FACTORS AFFECTING HOUSING SUPPLY IN NAIROBI COUNTY, KENYA

BY

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MASTER OF SCIENCE IN COMMERCE (FINANCE AND INVESTMENT)

KCA UNIVERSITY

2017

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE IN COMMERCE DEGREE (FINANCE AND INVESTMENT OPTION) IN THE SCHOOL OF BUSINESS & PUBLIC MANAGEMENT AT KCA UNIVERSITY

NOVEMBER 2017

DECLARATION

I declare that this dissertation is my original work and has not been previously published or submitted elsewhere for award of a degree. I also declare that this contains no material written or published by other people except where due reference is made and author duly acknowledged.

Student Name: _____ Reg. No: _____

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I do hereby confirm that I have examined the master's dissertation of

Purity Wanjira Chege

And have certified that all revisions that the dissertation panel and examiners recommended have been adequately addressed.

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ABSTRACT

This study looks at the factors that affect housing supply in Nairobi County, Kenya. The selection of factors to study was based on those factors identified by a major review of the literature on housing supply by Garces and Pires (2011); and these factors are: one, construction costs (building cost index); two, financing costs; and three, inflation rate. This study was aimed at determining the relationships between construction costs, inflation rate, financing costs and housing supply in Nairobi County. The study looked at data on these three selected variables affecting housing supply from 1970 to 2016. A descriptive research design that involved a quantitative approach was employed in the methodology. The target population was the residential housing units supplied by the housing market in Nairobi County. The data were collected from secondary sources including various Economic Surveys and Statistical Abstracts prepared by the Kenya National Bureau of Statistics (KNBS), the Central Bank of Kenya (CBK), and the Ministry of Lands & Planning. Statistical software was used to perform trend analysis and to determine the descriptive statistics, stationarity, cointegration, and fitting of the vector error correction model of the variables in the study. The results of this study indicate that there is a negative relationship between construction costs, financing costs and housing supply and a positive relationship between inflation rate and housing supply in Nairobi County, Kenya.

ACKNOWLEDGEMENTS

I would like to thank my supervisor Dr. Renson Muchiri, for his continuous guidance during this research process. I would also like to thank my family for their encouragement and patience as I undertook this research.

Above all, I thank God for giving me strength and ability to go through the research process to the very end.

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DEDICATION

I dedicate this work to my family and classmates for their support, encouragement and contribution towards my education.

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LIST OF ABBREVIATIONS

AfDB	African Development Bank
APHRC	African Population & Health Research Center
CBK	Central Bank of Kenya
GDP	Gross Domestic Product
KNBS	Kenya National Bureau of Statistics
KPDA	Kenya Property Development Association
NHC	National Housing Corporation
PES	Price Elasticity of Supply
SACCOs	Savings & Credit Co-operatives
UN	United Nation
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background

Nairobi County has a major housing supply problem that is underscored by the fact that more than half of the population of Nairobi lives in poor quality slum dwellings (African Population & Health Research Center, 2014). People who are knowledgeable about Nairobi know about its over-crowded filthy slums like Kibera, Mathare, Kawangware and Kangemi in which a huge proportion of the low-income earners live. Despite the rapidly growing national and urban population, affordable and social housing options in Kenya are few, and the government has struggled to keep pace with the demand for low-cost dwellings for low-income earners (Mkoji, 2014). There is rapid rural-to-urban migration in Kenya, and most of this migration is into Nairobi. This has contributed to the current situation in which the low-income population of Nairobi is much higher than the supply of affordable housing for low-income-earners, and it is the reason for the rapid rise in the slum-dwelling proportion of the city (World Health Organization, 2010)

Housing demand in Kenya is estimated at 200,000 units annually, yet just 30,000 to 40,000 units are supplied to the market each year, according to the Ministry of Land, Housing and Urban Development (Oxford Business Group, 2016). The Kenya National Housing Corporation (NHC) also reports that the number of social housing developments supplied each year is far short of the demand for low-cost affordable housing (NHC, 2013). The persistence of slums is a clear indication that both the private sector and the government have not yet found ways to supply enough low-cost affordable housing to the majority of low-income earners in Nairobi City.

It is interesting to note that although there is a major gap in terms of supplying housing to low-income earners in Nairobi, there is a strong supply of expensive housing for the minority middle-income and high-income earners. According to a Business Daily article (2014), Kenya's

housing market for high-income earners is feared to be headed for a real estate crash, after about a decade of booming business (Kantai, 2014). In the past decade, there has been an overinvestment in expensive housing for middle-income and upper-income earners. Out of an estimated 30,000 to 40,000 new units produced annually, over 80% target the middle-income and upper-income earners, yet the greatest housing demand is for the lower income bracket (Cytonn Weekly Report, 2016). Leading housing experts have warned of a looming glut in the middle and upper income segment where supply is almost outstripping demand. When demand decreases, or stagnates as supply increases, prices tend to drop which could lead to a real estate crash in the (middle-income and high-income) housing sector.

Put in other words, Nairobi County has a housing supply problem in which the supply of expensive housing for middle-income and upper-income earners is increasing rapidly and beginning to outstrip demand, while at the same time the supply of low-cost affordable housing for low-income earners is much lower than demand (Kantai, 2014; NHC 2013; UN-Habitat Report, 2014).

Nairobi County is made up entirely of an urban setting, unlike most of the other 46 counties of Kenya. Therefore, the social and economic dynamics of Nairobi County are really those of a city. According to the UN-Habitat Report of 2016, housing accounts for over 70% of land use in most cities. This same report indicates that the housing situation in cities of developing countries is generally poor and is dominated by severe housing shortages and an increase in slum-dwellings in the face of rapid urbanization. This UN-Habitat report also indicates that Nairobi City shares these problems of poor housing supply and slum dwellings with other cities of developing countries (UN-Habitat Report, 2016). Unfortunately, the provision of housing has not been central to most governments in developing countries. This can be seen by the rampant increase in slum

dwellings in their cities. The number of slum dwellers in developing countries increased from 689 million in 1990 to 880 million in 2014 (UN-Habitat Report, 2016).

Housing is a basic human need. According to Maslow's hierarchy of needs, people are motivated to achieve certain needs and some needs are more important than others (Maslow, 1943). The most basic needs are physiological and include the needs for air, food, drink, sex, and sleep. The second level of needs in Maslow's hierarchy is for safety and includes the need for shelter or housing. In other words, housing is not a luxury but a necessity. And, therefore, all individuals and families struggle for shelter or housing almost as much as they struggle for food. Developers or builders supply houses when there is a demand for housing. There are very many factors affecting the demand for housing in Nairobi, Kenya. One of the most obvious of these factors is the rapid increase in the human population of Nairobi (Akelola, 2013). According to Kenya National Bureau of Statistics (KNBS) the population of Nairobi is 4 Million (KNBS, 2016). Everyone in Nairobi needs housing or shelter, and different individuals and families will demand different qualities of housing depending on their levels of disposable income which is measured by Gross Domestic Product per capita (Luffman, 2006). People with high incomes can afford better housing in safer and cleaner suburbs. While people with very low income can only afford to live in slums such as Kibera. If Nairobi had a large supply of small, low-cost affordable houses, the majority of Nairobians would not be living in unhygienic slum dwellings that do not have proper toilets or drainage, and lead to increased rates of sickness and mortality.

It is important to study factors that affect housing supply in order to know in advance what could happen if there is housing supply shortage or over supply relative to demand. For example, a mismatch in the supply and demand can have extreme consequences. When there is a low demand for housing and an oversupply of properties, the prices of houses tend to fall. Falling

housing prices have a negative effect on banks and financial institutions. Banks will lose money if people default from their mortgage payments (Tracy & Wright, 2012). These banks' losses lead to lower bank lending and lower investment which negatively affect the whole economy. When the demand for houses is higher than the supply (which is the case for houses for low-income earners in Nairobi), the prices rise and this leads to a shortage of affordable homes (Baranoff, 2016) and an increase in informal settlements or slums.

1.2 Statement of the problem

Nairobi County has a population of 4 million people, and rising. Scholars have noted that more than half of this population of 4 million do not have adequate housing and live in slums because there is insufficient supply of affordable housing for low-income earners (Mkoji, 2014). At the same time, the GDP of Kenya has grown steadily over the last two decades leading to a rise in a middle class that is able to buy or rent expensive housing (World Bank Group, 2016). The rapid rise in Nairobi's population is driven by the generally high Kenyan national population growth rate and the high rural-to-urban migration in Kenya. The high population growth rate has increased the demand for housing at all income levels. However, at present most of the supply of housing in Nairobi seems to target middle-income and high-income earners (Gwinner & Cira, 2016), leaving low-income earners with few options outside of over-crowded, unhygienic slums (Mkoji, 2014).

Demand for housing in Kenya is estimated at 200,000 units annually, yet just 30,000 to 40,000 units are added to the market each year, according to the Ministry of Land, Housing and Urban Development (Oxford Business Group, 2016). Although literature on the housing market has generally grown in the last few years, housing supply remains understudied relative to housing demand (Garces & Pires, 2011). This study seeks to examine the effect of a select set of factors – identified in literature – on housing supply in Kenya. Such a study is useful for informing policy

and expanding knowledge on the behaviour of housing supply in the context of a developing country like Kenya. Specifically, this study focuses on the relationship between construction costs, inflation rate, financing costs and housing supply.

