *** sig. at 1%, ** sig. at 5%, * sig. at 10%			

Source: Author's Calculation

Firstly, as mentioned in Chapter 3, the constant term for excess security returns model refers to a discounting factor that captures time preference factor. Table 4.2a result shows that the time preference factor ranged from -0.18 to -0.09 in all three models estimated and all were significant at one percent level. Significance of the discounting factor (-log β) confirms that intertemporal consumption behavior is present in Kenya. This implies that Kenyan investor's decision is aimed at smoothening lifetime consumption.

Secondly, the coefficient of aggregate consumption growth (γ) refers to the level of risk aversion. Risk aversion coefficients in the standard and habit formation model were positive and significant at 5 percent level. The results in the estimated standard and habit excess security returns models show that an increase in aggregate consumption growth by one

percent increases excess security returns by 1.34 percent and 1.49 percent, respectively, holding all other factors constant. In addition, the coefficient of surplus-consumption ratio in the habit formation excess security returns model was negative and significant at one percent level. This would imply that a one percent increase in surplus consumption above the habit level decreased excess security returns by 0.27 percent holding all other factors constant.

The estimated results from the Two-Goods model presented in Table 4.2a reveal that both durable and non-durable consumption growths were significant at one percent level. On one hand, increase in non-durable consumption growth by one percent increases excess security returns by 0.62 percent holding all other factors constant. On the other hand, increase in durable consumption growth by one percent decreased excess security returns by 0.27 percent holding all other factors constant. Diagnostic tests, which include the GMM-Distance test, Wald-test and Sargan overidentification test, were carried out for the three sets of CCAPM models. The results are presented in Table 4.2b.

Table 4.2b: Diagnostic Tests for Excess Security Returns Models

Endogeneity: H_0: Exogeneity GMM-Distance test	4.26	5.86	17.081
P-Value: [Chi sq(1)]	0.039**	0.05**	0.05**
Weak Identification: H_0: Weak Instruments Wald F-Statistics	1.58	2.14	1.83
Stock-Yogo Critical Values	3.81	3.81	3.27
Test of Over-identifying Restrictions: Instruments are Valid			
Sargan Statistic	3.864	22.22	4.64
P-Value: [Chi sq(df)]	0.92 (9)	0.22 (18)	0.969 (12)
Key: t-statistics in parentheses. *** sig. at 1%, ** sig. at 5%, * sig. at 10%			

Source: Author's Calculation

The results in Table 4.2b present GMM-Distance which was used to test for presence of endogeneity. The null hypothesis states that variables are exogenous. The test results for the three models were significant at 5 percent. Therefore, the null hypotheses of exogenous variables were rejected. These results confirm that the log of consumption growth variable was endogenous in all CCAPM models.

The second test sought to establish whether instruments used in estimation are valid. The Wald-test with F-distribution was used because it is robust to violation of heteroskedasticity and/or autocorrelation. The null hypothesis states that the instruments are weak. In all three CCAPM models, the null hypothesis of weak instruments was not rejected at 5 percent significance level, suggesting that instruments chosen were weak. In view of this, the Limited Information maximum likelihood (LIML) estimator was used as it yields consistent results even in presence of weak instruments (Stock & Yogo, 2005). Thirdly, Sargan test was used to check for over-identification of the set of instruments. The null hypothesis stating that the instruments are valid was not rejected at 5 percent significance level for all three CCAPM models. Therefore, these results confirm that instrumental variable estimator was deemed appropriate.

The estimated values of the Adjusted R-square which measures goodness of fit are also presented in Table 4.2a. This measure is used to compare the model specifications. The result shows that Two-goods (durable and non-durable) model has better goodness of fit with adjusted R-square of 31.56 percent. This was followed by the Habit formation model with adjusted R square of 25.58 percent. This implies that introduction of habit formation and decomposition of consumption to durable and non-durable consumption growth components is important in explaining of asset pricing behavior in Kenya.

This study also introduced some important macroeconomic variables by augmenting the CCAPM models (see Table D.1, Appendix D). However, the results were not promising since according to Hunter and Wu (2009), this is a common problem when modeling financial returns due to its stationarity properties. In this regard, lagged values of specified consumption growth factors were used for estimation including log of aggregate consumption growth, surplus-consumption ratio and durable and non-durable consumption growth.

The following discussion presents important policy implications drawn from the regression results presented in Table 4.2a. It is important to note that the discounting factors, represented by constant coefficients, are in log form. These values were therefore converted into structural form by taking the anti-log of the estimated coefficients. For ease of reference, Table 4.3 presents a summary of structural parameters extracted from Table 4.2a

Table 4.3: Summary of Excess Security Returns Structural Parameter

	Excess Security Returns		
Structural Parameters	**Standard CCAPM**	**Habit CCAPM**	**Two-Goods CCAPM**
Time Preference factor (β)	0.86	0.84	0.91
Risk Aversion (aggregate) (γ)	1.34	1.49	--
Risk Aversion: Habit Formation (ρ)	--	-0.27	--
Risk Aversion: Non-durable growth (δ_1)	--	--	0.623
Risk Aversion: Durable growth (δ_2)	--	--	-0.278

Source: Author's Calculations

Table 4.3 reveals that the estimated values of the discounting factor (β) in the excess security model are significant in all the three models which range from 0.84 to 0.91. In addition, time preference factor is relatively high ($\beta > 0.8$) which suggests that it is an important determination of security price movements (Piazessi *et al.,*, 2007; Haider *et al.,* 2012; Kwan *et al*., 2016). Moreover, results obtained from developed countries such as U.S and U.K, discounting factor is approximately 0.99 which is relatively high compared to developing countries (Yogo 2006; Engsted, 2009; Hunter & Wu, 2009). This suggests that the results for Kenya found in this study is relatively lower to those of the developed countries implying that investors in Kenyan securities are relatively impatient and prefer present consumption relative to the future consumption (Haider *et al*., 2012).

Theoretically, CCAPM model stipulates that risk in the security market returns is explained by systemic risk as captured by consumption growth dynamics in the market. Table 4.3 present the coefficients of risk aversion coefficient that capture elasticity associated with aggregate consumption (γ), surplus-consumption ratio (ρ) durable consumption growth (δ_1) and non-durable consumption growth (δ_2). The results confirm that risk aversion coefficients associated with aggregate consumption growth in the standard and habit formation CCAPM models are 1.34 and 1.49, respectively. Therefore, risk aversion coefficients in all estimated CCAPM models are significantly low ($\gamma < 5$). This suggests that investors in Kenya have low level of risk aversion. Goodness of fit results in Table 4.2a further support by the fact that consumption risk factors explain 20 percent to 31 percent of excess security returns variations

Following from the preceding argument, the first objective sought to establish systemic risk factors that determine security price movement in Kenya. The findings establish that

aggregate consumption growth, non-durable consumption growth, habit formation and durable consumption growth are important factors that determine systematic risk in security market in Kenya. On one hand, the study established that asset pricing valuation is determined by investors need to smoothen aggregate consumption growth as estimated in the standard CCAPM model and non-durable consumption growth as estimated in the Two-Goods CCAPM model (Engsted, 2009; Campbell & Cochrane, 2000).

On the other hand, the results confirm that mechanism through which durable consumption growth and surplus-consumption ratio work are similar. The results obtained in this study are consistent the previous findings in selected countries. Inclusion of habit formation and Two-Goods model isolates consumption smoothing component and business cycle variation and are therefore considered to be superior models relative to the standard CCAPM model (Campbell & Cochrane, 2000; Yogo 2006; Engsted 2009; Cohn *et al*., 2015; Kwan *et al.,* 2016).

Following from the previous argument, the results from habit formation model show that the risk aversion coefficients associated with surplus consumption ratio in the excess security returns model is negative and significant. This implies that risk in the security market is determined by changes in both consumption growth and habit formation. In this regard, expected excess security returns are high (and consequently security prices are low) during bad times when surplus consumption ratio is close to the habit formation level. On the contrary, expected excess security returns are low (and consequently asset prices are high) during good times when surplus-consumption ratio are high (Yogo, 2006; Engsted, 2009).

Furthermore, results from the Two-Goods model confirm that risk aversion coefficients associated with non-durable consumption growth was positive and significant. These results support the supposition that non-durable consumption tends to be smoothen over time. According to Yogo (2006), non-durable consumption growth follows from permanent income and therefore may not depend on the timing of income. On the other hand, durable consumption growth coefficient in the excess security returns model is negative and significant. This implies that expected excess security returns are high (and consequently security prices are low) when durable consumption growth is low and expected excess security returns are low (and consequently asset prices are high) when durable consumption growth is high (Yogo, 2006; Engsted, 2009). The following inferences are based on results from the habit formation and Two-Goods models:

First, the non-risk aversion behavior among Kenyan investors is an indication that the financial asset market is ready for more sophisticated asset classes such as financial derivatives, forex trade among others. If well regulated, introduction of riskier asset classes maybe a welcomed move to the extent that it may lead to diversification of Kenyan investor's portfolio and lead to capital market growth and development Piazessi *et al.,* 2007; Engsted 2009).

This notwithstanding, it should be noted that diversification of portfolio may actually increase probability of systemic risk build up because by definition, systemic risk is not necessarily mitigated using portfolio diversification mechanisms (Campbell & Cochrane, 2000). According to Cohn *et al*. (2015), consumption growth and investment are procyclical to business cycle and tend to build up during boom periods. Persistent increase in consumption growth during boom periods leads to low risk aversion behavior and

subsequently build up of systemic risk over time due to speculative bubble. Consequently, emergence of shocks from asset markets or may lead to changes in risk aversion attitude, financial panic and consequently have adverse effect on systemic risk and financial stability in the economy (Yogo, 2006; Piazessi *et al.,* 2007; Engsted 2009; Hunter & Wu, 2009; Haider e*t al,* 2012; Kwan *et al,* 2016).

Second, negative and significant coefficients of habit formation and durable goods consumption growth reveal that investors exhibit countercyclical risk aversion relative to business cycle movement. This means that investors tend to be less risk averse during good economic times relative to recessionary periods. In this regard, systemic risk captured, by high level of excess security returns, tends to build up during good economic times. Upward adjustment of risk aversion during bad times is an indication that investors in security market may result to flight-to-safety and flight-to-liquidity investment strategies during bad times.

4.3.2 Systemic Risks Factors in Housing Prices Movement in Kenya

The second objective sought to analyze the systemic risks in the housing prices movement in Kenya. To achieve this objective, the Consumption Capital based asset pricing models (CCAPM) for Housing prices movement were estimated. As mentioned in Chapter 3, excess housing returns represents housing prices movement and was used as dependent variable in the various forms of CCAPM models. Similar model specifications explained in Section 4.3.1 were followed in the estimation of excess housing returns. The excess housing returns models were estimated using generalized least square (GLS) estimator to account for autocorrelation and since exogeneity of consumption factors was established. The regression results and diagnostic tests results are presented in Table 4.4a and Table 4.4b, respectively.

