PREDICTING PRICES IN THE REAL ESTATE SECTOR IN KENYA
USING THE HEDONIC PRICING MODEL

BY

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K102/CTY/PT/21498/2010

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF
APPLIED ECONOMICS IN THE SCHOOL OF ECONOMICS IN
PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD
OF THE DEGREE OF MASTER OF ECONOMICS OF KENYATTA
UNIVERSITY

JUNE 2014
DECLARATION

This project is my original work and has not been presented for a degree in any other University or any other award.

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DEDICATION

This work is dedicated to my little girl Natasha. You are my fountain of joy and pillar of love. I cherish you a lot.
ACKNOWLEDGEMENTS

I would like to express my gratitude and acknowledgements to the following people: My supervisor Dr George Kosimbei for his encouragement and patience when reading my works, his constructive criticism and valuable guidance throughout to make this project what it is now.

Great deals of gratitude especially go to Dr. Njaramba who offered valuable guidance with the benefit of hindsight.

I cannot forget KNBS officials who gave me access to the information I required.
My thanks go to the Masters of Economics class of year 2010 for their wise and pertinent contribution, which will be forever treasured.
Last but not least I thank God. This research would not have been possible without his grace. To him I give glory and honour.
ABSTRACT

In real estate valuation and house market research, house prices and rental value are commonly analysed on comparable based model. The hedonic price model has not been widely applied to study the housing market because of the heterogeneity nature of housing products. Hedonic model examines the effect of characteristics of goods on their prices. This study adopts the hedonic model putting in context the factors that determine the house prices in Kenya. An analysis is done using secondary data collected between 2000-2012 housing research data. The theoretical background and some major empirical as well as the applicability of the model to the housing market are critically reviewed. Previous empirical studies related to housing attributes on property prices are reviewed. The results obtained would enable us to both identify those housing attributes that most influence price and quantify their impact in monetary terms. The resulting model can be used to provide an alternative to traditional valuation techniques and affords greater flexibility in accounting for sustainability in real estate valuation.
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OPERATIONAL DEFINITION OF TERMS

Real estate: Property consisting of land and the buildings on it, along with its natural resources such as crops, minerals, or water; immovable property of this nature; an interest vested in this; (also) an item of real property; (more generally) buildings or housing in general.

Housing: Buildings or other shelters in which people live; they include commercial, residential, industrial and special purpose properties

Hedonic model: This is a revealed preference method of estimating demand or value. It decomposes the item being researched into its constituent characteristics, and obtains estimates of the contributory value of each characteristic

Valuation: It is the process of estimating market value for a specific purpose of a particular interest in property.

Residential property: Property that consists of homes, apartments, townhouses, and condominiums.

Property price: It is the exchange value of a commodity in monetary terms in an arm’s length transaction.
CHAPTER ONE

1.1 Background
The housing sector is associated with the economic health and wealth of a nation. The connection between housing and the economy has always been close. For decades, the housing sector was the channel through which monetary policy influenced the pace of the United States economy (Quigley, 1999). The connection between housing and the economy was amplified in most of the 20th century by the nature of financial products that banks and savings and loan associations could offer (Chui & Chau, 2005).

Housing also constitutes an important component of the real wealth of people who own it. When there is an appreciation of the value of housing, it translates into increases in the real wealth of owners (Salvi, 2007). Thus there is the need to be aware of the value of the real estate concerned.

Various studies including Green (1997), Coulson and Kim (2000), Chau and Zou (2000), Wen (2001), Liu et al. (2002), Leung (2003) among others have established the effects of housing investment on a country’s economic growth. These studies portrays that housing investment may stimulate GDP growth more than other types of investment. In an emphasis (Antonio,2006) also indicates that the real estate accounts for a large share of wealth, about 33% and GDP of about 11% in the United States of America.

In Kenya, real estate forms an integral part of the economy and plays an important role in the development of the country's infrastructure base and is one of the largest generators of economic activity (Nzuve, 2011). The Kenyan real estate sector comprises the residential, commercial, industrial and the agricultural sectors with the residential market constituting the major component in the sector and accounting for almost 40% of Nairobi’s urban land (Hass Consult, 2010). The government of Kenya through the Sessional Paper No. 3 on the National Housing
policy has put mechanisms on means of achieving affordable housing through the regulation of the property prices in the market; it underscores the need for affordable housing for a positive economic growth. The contribution of real estate to Kenya’s GDP has continued to rise with an estimated contribution of between 4.5-5% in 2012 (Statistical Abstract, 2012). This reflects that housing prices not only act as a good measure for reflecting expected real estate demand but also serve as good predictors of economic growth (Knight Frank, 2011).