1.3 Research objectives

The objectives of the study are to determine the effect of:

1) Construction costs on housing supply in Nairobi County
2) Inflation rates on housing supply in Nairobi County
3) Financing costs on housing supply in Nairobi County

1.4 Justification of the study

The findings of this research will provide a better understanding of the drivers of housing supply in Nairobi County. These findings will be of great value to policy makers, housing developers, financial institutions, housing investors and other researchers as well**.**

The findings will be used to inform housing policy debates in Nairobi County and in the rest of the country especially in the current situation where the government and private developers are trying to bridge the huge gap between housing demand and supply. The findings will also provide guidance to housing investors, on housing markets in the country enabling them to make informed housing investment decisions. The findings of this study will also be valuable to other researchers because they are likely to form a basis for further research

1.5 Scope and Limitations of the study

The study will focus on the housing market in Nairobi County because Nairobi is the Capital City of Kenya, the commercial centre, the intellectual and technological hub, the main economic centre of Kenya that generates 60% of Kenya's GDP, and the location with the most dynamic housing supply situation in all of Kenya.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the theoretical and empirical literature on the factors that affect housing supply.

2.2 Theoretical Review

There are two major theoretical foundations that have been used in most studies of housing supply, and these are the investment theory, and the urban spatial theory. The main difference between these two theories is their treatment of land (Garces & Pires, 2011). The studies based on the investment theory tend to ignore the unique characteristics of land as a factor of production, while those studies based on urban spatial theory incorporate both the finding that land is unique because it is inelastic (Mayer & Somerville, 2000) and the land market in the theoretical structure (DiPasquale, 1999).

2.2.1 The Investment Theory

The investment theory assumes that the home building industry is composed of competitive firms that face rising factor cost schedules for labor and building materials (DiPasquale, 1999). This theory treats residential construction like other types of investments and does not account for perhaps the most unique aspect of housing supply which is land. The investment theory framework is well illustrated in the works of Poterba (1984) and Topel and Rosen (1988).

Poterba (1984) uses the asset market approach to model housing markets. He defines housing supply as a net investment in structures ignoring land. Topel and Rosen (1988) consider housing production decisions as housing investment decisions by comparing current asset prices with current marginal costs of production. They argue that current asset prices are sufficient statistics for housing investment if short run and long run investment supply are the same. Topel and Rosen (1988) also conclude that investment responds elastically to changes in asset prices,

and that “labor and other resources used in house construction are not highly specialized to the industry and they are widely used in all sectors of the economy.” This is why they see investment in housing as similar to all other investments, unlike the view of the urban spatial theory.

Although both the investment theory and the urban spatial theory explain housing supply, urban spatial theory is more relevant because it offers a better understanding of what happens in urban settings. In urban areas, unlike rural areas, there is less available land due to high population density. It is the urban spatial theory that puts an emphasis on the inelasticity of land in cities that is ignored by the investment theory.

2.2.2 The Urban Spatial Theory

Urban Spatial theory argues that land is different from other factors of production because land is inelastic (Pires & Garces, 2011). According to this theory, land prices depend more on the stock of housing, than on the level of building activity or construction. This theory also states that as the stock of housing units increases, land prices also increase and affect the return on investment negatively. This decline in the return on investment over time leads to a decline in housing construction activity which leads to less housing supply (DiPasquale, 1999). This urban spatial theory is also well presented in the work of DisPaquale and Wheaton (1994) and Mayer and Somerville (2000).

DiPasquale and Wheaton view the supply of housing as more closely intertwined with factor market for land (DiPasquale & Wheaton, 1994). DiPasquale and Wheaton present new construction as a linear function of new housing price, short term real interest rate, the price of agricultural land, construction costs and lagged housing stock**.** The study finds that the price and stock coefficients have negative signs but are not statistically significant. Price of agricultural land,

construction costs and short term real interest rates have a negative effect on new construction and are statistically significant.

Mayer and Somerville argue that land makes housing different: land and thus housing prices must ensure a spatial equilibrium with metropolitan area and land is inelastically supplied (Mayer & Somerville, 2000). Mayer and Somerville assert that land is not like other investment goods because the long run cost curve for land is upward sloping. A one-time increase in demand that results in a larger city, and more construction to accommodate these additional households, also causes a permanent increase in land prices.

Urban spatial theory provides equilibrium models in which the stock of housing always equals the urban population in these models, there is no supply theory dealing with construction flows since construction or the flow of housing equals the growth in population (DiPasquale, 1999).

2.2.3 The Price Elasticity of Supply

The price elasticity of supply examines how the quantities of goods or services supplied respond to price changes. It is expected that when prices of goods or services increases, the supply side of those goods and services will increase, every other factor affecting supply being held constant (Akelola, 2013). Price elasticity of supply is defined as the percentage change in the quantity supplied divided by the percentage change in price.

Empirical evidence on price elasticity of housing is mixed (Blackley, 1999). Some studies find evidence of perfect elasticity of housing supply (Muth, 1960; Follain, 1979; Stover, 1970) while other studies find evidence of less than perfectly elastic housing supply (DeLeeuw & Ekanem, 1971; Poterba, 1984; Topel & Rosen, 1988; DiPasquale & Wheaton, 1994). Mankiw and Weil (1989) argue that housing supply is highly inelastic. .

2.3 Empirical Review

Factors Affecting Housing Supply:

The three major factors that affect housing supply as identified in a major review of the literature by Garces and Pires (2011) are: one, construction costs; two, inflation rates; and three, financing costs.

2.3.1 Construction costs

According to Liu and London (2011) the output level of new housing is correlated to residential construction costs. Costs of residential constructions include costs of cement, roofing materials, tiles and other building materials. Some of the challenges facing the housing construction sector in Kenya include high cost of building materials and unavailability of affordable housing loans. The cost of residential construction is high relative to household incomes due to high building material costs, expensive permits and many building regulations. AfDB estimated that building costs in Kenya are roughly 60% of the total cost of building a formal housing structure; 10% is in land; 10% in infrastructure; and 20% in professional fees and finance charges (AfDB, 2012).

According to Gwinner and Cira, who are World Bank urban specialists, construction costs are 30 to 40 percent higher in Kenya than in many other African countries and this is partly because builders target the high-end market, work on small volumes, and hence they are unable to take advantage of economies of scale in building methods and material procurement (Gwinner & Cira, 2016). According to the Kenya Property Development Association (KPDA) 2015 report, the cost of construction permits has also risen from as low as 0.006% of construction cost in 2013 to 1.25% of the construction cost in 2015. The report pointed out that Nairobi's building permit fees are the highest across the continent. The increased costs are slowing down the supply of new homes in Nairobi amid the growing demand (Thuita, 2014).

Some developers in Kenya are embracing technology of building prefabricated homes in a bid to find a solution for the rising construction costs (Thuita, 2016). Prefabricated building technology lowers the overall cost of construction by up to 30 per cent while reducing construction time lines, thus opening doors for the supply of more affordable homes (Makena, 2017). In Kenya, housing companies such as Koto Housing Ltd and state owned National Housing Corporation (NHC) have embraced the prefab housing trend. The mandate of the National Housing Corporation (NHC) of Kenya is to build decent affordable houses for Kenyans in order to reduce the housing shortage in Kenya.

Several empirical studies have incorporated construction costs into the housing supply equation (Somerville, 1999; Mayer & Somerville, 2000; Hwang & Quigley, 2006). Somerville (1999) looks at the effect of residential construction costs on supply of new housing and concludes that higher construction costs reduce residential construction. Mayer and Somerville (2000) developed an empirical model linking new housing supply to changes in prices and costs and concluded that new construction is a function of changes in housing price, as well as changes in other variables such as construction costs.

Hwang and Quigley estimate housing supply as a function of housing prices and input prices, including the costs of labor, materials, financing and regulations inhibiting new construction (Hwang & Quigley, 2006). Hwang and Quigley look at construction costs in terms of labor costs and material costs and find that both labor costs and material costs variables have negative effects on housing supply and the variables are highly significant.

2.3.2 Inflation rates

Inflation, which is the persistent increase in general prices of goods and services, influences an individual's economic power to purchase goods such as houses (Theuri, 2012). Inflation rate is

commonly measured by Consumer Price Index (CPI). Consumer Price Index indicates how much prices of goods and services have increased or decreased. An increase in inflation leads to a decrease in purchasing power which has negative economic consequences such as rising costs of goods and services as well as high interest rates. Most empirical studies have found that when inflation increases the rate of housing construction decreases (Topel & Rosen, 1988; DiPasquale & Wheaton, 1992; Blackely, 1999).

Topel and Rosen include inflation rate as a regressor in the housing supply equation and find a significant and negative effect on housing starts (Topel & Rosen, 1988). A one point increase in expected rate of inflation reduces construction by 8.0 percent. When the model included both the current and lagged effects of expected inflation rate, both have similar statistically significant negative effects on current housing supply. According to DiPasquale and Wheaton, the combination of inflation, interest rates and tax policies influences housing supply negatively (DiPasquale & Wheaton, 1992).

Blackley studied the new housing supply in the U.S.A from 1950 to 1994 and found that residential construction varies inversely with expected inflation rates (Blackely, 1999). These studies show that inflation rate is an important factor to consider when measuring the rate of housing supply and that there exists a negative relationship between inflation rates and housing supply.

2.3.3 Financing costs

Most empirical studies that have studied finance costs as a determinant of housing supply, conclude that the cost of financing negatively affects housing starts (Garces & Pires, 2011). Financing costs include interest rates in various forms. The study by Porteba (1984) on the housing market, detects a significant relationship between credit availability and the rate of housing

investment, supporting the "supply effect" hypothesis that credit availability affects the flow of new construction. Topel and Rosen (1988) also conclude that real interest rates and expected inflation have a significant impact on housing starts. Blackley (1999) looks at annual housing supply data from USA for the period 1950-1994 and concludes that nominal interest rates influence new housing supply directly.