Table 4.4a: Regression Results for Excess Housing Returns Models

Dependent Variable: Excess Housing Returns	Standard CCAPM	Habit CCAPM	Two-Goods CCAPM
Constant (-Log β)	-0.08 (-11.2)***	-0.08 (-10.5)***	-0.08 (-11.2)***
Gross consumption growth (γ)	0.203 (2.14)**	0.20 (2.11)**	
Surplus Consumption ratio (ρ)		-0.008 (-0.06)	
Non-durable Consumption growth (δ_1)			0.17 (1.90)*
Durable Consumption growth (δ_2)			0.11 (1.76)*
Number of Observations	50	50	50
Diagnostic Tests			
Goodness of fit: Adjusted R-Square (%)	8.74	8.75	9.33
Notes: t-stat in parentheses and *** sig. at 1%, ** sig. at 5%, * sig. at 10%,			

Source: Author's Calculation

Table 4.4a results show that the constant terms, which capture time preference factor, were negative and significant at one percent level. The constant term coefficient was approximately -0.08 in the excess housing returns model which implies that β, estimate as the antilog of the coefficient, is approximately 0.92. Significance of the discounting factor (β) confirms that intertemporal consumption behavior is significant in Kenya. This implies that Kenyan investors in the housing prefer to smoothen their consumption over time similar to the results obtained in the Excess Security returns model. The coefficient of risk aversion associated with aggregate consumption growth in the excess housing returns model is approximately 0.20 in both the standard and habit models. Therefore, risk aversion

coefficients in all competing CCAPM models are significantly low ($\gamma < 5$) when compared to excess security return estimates obtained in Section 4.3.1.

Table 4.4b: Diagnostic Tests for Excess Housing Returns Models

Heteroskedasticity :BP Test	1.03	0.99	0.03
P-Value	0.309	0.319	0.856
Autocorrelation: BG-LM test	21.74	21.73	21.37
P-Value	0.00***	0.00***	0.00***
Ramsey RESET Test: F(3,44)	1.81	2.04	2.04
	0.1581	0.1225	0.06*
Multicollinearity Test: VIF Test	1.00	1.03	1.18
*** sig. at 1%, ** sig. at 5%, * sig. at 10%,			

Source: Author's Calculation

Diagnostic tests analyses for excess housing returns given as follows: First, Breusch-Pagan (BP) test was used to check for presence of heteroskedasticity. The null hypothesis assumed that the variance was homoskedastic. BP test results in all the three models show that the residuals were homoskedastic as the BP test was not rejected at 1 percent significance level.

Second, autocorrelation was tested using Breusch-Godfrey test. The null states that there is no serial correlation in the model residuals. The results reject the null hypothesis at 10 percent significance level in all the three models. The presence of serial correlation was corrected by using robust standard errors. Finally, the Ramsey RESET test determined whether the equations were well specified. The null hypothesis held that there were no omitted variables. The results proved that the all the models are well specified at 1 percent significance level.

Goodness of fit result was evaluated based on Adjusted R-Square coefficient. The results presented in Table 4.4a show that all the estimated CCAPM models performed poorly since

the adjusted R square was less than 10 percent. This implies that CCAPM models do not fit well in explaining excess housing returns. Therefore, the augmented CCAPM regressions were used to evaluate excess housing returns. The explanatory macroeconomic variables included in the models were based on empirical studies employed by Kwan *et al*., (2016). This included GDP growth, lending rate, Exchange rate and Inflation. Table 4.7 presents augmented regression results for excess housing returns.

Table 4.5a: Augmented Model for Excess Housing Returns

Dependent Variable: Excess Housing returns	**Coefficient**
Constant	0.09**
	(-2.17)
Growth of Gross Domestic Product	-0.4
	(-1.23)
Lending rate	-0.007
	(-3.61)***
Inflation rate	-0.005
	(3.14)***
Change in Exchange rate	0.3
	(1.87)*
No. Of Observations	50
Diagnostic Tests	
Goodness of fit: Adjusted R-Square	34.03
Key: t-statistics in parentheses *** sig. at 1%, ** sig. at 5%, * sig. at 10%	

Source: Author's Calculation

The results in Table 4.5a confirm that GDP growth was insignificant at 10 percent level. Lending rate and inflation rate were negative and significant at 1 percent. This asserts that increase in lending rate by one percent decreases excess housing returns by 0.007 percent, holding other factors constant. This asserts that increase in Inflation rate by one percent decreases excess housing returns by 0.005 percent, holding other factors constant. Change in

exchange rate was positive and significant at 10 percent. This implies that depreciation of exchange rate has a positive effect on excess housing returns. Table 4.5b presented diagnostic tests for the augmented excess housing returns model.

Table 4.5b: Diagnostic Tests for Augmented Excess Housing Returns Models

Heteroskedasticity: BP Test Chi2(1)	2.23
P-Value	0.136
Autocorrelation: BG-LM test Chi2(1)	16.52
P-Value	0.000***
Ramsey RESET Test: F(3,42)	0.45
	0.717
Multicollinearity Test: VIF Statistic	1.29
Notes: t-statistics in parentheses *** sig. at 1%, ** sig. at 5%, * sig. at 10%,	

Source: Author's Calculation

Diagnostic tests analyses for augmented CCAPM excess housing returns models given as follows: First, Breusch-Pagan (BP) test was used to check for presence of heteroskedasticity. The null hypothesis assumed that the variance was homoskedastic. BP test result show that the residuals were homoskedastic as the BP test was not rejected at 1 percent significance level.

Second, autocorrelation was tested using Breusch-Godfrey test. The null stated that there is no serial correlation. The results show that the null hypothesis was rejected at 1 percent significance level. Presence of serial correlation was corrected by using robust standard errors for analysis. Thirdly, Ramsey RESET test was used to test whether the equations were well specified. The null hypothesis held that there were no omitted variables. The results confirm that the models were well specified at 1 percent significance level.

Goodness of fit result was evaluated based on Adjusted R-Square coefficient. Diagnostic tests analyses for excess housing returns given as follows: First, Breusch-Pagan (BP) test was used to check for presence of heteroskedasticity. The null hypothesis stated that the variance was homoskedastic. BP test results in all the three models show that residuals were homoskedastic as the BP test was not rejected at 1 percent significance level.

Second, autocorrelation was tested using Breusch-Godfrey test. The null stated that there is no serial correlation. The results show that the null hypothesis was rejected at 10 percent significance level in all the three models. Presence of serial correlation was corrected by using robust standard errors for analysis. Thirdly, Ramsey RESET test was used to test whether the equations were well specified. The null hypothesis held that there were no omitted variables. The results in all the three models proved that the models were well specified at 1 percent significance level.

Diagnostic tests analyses for excess housing returns given as follows: First, Breusch-Pagan (BP) test was used to check for presence of heteroskedasticity. The null hypothesis assumed that the variance was homoskedastic. BP test results in all the three models show that the residuals were homoskedastic as the BP test was not rejected at 1 percent significance level.

Second, autocorrelation was tested using Breusch-Godfrey test. The null stated that there is no serial correlation. The results show that the null hypothesis was rejected at 10 percent significance level in all the three models. Presence of serial correlation was corrected by using robust standard errors for analysis. Thirdly, Ramsey RESET test was used to test whether the equations were well specified. The null hypothesis held that there were no omitted variables. The results in all the three models proved that the models were well

specified at 1 percent significance level. Notably, the adjusted R-square results in Table 4.5a show that the augmented excess housing model explains up to 34 percent of variations in excess housing returns. Therefore, for the purpose of addressing the second objective, the CCAPM models and the augmented model are used for analysis.

Following from the preceding argument, the second objective sought to establish systemic risk factors that determine housing prices movement in Kenya. The findings confirm that aggregate consumption growth and non-durable consumption growth are significant factors that explain housing prices movement. However, habit formation was not significant and growth of durable goods had a weak but positive influence on housing prices movement.

There are two important deductions from CCAPM results. First, aggregate consumption growth coefficients in the standard and habit formation CCAPM models, presented in Table 4.4a, provides evidence of significantly low level of risk aversion (γ=0.2). Second insignificance of habit formation and weak but positive influence of growth of durable goods on housing prices suggest that housing prices are nonresponsive and at best weakly procyclical to business cycle.

The results from the augmented model presented in Table 4.5a show that housing prices respond to market prices changes as estimated using inflation rate, lending rates and exchange rate. However, GDP growth is insignificant confirming that housing prices weakly respond to consumption volatility and business cycle variations. The following inferences are made based on the deductions drawn from the CCAPM and augmented housing models:

First, Yogo, (2006) and Kwan *et al*. (2016) explained that low level of risk aversion among investors in the housing market is common since investors are likely to borrow and invest in

the housing market as opposed to saving to invest. Njaramba *et al*., (2018) observed that housing market prices fail to respond to both GDP growth and household indebtedness in Kenya. However, house indebtedness responded to changes in housing prices. Obere and Miregi (2014) deduced that housing prices movement in Kenya fails to respond to market fundamentals and this may explain the low risk aversion tendency and nonresponsiveness to business cycle variations.

Second, housing is more of a consumption commodity than a financial asset. The augmented regression results further confirmed that housing market behavior is similar to durable consumption asset as it responds negatively to lending rate and inflation rate (Yogo, 2006; Obere & Miregi, 2014). Unlike financial assets, housing provides service flows to households in the long run; therefore, the need to smoothen housing service flows explains existence of low risk aversion in the housing market, nonresponsiveness to business cycle and failure to respond to market fundamentals (Piazessi *et al*., 2007; Kwan *et al.,* 2016).

4.3.3 Credit Risk, Asset Prices and the Real Sector Economy in Kenya

The third objective sought to investigate the relationship among financial risk, asset prices movement and the real sector economy in Kenya. The theoretical literature identified macro-financial model that link asset market, financial risk and the real economy as important in analyzing joint evolution of systemic risk in the economy. Therefore, analysis of the relationship between credit risk and asset prices was based on the model specified in equation (3.33) in Chapter. The relationships among these variables are analyzed using system of equations presented in the vector autoregressive (VAR) model. The VAR model was chosen because it captures the linear interdependence among financial risk, asset prices movement

and real sector variables. The study follows from Ocampo and Rodriguez (2012) in using VAR-X model which provides for inclusion of exogenous variables. The VAR-X model is estimated using the maximum likelihood estimation (MLE).

For the purposes of estimation, endogenous variables included credit risk, as a proxy of financial risk, asset returns portfolios, which include security market returns and housing market returns, GDP growth and inflation. GDP growth and inflation measure the real sector conditions in the economy. Credit risk was measured by probability of loan default (default rate) in the commercial banking sector. Lending rate and interbank rate were introduced as exogenous variables to control for the effect of interest rates in the economy.

According to the literature the individual coefficients in the VAR model do not have economic interpretation. Therefore, the relationship among the variables of interest can be analysis through (i) the impulse response functions (IRF) and (ii) the variance decomposition. The impulse responses capture the effect of a shock to a specific variable on the adjustment path of the variables. The IRF also captures the feedback effect and possible linkage between markets and maybe important in explaining systemic risk among macro-financial variables. Figure 4.6 through 4.10 shows the effect of shocks on specific endogenous variables on the system variables. Notably, the IRF results are not monotonic due to the volatile nature of financial and real variables due to high frequency nature of the dataset.

Variance decomposition is also used in analysis to complement the IRF results. The variance decomposition indicates the proportion of variance in the left-hand side variable due to the variance of other variables in the system. VAR-X model was estimated and reported in Table

E.1 in Appendix E. Variance decomposition tables were estimated and presented in Table E5A through Table E9 Figure 4.6 presents panel of four IRF graphs representing the response of credit risk, estimated using default rate, due to shocks in GDP growth, housing market returns, security market returns and inflation.