The movement in both real estate growth and GDP growth portray a positive relationship over time Figure 1.1 looks at the quarterly real estate growth between 2000-2011 compared to the country’s GDP growth within the same period.

![Figure 1: Kenya's Quarterly real estate growth versus the Quarterly GDP growth rate](image)

Although there were some quarters where the relationship between the two variables was inverse, the overall representation is of a direct relationship between real estate growth and GDP growth, house prices increased by 77% between
2003-2012, this compared to the total GDP which grew by almost 150% in real terms within the same period. While the total change in GDP may not wholly be attributed to growth in the housing sector, the housing sector contributes at between 4.5-5% of the total GDP in Kenya.

Movements in real house prices have also been closely correlated with the business cycle. For example, a strong increase in property values was associated with the overheating in the late 1980s in several countries, and is widely considered to have contributed significantly to an unsustainable expansion in demand. Falling property values accompanied recessions in Japan and some European Union countries since the early 1980s. Conversely, the overheating in the late 1980s in the United Kingdom and some of the Nordic countries was associated with sustained growth of inflation-adjusted real estate prices. Statistical correlations of property values and a country’s economy suggest strong links between the two and in particular in the United Kingdom, Canada, Germany, Spain and some of the Nordic countries over the 1970-99 periods. For France, Japan, and Italy the correlation coefficients are significant for the period since 1980 (Hany, 2005).

House prices are therefore an important consideration when assessing macroeconomic and financial developments in an economy (Thwaites and Wood, 2003). The precise estimation of a house price is of importance for all the different agents that form the real estate market: buyers and sellers, owners and investors, builders and resellers, and banks and fiscal authorities. Numerous methods are available to estimate house prices. Pagourtzi et al. (2003) classify these methods into two categories: traditional and advanced. The traditional valuation methods are comparable method, investment/income method, profit method, development/residual method, contractor’s method/cost method, multiple regression method and stepwise regression method. On the other hand, the advanced valuation methods are artificial neural networks, spatial analysis
methods, fuzzy logic and autoregressive integrated moving average. The majority of the methods rely upon some form of comparison to assess market value, and this may be done in its simplest form by direct capital comparison or may rely upon a range of observations that allow determining a regression model.

The hedonic pricing model is used to reveal the implicit prices of various attributes constituting a house price. It is based on the premise that the price/value of a good is determined by the utility that the various attributes of the particular product bears. Malpezzi (2003) describes hedonic modelling as having been applied in every permanently inhabited region of the globe. Indicating the established state of the technique, he concludes that over the past three decades, hedonic estimation has clearly matured from a new technology to become the standard way economists deal with housing heterogeneity (Malpezzi, 2003). Watkins (1998) also notes the dominance of hedonic modelling in the real estate literature. When the property values are regressed on the various housing attributes, the empirical magnitudes of the coefficients of the various attributes constitute the hedonic prices of the various characteristics (Rosen, 1974; Wilhelmsson, 2009). However, the attributes themselves are not explicitly traded, and they tend to vary according to cultural and idiosyncratic factors, the attributes identified in previous studies, mostly in western countries, may not be sufficient in formulating the housing price models. There may be other attributes that are not significant in markets in western countries but significant in another country.

More data and studies are needed to identify these and test their significance. In sum however, investment in housing remains as a single important channels of economic growth reflecting a wave of financial reforms motivated by broader economic efficiency goals.
1.2 Statement of the problem

Several studies have been done on prices for houses and other property (Eleonora & Sharon, 2012, Walden, 1990 Li & Brown; 1980). These studies suggested that real estate prices are not determined by one variable but rather a bundle of attributes. Each house is a composite of goods that possess a myriad of attributes that combine to form bundles of these characteristics (or objectively measurable, utility-affecting attributes), which the consumer values. Models of differentiated product markets also suggest that prices should be a function of product characteristics and that only product characteristics that are valued by the consumer should be included as there is no market for an individual characteristic since it can never be sold separately.