In Kenya, financial access has been low due to high interest rates and low-income levels and most financial activity occurs outside of formal institutions (Shibia, 2012). The mortgage sector is underdeveloped and is mainly concentrated in a small high-income market segment. In Kenya, the mortgage penetration rate stands at 4.3% of GDP (AfDB, 2013). Despite the Kenyan mortgage market growing at around 30%, the overall mortgage portfolio remains modest, with fewer than 25,000 total active mortgages countrywide, with an average size of $80,000 (World Bank Report, 2017). Access to finance in Kenya is a constraint for both housing developers and buyers. To start a housing project a huge sum of capital is required. Borrowing is therefore a significant feature of residential development (Lidonga, 2014). A study done by Levin and Pryce (2009), concluded that changes in the long run real interest rate cause a low-price elasticity of supply.

When interest rates are low, developers are more likely to borrow money as doing so costs them less. On the other hand, when interest rates are high, credit becomes more expensive, making more developers shy away from loans (Lidonga, 2014). A study done Poterba (1984), detected a significant relationship between credit availability and the rate of housing investment, supporting the hypothesis that credit availability affects the flow of new construction.

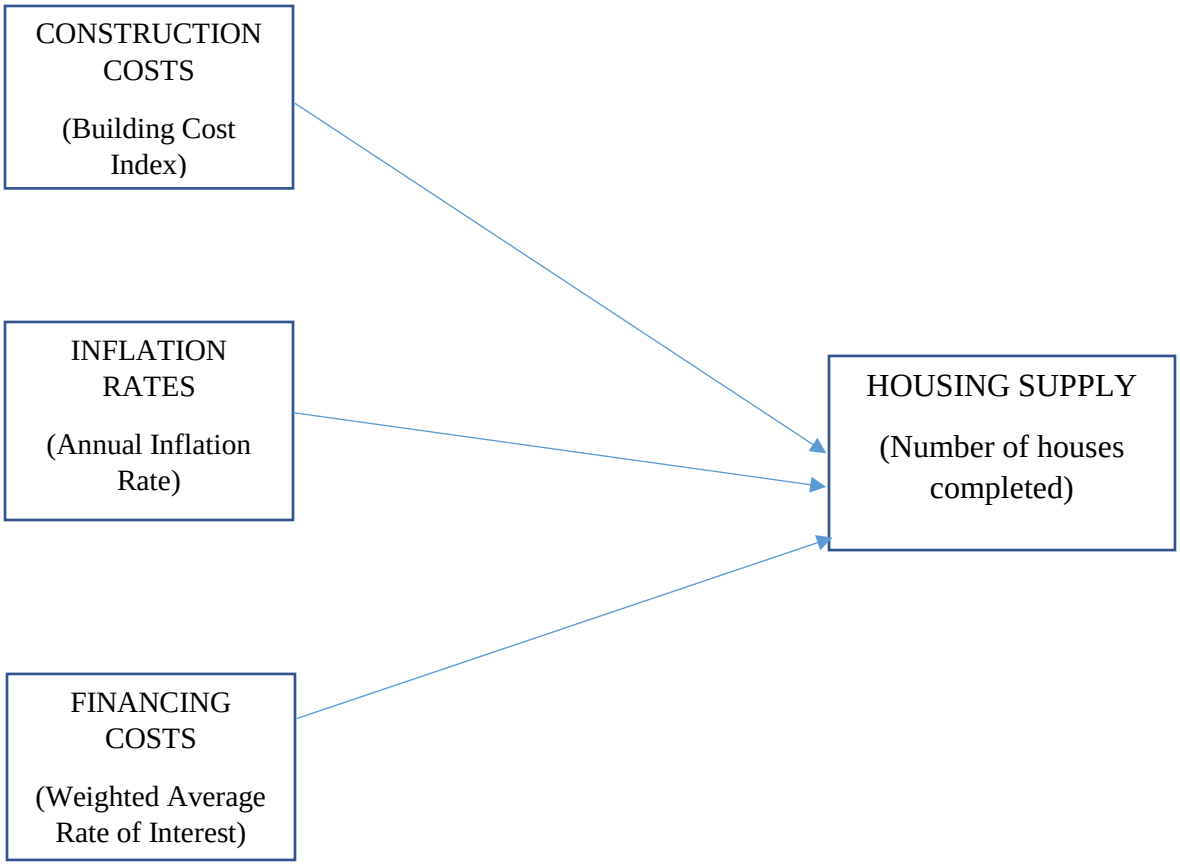
The Kenyan parliament recently (August 2016) passed a law capping interest rates with the aim of reducing the high cost of credit. The law limits interest on loans at four percentage points

above the Central Bank Rate. It remains to be seen over the next 5 years, or so, how this reduction in interest rates affects the supply of housing. The most likely scenario is that the supply will be affected positively because the cost of credit will be lower for both individual developers and the big companies. In addition to using credit from banks, many Kenyan individuals also use credit from Savings and Credit Co-operatives (SACCOs) to finance housing developments because the co-operative sectors provide development loans at a more affordable rate and provide unsecured loans at lower interest rates than many of the main banks can offer. The credit is also more easily accessible. The World Bank Lead Financial Sector Specialist Mehnaz Safavian reported that the share of savings and credit co-operative financed housing in Kenya stands at more than 90 per cent as banks do not consider housing finance to be attractive (Safavian, 2017).

Follain's study expresses the quantity of houses supplied as a function of housing price and input prices. Input prices include cost of construction materials, cost of labor, and interest rates that reflects the cost of working capital for builders or developers. According to Follain's study, interest rate is negatively related to housing supply indicating that developers are less willing to construct new homes when the cost of capital is expensive (Follain, 1979). Mayer and Somerville (1999) also found out that changes in real interest rates have a significant effect on housing starts. A 1.3 percentage point increase in real interest rates lowers total housing starts by 12,000 units. Akelola (2016) studied the housing supply in Nairobi County from 1984 to 2014, and found that mortgage interest rates were negatively correlated to housing supply.

2.4 Conceptual Framework

The conceptual framework is adopted from literature and it demonstrates the visualized relationships between construction costs, financing costs,inflation rates, and housing supply.



2.5 Operationalization/Measurement of variables

Variable	Measurement
Housing Supply (HS)	Reported Number of houses completedin Nairobi County
Construction Costs (BCI)	Building Cost index calculated by Kenya National Bureau of Statistics (DiPasquale & Wheaton, 1992; Kenny, 1999)
Inflation Rates (IR)	Annual inflation rate recorded by the Central Bank of Kenya (Theuri, 2013).
Financing costs (FC)	Weighted average rate of interest for commercial banks loans and advances recorded by the Central Bank of Kenya

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter looked at the research methods and procedures that was be used in carrying out the research. It focused on the research design, target population and sampling, data collection, processing and analysis procedures.

3.2 Research design

The primary aim of this study was to examine the factors affecting housing supply. To achieve this objective, a descriptive type of research design with a quantitative approach was employed. A descriptive type of research design involves describing the behaviour of a subject without influencing it in any way (Williams, 2011). A descriptive research design helps to identify and evaluate the causal relationships between variables under consideration (Marczyk, DeMatteo, & Festinger, 2005). A descriptive research design is the appropriate design for my study because my study will examine the relationship of the stated variables. Time series data was used. The major advantage of using time series data analysis is that it can be used to predict the past as well the future.

3.3 Target Population and Sampling

The study population will comprise of the residential housing units supplied by the housing market in Nairobi City County and approved by the Nairobi City County Planning Compliance & Enforcement Department. Nairobi County was preferred because it is the main economic centre of Kenya that generates 60% of Kenya's GDP, and the location with the most dynamic housing supply situation in all of Kenya. This population was also preferred due to availability of data on the study variables, which have been measured consistently.

The study period was 47 years i.e. the year 1970 to 2016. My unit of analysis are the number of residential housing units (both private and public) completed and recorded by Nairobi County government. My study will use secondary time series data and did not require application of sampling methods.

3.4 Data collection

The data for this study was collected from secondary sources. The secondary sources of data was generated from various Economic Surveys and Statistical Abstracts prepared by the Kenya National Bureau of Statistics (KNBS), the Central Bank of Kenya (CBK), and the Ministry of Lands & Planning.

3.5 Data processing and analysis

The study used econometric models to establish the relationships between financing costs, inflation rates, construction costs, and housing supply in Nairobi County. The Vector Error Correction model was used to investigate the relationships between the study variables. Johansen cointegration test, Granger causality test, impulse response function tests were carried out using STATA as the statistical software.

A trend analysis was carried out to identify the pattern of movement of the study variables over time. This was followed by a stationarity test to check if the time series is stationary using the Augmented Dickey Fuller (ADF) test (Dickey & Fuller, 1979). For the time series that was non-stationary, the time series was differenced to make it stationary.

A cointegration test using the Johansen cointegration test was carried out. Johansen cointegration test is used to determine whether there exists a cointegrating equation among the variables (Johansen, 1988). The test is used to determine the long run relationship between two variables (Hwang, 2002). The test indicated the presence of a cointegrating equation among the

variables, therefore a Vector Error Correction Model was used in the study. Post estimation tests were done to ensure that the model had not been mispecified.