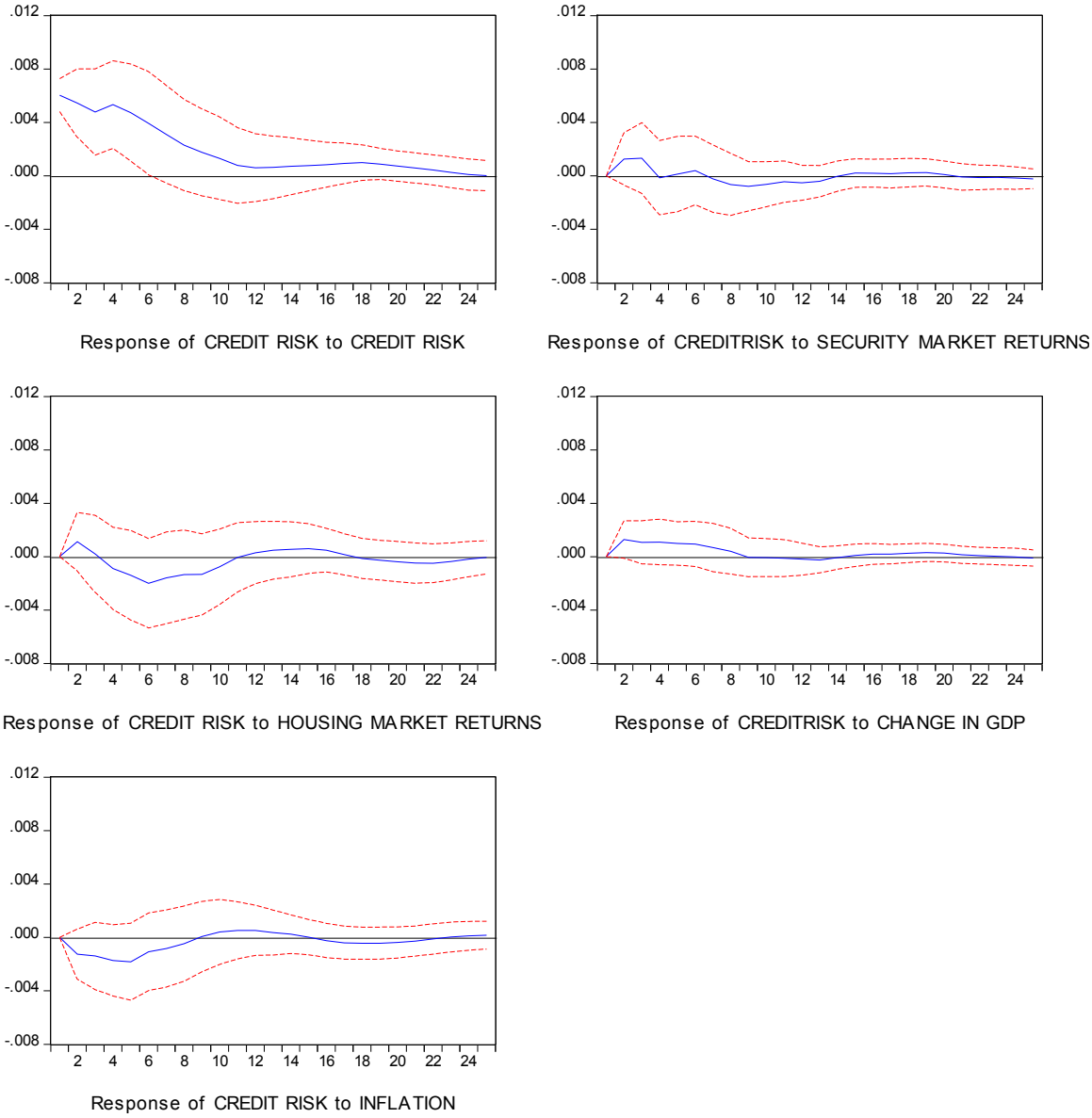

Figure 4.6: Impulse Response of Credit Risk to System Variables

Figure 4.6 shows that a shock to credit risk leads to gradual decline of credit risk. A shock on security market returns initially increases credit risk but the effect is speedily reversed after 4 quarters before it dissipates over 20 quarters. A shock on housing market return initially increases credit risk but the effect is reversed decreases after approximately 8 quarters. A positive shock on change in GDP increases credit risk and the effect is reversed after 3 quarters and dissipates fairly slowly. The results show that inflation leads to decrease in but the effect is reversed after 4 quarters and dissolves slowly over the horizon credit risk

Variance decomposition of credit risk results in Table E5 Appendix E confirm that after 12 quarters, up to 81 percent of variation of forecasted error of credit risk is explain by its own shock. A unit shock on housing market returns and a unit shock on inflation explain approximately 7 percent and 6 percent of the variance of forecasted error of credit risk respectively. The results suggest that both security and housing market returns and real sector variables have minimal effect on variation of credit risk. However, credit risk increases as security market returns and increase in economic activity. Figure 4.7 presents panel of four IRF graphs capturing the response of housing market returns to shocks GDP growth, credit risk, security market returns and inflation.

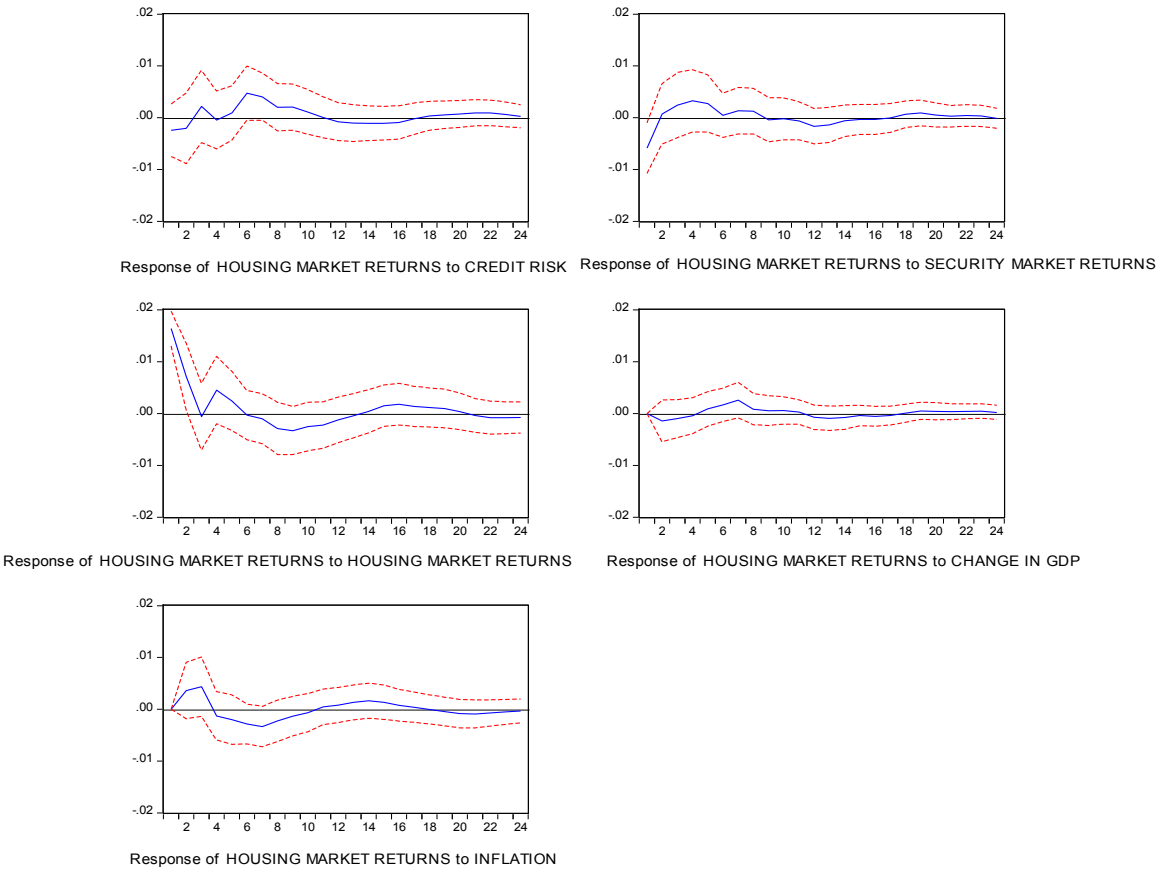

Figure 4.7: Impulse Response of Housing Market Returns

IRF results presented in Figure 4.7 show that a positive shock on credit risk has a positive effect on adjustment of housing market returns but the effect dissolves with a ragged movement after approximately 8 quarters. A positive shock on security market returns increases housing market returns but the effect is reversed after quarters before it dissipates with a ragged movement after approximately 4 quarters. However, a positive shock on change in GDP growth initially decreases housing market returns but the effect is slightly reversed before it dissipates after 8 quarters. A positive shock on inflation initially leads to increase in housing market returns during the first and second quarter. The movement is thereafter reversed before it dissipates over the 24-quarter horizon.

Variance decomposition of housing market returns results in Table E6 in Appendix E confirm that after 12 quarters, up to 64 percent of variation of forecasted error of housing market returns explain by its own shock. Security market returns explain approximately 11 percent of the variance of forecasted error of housing market returns. Credit risk explains approximately 11 percent of the variance of forecasted error of housing market returns. Inflation explain approximately 11 percent of the forecasted error of housing market returns

Despite the fact that housing market returns is significantly explained by its own shocks, there is evidence to show that security market returns, credit risk and inflation explain a significant proportion of housing market dynamics. Notably, housing market returns respond positively to increase credit risk and negatively to increase in GDP growth. It is important to note that housing is among the most important collaterals used in acquisition of credit. Increase in housing prices volatility therefore affects commercial banks' balance sheet and leads to increased financial risk in the market. Figure 4.8 presents panel of five IRF graphs capturing the response of security market returns to shocks security market returns GDP growth, credit risk, housing returns and inflation.