Even with the increased sophistication of real estate investors and the widespread use of modern tools of financial analysis there is lack of a price prediction for housing which can give the market participants more accurate information about residential real estate price levels and deliver products that satisfy the time and cost needs of the financial institutions, while attempting to avoid increased risk. The traditional house price determination models which are based on cost and sale price comparison lacks an accepted standard and a certification process; they are subjective; thus prone to inconsistencies which create inefficiencies and a consistently weak correlation between the predicted prices and the actual transaction prices in the real estate market. The inconsistencies have also led to different values being developed for the same property. Thus the availability of a house price prediction model that would help fill up an important information gap and improve the efficiency of the real estate market may not be overlooked.

The hedonic pricing model could be the alternative to the traditional method of valuation; this method takes into account the composite and the heterogeneous nature of differentiated goods which is generally the nature of the real estate market. Over the last four decades there has been a proliferation of empirical
studies on hedonic pricing that have tried to analyze the residential property prices (Ball, 1973) being the last major study. However no study has demonstrated the potential of the same technique to housing markets in developing countries like Kenya.

This research therefore seeks to fill in the gap by identifying, analysing and modelling with the aim of providing a framework for value estimation using the hedonic model in Kenya. It intends to distil the informational content of individual housing prices so that it can be used to predict housing prices. Finding evidence about this relationship will not only guide estate agents and the valuation professionals, it will also help in improving efficiency in the real estate market in Kenya.

1.3 Research questions
i. What is the relationship between financial-economic factors and house price?
ii. What is the significance of structural and locational attributes to house prices in Kenya?

1.4.1 Objectives of the Study
The general objective of this study is to predict prices in the real estate sector in Kenya using the hedonic pricing model.

1.4.2 Specific Objectives
The specific objectives of this study are:

i. To identify the determinants of housing prices in the Kenyan real estate sector.

ii. To develop a model for estimating housing prices in Kenyan market.

1.5 Significance of the study
By finding empirical evidence about how much each housing characteristic influence property values, it will inform the policy makers on how various
characteristics affect housing values and probably adopt the proper method of imposing the property rates instead of just depending on the cost of replacing the house.

Secondly it will provide players in the market with information about house prices; allowing them to make informed decisions in order to enjoy the best possible returns.

Thirdly, the implicit prices generated have the potential to facilitate decision making by urban planners, valuers and policy-makers about where to locate residential buildings where they would take into consideration the desired housing attributes valued by the prospective buyers. And lastly, the Kenyan vision 2030 aims at achieving adequate and decent housing by increasing the annual production of housing units from the current 35,000 annually to over 200,000; the application of the model will help housing developers provide quality housing as they can better predict buyers’ preferences of attributes.

1.6 Scope of the study

This research limits itself to the urban residential housing units in Nairobi, the study uses data from both the middle and high income residential apartments in Nairobi which include seven of the city's upmarket suburbs: Hurlingham, Kileleshwa, Kilimani, Lavington, Nyali, Riverside and Westlands. The areas were chosen due to the fact that the real estate market is more active and prices have distinct homogeneities.

1.7 Organization of the study

The remaining part of this study is organized as follows; chapter two provides a review of both theoretical and empirical literature on the use of other valuation methods as well as hedonic pricing while chapter three develops the methodology of the study, chapter four is the data analysis and interpretation as chapter five closes with the summary, conclusion and policy recommendations.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction
This chapter contains both theoretical and empirical literature on previous studies, a review of the hedonic modeling and house prices is reviewed with the aim of understanding what the previous studies came up with; methods of valuation are analysed; previous models are also reviewed with the aim of understanding the deeper issues on house pricing. Literature that employs hedonic regression model for real estate valuation is presented.

2.2 Theoretical Literature Review
2.2.1 Housing Valuation Methods
The valuation of real estate provides a quantitative measure of the benefit and liabilities accruing from its ownership. Market value is estimated through the application of valuation methods and procedures that reflect the nature of property and the circumstances under which the given property would most likely trade in the open market (Pagourtzi et al., 2003).