A granger causality test was used to determine the causal relationship of the study variables (Granger, 1969). This test explains how much of a variable X can be explained by its own past values and whether adding lagged values of another variable Y can explain it better.

To analyse the relationship between financing costs, inflation rates, construction costs, and housing supply, the Vector Error Correction model was used.

Impulse response function was performed to trace out the responsiveness of the dependent variable in the VECM to shocks of each of the variables.

After processing and analysing the data, the findings were presented in chapter four of the final research report.

CHAPTER FOUR: DATA ANALYSIS, FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter presents the result of comprehensive data analysis. The results are presented using visual aids which include tables and graphs. The data were tested for stationarity, cointegration and modelled using multivariate time series.

4.2 Descriptive Statistics

Table 1: Descriptive statistics

The table below summarizes the descriptive statistics of the study variables.

Variable	Observation	Mean	Std. Dev.	Min	Max
Housing Supply	47	1505.426	1191.025	416	5811
Construction Cost (Building Cost Index)	47	1.110426	0.085439	1.03	1.53
Inflation Rate	47	1.115957	0.076858	1.02	1.46
Financing Cost	47	1.161064	0.056999	1.09	1.31

A total number of 47 observations were used in the study with four variables (three independent: Construction Cost (Building Cost Index), Inflation Rate, and Financing Cost; and one dependent variable: Housing Supply). The spread of the mean is shown by the standard deviation which is essential for purposes of comparing the variables of the study. Housing supply has the highest standard deviation when compared to the other variables. In order to reduce the high variance in the dataset, natural logs were applied on the housing supply variable. Building cost index has a standard deviation of 0.085439, inflation rate has a standard deviation of 0.076858 and financing cost has a standard deviation of 0.056999.

STUDY VARIABLES

Trend in the study variables

The trends in the variables of the study (Three independent; Building Cost Index, Inflation Rate, and Financing Cost; and one dependent variable; Nairobi Housing Supply) is as illustrated and discussed below:

Figure 1: Housing Supply trend (1970-2016)

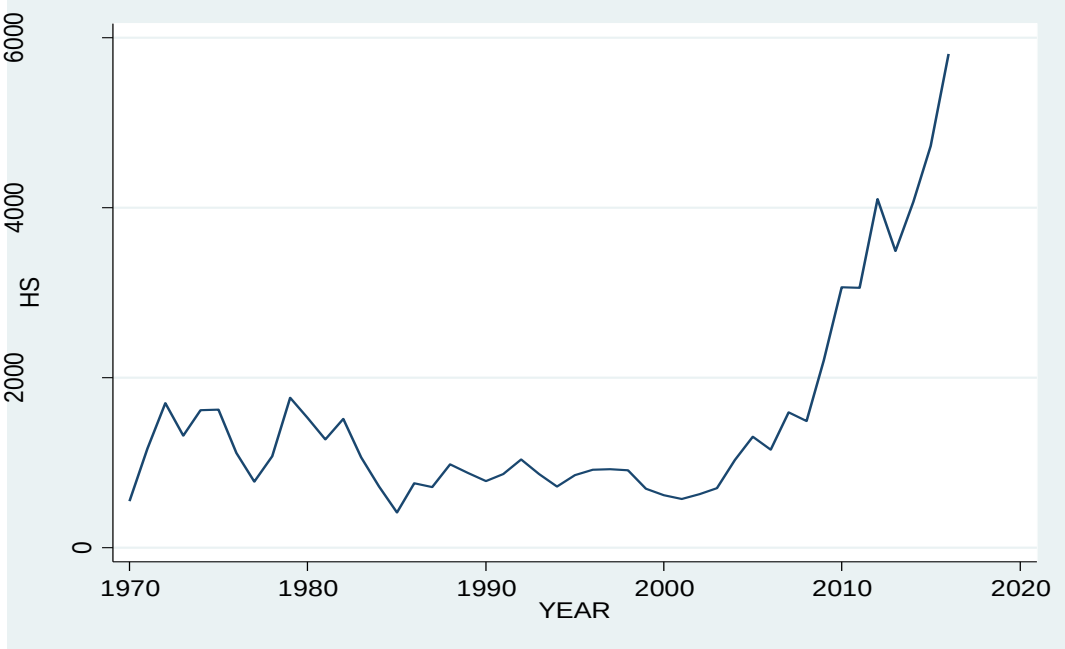


Figure 1 above illustrates the trend in housing supply in Nairobi County over the last 47 years. The number of supplied housing units in 1970 was approximately 550 units. There was an onward upward trend to about 1625 units in 1975. However, in the following three years there was a slight downward trend in the number of units build.

The housing supply growth is slow between 1984 and 2000, with the number of units supplied averagely remaining almost in the same trend. The number of units supplied between 2001 and 2004 grew steadily with the trend indicating a slow upward trend in the number of units supplied.

In 2004, 1031 units were supplied and this number rose to 1595 housing units supplied in 2007. The increase in housing supplied can be explained by a steady growth in demand for housing coupled with improved mortgage schemes by commercial banks, insurance companies and financial institutions. A better regulated financial sector, with a robust and growing middle class contributes to an onset in the growth of housing units supplied.

The period between 2008 and 2016 has shown the highest growth in the number of housing units supplied. Better monetary and physical policy framework, working financial institutions and a rapidly growing middle class explain this trend.

Figure 2: Construction Cost (Building Cost Index) Trend (1970-2016)

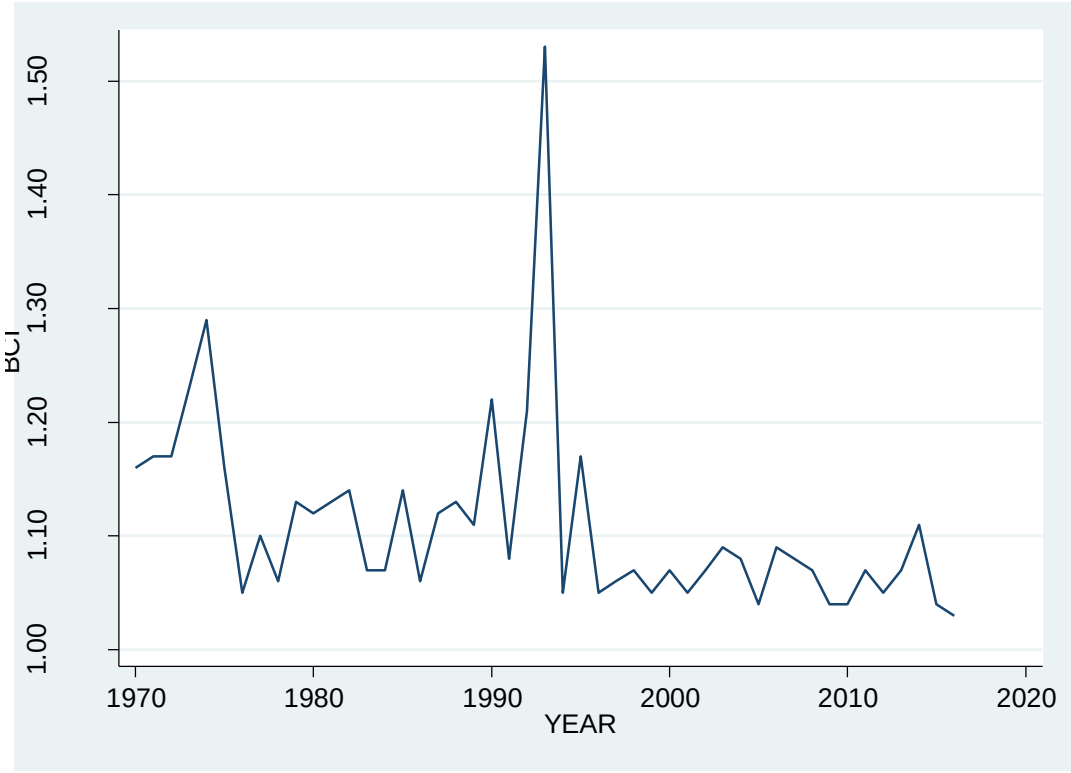
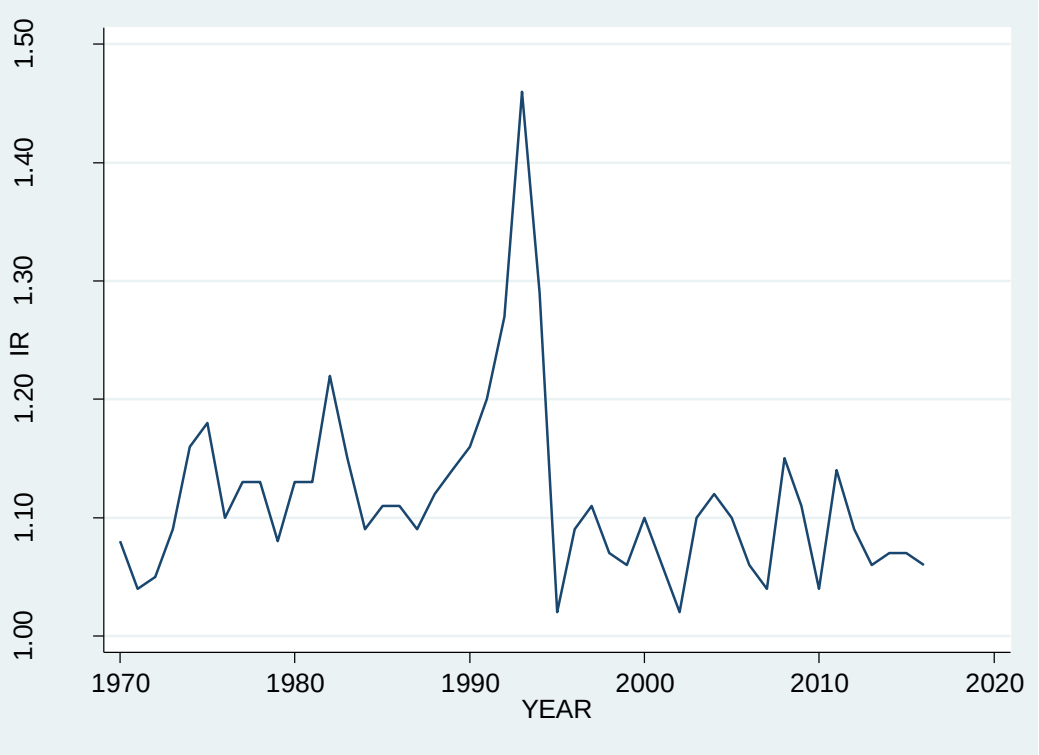


Figure 2 above indicates the trend in building cost index for the period 1970 to 2016. The Building cost index which measure how cheap or expensive building a house is especially in Nairobi was

at about 16% in 1970. This saw it increase to about 29% then drastically drop to 5% in the following six years. The value of 53 % in 1993 was the highest building cost at any given time in the entire period. High building costs affect costs of construction which in turn influence the housing units that are available.