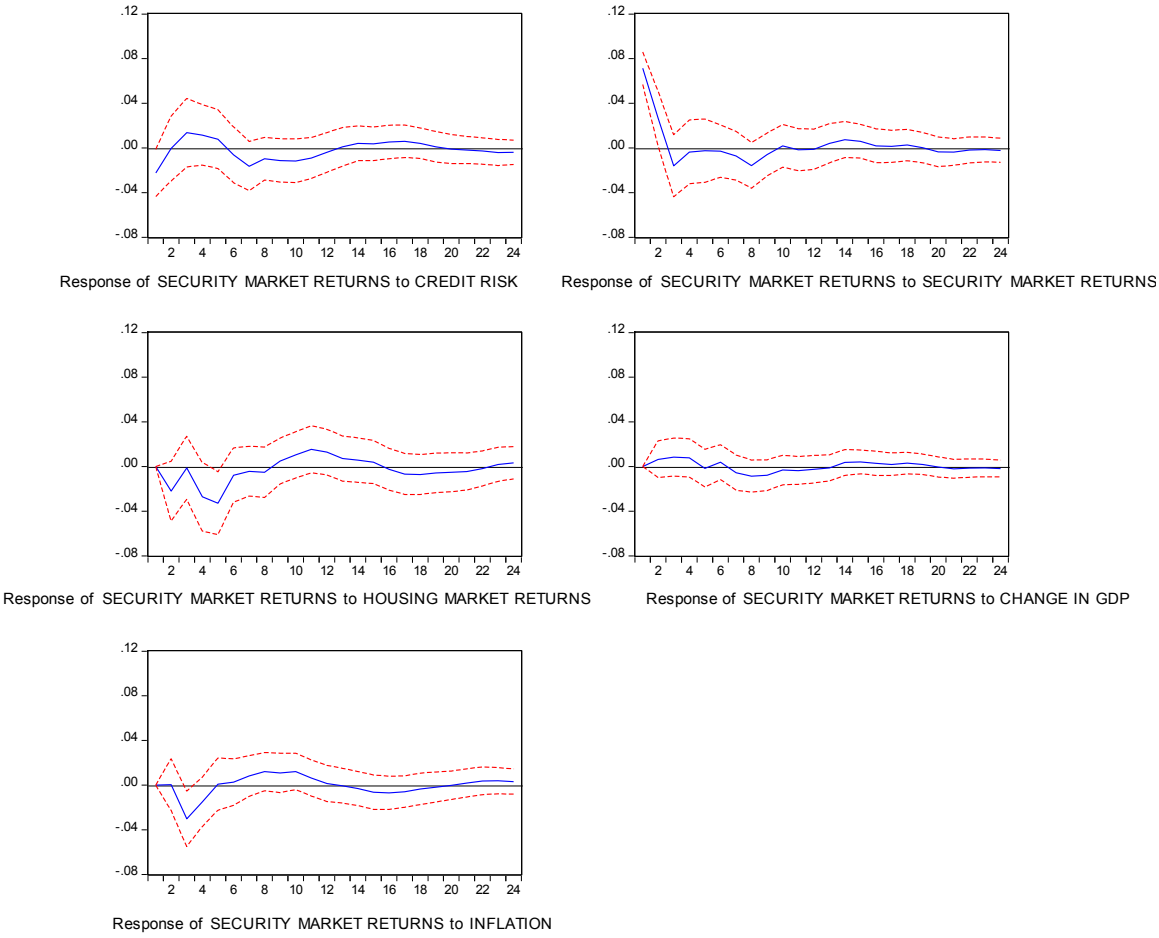

Figure 4.8: Impulse Response of Security Market Returns

Impulse response function results presented in Figure 4.8 shows that a unit increase in credit risk increases security market returns but the trend quickly reversed after 4 quarters. Notably, a unit shock on housing market return growth initially leads to decline in security market returns but the trend is reversed after 7 quarters before it dissipates with a ragged movement. A shock on GDP growth tends to increase security market return but the effect dissipates with a ragged movement after 8 quarters. A shock on inflation initially reduces security market returns but the trend is quickly reversed to positive movement after 3 periods before it dissolves over the 24 quarter horizon.

Variance decomposition of security market returns results in Table E7 in the Appendix confirm that after 12 quarters, up to 49 percent of variation of forecasted error of security market returns is explains by its own shock. Housing market returns explain approximately only 22 percent of the variance of forecasted error of security market returns while a shock on credit risk explain up to 12 percent of variations of forecasted error of security market returns and inflation explain up to 12 percent of variations of forecasted error of security market returns.

The results in Figure 4.7 and Figure 4.8 confirm that security market returns and housing market returns suggest that both assets have a mutually reinforcing relationship. Variance decomposition results in Table E6 and E7 in Appendix E. suggest that the interlinkage between the two asset markets is relatively strong. Notably, increase in systemic risk captured by high security market returns has a negative effect on housing market returns in Kenya because the later is a commodity asset which provides service flows to investors in the economy. Figure 4.9 presents panel of four IRF graphs capturing the response of GDP growth to shocks on credit risk, housing returns, security returns and inflation.

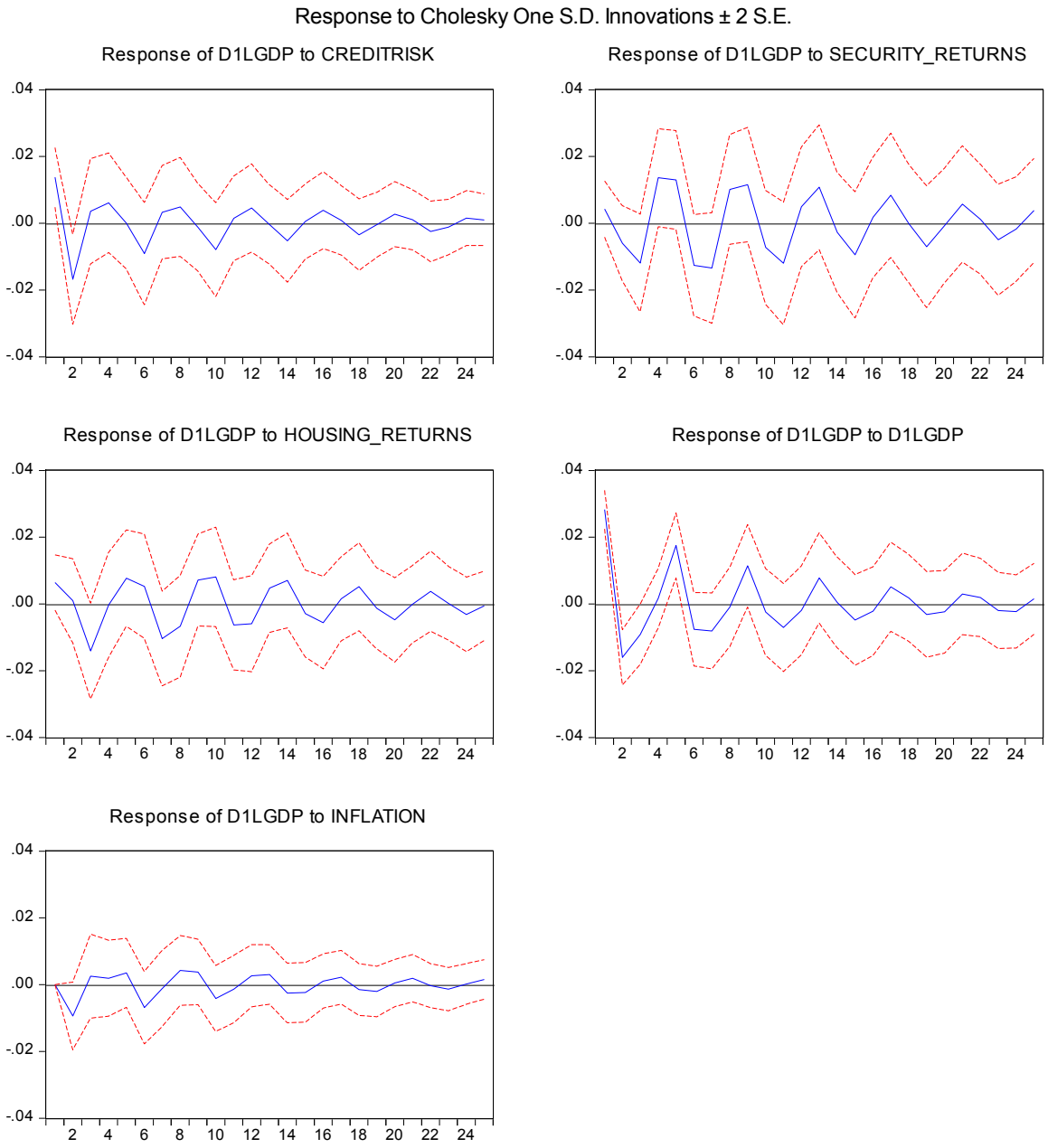

Figure 4.9: Impulse Response of change in GDP to System Variables

Figure 4.9 shows that a positive shock to all the variables tends to initially decrease GDP growth and the trend oscillates as it dissolves over the 24 period. Variance decomposition of GDP growth results in Table E8 in the Appendix confirm that after 12 quarters, 37 percent of variation of forecasted errors of GDP growth are explained by its own shock. Notably,

security and housing market returns explain approximately 28 percent and 14 percent of the variance of forecasted error of GDP respectively. A shock on credit risk explains 15 percent of variations of forecasted error of GDP growth. Figure 4.10 presents panel of four IRF graphs capturing the response of inflation to shocks on credit risk, housing returns, security returns and GDP growth.

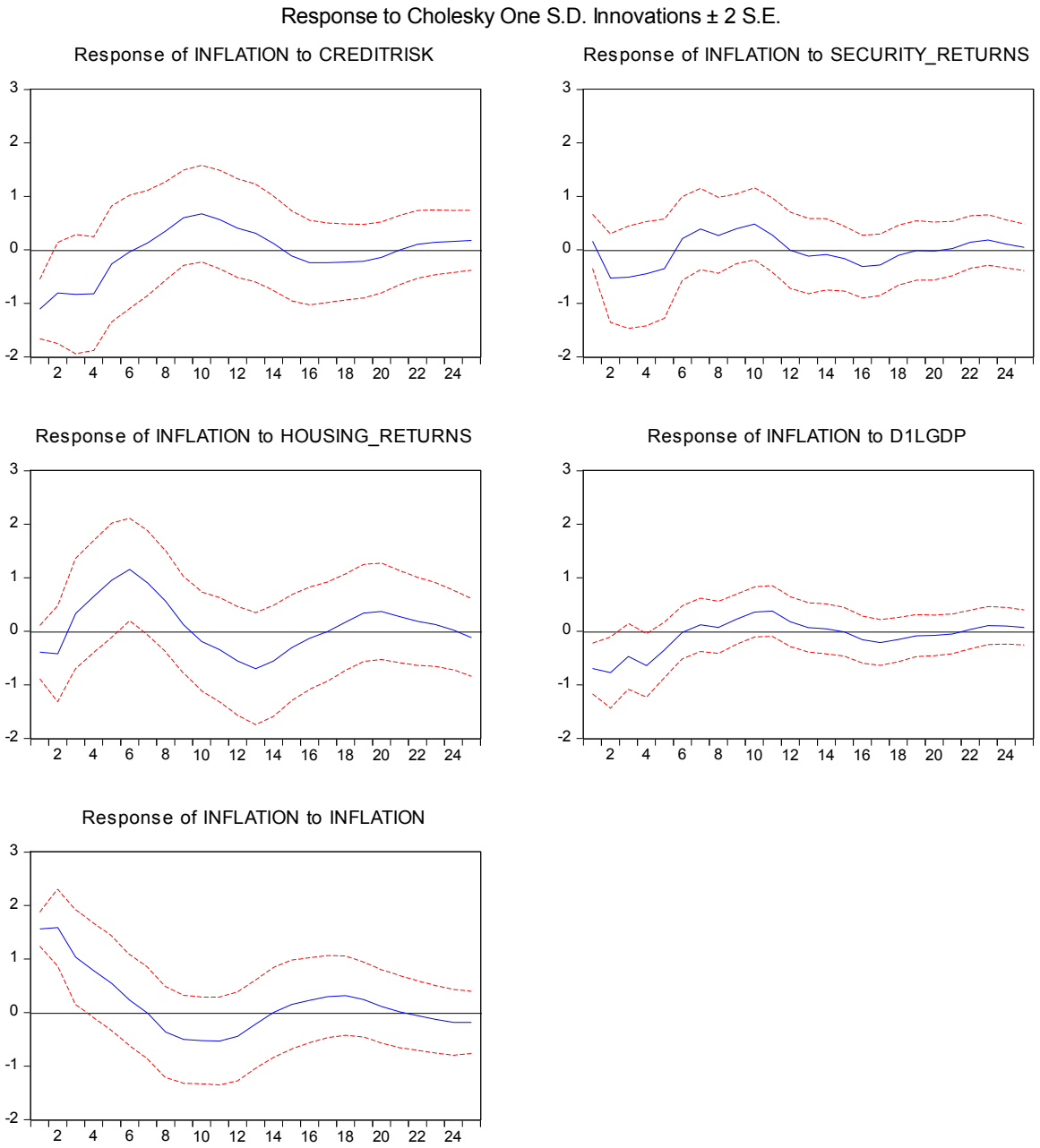

Figure 4.10: Impulse Response of Inflation to System Variables

Figure 4.10 shows that a shock to credit risk has a positive impact on inflation but the trend is reversed after 10 quarters before it dissolves after 15 quarters. Similarly, a positive shock on change in GDP generally leads to inflation rate to increase but the effect is reversed after 12 quarters. A shock on Housing returns leads to increase in inflation but the effect is reversed after 5 quarters. The effect of security returns on inflation is negative in the initial periods but the effect is reversed after 12 periods.