(Pagourtzi et al., 2003) classify these methods into two categories: traditional and advanced. Herein, the traditional valuation methods are comparable method, investment/income method, profit method, development/residual method and contractor’s method/cost method. On the other hand, the advanced valuation methods are Artificial Neural Networks (ANN), hedonic pricing method, spatial analysis methods, fuzzy logic and autoregressive integrated moving average. In this paper, we employ hedonic pricing method in our analysis.
2.2.2 The Cost Approach to Valuation

This approach was developed by the royal institute of surveyors in the early 19th century. The Cost Approach is based on the principle of substitution which asserts that no prudent buyer or investor will pay more for a property than that amount for which the site could be acquired and which improvements that have equal desirability and utility can be constructed without undue delay. It is a method of appraising property based on the depreciated reproduction or replacement cost (new) of improvements plus the market value of the site.

This approach is considered most reliable when used on newer structures but the it tends to become less reliable for older properties due to the greater subjectivity involved in estimating accrued depreciation or replacement costs of the improvements are estimated as if the improvements were new. The estimate is then further adjusted for all elements of accrued depreciation including physical depreciation, functional and/or external obsolescence. In most instances when the cost approach is involved, the overall methodology is a hybrid of the cost and sales comparison approaches. For example, the replacement cost to construct a building can be determined by adding the labor, material, and other costs. On the other hand, land values and depreciation must be derived from an analysis of comparable sales data.

The method is often the only reliable approach when dealing with special use properties (e.g. public assembly, marinas).

2.2.3 The Sales Comparison Approach

This approach is premised on the fact that there is a direct relationship between the market value of the subject property and the prices being paid for comparable and competitive properties within the market. (David et al., 1943).

It determines the value of a property by comparing it to similar properties in the vicinity that have been recently sold along with proper adjustments to various
attributes and amenities. This approach assumes that a prudent individual will pay no more for a property than it would cost to purchase a comparable substitute property. It recognizes that a typical buyer will compare asking prices and seek to purchase the property that meets his or her wants and needs for the lowest cost. In developing the sales comparison approach, the appraiser attempts to interpret and measure the actions of parties involved in the marketplace including buyers, sellers and investors.

2.2.4 Income Approach

The income approach values properties based on the income that they produce (Rees, 1949) typically; the analysis starts with calculating a net operating income for the property that takes its rent and its operating expenses into account. Next a capitalization rate is chosen which is an income multiplier. The cap rate is usually derived from comparable sales data. The price gets calculated by dividing the NOI by the cap rate.

\[ P = \frac{\text{NOI}}{\text{Cap rate}} \]  \hspace{1cm} (2.1)

2.2.5 The Hedonic Price Model

Majority of all the methods above used in valuation rely upon some form of comparison to assess market value. The hedonic price model posits that goods are typically sold as a package of inherent attributes (Rosen, 1974). Therefore, the relative price of a house is then the summation of all its marginal or implicit prices estimated through the regression analysis. Rosen (1974) attributes the bid price as the maximum amount of money which a consumer would be willing to pay for a good under the condition that he or she retains a specific level of happiness or utility. He states the offer function as a determinant of the minimum value of price which a producer should accept to sell a good for a certain profit.
The application of the hedonic price model to the housing market rests on two key assumptions. First, homogeneity of the housing product and second the market operates under perfect competition where there are numerous buyers and sellers.

The hedonic model determines how the price of a unit of commodity varies with the set of attributes it possesses. It focuses on the utility derived from individual characteristics of a house (Rosen, 1974). Empirically, the technique uses regression analysis to explain the variation in market values using property characteristics (Goodman and Thibodeau, 1995). If the prices of these attributes are known, or can be estimated, and the attribute composition of a particular differentiated good is also known, hedonic methodology will provide a framework for value estimation (Ustaoglu, 2003).

The key advantage of the general hedonic formulation, and the reason why it is used is that it provides direct estimates of pure price changes (house price inflation) and can in principle control for housing characteristics, change in the composition of the mean index and quality of houses sold (Hansen, 2006).

However, a major empirical issue pertaining to the hedonic price model is the choice of the functional form. There are several basic functional forms such as linear, semi-log, and log-log forms that can be applied to the hedonic price model. An incorrect choice of functional form may result in inconsistent estimates (Bloomquist & Worley, 1981). The most common functional form recommended in the hedonic literature is the semi-logarithmic form. This form is preferred because it fits the data particularly well and because the coefficient estimates generated from the model can be interpreted as being the proportion of a good’s price that is directly attributable to the respective characteristics of that good.