Between 1996 and 2016, the building cost index has shown a slow declining and stagnant trend. The period 1996 begun with a building cost index of 5% which is almost 10 times lower than that experienced in 1993 when it was at the highest value. This can be explained by a change in monetary and physical policies by the Central Bank of Kenya and the government towards addressing the high building cost index. The change in policy and an improved macro-economic environment seemed to have paid off well with a steady rise in the housing units that were available. The year 2016 has the lowest Building cost index at 3.4%, which explains the highest number of houses supplied into the market.

Figure 3: Inflation Rate trend (1970-2016)



The trend in inflation is illustrated by figure 3 above. Inflation rate in 1970 was at 8% however in the following 2years, the value dropped to 5%. In 1988, there was a sharp upward trend in the rate of inflation that saw it peak at 46.0% in 1993. At its peak in 1993 when inflation stood at 46.0%, the building cost index was also at the highest level in the entire time period at 53%. These two combinations could explain the low housing units that were available and the consistent lack of growth in houses supplied over the same time period.

A change in policy to try and regulate the interest rates by regulatory bodies such as the Central Bank of Kenya and the Ministry of Finance saw a fall in the inflation rate to about 29% in 1994. The rate of inflation then fell to below 2% in 2002. The inflation rate took a fairly steady trend in the years between 1996 and 2007. The number of housing units supplied began to show steady growth in 2004 when it crossed and steadily remained above the 1000 units level for the first time ever.

Inflation rates rose briefly in 2008, explained by unstable political environments and a slump in economic growth. This systemic risk did not however affect housing units that were available as the trend indicates a steady rise in the number of housing units supplied over the same period.

The stability in inflation rates between 2009 and 2016 is followed with the highest number and biggest upward trend in housing units that were available. The rate of inflation is seen to be one of the factors explaining this trend.

Figure 4: Financing Cost trend (1970-2016)

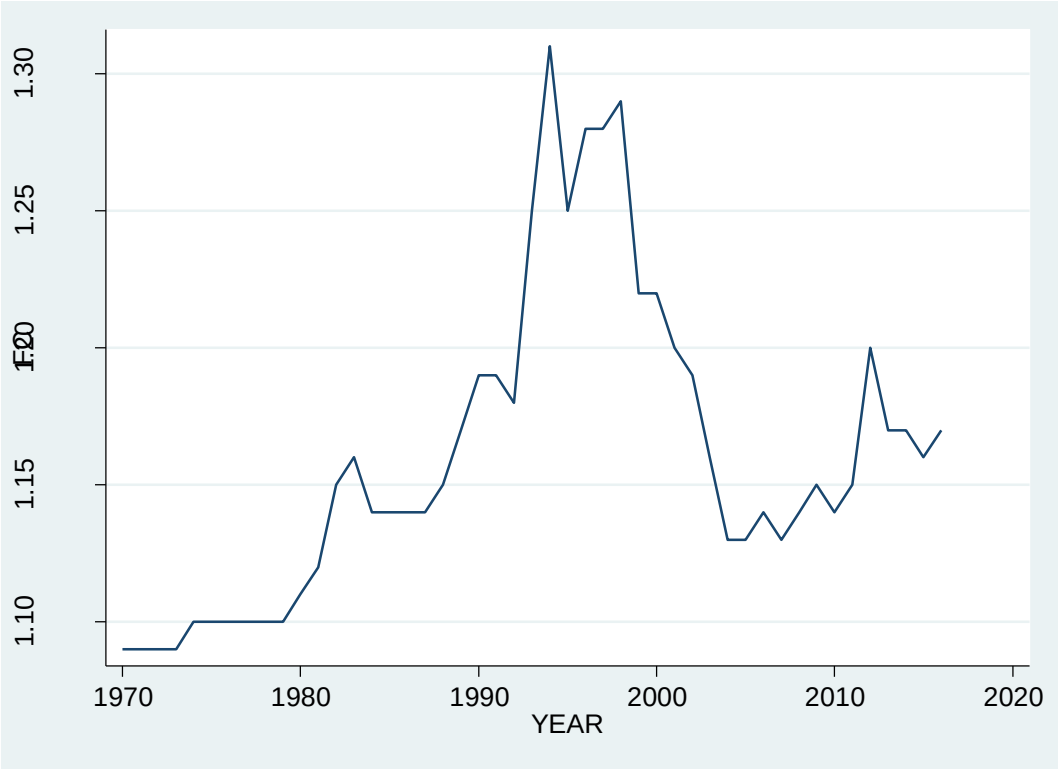


Figure 4 above indicates the trend in financing cost in Kenya between the years 1970 to 2016.

The financing cost is at 9% at the onset and remains fairly stable for a period of 4 years before it begins to show an upward trend. The rate shows an upward trend that sees it steadily rise from 19% in 1990 to about 30% in 1998. The number of housing units that were available around this period had a steady trend with no significant changes. The trend indicates that financing cost has had little to no effect on the housing units available around that period. The trend in the financing cost begins to decline steadily and reaches the lowest value of 13% in 2005. Within the same

time period, housing units supplied into the market begin to show an upward trend. The financing cost then becomes fairly stable in the following 10 years between 2006 and 2016. In the same time period, the housing units that were available has the highest upward trend.

4.3: Time Series Analysis

Testing for stationarity

Stationarity implies that a variable has been integrated with an order of zero and it is therefore possible to apply inference. The presence of a unit root however results in spurious regression which makes inference inapplicable, rendering the model incapable of being used to forecast. The Augmented Dickey Fuller Test was used to test the unit roots on the individual variables of the study.

Table 2: Stationarity Test.

Variables	Test Statistic	5% critical level	10% critical level	P-Value	Decision
Housing Supply	-1.165	-3.516	-3.190	0.9174	Not Stationary
Building Cost Index	-5.818	-3.516	-3.190	0.0000	Stationary
Inflation Rate	-3.598	-3.516	-3.190	0.0300	Stationary
Financing Cost	-1.582	-3.516	-3.190	0.7994	Not Stationary

The table 2 above shows that two variables are not stationary at levels (i.e. housing supply and financing cost) and two variables are stationary at levels (i.e. building cost index and inflation rate). After first differencing both housing supply and financing cost became stationary as seen in the table 3 below.

Table 3: Stationarity Test (First Difference)

Variables	Test Statistic	5% critical level	10% critical level	P-Value	Decision
Housing Supply	-6.832	-3.520	-3.192	0.0000	Stationary
Financing Cost	-6.957	-3.520	-3.192	0.0000	Stationary

Lag Length Selection

The lag length selection was done before testing for cointegration. This is done in order to specify the maximum lag length when testing for cointegration. The decision criteria for choosing the appropriate lag is to choose the lag with the lowest Information Criteria (IC). The three well known and used information criteria procedures are Likelihood Ratio (LR), Final Prediction criteria (FPE), Akaike'S Information Criteria (AIC), Schwartz's Bayesian Information Criteria (SBIC), and Hannan-Quinn Criterion (HQIC) method. The use of too many lags causes a loss in the degrees of freedom while the use of too few lags causes the model to be less accurately specified.

Table 4: Lag selection criteria.

Selection-order criteria
Sample: 1974 - 2016 Number of obs = 43

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-192.191				.107926	9.12517	9.18558	9.289
1	-78.3177	227.75	16	0.000	.001143*	4.57292*	4.875*	5.39208*
2	-63.1597	30.316	16	0.016	.001213	4.61208	5.15583	6.08657
3	-49.3704	27.578	16	0.035	.001418	4.7149	5.50032	6.84473
4	-31.9446	34.852*	16	0.004	.001473	4.64859	5.67567	7.43374

Endogenous: HS BCI IR FC
Exogenous: _cons

The FPE, AIC, HQIC and SBIC methods select 1 lag as indicated by the * in the output. Most information criteria methods selected 1 lag as the optimal number of lags and therefore 1 lag was used in the study.

Cointegration Test

Cointegration means the co-movement of variables towards a long run equilibrium. Cointegration test is used to determine whether there exists a cointegrating equation among the variables (Johansen, 1988). The test is used to determine the long run relationship between two variables (Hwang, 2002). If there exists a cointegrating equation among the variables, a Vector Error Correction Model is used in the study, if there is no cointegration among the variables VAR model is used. Johansen method was used to test for cointegration between the study variables.