Variance decomposition of inflation results in Table E9 in Appendix E confirm that after 12 quarters, only 38 percent of variations of forecasted errors are explained by its own shock. A unit shock on credit risk explains up to 22 percent of the variance of forecasted error of inflation rate while a shock on housing market returns and GDP changes explain 22 percent and 10 percent of variations of forecasted error of inflation rate respectively. A shock on security market returns explains only 7 percent of variations of forecasted errors of inflation rate.

The findings in Figure 4.9 and Figure 4.10 and the corresponding variance decomposition results further provides evidence of direct and indirect interlinkage between macro-financial system in Kenya. Notably, up to 30 percent of changes in GDP is explained by housing market returns, while up to 22 percent of variation in inflation is explained by credit risk. This provides evidence of presence of a fairly strong credit channel. In this regard, the results suggest that the effect of increase in credit risk is likely to be transmitted through inflation and ultimately affect the GDP growth.

Lastly, analysis of credit risk equation in the VAR-X model presented in Table E1 in Appendix E shows that the control variables which include lending rate and interbank rate results are were significant at 5 percent level. The results show that increase of the lending rate by one percent decreases the credit risk by 0.002 percent, holding other factors constant. On the other hand, increase of the interbank rate by 1 percent increases the probability of default by 0.001 percent, holding other factors constant

Diagnostic results for the VAR-X model were reported in Table E2 through Table E4 in Appendix E. Three tests are reported: Firstly, Lag selection criteria reported in Table 8A in the Appendix shows that three-lag model was the most appropriate. However, the LR tests established that VAR-X model estimated using 3 lags was the most appropriate. Given that MLE estimator was used to estimate VAR-X model. This study utilized VAR-X model with one lag. Secondly, Figure E1 in the Appendix E shows the stability condition results. This test was conducted where the Eigen roots of the VAR-X were estimated. The null hypothesis stated that the VAR is stable and all roots lie inside the unit circle. The results in Figure E1 confirm that the null could not be rejected. Therefore, stability condition was satisfied.

Autocorrelation was tested using the LM tests under the null hypothesis of no serial correlation. The results in Table E4 in the Appendix E confirm that the null could not be rejected at 5 percent confidence interval. In this regard, the VAR-X model was deemed fit for analysis. Lastly, Heteroskedasticity test was conducted using White test. The null hypothesis stated that there is no heteroskedasticity. The results in Table E4 in the Appendix E show that the null hypothesis could not be rejected at 1 percent significance level. The following inferences were made from the analysis of impulse response function results:

First, the impulse response function results in Figure 4.6 and variance decomposition results in Table E5 in the Appendix E shows that asset market returns and macroeconomic variables have a minimal effect in determination of credit risk. On the other hand, Figure 4.7 and Figure 4.8 also show that the effect of credit risk on housing market returns and security market returns is mild. This confirms existence of weak asset channel in transmission of monetary policy and/or nonresponsiveness of asset market to monetary policy signals in Kenya (Misati & Nyamongo, 2012; Miregi & Obere, 2014). These results therefore confirm the assertion that monetary policy maybe ineffective in countering systemic risk in the asset market in Kenya.

Second, even though the security market returns have a relatively smaller effect on credit risk, the results confirm that increase in security returns, which is synonymous with increase in systemic risk in financial market, leads to increase credit risk. Impulse response function results presented in Figure 4.6 and variance decomposition results presented in Table E5 in the Appendix E. show evidence that the effect of security market and housing market returns on credit risk is relatively low. These results may be explained by the findings in section 4.31 and 4.3.2 which shows that Kenyans exhibit low risk aversion behavior towards in the security market and the phenomenon is heightened in the housing market.

These results suggest that commercial banks do not fully internalize systemic cost associated with downward asset prices movement. According to Cohn *et al.,*(2015) in absence of prudential regulation, non-risk aversion may prompt commercial banks to take on excess risk in an attempt to maximize shareholders wealth. Therefore, there is need for government to actively intervene in order to ensure systemic risk is properly monitored and managed in the

Kenyan market. Introduction of policies that explicitly focuses on monitoring of systemic risk in asset market may be critical in safeguarding financial stability.

Second, the results in Figure 4.6 through Figure 4.10 confirm the existence of feedback loop between the asset markets, dynamics in financial system and real sector of the economy. Notably, the results show that the effect of financial risk is likely to be transmitted through inflation and ultimately affect the GDP growth. Existence of direct and indirect linkages among asset prices movement, financial system and the real sector of the economy was established. Financial sector risk can be transmitted directly to the real sector economy in Kenya. On the other hand, asset market risk can be transmitted to the financial sector through the real sector economy in Kenya.

Pouvelle (2012) stipulated that decline GDP growth and inflationary pressures may increase uncertainty leading to increase in systemic risk as a result of increase in financial asset price volatility and increase in probability of default. These findings conform to theoretical expectations and suggest that systemic risk is countercyclical to business cycles and tend to worsen during recession and reduce during boom periods. Therefore, there is need to introduce countercyclical macroprudential measures to mitigate the effect of adverse macroeconomic shocks on financial stability (Torre & Ize, 2009; Pouvelle, 2012; Koivu, 2014).

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

5.1. Introduction

This chapter presents the summary of the study, conclusion and policy implications. Moreover, the study's contribution to knowledge and recommendation for areas of further research are presented in the later part of the chapter.

5.2. Summary

The global economy enjoyed low inflation and stable growth during the great moderation period just after the mid 80's. The policy environment during this period focused on inflation management with the belief that this fosters financial stability and tranquility in overall macroeconomic environment. In contrast however, this period was marked with unprecedented number of financial crises starting with the Asian financial crisis in 1997. The prevalence of financial crises during the great moderation period and its colossal effect on both domestic and global economies led to paradigm shift with regards to the efficacy of monetary policy. In retrospect, the following lessons were deduced with regards to monetary policy and management of financial system.

First, asset prices movement played a significant role in causing and/or propagating financial crises in the economy. Evaluation of incidences of financial crises around the world reveals that asset prices burst led to erosion of capital with profound effects on both financial and real sectors of the economy. Second, it was evident that pursuing monetary policy targeting

stable inflation or price stability was not sufficient to safeguard financial stability. This is because financial market development, financial innovation and global financial integration limit the ability of monetary policy in safeguarding financial stability. Finally, the prevalence of financial crises led to the realization that there was great uncertainty as to the policy instrument needed to safeguard financial health in the economy.

In view of the above, financial stability objective has, therefore, become central to overall macroeconomic stability. Financial stability refers to the ability of the financial system to withstand economic shocks and effectively undertake its intermediation functions. Financial stability encompasses management of systemic risk factors that causes turmoil in the financial and real economic sectors. Systemic risks consist of all risk in the economic system and encompass potential risk that emanate from the asset market and the real economy. In this regard, safeguarding financial stability is a systemic problem that goes beyond management of individual financial institutions' financial health.

Kenya's financial sector has witnessed robust growth, and this is partly attributed to improvement in regulatory and development policies. Even though incidences of financial disruption in Kenya have been effectively managed, the financial sector is still susceptible to both domestic and external macroeconomic shocks such as food shortages, fluctuations in commodity prices in the international market, high levels of inflation, among others. Notably, significant improvement has been made with regards to introduction of micro-prudential regulations in Kenya. However, these policies target individual banks financial health and are therefore ill suited in monitoring systemic risk at the macro level.

This study argues that to be able to promote macroeconomic stability in Kenya, there is a need to also pursue financial stability in conjunction with monetary policy objective. The task of ensuring financial stability calls for the management and monitoring of systemic risk factors and timely identification of potential threats that may cause financial vulnerabilities in the economy. Therefore, based on the foregoing discussions, the general objective of this study is to analyze the relationship among asset prices movement, financial risk and the real sector of the economy in Kenya to identify systemic risk factors that might lead to financial instability in the Kenyan economy. The specific objectives of the study are as follows: (i) to analyze the systemic risk in security asset prices movement in Kenya; (ii) to analyze the systemic risk in housing asset prices movement in Kenya; and (iii) to investigate the relationship among financial risk, asset prices and real sector economic variables in Kenya.

To address the first objective of the study, the consumption-based capital asset pricing model (CCAPM) is used to analyze the risk associated with asset prices movement specifically in the excess security asset returns. According to economic theory consumption is identified as the fundamental source of systematic risk that explains asset prices behavior. Three variants of the CCAPM models characterizing agents' behavior were employed namely, the Standard CCAPM, Habit formation model, and the Two-goods model. These models used excess security asset returns as the dependent variables.

The standard CCAPM identifies aggregate consumption growth as the main source of systematic risk. The the second specification, the Habit formation CCAPM model, introduces Surplus-consumption term above a habit level to capture the effect of business cycle defined as the series of economic booms and recessions. Finally, the third CCAPM specification–Two-goods model decomposes consumption into two distinct goods namely,

durable and non-durable consumption. In this model, durable consumption growth captures the business cycle. To further evaluate the asset pricing movement, the study estimated an augmented version of Standard CCAPM where some macroeconomic variables are included as the control variables. These macroeconomic variables include output growth (GDP growth), inflation, exchange rate and lending rates.

The excess security asset returns models are estimated using the instrumental variable (IV) estimation approach because of the perceived endogenous relationship between consumption growth variables and excess security returns.

The estimated regression results show that the coefficient of discounting factor was significant and relatively large ($\beta > 0.8$). This implies that investors prefer to smoothen consumption over time and state of nature. The risk aversion coefficients estimated in the standard and habit formation models for excess security returns are positive and significant. However, risk aversion was relatively low implying that Kenyan investors have a high risk appetite. Low risk aversion behavior maybe an indication that the Kenyan financial asset market is ready for more sophisticated asset classes. However, diversification of portfolio may actually increase probability of systemic risk build up because, by definition, systemic risk is not necessarily mitigated using portfolio diversification mechanisms.

The estimated regression results from the habit formation model of excess security returns show that the coefficient of Surplus-consumption ratio is negative and significant. This implies that asset prices are low during recession periods when surplus consumption is close to the habit level and consequently, asset prices are high during boom period when consumption is significantly above to the habit level. Therefore, Surplus consumption ratio

was identified as an important indicator that captures the effect of business cycle on asset pricing movement.

On the other hand, results from the Two-Goods security returns model display positive and significant coefficient for non-durable consumption growth. It was established that non-durable consumption growth captures is procyclical to asset returns because consumers tend to smoothen non-durable consumption over time. However, the durable consumption growth coefficient is negative and significant. This implies security returns are high when durable consumption growth is low and vice versa. These findings show that durable consumption growth is an important determinant of asset pricing behavior as it captures countercyclical relationship between business cycles and asset returns.