2.3 Empirical Literature Review

Sibel (2008) used the semi-logarithmic form to study house determinants in Turkey. He expressed his model as:
\[ \ln P = \beta x + \epsilon \]  
(2.2)

The results of his study revealed that prices of houses that are between 5-10 years of age are less than those that are 0-5 years of age by 8% and 12% respectively for the full sample and rural areas. Prices of the other types of building are less than those of the base category (Ferro concrete) in a range of 8.33% to 29.24%. Level of the floor and living room floor variables are insignificant in rural area. Ground floor types negatively affect the house prices compared to the parquet in the urban area. His results also indicate that most of the other structural characteristics have a significant and positive effect on the house prices. The effect changes between 14%-156%.

Goodman (1991) typically classified housing attributes into locational attributes (L), structural attributes (S), and neighbourhood attributes (N) which encompass both quantitative and qualitative attributes.

He expressed house price as a function of the three major attributes as:

\[ P = f(L, S, N) \]  
(2.3)

The partial derivative of the function with respect to each attribute is the implicit marginal attribute price.

\[ \frac{\partial p}{\partial L} = P_L, \quad \frac{\partial p}{\partial S} = P_S, \quad \frac{\partial p}{\partial N} = P_N \]  
(2.4)

Therefore it follows that:

\[ P_h = P_L + P_S + P_N \]  
(2.5)

His study concludes that locational is the most crucial attribute in predicting property prices; however he fails to write off other two attributes as non-essential but rather recommends a further research on their composite role in house pricing.
(Ball 1973, Kohlhase, 1991) notes that structural attributes are also key in property valuation.

Leong (2002) predicted the house price in Penang using a sample comprised of 120 records of sales transacted for the year 1998 and 1999. He expressed his model of price as a function of floor area, shop, school and a dummy facility.

\[
\ln(\text{PRICE}) = \alpha_0 + \alpha_1 AFA + \alpha_2 FL + \alpha_3 DCBD + \alpha_4 SHOP + \alpha_5 SCH
+ \alpha_6 FAC + \varepsilon \quad (2.6)
\]

All the factors were statistically significant in determining house prices, however the size and magnitude was different. The value of the adjusted R2 (0.75) indicating that the condominium units were very homogenous, which is a desirable characteristic for the application of hedonic price models.

Richard’s (2002) found out that

\[
P = f(F^+, B^+, G^+, SQ^+) \quad (2.7)
\]

Meaning, the real sales price P of a house is a positive function of the number of fireplaces(F), bedrooms(B), stories in structure(G), and the number of square feet of finished living space in the house(SQ). In addition, the presence of a pool or hot-tub, a deck, a private courtyard, or an underground sprinkling system adds to the sales price.

Joachim (2007) found out that the regression coefficients of some variables behave differently across different house price levels. Buyers of higher-priced homes appear to price certain housing characteristics differently from buyers of lower-priced homes.

His hedonic model took the form:

\[
\ln sP = \alpha + \sum B_t X_t - x + \varepsilon \quad (2.8)
\]
Where Ln sP is the selling price expressed in log form, Bi is the regression coefficient for the ith housing characteristic.

He concluded that locality L was the most influential factor in price that explained 50.3% and 63% of price variation for 2000 and 2007 in Florida. The proportion reflected the perceived importance of location to the buyers in the ‘price’ that they paid for the house.

Quigley analyzing the US housing market argued that

\[ P_t = f(Y, X) \]  

(2.10)

Where Y represents the resident’s income and X represents a vector of the exogenous variables.

His model takes the form:

\[ P_{it} = f(P_{i,t-1}) \]  

(2.11)

He analysed the relationship as

\[ (P_{i,t-1}) = f((POP_{it}, INC_{it}, EMP_{it}, CONSE_{it}, VACANCY_{it}, L[P_{it}]) \]  

(2.12)

This indicates that housing prices are solely on the basis of past prices. Prices today are closely related to prices last year. The strong autocorrelation in prices and price changes is consistent with prior research (for example; Case and Shiller, 1989).