Table 5: Cointegration Test

Johansen tests for cointegration

Trend: constant — Number of obs = 46
Sample: 1971 - 2016 — Lags = 1

maximum rank	parms	LL	eigenvalue	SBIC	HQIC	AIC
0	4	202.60867		-8.476147	-8.575593	-8.63516
1	11	222.74379	0.58332	-8.768968	-9.042443	-9.206252
2	16	239.52652	0.51794	-9.082495*	-9.480277*	-9.718545
3	19	242.51723	0.12193	-8.962832	-9.435197	-9.71814
4	20	242.93465	0.01798	-8.897749	-9.394976	-9.692811

The Johansen test for cointegration shows that there are 2 cointegrating equations indicated by *in the output above. The study therefore chose to fit Vector Error Correction model.

4.4 Model Fitting

The appropriate model for cointegrated time series is the Vector Error Correction Model. The Vector Error Correction Model is fitted when there exist a long run relationship between

variables.The presence of a cointegrating equation in this study indicates the presence of long run relationship.

A VECM is fitted to non-stationary data which becomes stationary after first difference. The model allows the fitted time series to have linear trends, but the cointegrating vector removes those trends just as it removes the unit roots, so the cointegrating equation does not contain any trend. The VEC Model shows both the long run causality and the short run causality between variables. The long run relationship between the study variables is shown by the cointegrating equations. In this study, two cointegrating equations exist.

The VECM estimation (in Appendix 2, table 10) shows information about the sample, the fit of each equation and the overall model fit statistic. The first estimation table contains the estimates of the short run parameters, along with their standard errors, z statistics, and confidence intervals. The estimated parameters of the cointegrating equations (β) are:

$$\beta = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 23.691 & -1.285 \\ -3.606 & 0.306 \\ -30.270 & 0.002 \end{bmatrix}$$

The two cointegrating equations can be written as below:

$logHS_t = 23.691IR_t - 3.606FC_t - 30.270$ ----------Eqn 1

$BCI_t = -1.285IR_t + 0.306FC_t + 0.002$ ----------Eqn 2

Eqn 1 above indicates that there is a positive long run relationship between inflation rate and housing supply. This means that when inflation increases, housing supply increases in the long run.It also shows that there exists a negative long run relationship between financing cost and housing supply. This means that when financing cost decreases, housing supply increases in the long run.

Eqn 2 above indicates that there is a negative long run relationship between inflation rateand building cost index. This means that when inflation rate decreases, building cost index increases in the long run. The equation also shows a positive long run relationship between financing cost and building cost index. This means that when financing cost increases, building cost index increases in the long run.

The adjustments coefficients (α) are:

$$\alpha = \begin{pmatrix} -0.044 & -0.391 \\ -0.024 & -0.703 \\ -0.009 & 0.071 \\ 0.007 & -0.023 \end{pmatrix}$$

The short run coefficients (Υ) are:

$$\Upsilon = \begin{pmatrix} 0.065 & 0.139 & 0.639 & -0.042 \\ 0.056 & -0.176 & -0.018 & -0.859 \\ 0.028 & 0.179 & 0.121 & -1.050 \\ 0.009 & 0.118 & 0.007 & -0.368 \end{pmatrix}$$

The VECM equations from the study are as written below:

$\Delta logHS_t = -0.044z_{1t-1} - 0.391z_{2t-1} + 0.065\Delta logHS_{t-1} + 0.139\Delta BCI_{t-1} + 0.639\Delta IR_{t-1} - 0.042\Delta FC_{t-1} + 0.006$

$\Delta BCI_t = -0.024\, z_{1t-1} - 0.703\, z_{2t-1} + 0.056\Delta logHS_{t-1} - 0.176\Delta BCI_{t-1} - 0.018\Delta IR_{t-1} - 0.859\Delta FC_{t-1} - 0.005$

$\Delta IR_t = -0.009\, z_{1t-1} + 0.071\, z_{2t-1} + 0.028\Delta logHS_{t-1} + 0.179\Delta BCI_{t-1} + 0.121\Delta IR_{t-1} - 1.050\Delta FC_{t-1} - 0.009$

$\Delta FC_t = 0.007\, z_{1t-1} - 0.023\, z_{2t-1} + 0.009\Delta logHS_{t-1} + 0.118\Delta BCI_{t-1} + 0.007\Delta IR_{t-1} - 0.368\Delta FC_{t-1} + 0.009$

In VECM it important to check whether the coefficients of the variables and the lagged differences are significant. Both inflation rate equation and financing cost equation had one significant coefficient. Housing supply did not have any significant coefficient meaning that it does not adjust when the variables depart from their long run relationship. Housing supply is therefore weakly exogenous. The constant term is significant in financing cost.

Post estimation analysis

We perform post estimation analysis of the model to check for robustness of the model in modelling the relationship between housing supply, construction costs, inflation rate and financing costs. We first check for serial correlation (autocorrelation) in the residuals using the Langrage multiplier test. Then we test for normality using the Jarque-Bera test and finally we check the stability of the modelling process.

Testing for serial autocorrelation

The test for serial autocorrelation focuses on the residuals. According to Gonzalo (1994), underspecifying the number of lags in VECM can significantly increase the finite sample bias in the parameter estimates and lead to serial correlation. The existence of serial correlation in the residuals implies that the model has been mispecified. If serial correlation exists, it is important to refit the model by increasing the number of lags. Serial correlations exists if the p-value < 0.05.

Table 6: Serial correlation test

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	19.5331	16	0.24199
2	20.5999	16	0.19441
3	16.4421	16	0.42255
4	16.2227	16	0.43753

H0: no autocorrelation at lag order

The langrage multiplier test above shows that the p-values in all the lags are greater than 0.05 therefore we cannot reject the null hypothesis. This clearly indicates that serial correlation (autocorrelation) does not exist in our model. The test finds no evidence of model misspecification.

Table 7: Normality test

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_logHS	1.215	2	0.54472
D_BCI	119.945	2	0.00000
D_IR	4.956	2	0.08390
D_FC	6.428	2	0.04020
ALL	132.544	8	0.00000

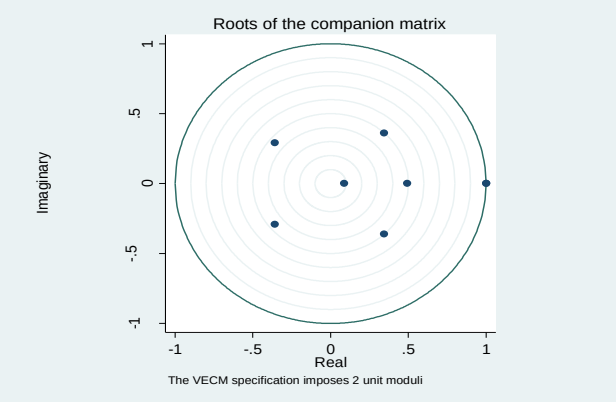
H0: Errors are normally distributed

The results in the Jarque-Bera test above show that the p-value of housing supply (dependent variable) is greater than 0.05. This indicates that the housing supply errors are normally distributed. The test finds no evidence of model misspecification.

Testing for stability

It is important to check whether the process is stable in order to ensure that the study has correctly specified the number of cointegrating equations. The companion matrix of a VECM with K endogenous variables and r cointegrating equations has k-r unit eigenvalues (Barel, 2008). If the process in this study is stable, the moduli of the remaining r eigenvalues are strictly less than one.

Table 8: Stability test



The above graph shows that none of the remaining eigenvalues appears close to the unit circle and there are strictly less than one. The stability check does not indicate the model is mispecified.

Granger Causality Test

Granger causality checks whether one variable significantly affects the other variable. The causality could be unidirectional, bidirectional or independent (no significance for both). If the p-value is less than 0.05 then we can conclude the variable significantly affects the other variable.