For the second objective, the three variants of the CCAPM models as well as the augmented version are also estimated for the excess housing asset returns to analyze the systemic risk in this particular asset prices movement. The excess housing returns models were estimated using the generalized least squares (GLS) method to take care of autocorrelation. The estimated results show that the coefficient of discounting factor was significant and relatively large ($\beta > 0.8$). Again, this implies that investors prefer to smoothen consumption streams. However, CCAPM model generally performed poorly in prediction of excess housing returns since adjusted R square was less than 9.4 percent for all respective CCAPM models. In this regard, augmented model was used to evaluate determinants of excess housing returns. It was established that lending rate and inflation rate had a negative and significant influence on excess housing returns but GDP growth was insignificant

The findings therefore show evidence of low risk aversion in both security and housing market. Non-risk aversion is more pronounced in the housing market to the extent that the market is non-responsiveness to business cycle variations. This was attributed to the fact that housing is more of a commodity asset than a financial asset. In addition, social prestige and cultural values attached to housing may explain nonresponsiveness of housing returns to business cycles. This result supports the trend analysis where housing returns is less volatile compared to security returns.

Finally, the third objective employs macroeconomic-financial model, a system of equations that link asset market returns, financial risk and the real economy. This model assumes that all the asset market returns, represented by security market returns and housing market returns, the financial risk represented by the credit risk or probability of default; and the variables in the real sector in the economy are all endogenous and values are jointly determined within the system. Endogenous variables included credit risk, as a proxy of financial risk, asset returns portfolios; which include security returns and housing returns and GDP growth and inflation which measure the real sector conditions in the economy. Lending rate and interbank rate were introduced as exogenous variables to control for interest rate. The study employed VAR-X model where impulse response function was used to analysis the interrelationship among the variables. The following results were obtained from impulse response function.

First, it was established that the feedback effect between asset markets and commercial banks was weak. These results therefore confirm the assertion that monetary policy maybe ineffective in countering systemic risk in the asset market. Notably, the results suggest that commercial banks do not fully internalize systemic cost associated with downward asset

prices movement. High level of risk in the market may prompt commercial banks to take on excess risk in an attempt to maximize shareholders wealth. These results further confirm the assertion that monetary policy maybe ineffective in countering systemic risk in the asset market.

Second, the findings confirm that the existence of feedback loop between the asset market and real sector of the economy on one hand; and feedback effect between real sector variables and financial risk in the Kenyan economy on the other. It was established that buoyancy of economic activity as captured by positive shocks to real GDP growth and inflation may decrease the financial risk and instability in the financial market. These findings suggest that financial risk is countercyclical to business cycles and tend to increase during recession and reduce during boom periods.

5.3. Conclusion

The following insights and conclusions were deduced from the study findings. The first objective sought to analyze systemic risk factors in the security market. Using CCAPM models, the study identified consumption risk factors as fundamental in explaining systemic risk of security pricing behavior in the financial market. Low levels of risk aversion maybe an indication that the Kenyan market is ready for more risky asset categories such as derivatives. However, non-risk aversion heightens systematic risk as it is associated with increased consumption growth and growing debt level. This may pose threat to financial stability especially if the economy switches to recession.

Furthermore, the excess security returns estimates confirm that habit formation CCAPM model and Two-Goods CCAPM model captured the countercyclical relationship between

security asset returns and macroeconomic cycles. These models identified habit formation-as captured using surplus consumption ratio - and non-durable consumption growth as important in determination of the influence of business cycle on asset pricing movement. It was established that security prices are low during recessionary periods and consequently asset prices are high during economic boom. The results confirm that durable consumption growth is an important variable in determination of the effect of business cycle variation on systemic risk in the economy.

The second objective sought to analyze systemic risk factors in the housing market. CCAPM models performed poorly in predicting excess housing returns. However, the results from CCAPM model shows that housing responds to consumption growth and growth of non-durable goods but weakly responds to business cycle variation. Notably, the coefficient of risk aversion was significantly low relative to the security market. Augmented model results show that excess housing returns is influenced positively by exchange rate and negatively by inflation rate and lending rate.

This led to the conclusion that excess housing returns market was characterized by significantly low risk aversion behavior and in turn non-responsiveness to business cycle. This was attributed to the fact that housing market may partly be driven by non-fundamental market factors such as social prestige and cultural values. In addition, it could be concluded that housing is more of a commodity asset than a financial asset since it provides service flows to households.

The following conclusions were made with regards to the findings obtained from analyses of the third objective: First, there is evidence to suggest that commercial banks do not fully

internalize systemic cost and may take on excess risk in an attempt to maximize shareholders wealth. Therefore, there is need for government to actively intervene in order to ensure systemic risk is properly monitored and managed in the Kenyan market. In addition, existence of interlinkages between of asset market; financial risk and the real sector economy emphasizes on the need to constantly monitor systemic risk in the asset market in an attempt to detect potential threats to financial health in Kenya.

Secondly, the study findings indicate that low inflation levels maybe associated with higher levels of financial risk in the market. In addition, tightening of monetary policy may have an adverse effect on financial risk in the Kenyan economy. The findings therefore indicate that macroeconomic goals which include full employment of resources, moderate interest rates, stable prices and financial stability might not be aligned. Emphasis on maintaining low inflation may have a negative effect on financial risk in the Kenyan economy. These findings emphasize on the need to explicitly focus on financial stability objective to complement conduct of monetary policy.

5.4. Policy Implications

The following policy implications were drawn from the study findings. The first and second objectives sought to establish systemic risk factors among security and houses prices movement. The study established that the asset prices movement and its relationship to business cycle variations was central to the management and monitoring of systemic risk in the market. This study recommends macroprudential authority to broaden supervision to include monitoring of consumption growth, habit formation and durable goods growth as measures of business cycle dynamics experienced in the real economy.

Second, evaluation of the first objective established that systemic risk is countercyclical to macroeconomic cycles and tends to increase during bad times and reduce during good times. This study therefore recommends introduction of countercyclical financial instruments such as deposit insurance and countercyclical buffer to mitigate systemic risk associated with asset price movement and the effect of business cycle on the financial risk of the economy. Introduction of countercyclical financial instruments may be critical in ensuring systemic risk is neutralized during downswings in the market.

In addition, based on the findings of the first and second objectives, the results established that Kenyan investors exhibit low risk aversion behavior in both security and housing market. High risk appetite may signal the capital market's ability to effectively introduce more sophisticated financial assets. This study, therefore, recommends introduction of well regulated financial vehicles by the capital market authority to ensure that the trade-off between capital market development and systemic risk management is safeguarded.

The results from the third objective show that the asset monetary policy channel was weak since the relationship between credit risk and asset prices movement was mild at best. This findings support the assertion that financial stability objective is not always aligned with monetary policy objective. Emphasis on conventional monetary policy objectives which focuses on output growth and inflation stability may not sufficient in guaranteeing financial stability. In this regard, there is need for Central bank to reinvent its core objectives to include management and monitoring of systemic risk in the economy. This study therefore recommends designation of an autonomous macroprudential arm within Central bank with clear mandate and structures that will enable the authority to effectively monitor and manage systemic risk in order to safeguard financial stability in the Kenyan economy.

5.5. Areas for Further Research

The following section presented critical issues that may inform further research in financial stability area. First, the asset pricing models and macro-financial models estimated in this study provide useful information that may be used in formation of macroprudential policies. However, these results should be interpreted with caution due to the following issues:

First, due to the limited scope of this study, asset pricing models have been estimated based on Consumption-based asset pricing model under the assumption that the economy is best explained using power utility framework. It should be noted that multiple utility specifications and theoretical underpinning should be used in order to obtain robust results that adequately explain asset market in Kenya. In addition, the use of disaggregated data, such as modeling individual sectors, may provide useful insight with regards to the link between systematic risk and macroeconomic performance.

Second, some latitude should be exercised when interpreting macro-financial model. In light of data availability problem, the model applied in this study (while considered as the best approximation of the actual financial system) may not adequately capture the entire macro-financial system. In this regard, consideration of alternative specifications of the macro-financial model maybe vital for the purpose of general equilibrium analysis.

Lastly, effective monitoring and management of systemic risk requires development of effective forward-looking models can be used to detect potential structural vulnerability in the financial system. Therefore, future research should focus on development of effective forward-looking frameworks, such as stress-testing models, to effectively assess the appropriateness of macroprudential policy action.

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APPENDIX

APPENDIX A: Derivation of Systemic risk from CCAPM

Equation (3.10) shows the expected value of the stochastic discount factor (*m)* and Excess returns (R^e) is given as:

$$E(M_{t+1}, R_{it+1}) = 1 \qquad \text{A(1)}$$

From the basic rules of expected value, the equation can be expressed as follows:

$$E(M_{t+1}, R_{it+1}) = E(M_{t+1})E(R_{it+1}) + Cov(M_{t+1}, R_{it+1}) = 1 \qquad \text{A(2)}$$

A risk free assets return is known in every state of nature (during good and bad times). Therefore, $Cov\left(M_{t+1}, R^f_{t+1}\right) = 0$ and $E(R^f_{t+1}) = R^f_{t+1}$. Equation A(2) associated with risk free return (R^f) is:

$$E(M_{t+1})R^f_{t+1} = 1 \qquad \Rightarrow \qquad R^f_{t+1} = \frac{1}{E(M_{t+1})} \qquad \text{A(3)}$$

Based on equation (3.12)

$$E(M_{t+1}, R^e_{it+1}) = E(M_{t+1})E(R^e_{it+1}) + Cov(M_{t+1}, R^e_{it+1}) = 0 \qquad \text{A(4)}$$

$$\Rightarrow \quad E(M_{t+1})E(R^e_{it+1}) = -Cov(M_{t+1}, R^e_{it+1}) \qquad \text{A(5)}$$

$$\Rightarrow \quad E(R^e_{it+1}) = -\frac{Cov\left(M_{t+1}, R^e_{it+1}\right)}{E(M_{t+1})} \qquad \text{A(6)}$$

Variance of (*m)* is introduced on the right hand side such that:

$$\Rightarrow \quad E(R^e_{it+1}) = -\frac{Cov\left(M_{t+1}, R^e_{it+1}\right)}{Var\,(M_{t+1})} \cdot \frac{Var\,(M_{t+1})}{E(M_{t+1})} \qquad \text{A(7)}$$

Equation A(7) shows that the expected excess returns of an asset is determined by asset volatility and variance of the (*M*). Asset risk is determined by two main components. The quantity of risk associated with a specific asset *i* and is captured by $\left(\frac{Cov(M_{t+1},R^e_{it+1})}{Var(M_{t+1})}\right)$. Systemic risk is represented by $\left(\frac{Var\,(M_{t+1})}{E(M_{t+1})}\right)$ and depends on volatility of consumption as captured using consumption variance or macroeconomic state of nature (Campbell & Cochrane, 2000).