Wen Hai(2001) while studying the Hangzhou housing market found out that R square of the model was 0.852, adjusted R\(^2\) was 0.851, the D-W (Durbin-Watson) value was 1.991, all which indicated the fitness of the model was high. The F value was 787.431 and the p-value was 0.000, which indicated that the fitness of samples data to the model was meaningful statistically and that the regression equation was effective.
2.4 Critical Review

By examining hedonic pricing models for most empirical studies, the studies disagree on both the magnitude and direction of the effect of certain characteristics. This can be based on the fact that housing prices may not be correlated for a number of reasons. The factors that determine a house's value may vary from locale to locale, so that the absolute position of a house determines which factors come into play, and to what extent they affect the price.

Houses that share many of the same size and structural characteristics are also commonly built in a single area so that while there isn't causality, there is correlation in the characteristics that determine prices. Likewise, the values of the houses themselves may be auto correlated so that high-value homes are built together in a single area while low value homes are built in another. In this case there would also be network effects amongst house values so that the value of one home is changed simply because it is situated next to another home whose value has changed.

It should be that incorporating the additional information provided by the absolute and relative positions of the data in a hedonic housing price model increases the accuracy of the out-of-sample predictions of the model. Estimating the market values of houses that haven't sold yet, that is, for an appraisal, is an important function of hedonic models. Improving out-of-sample prediction is central to this endeavour.

Although it is accepted that housing characteristics are not constant over space, the coefficients for hedonic models are dependent on the absolute position of the point in space at which they are being estimated. There have been a variety of approaches to controlling for this heterogeneity, usually using dummy variables to estimate a price surface. The issue which has not been clear is how to define the areas that the captured correlations are maximized. Empirical applications of the hedonic price model rarely involve rigorous specification testing. Econometric
methodologies could be employed to construct a model that the relative significance of various characteristics are defined and their influence on price levels from one time to another, or between one region and another are allowed for simultaneously. Once the exact mathematical relationship between the house price and the house attributes is determined, it should be possible to derive the market price of a house.

In order to capture price variations in the individual attributes, it is important that a hedonic function derived from Multiple Regression Analysis is used to enable the estimation of changes in average price from one time period to another. The output of the regression will provide information on how much a change in a property attribute would affect the price of a property and estimate the predictive capability of pricing model incorporating these factors. These have been missing in most of the studies reviewed.

A crucial and an important variable that is related to housing and one which none of the studies have featured in order to capture the effect of house price movement are the financial and economic indicators such as per capita income, unemployment rate, interest rates and durable goods inflation rate which perhaps would create a more clear picture of the housing market. Per capita income represents the average household income while unemployment rate indicates the ability to generate income and Consumer Price Index for durable goods provides a general inflation rate of other durable goods. Financial indicators such as total loans to housing, and average lending rate that indicate availability and cost of housing mortgage loan respectively; should have been used to show the substitution effect of different investment options.

However a major empirical issue pertaining to the hedonic price model is the choice of the functional form. Although there are several basic functional forms such as linear, semi-log, and log-log forms that can be applied to the hedonic price model. Different studies have used different choices of hedonic model and
thus a clear uniform model has not been identified as the most suitable. Despite having a long history, the theory of hedonic pricing provides very little guidance on the choice of the proper functional form.
CHAPTER THREE
METHODOLOGY

3.1 Introduction
This chapter highlights the methodology used in the analysis of the research. It identifies the model for use in the analysis and the sampling frame.

3.2 Research Design
In order to obtain the necessary data, the study adopted a non-experimental research design. The selection of the design was attributed to various reasons. First, it would facilitate the collection of necessary data needed to realize the research objectives. Secondly, it is also appropriate in collecting useful data that could be quantified and reported as a representation of the real situation. The target population was the middle income residential housing in Nairobi identified through stratified sampling. The study also used time series date collected between 2000-2012.

3.3 Theoretical Framework

3.3.1 Hedonic pricing model
The study adopts Rosen’s (1974) equilibrium model of market supply and demand based on product characteristics in a competitive economy.

\[ P = \sum_{i=1}^{n} x_i \] \hspace{1cm} (3.1)

Where \( P \) is the price and \( x_i \) are implicit prices of inherent attributes.