Table 9: Granger causality test

Granger causality Wald tests

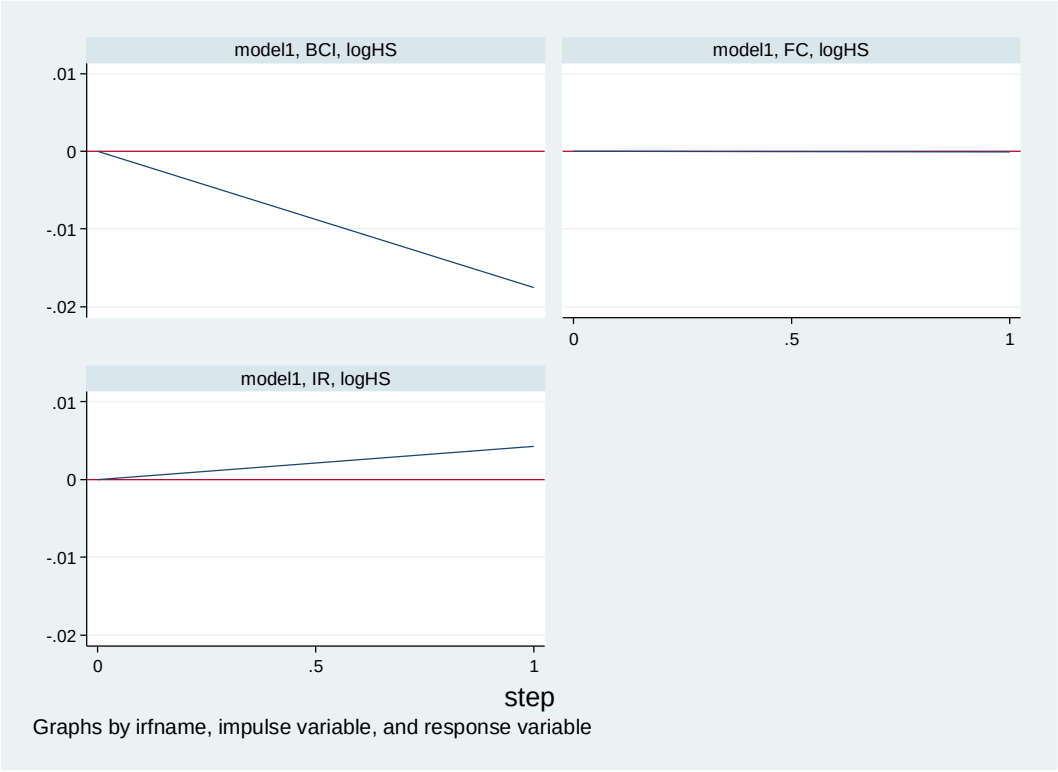
Equation	Excluded	chi2	df	Prob > chi2
logHS	BCI	.2218	2	0.895
logHS	IR	.74283	2	0.690
logHS	FC	.16291	2	0.922
logHS	ALL	2.6293	6	0.854
BCI	logHS	1.2085	2	0.546
BCI	IR	1.3595	2	0.507
BCI	FC	3.9637	2	0.138
BCI	ALL	5.2549	6	0.512
IR	logHS	.2953	2	0.863
IR	BCI	6.3633	2	0.042
IR	FC	5.9557	2	0.051
IR	ALL	16.718	6	0.010
FC	logHS	3.8011	2	0.149
FC	BCI	15.367	2	0.000
FC	IR	13.361	2	0.001
FC	ALL	45.096	6	0.000

From the table above, it is evident that inflation rate granger causes building cost index, and financing cost granger causes inflation rate and building cost index.

Impulse Response Functions (IRFs)

After fitting the model and establishing that it is well fitted then impulse response functions are estimated. Impulse functions traces out the responsiveness of the dependent variable in VECM to shocks of each of the variables. Whereas IRFs from the stationary VAR die out over time, IRFs from cointegrating VECM do not always die out over time. When the effect of a shock dies out over time, the shock is said to be transitory. When the effect of a shock does not die out over time, the shock is said to be permanent (Rossi, 2007).

Figure 5: IRF graph



The graph above indicates that an orthogonalized shock of building cost index affects housing supply negatively. Shocks on financing costs do not have any effect on housing supplied. Housing supply responds positively to shocks of inflation rate as shown in the graph above.The shocks do not seem to die out over time which means they are permanent shocks.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

A summary of the findings, conclusions and recommendations of this study is presented in this chapter. The limitations of the study and recommendations for future studies are also included in this chapter.

5.2 Summary and Conclusions

Housing has been identified to be a major of concern in countries that are still developing putting into consideration high rates of rural-urban migration of people seeking work, high levels of urbanization and a rapid increase in informal settlement areas. The supply of housing has been examined in previous reviews with such factors as land prices, housing prices, rate of population growth, financing costs, mortgage costs, disposable incomes of households, buildings regulations among other factors.

Secondary data on building cost index, inflation rates and financing rates covering a period of 47 years (1970 to 2016) was regressed on housing supply data within the same time period to establish existence of any significance between the variables under study.

Construction Cost

The variables of the study established that they had both positive as well as negative effects on housing supply when they were considered individually. The shocks of building cost index affect housing supply.Building Cost was found to have a negative relationship with housing supply in Nairobi County.

Inflation Rate

Inflation rate was found to have a positive effect on housing supply in the long run.This variablehas been established as having direct effects on housing supply.The shocks of inflation rate affect housing supply positively.

Financing Cost

Financing cost have been established as having direct effects on housing supply in the long run. Financing costs was found to have a negative effect on housing supply in the long run

5.3 Policy Recommendations

In spite of the considerable efforts made by Kenya to ensure citizens have equal access to housing that is affordable, the problem of housing shortage still widely exists. The shortage is rampant especially in urban areas due to a high rate of rural-urban migration. The situation needs long term policy guidelines and this study makes additional policy recommendations towards addressing the problem.

Regarding Building construction costs, the stakeholders and ministry in charge have to formulate and implement policies that are aimed at reducing the costs incurred when building houses. The study identified building cost to have an effect on housing supply and maintaining this cost at the lowest possible rate will result in an increase in the number of housing units supplied to the market. It is however important to note that low building costs should not be achieved at the cost of quality and safety whose importance cannot be overemphasized in the housing sector. Having a balance between costs and safety should therefore be considered significantly.

The Central Bank of Kenya and ministry of finance have to continually ensure they check and regulate inflation rates. Monetary and fiscal policies should therefore not allow any significant spike in inflation rates especially on the long term.

The government should also implement policies that encourage low cost financing for houses. The government plays a significant role in the determination of house prices. Housing price index influences housing supply and it is important to monitor and regulate financing costs to ensure that such costs do not negatively affect the number of housing units supplied into the market.

5.3.1 Recommendations for further study

Further research on factors affecting housing supply can be conducted by examining the effect that variables such as housing prices, preference for location, land costs and changes in consumer tastes have on housing supply.

An examination into variables influencing housing supply in other counties can also be undertaken to establish whether the factors are similar or different to those in Nairobi County.

Limitations of the study

Disclosure of housing supply information was a problem. It was difficult and time consuming to collect housing data due to lack of a centralized data collection point in Nairobi County.

The study could not include variables such as housing prices and land costs due to unavailability of data covering the study period (1970-2016).

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APPENDICES

APPENDIX 1

Cointegration Test

Johansen tests for cointegration

Trend: constant — Number of obs = 46

Sample: 1971 - 2016 — Lags = 1

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	4	205.16134	.	80.3345	47.21
1	11	225.21006	0.58175	40.2370	29.68
2	16	242.12219	0.52064	6.4128*	15.41
3	19	244.8991	0.11373	0.8589	3.76
4	20	245.32856	0.01850		

APPENDIX 2

Table 10

Vector Error Correction Model

Vector error-correction model

Sample: 1972 - 2016				No. of obs	= 45
				AIC	= -9.904096
Log likelihood = 254.8422				HQIC	= -9.425159
Det(Sigma_ml) = 1.42e-10				SBIC	= -8.619359

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_logHS	7	.272696	0.0768	3.079668	0.8775
D_BCI	7	.085115	0.4402	29.09818	0.0001
D_IR	7	.058892	0.4416	29.25595	0.0001
D_FC	7	.01854	0.5198	40.04571	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_logHS						
_ce1						
L1.	-.043893	.0399533	-1.10	0.272	-.1222001	.034414
_ce2						
L1.	-.3907489	.9444129	-0.41	0.679	-2.241764	1.460266
logHS						
LD.	.0648	.1516169	0.43	0.669	-.2323636	.3619636
BCI						
LD.	.1385798	.6660303	0.21	0.835	-1.166816	1.443975
IR						
LD.	.6386816	.7463153	0.86	0.392	-.8240695	2.101433
FC						
LD.	-.0423981	2.276076	-0.02	0.985	-4.503425	4.418629
_cons	.0062908	.0522868	0.12	0.904	-.0961895	.1087711

D_BCI						
	_ce1					
	L1.	-.0244308	.0124705	-1.96	0.050	-.0488725	.0000109
	_ce2					
	L1.	-.7030734	.2947758	-2.39	0.017	-1.280823	-.1253234
	logHS					
	LD.	.056057	.0473236	1.18	0.236	-.0366955	.1488094
	BCI					
	LD.	-.175896	.2078854	-0.85	0.397	-.5833438	.2315519
	IR					
	LD.	-.0177776	.2329444	-0.08	0.939	-.4743402	.438785
	FC					
	LD.	-.8593701	.7104225	-1.21	0.226	-2.251773	.5330324
	_cons	-.0047666	.0163201	-0.29	0.770	-.0367533	.0272202

D_IR						
	_ce1					
	L1.	-.0095301	.0086283	-1.10	0.269	-.0264413	.0073811
	_ce2					
	L1.	.0710264	.2039557	0.35	0.728	-.3287194	.4707723
	logHS					
	LD.	.0283777	.0327432	0.87	0.386	-.0357979	.0925532
	BCI					
	LD.	.1798923	.1438361	1.25	0.211	-.1020214	.4618059
	IR					
	LD.	.1207776	.1611745	0.75	0.454	-.1951186	.4366738
	FC					
	LD.	-1.050044	.4915422	-2.14	0.033	-2.013449	-.0866393
	_cons	-.0094479	.0112919	-0.84	0.403	-.0315795	.0126838

D_FC						
_ce1						
L1.	.007332	.0027164	2.70	0.007	.0020079	.012656
_ce2						
L1.	-.0233847	.06421	-0.36	0.716	-.1492339	.1024646
logHS						
LD.	.0085957	.0103083	0.83	0.404	-.0116083	.0287996
BCI						
LD.	.1182271	.0452829	2.61	0.009	.0294742	.2069801
IR						
LD.	.0068833	.0507415	0.14	0.892	-.0925682	.1063347
FC						
LD.	-.3677215	.1547489	-2.38	0.017	-.6710237	-.0644193
_cons	.0094969	.0035549	2.67	0.008	.0025294	.0164645

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	2	24.08456	0.0000
_ce2	2	30.28812	0.0000

Identification: beta is exactly identified

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
logHS	1	.	.	.	.	.
BCI	0	(omitted)				
IR	23.69127	4.843064	4.89	0.000	14.19904	33.1835
FC	-3.606423	4.994619	-0.72	0.470	-13.3957	6.182851
_cons	-30.27048	.	.	.	.	.
_ce2						
logHS	0	(omitted)				
BCI	1	.	.	.	.	.
IR	-1.28519	.2335263	-5.50	0.000	-1.742893	-.8274867
FC	.3055305	.2408342	1.27	0.205	-.1664958	.7775568
_cons	.0016689	.	.	.	.	.