The Two-Goods CCAPM Model

The two-good utility model for period t+i$\forall\ i = 0,1$is given as:

$$U(nD_{t+i}, D_{t+i}) = \frac{(nD_{t+i},D_{t+i})^{1-\gamma}-1}{1-\gamma} = \frac{[(1-\alpha)nD^{\rho}_{t+i}+\alpha D^{\rho}_{t+i}]^{\frac{1-\gamma}{\rho}}-1}{1-\gamma} \forall\ i = 0,1 \text{ (A.8)}$$

$$\frac{\boldsymbol{\partial U(nD_{ti},D_{t+i})}}{\boldsymbol{\partial D_{t+i}}} = \left[\frac{1-\gamma}{\rho}\right](1-\alpha)nD^{\rho-1}_{t+i}\left[(1-\alpha)nD^{\rho}_{t+i} + \alpha D^{\rho}_{t+i}\right]^{\frac{1-\gamma-\rho}{\rho}} \forall\ i = 0,1$$

(A.9)

NB: Factoring out nD_{t+I} yields:

$$\frac{\boldsymbol{\partial U(nD_{ti},D_{t+i})}}{\boldsymbol{\partial nD_{t+i}}} = \left[\frac{1-\gamma}{\rho}\right] \times (1-\alpha)nD^{\rho-1}_{t+i} \times nD^{1-\gamma-\rho}_{t+i} \qquad \text{A(10)}$$

$$\Rightarrow \qquad \left[\frac{1-\gamma}{\rho}\right] \times (1-\alpha)nD^{-\gamma}_{t+i}\left[1+\alpha\left[\left[\frac{D_{t+i}}{nD_{t+i}}\right]^{\rho}-1\right]\right]^{\frac{1-\gamma-\rho}{\rho}} \forall\ i = 0,1 \qquad \text{A(11)}$$

Equation (A.11) gives the **intra-period** marginal rate of substitution between durable and non-durable goods. SDF is the ratio of **inter-period** marginal rate of substitution$M_{t+1} = \beta\frac{U'(nD_{t+1},D_{t+1})}{U'(nD_t,D_t)}$. Therefore durable goods models SDF is given as:

$$M_{t+1} = \beta\frac{\left[\frac{1-\gamma}{\rho}\right]\times(1-\alpha)nD^{-\gamma}_{t+1}\left[1+\alpha\left[\left[\frac{D_{t+1}}{nD_{t+1}}\right]^{\rho}-1\right]\right]^{\frac{1-\gamma-\rho}{\rho}}}{\left[\frac{1-\gamma}{\rho}\right]\times(1-\alpha)nD^{-\gamma}_{t}\left[1+\alpha\left[\left[\frac{D_t}{nD_t}\right]^{\rho}-1\right]\right]^{\frac{1-\gamma-\rho}{\rho}}} \approx \beta\left(\frac{nD_{t+1}}{nD_t}\right)^{-\gamma}\left(\frac{D_{t+1}}{D_t}\right)^{1-\gamma-\rho}$$

APPENDIX B. ESTIMATED PAIRWISE CORRELATION COEFFICIENTS

Table B.1: Correlation Analysis of Selected Variables

	NSEXC	EXHPI	LSTSDF	SURP	LNDSF	LDUR	GDP	CONS
NSEXC	1.00							
EXCHPI	0.19	1.00	0.30					
LSTDSDF	0.27	0.30	1.00					
SURPLUS	-0.31	-0.08	-0.18	1.00				
LNDURSDF	0.41	0.18	0.90	-0.10	1.00			
LDURSDF	-0.34	0.15	0.04	-0.15	-0.39	1.00		
GDPMP	-0.26	-0.20	-0.28	0.67	-0.21	-0.08	1.00	
CONSCRE	-0.30	-0.25	-0.29	0.80	-0.20	-0.13	0.95	1.00

Source: Author's Calculations

Table B.2: Correlation Analysis (Variables used in VAR Model)

	CREDIT RISK	HMR	SMR	GDPG	INF	IBR	LND
CREDITRISK	1.00						
HOUSINGMR	-0.14	1.00					
SECURITYMR	0.18	-0.34	1.00				
GDP GROWTH	0.10	-0.26	0.13	1.00			
INFLATION	0.00	-0.09	-0.30	-0.33	1.00		
INTERBANK	-0.13	-0.08	-0.14	-0.11	0.44	1.00	
LENDING	-0.70	0.20	0.00	-0.03	0.01	0.50	1.00

Source: Author's Calculations

APPENDIX C. STATIONARITY TESTS

Table C.1: Stationarity test Results

Variable	ADF Test Type of test			KPSS test Type of test		
	Trend & Intercept	Intercept Only	None	Trend & Intercept	Intercept Only	Conclusion
Excess Security Returns	-3.94	-3.86	-3.44	0.07	0.13	Stationary at 5 percent (no intercept and trend)
Excess Housing Returns	-4.21	-3.95	-0.15	0.07	0.20	Stationary at 5 percent (Intercept only)
Security Market Returns	-4.37	-4.32	-4.30	0.07	0.20	Stationary at 5 percent (no intercept and trend)
Housing Market Returns	-3.88	-3.94	-0.15	0.08	0.08	Stationary at 5 percent (no intercept and trend)
Aggregate Consumption growth	-6.99	-6.59	-4.07	0.08	0.17	Stationary at 5 percent (with intercept and trend)
Non-durable Consumption growth	-6.54	-6.25	-4.44	0.05	0.14	Stationary at 5 percent (Intercept only)
Durable Consumption growth	-8.58	-8.58	-8.65	0.09	0.11	Stationary at 5 percent (no intercept and no trend)
Surplus-Consumption ratio	-5.12	-4.17	0.60	0.24	0.83	Stationary at 5 percent (Intercept only)
Inflation rate	-4.79	-4.72	-0.56	0.07	0.07	Stationary at 5 percent (Intercept only)

Treasury bill rate	-4.09	-3.89	-1.49	0.09	0.20	Stationary at 5 percent (Intercept only)
Credit Risk	0.82	-2.04	-4.25	0.25	0.94	Stationary at 5 percent (no intercept and no trend)
GDP Growth	-2.92	-2.84	-0.34	0.08	0.34	Stationary at 5 percent (with intercept and trend)
Interbank Rate	-4.21	-4.16	-1.89	0.07	0.11	Stationary at 5 percent (Intercept only)
Lending rate	-2.81	-2.82	-0.78	0.15	0.15	Stationary at 5 percent (Intercept only)
Asymptotic Critical Values	***-3.52***	***-2.94***	***-1.94***	***0.15***	***0.46***	*****Test at 5 percent significance level***

Source: Author's Calculation

APPENDIX D. AUGMENTED CCAPM MODELS

Table D.1: Augmented Model for Excess Security Returns

VARIABLE	Coefficient
Constant	0.18
	(0.14)
Growth of Gross Domestic Product	0.003
	(0.007)
Lending rate	-0.015
	(0.007)**
Inflation rate	0.003
	(0.004)
Change in Exchange rate	-0.017
	(0.005)***
Number of Observations	66
Diagnostic Tests Analysis	
Goodness of fit: Adjusted R-Square (%)	17.3
Heteroskedasticity :BP Test Chi2(1)	0.24
P-Value	0.625
Autocorrelation: BG-LM test Chi2(1)	22.47
P-Value	0.000***
Ramsey RESET Test: F(3,54)	2.15
	0.104
Multicollinearity Test: VIF Statistic	1.17
Key: Std errors in parentheses. *** sig. at 1%, ** sig. at 5%, * sig. at 10%,	

Source: Author's Calculation

Table D.2: Augmented Model for Excess Housing Returns

VARIABLE	Coefficient
Constant	0.09**
	(0.043)
Growth of Gross Domestic Product	-0.004
	(0.003)
Lending rate	-0.007
	(0.002)***
Inflation rate	-0.005
	(0.001)***
Change in Exchange rate	0.003
	(0.002)*
Number of Observations	50
Diagnostic Tests Analysis	
Goodness of fit: Adjusted R-Square (%)	34.03
Heteroskedasticity :BP Test Chi2(1)	2.23
P-Value	0.136
Autocorrelation: BG-LM test Chi2(1)	16.52
P-Value	0.000***
Ramsey RESET Test: F(3,42)	0.45
	0.717
Multicollinearity Test: VIF Statistic	1.29
Key: Std errors in parentheses. *** sig. at 1%, ** sig. at 5%, * sig. at 10%,	

Source: Author's Calculation

APPENDIX E. ESTIMATED RESULTS FOR VAR MODELS

Table E.1: Estimated Regression Results for Each Variable Equation

	CREDITRISK	SECURITY_RETURNS	HOUSING_RETURNS	D1LGDP	INFLATION
CREDITRISK(-1)	0.791914	-0.230895	0.430699	-2.220811	22.11113
	(0.22649)	(2.80722)	(0.65910)	(1.21415)	(77.9021)
	[3.49640]	[-0.08225]	[0.65347]	[-1.82911]	[0.28383]
CREDITRISK(-2)	0.090926	-0.457551	0.320529	0.676493	-68.90148
	(0.31481)	(3.90179)	(0.91609)	(1.68757)	(108.277)
	[0.28883]	[-0.11727]	[0.34989]	[0.40087]	[-0.63634]
CREDITRISK(-3)	-0.005879	0.680516	-0.487649	1.130605	44.67181
	(0.21602)	(2.67737)	(0.62861)	(1.15799)	(74.2986)
	[-0.02722]	[0.25417]	[-0.77576]	[0.97635]	[0.60125]
SECURITY_RETURNS(-1)	0.021180	0.241280	0.044840	-0.011885	-9.577390
	(0.01422)	(0.17630)	(0.04139)	(0.07625)	(4.89243)
	[1.48900]	[1.36858]	[1.08328]	[-0.15587]	[-1.95759]
SECURITY_RETURNS(-2)	-0.012626	-0.190984	0.007277	-0.236996	5.911935
	(0.01677)	(0.20786)	(0.04880)	(0.08990)	(5.76837)
	[-0.75284]	[-0.91879]	[0.14910]	[-2.63612]	[1.02489]
SECURITY_RETURNS(-3)	-0.008645	-0.159602	0.070928	0.100580	-3.696597
	(0.01465)	(0.18152)	(0.04262)	(0.07851)	(5.03741)
	[-0.59028]	[-0.87923]	[1.66421]	[1.28109]	[-0.73383]

HOUSING_RETURNS(-1)	0.038809	-1.432327	0.487905	0.196447	-0.611507
	(0.06486)	(0.80394)	(0.18875)	(0.34771)	(22.3097)
	[0.59831]	[-1.78165]	[2.58489]	[0.56497]	[-0.02741]
HOUSING_RETURNS(-2)	-0.039489	0.545288	-0.174718	-0.600351	22.92696
	(0.06439)	(0.79808)	(0.18738)	(0.34518)	(22.1471)
	[-0.61327]	[0.68325]	[-0.93244]	[-1.73926]	[1.03521]
HOUSING_RETURNS(-3)	-0.020179	-2.136267	0.289494	-0.279671	12.70111
	(0.06369)	(0.78940)	(0.18534)	(0.34142)	(21.9063)
	[-0.31683]	[-2.70619]	[1.56196]	[-0.81913]	[0.57979]
D1LGDP(-1)	0.025227	0.233450	0.005709	-0.714432	-2.267514
	(0.02206)	(0.27341)	(0.06419)	(0.11825)	(7.58725)
	[1.14360]	[0.85385]	[0.08893]	[-6.04162]	[-0.29886]
D1LGDP(-2)	0.006994	-0.054716	0.018509	-0.749187	2.033187
	(0.02293)	(0.28417)	(0.06672)	(0.12291)	(7.88598)
	[0.30505]	[-0.19255]	[0.27741]	[-6.09552]	[0.25782]
D1LGDP(-3)	0.015593	0.175761	-0.044679	-0.579291	-11.83034
	(0.02032)	(0.25182)	(0.05912)	(0.10891)	(6.98814)
	[0.76745]	[0.69796]	[-0.75568]	[-5.31878]	[-1.69292]
INFLATION(-1)	-0.000806	0.000305	0.002305	-0.006027	1.017106
	(0.00060)	(0.00738)	(0.00173)	(0.00319)	(0.20488)
	[-1.35327]	[0.04125]	[1.32964]	[-1.88749]	[4.96444]