Under general regularity conditions, the model assumes, a specific functional relationship exists between the characteristics \((x_1, \ldots, x_n)\) and the price \( P \) of a differentiated good. In other words,

\[ P = f(x_1, \ldots, x_n) \] \hspace{1cm} (3.2)
A consumer with fixed income $M$ and consuming vector $X$ of different attributes and a composite good $Y$ will have his preference represented by the utility function

$$U = u(x, y)$$

Thus

$$\text{Max } u(x, y)$$

subject to

$$M = P(X) + Y$$

Subject to this relation and a standard budget constraint, maximization of utility gives rise to a hedonic function relating the price of a property to the characteristics embodied in it. The marginal price of an additional unit of a given characteristic $x_i$ will be given by:

$$Dp_x = \frac{\partial P}{\partial x_i}$$

The model for the hedonic price function for $X$ attributes hypothesized to contribute to the price of a house will be specified as

$$P = \alpha_0 + \alpha_1 S + \alpha_2 F + \alpha_3 E + \alpha_4 N + \alpha_5 L$$

This represents the hedonic function relationship of the property price $P$ and a vector of structural($S$), financial ($F$), economic ($E$), neighborhood ($N$) and locational ($L$) characteristics.

Thus the hedonic function/model can therefore be expressed as:

$$P = f(A_t, L_t, N_t, Q_t)$$
Collapsing the vectors $A$, $L$, $N$ and $Q$ into a larger vector $X$ for notational convenience, and adopting a common semi-logarithmic functional form, we rewrite compactly as:

$$ P = e^{X p e} $$

so that

$$ \ln P = X \beta + \epsilon $$

we therefore estimate:

$$ \ln P = X b + \epsilon $$

Where $\beta$ and $\epsilon$ are the unknown true parameters and $b$ and $e$ are actual estimates.

A consumer will therefore maximize his utility given by the function

$$ \text{Max } U = U(x_1 x_2 \ldots x_n) $$

s.t

$$ p_1 x_1 + p_2 x_2 + \ldots + p_n x_n \leq Y, I $$

where $Y$ and $I$ represent income and investment respectively

However the consumer's willingness to pay will depend on his income and taste which determines her preference for given combination of characteristics.

$$ P = f(Y, T) $$

where $T = f(x_1, x_2, \ldots x_n)$

The price-attribute relationship is identified through the exchange between the buyers and sellers. The transaction resulting from supply and demand interactions could be used to generate data on prices and characteristics or the marginal value
of a characteristic which is the partial derivative of the price equation with respect to a particular characteristic.

The theory of hedonic price functions provides a framework for the analysis of differentiated goods. It has been utilized extensively in the housing market literature to investigate the relationship between house prices and housing characteristics. (Can, 1992; Sheppard, 1999). Unlike other models, it enables the decomposition of the transaction price into various components and traits that affect the price from which the relative contribution (significance and magnitude of effect) of any given house attribute can be estimated. This helps to estimate house values based on actual choices.

The approach has also been recommended by various studies (Lillydahl & Singell, 1978; Cropper et al; 1988 Chau et al 2001; Hulten, 2003) for use in adjusting for the problems associated with researching a good that is as heterogeneous as buildings. Because buildings are so different, it is difficult to estimate the demand for buildings generically. Instead, it is assumed that a house can be decomposed into characteristics.

### 3.4 Model specification

From equation 3.11 the model will be presented as:

\[
\ln P = \beta x + \epsilon \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.15)
\]

Here, \( P \) House prices, \( \beta \) coefficient matrix, \( x \) set of independent variables and \( \epsilon \), error term.

Transforming equation 3.15 to take the form:

\[
\ln HP = a + b_1x_1 + b_2x_2 + b_3x_3 + \cdots b_nx_n + \epsilon \ldots \ldots (3.16)
\]

Where; the log of house price is a function of locational, structural, financial and economic factors for the \( i^{th} \) houses. The intercept ‘\( a \)’ represents that portion of
house price variation for each house that may be attributed to the overall level of house price. The coefficients $b_1$ to $b_n$ change over time. Any unexplained variation is captured by the random error $\varepsilon$.