Cointegrating Equations

$logHS_t = 23.691IR_t – 3.606FC_t – 30.270$ ----------Eqn 1

$BCI_t = -1.285IR_t + 0.306FC_t + 0.002$ ----------Eqn 2

VECM Equations

$\Delta logHS_t = -0.044z_{1t-1} - 0.391z_{2t-1} + 0.065\Delta logHS_{t-1} + 0.139\Delta BCI_{t-1} + 0.639\Delta IR_{t-1} - 0.042\Delta FC_{t-1} + 0.006$

$\Delta BCI_t = -0.024\ z_{1t-1} - 0.703\ z_{2t-1} + 0.056\Delta logHS_{t-1} - 0.176\Delta BCI_{t-1} - 0.018\Delta IR_{t-1} - 0.859\Delta FC_{t-1} – 0.005$

$\Delta IR_t = -0.009\ z_{1t-1} + 0.071\ z_{2t-1} + 0.028\Delta logHS_{t-1} + 0.179\Delta BCI_{t-1} + 0.121\Delta IR_{t-1} - 1.050\Delta FC_{t-1} - 0.009$

$\Delta FC_t = 0.007\ z_{1t-1} - 0.023\ z_{2t-1} + 0.009\Delta logHS_{t-1} + 0.118\Delta BCI_{t-1} + 0.007\Delta IR_{t-1} - 0.368\Delta FC_{t-1} + 0.009$

Serial correlation test

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	19.5331	16	0.24199
2	20.5999	16	0.19441
3	16.4421	16	0.42255
4	16.2227	16	0.43753

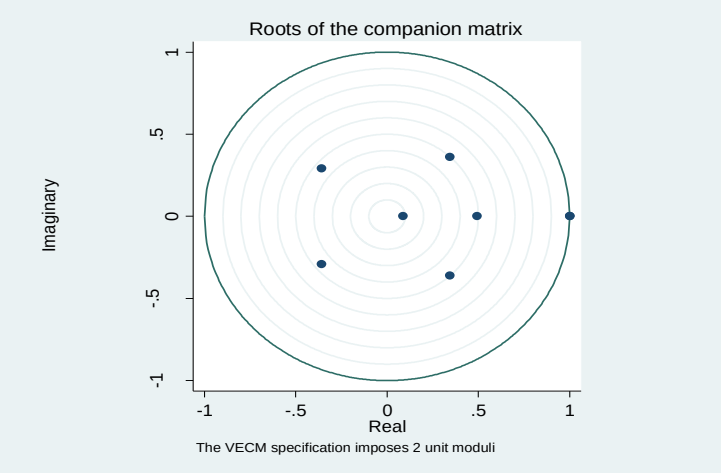
H0: no autocorrelation at lag order

Normality test

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_logHS	1.215	2	0.54472
D_BCI	119.945	2	0.00000
D_IR	4.956	2	0.08390
D_FC	6.428	2	0.04020
ALL	132.544	8	0.00000

Stability Test

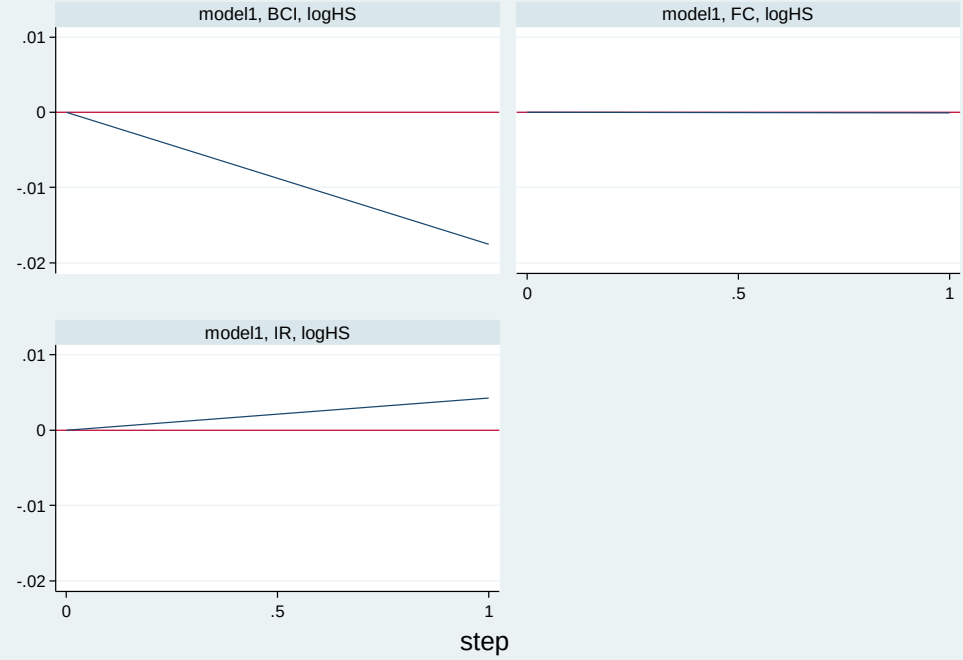


Granger Causality Test

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
logHS	BCI	.2218	2	0.895
logHS	IR	.74283	2	0.690
logHS	FC	.16291	2	0.922
logHS	ALL	2.6293	6	0.854
BCI	logHS	1.2085	2	0.546
BCI	IR	1.3595	2	0.507
BCI	FC	3.9637	2	0.138
BCI	ALL	5.2549	6	0.512
IR	logHS	.2953	2	0.863
IR	BCI	6.3633	2	0.042
IR	FC	5.9557	2	0.051
IR	ALL	16.718	6	0.010
FC	logHS	3.8011	2	0.149
FC	BCI	15.367	2	0.000
FC	IR	13.361	2	0.001
FC	ALL	45.096	6	0.000

Impulse Response Functions graph



Graphs by irfname, impulse variable, and response variable

BASIC DATA

YEAR	Housing Supply (HS)	Building Cost Index (BCI)	Inflation Rate (IR)	Financing Cost (FC)
1970	550	1.16	1.08	1.09
1971	1168	1.17	1.04	1.09
1972	1699	1.17	1.05	1.09
1973	1320	1.23	1.09	1.09
1974	1616	1.29	1.16	1.10
1975	1625	1.16	1.18	1.10
1976	1115	1.05	1.10	1.10
1977	774	1.10	1.13	1.10
1978	1079	1.06	1.13	1.10
1979	1762	1.13	1.08	1.10
1980	1528	1.12	1.13	1.11
1981	1274	1.13	1.13	1.12
1982	1516	1.14	1.22	1.15
1983	1063	1.07	1.15	1.16
1984	719	1.07	1.09	1.14
1985	416	1.14	1.11	1.14
1986	757	1.06	1.11	1.14
1987	715	1.12	1.09	1.14
1988	980	1.13	1.12	1.15
1989	879	1.11	1.14	1.17
1990	782	1.22	1.16	1.19
1991	865	1.08	1.20	1.19
1992	1036	1.21	1.27	1.18
1993	869	1.53	1.46	1.25
1994	722	1.05	1.29	1.31
1995	851	1.17	1.02	1.25
1996	920	1.05	1.09	1.28
1997	923	1.06	1.11	1.28
1998	908	1.07	1.07	1.29
1999	695	1.05	1.06	1.22
2000	617	1.07	1.10	1.22
2001	571	1.05	1.06	1.20
2002	630	1.07	1.02	1.19
2003	703	1.09	1.10	1.16
2004	1031	1.08	1.12	1.13
2005	1305	1.04	1.10	1.13
2006	1154	1.09	1.06	1.14
2007	1595	1.08	1.04	1.13
2008	1493	1.07	1.15	1.14
2009	2204	1.04	1.11	1.15
2010	3063	1.04	1.04	1.14
2011	3059	1.07	1.14	1.15
2012	4103	1.05	1.09	1.20
2013	3494	1.07	1.06	1.17
2014	4069	1.11	1.07	1.17
2015	4727	1.04	1.07	1.16
2016	5811	1.03	1.06	1.17

APPENDIX 3

Research Time Frame

TASK/MONTH	APR	MAY	JUN	JUL	AUG	SEP	OCT
IDENTIFYING THE RESEARCH PROBLEM							
IDENTIFYING THE RESEARCH TOPIC							
WRITING THE RESEARCH PROPOSAL							
PROPOSAL DEFENSE							
CORRECTION ON DEFENSE							
DATA COLLECTION							
DATA ANALYSIS							
DISSERTATION DEFENSE							
CORRECTION ON FINAL DISSERTATION							
SUBMISSION TO S.O.B							

APPENDIX 4

BUDGET

ITEM	**AMOUNT (Shillings)**
Printer cartridge	3,000
Printing paper	600
Internet costs	12,500
Telephone costs	4,700
Data collection (trips)	3,400
Stata Software (free from Econometrics lecturer)	0
Laptop	40,000
Other costs	5,000
TOTAL	69,200