INFLATION(-2)	0.000625	-0.015231	-0.000305	0.001190	-0.362822
	(0.00079)	(0.00982)	(0.00231)	(0.00425)	(0.27260)
	[0.78881]	[-1.55048]	[-0.13213]	[0.28014]	[-1.33098]
INFLATION(-3)	-2.82E-05	0.011860	-0.001393	-0.000103	-0.062454
	(0.00052)	(0.00647)	(0.00152)	(0.00280)	(0.17957)
	[-0.05408]	[1.83286]	[-0.91696]	[-0.03685]	[-0.34779]
C	0.062008	2.985280	0.260574	0.851405	-28.35888
	(0.08551)	(1.05982)	(0.24883)	(0.45838)	(29.4106)
	[0.72516]	[2.81679]	[1.04720]	[1.85741]	[-0.96424]
LENDING	-0.002183	0.006700	0.008119	-0.003115	-0.289962
	(0.00111)	(0.01370)	(0.00322)	(0.00593)	(0.38022)
	[-1.97456]	[0.48901]	[2.52388]	[-0.52566]	[-0.76262]
INTERBANK	0.000792	-0.000557	-0.002254	0.001140	0.128266
	(0.00044)	(0.00548)	(0.00129)	(0.00237)	(0.15214)
	[1.79080]	[-0.10167]	[-1.75086]	[0.48064]	[0.84305]
R-squared	0.988663	0.590209	0.502817	0.756275	0.847669
Adj. R-squared	0.982239	0.357993	0.221079	0.618165	0.761349
Sum sq. resids	0.001095	0.168195	0.009272	0.031464	129.5269
S.E. equation	0.006041	0.074877	0.017580	0.032385	2.077875
F-statistic	153.9011	2.541645	1.784700	5.475865	9.819994
Log likelihood	188.4099	67.58288	137.1387	107.8140	-91.93356
Akaike AIC	-7.100412	-2.065953	-4.964114	-3.742251	4.580565
Schwarz SC	-6.398711	-1.364253	-4.262414	-3.040551	5.282265
Mean dependent	0.118399	-0.001189	1.014904	0.010953	8.091834

S.D. dependent	0.045331	0.093449	0.019919	0.052409	4.253411

Source: Author's Calculation

Table E.2: Lag selection-order criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	213.6541	NA	1.01e-10	-8.829072	-8.226851	-8.604570
1	346.7611	218.8870	8.41e-13	-13.63383	-12.02790*	-13.03515
2	374.1954	39.01768	8.06e-13	-13.74202	-11.13239	-12.76918
3	426.7330	63.04515*	2.76e-13	-14.96591	-11.35259	-13.61890
4	459.0610	31.60955	2.67e-13*	-15.29160	-10.67457	-13.57042
5	487.9661	21.83940	3.83e-13	-15.46516	-9.844430	-13.36981
6	529.8773	22.35268	4.73e-13	-16.21677*	-9.592341	-13.74725*

Source: Author's Calculation

Table E.3: VAR Residual Serial Correlation LM Tests

Lags	LM-Stat	Prob
1	33.89336	0.1102
2	18.80432	0.8064
3	8.949866	0.9987
4	37.47638	0.0520

Source: Author's Calculation

Table E.4: VAR Residual Heteroskedasticity Tests: Includes Cross Terms
Null Hypothesis: No heteroskedasticity
Included observations: 50

Joint test:

Chi-sq	Df	Prob.
511.226	510	0.4764

Source: Author's Calculation

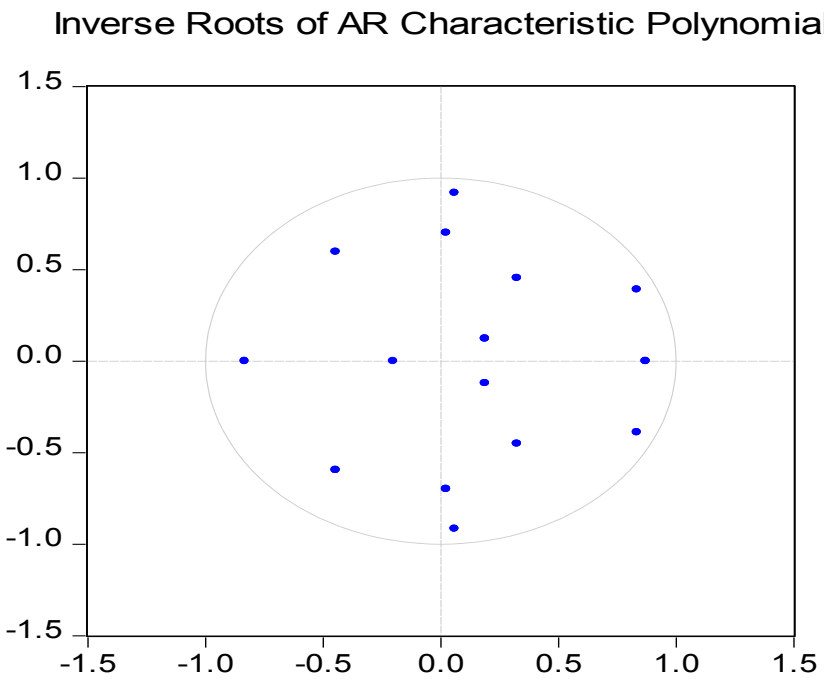

Figure E.1: Analysis of Invertibility Condition of VAR Model

Table E.5: Variance Decomposition: Decomposition of Credit Risk

Period	S.E.	CREDITRISK	SECURITY_RETURNS	HOUSING_RETURNS	D1LGDP	INFLATION
1	0.006041	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.008501	91.64656	2.208585	1.710826	2.245692	2.188334
3	0.010004	89.09752	3.356428	1.278474	2.764122	3.503455
4	0.011557	88.11875	2.529465	1.545121	2.965885	4.840781
5	0.012736	86.34636	2.093574	2.482900	3.036216	6.040950
6	0.013562	84.56582	1.932845	4.377138	3.161469	5.962731
7	0.014045	83.71951	1.826523	5.368113	3.180213	5.905644
8	0.014324	83.06669	1.959912	6.054252	3.134258	5.784890
9	0.014514	82.36454	2.198753	6.746748	3.054145	5.635813
10	0.014614	82.06025	2.360417	6.927061	3.015099	5.637176
11	0.014651	81.92570	2.436854	6.893536	3.006351	5.737558
12	0.014686	81.70567	2.548235	6.899584	3.009705	5.836801

Cholesky Ordering: CREDIT RISK SECURITY MARKET RETURNS HOUSING MARKET RETURNS CHANGE IN GDP INFLATION

Source: Author's Calculation

Table E.6: Variance Decomposition: Decomposition of Housing Market Returns

Period	S.E.	CREDITRISK	SECURITY_RETURNS	HOUSING_RETURNS	D1LGDP	INFLATION
1	0.006041	1.911381	11.18084	86.90778	0.000000	0.000000
2	0.008501	2.673986	9.238639	84.13620	0.546917	3.404256
3	0.010004	3.606539	9.973928	77.88907	0.750101	7.780362
4	0.011557	3.381947	11.62690	76.68054	0.737651	7.572967
5	0.012736	3.423159	12.75863	74.78984	0.879626	8.148740
6	0.013562	7.694354	11.93719	69.75598	1.363592	9.248888
7	0.014045	10.21670	11.44367	65.11418	2.514398	10.71105
8	0.014324	10.58141	11.31806	64.31481	2.543009	11.24270
9	0.014514	10.99019	11.00430	64.27759	2.515024	11.21290
10	0.014614	11.03695	10.85310	64.44941	2.533047	11.12750
11	0.014651	10.93055	10.81433	64.67763	2.520181	11.05730
12	0.014686	10.92152	11.16798	64.26863	2.588968	11.05290

Cholesky Ordering: CREDIT RISK SECURITY MARKET RETURNS HOUSING MARKET RETURNS CHANGE IN GDP INFLATION

Source: Author's Calculation

Table E.7: Variance Decomposition: Endogenous Variable Security Market Returns

Period	S.E.	CREDITRISK	SECURITY_RETURNS	HOUSING_RETURNS	D1LGDP	INFLATION
1	0.006041	8.986484	91.01352	0.000000	0.000000	0.000000
2	0.008501	7.359635	84.91688	7.123948	0.596245	0.003296
3	0.010004	8.360281	73.35039	5.912291	1.342223	11.03482
4	0.011557	8.734963	64.40374	13.00184	1.803221	12.05623
5	0.012736	8.365295	57.43495	21.82410	1.630024	10.74564
6	0.013562	8.611390	56.82904	22.12199	1.752617	10.68497
7	0.014045	10.67396	55.07236	21.42482	1.964328	10.86453
8	0.014324	10.94331	54.42778	20.57950	2.502116	11.54730
9	0.014514	11.65813	53.08364	20.15852	2.929344	12.17037
10	0.014614	12.36941	51.38472	20.37248	2.913290	12.96009
11	0.014651	12.65030	49.91768	21.61200	2.931229	12.88879
12	0.014686	12.58891	49.20255	22.55848	2.933268	12.71679

Cholesky Ordering: CREDIT RISK SECURITY MARKET RETURNS HOUSING MARKET RETURNS CHANGE IN GDP INFLATION

Source: Author's Calculation

Table E.8: Variance Decomposition: Decomposition of GDP Growth

Period	S.E.	CREDITRISK	SECURITY_R ETURNS	HOUSING_RE TURNS	D1LGDP	INFLATION
1	0.006041	18.04456	1.740923	3.958826	76.25569	0.000000
2	0.008501	27.50796	3.184077	2.477931	61.66800	5.162041
3	0.010004	22.45678	9.112500	11.17769	52.85985	4.393178
4	0.011557	21.86578	16.02176	10.10464	47.88297	4.124846
5	0.012736	17.78859	18.75049	10.25609	49.42613	3.778703
6	0.013562	18.26457	21.44123	9.930957	45.58073	4.782523
7	0.014045	16.74810	24.20139	11.86843	42.83839	4.343695
8	0.014324	16.54430	25.66670	12.43610	40.75721	4.595687
9	0.014514	15.27097	26.82430	12.67319	40.65557	4.575958
10	0.014614	15.98529	26.77364	13.57690	38.90744	4.756720
11	0.014651	15.21155	28.51383	13.73466	37.98844	4.551519
12	0.014686	15.36219	28.47979	14.21234	37.33039	4.615291

Cholesky Ordering: CREDIT RISK SECURITY MARKET RETURNS HOUSING MARKET RETURNS CHANGE IN GDP INFLATION

Source: Author's Calculations

Table E.9: Variance Decomposition: Decomposition of Inflation

Period	S.E.	CREDITRISK	SECURITY_R ETURNS	HOUSING_RE TURNS	D1LGDP	INFLATION
1	0.006041	28.33488	0.595350	3.500042	11.19904	56.37069
2	0.008501	21.94872	3.557408	3.837713	12.63744	58.01873
3	0.010004	23.54256	5.201667	4.021324	11.93737	55.29708
4	0.011557	24.48762	5.795739	6.547058	12.95023	50.21935
5	0.012736	22.42266	6.037943	12.06578	12.43030	47.04332
6	0.013562	20.44163	5.781094	19.24951	11.32951	43.19826
7	0.014045	19.35742	6.329350	22.85604	10.75818	40.69901
8	0.014324	19.35595	6.508968	23.78469	10.39326	39.95714
9	0.014514	20.43406	7.048348	22.80110	10.19749	39.51900
10	0.014614	21.57132	7.829627	21.68553	10.26795	38.64557
11	0.014651	22.14299	7.838203	21.27707	10.48906	38.25268
12	0.014686	22.18311	7.581616	22.01728	10.29583	37.92216

Cholesky Ordering: CREDIT RISK SECURITY MARKET RETURNS HOUSING MARKET RETURNS D1LGDP INFLATION

Source: Author's Calculations