The actual model will therefore be:

$$\log HP = a + b_1 \text{INF} + b_2 \text{DIST} + b_3 \text{INT} + b_4 \text{NOB} + b_5 \text{AGE} + b_6 \text{AVI}$$
$$+ b_7 \text{FAC} + \varepsilon \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldotted{3.17}
Table 3.1 Definition of variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>INF</td>
<td>Inflation</td>
<td>Growth of CPI</td>
</tr>
<tr>
<td>DIST</td>
<td>Distance</td>
<td>Kilometres</td>
</tr>
<tr>
<td>INT</td>
<td>Interest</td>
<td>Market rate of interest</td>
</tr>
<tr>
<td>NOB</td>
<td>Average number of bedrooms</td>
<td>Number of bedrooms per house</td>
</tr>
<tr>
<td>AGE</td>
<td>Average age of the houses in years</td>
<td>Years</td>
</tr>
<tr>
<td>AVI</td>
<td>Income</td>
<td>Kshs</td>
</tr>
<tr>
<td>FAC</td>
<td>Dummy</td>
<td>1 or 0</td>
</tr>
</tbody>
</table>

3.5 Area of Study

First, the research will narrow the dataset down to a particular income group; namely the middle income residential housing which included Kilimani, Lavington, Riverside, Westlands, South B, Hurlingham, Kileleshwa, Amboseli, Lang'ata, Highridge and Parklands. The research will overlook other income bracket estates namely the low income and the high income as they are likely to throw off the results of the regression modeling. Foreclosure sales will also not be included. While foreclosures are a significant portion of the real estate market,
most of the sales are below the market determined value and may not accurately represent the average consumer's purchasing decisions and as such are likely to potentially skew the results of the analysis.

3.6 Data Types and Sources
This study used Kenyan quarterly data from 2000 to 2012. The data for House prices was obtained from a property index obtained from Hass Consult a real estate company based in Nairobi, average income data was sourced from Kenya National Bureau of Statistics (KNBS) economic surveys, and CBK publications. Interest rate data was sourced from Central Bank of Kenya.

3.7 Data Analysis
The study addressed its main objective which was to obtain the value of the various coefficients for the various attributes.

The data collected was analysed using the relevant econometric software. Diagnostic tests using the Augmented-Dicker fuller test and unit root tests was conducted for refinement of the data collected. Further the variance inflation factor (VIF) was used to detect multicollinearity.

After estimation of the model, all the relevant diagnostic tests were conducted to ascertain the econometric validity of the estimated model presented.

3.8 Diagnostic tests
Before analysing of data, various diagnostic tests were conducted on the data series to ensure that time series properties were not violated. After estimation of the model, all the relevant diagnostic tests to ascertain the econometric validity of the estimated model were carried out and presented. Unit root and cointegration tests were performed before estimating the error correction model.
CHAPTER FOUR
DATA ANALYSIS AND INTERPRETATION

4.1 Introduction
In this section, data analysis and interpretation is presented.

4.2 Descriptive statistics
The dataset used for the study comprises of quarterly residential property values in Nairobi’s middle income estates which are Hurlingham, Kileleshwa, Kilimani, Lavington, Nyali, Riverside and Westlands from the year 2000 to the year 2011, a total of 11 years. The property value data is obtained from opinions formed by professional real estate valuers.

Seven characteristic variables are included in the hedonic model. The means and standard deviations of these variables are presented in Table 3.1

Table 4.1 summary of descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRICE</td>
<td>8,245,000</td>
<td>14,000,000</td>
<td>5,000,000</td>
<td>1,976,654</td>
</tr>
<tr>
<td>Ln Price</td>
<td>15.925</td>
<td>16.706</td>
<td>14.914</td>
<td>0.483</td>
</tr>
<tr>
<td>DCBD</td>
<td>6.5</td>
<td>12</td>
<td>3</td>
<td>1.823</td>
</tr>
<tr>
<td>INFL</td>
<td>5.86</td>
<td>13.0</td>
<td>0.4</td>
<td>2.833</td>
</tr>
<tr>
<td>INT</td>
<td>15.9</td>
<td>25.39</td>
<td>12.12</td>
<td>3.25</td>
</tr>
<tr>
<td>NOB</td>
<td>3.8</td>
<td>5</td>
<td>1</td>
<td>0.71</td>
</tr>
<tr>
<td>AVI</td>
<td>176504</td>
<td>287,000</td>
<td>116,800</td>
<td>61839</td>
</tr>
<tr>
<td>AGE</td>
<td>8.12</td>
<td>11</td>
<td>&lt;1</td>
<td>1.703</td>
</tr>
<tr>
<td>FAC</td>
<td>0.61</td>
<td>1</td>
<td>0</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Table 4.1 above presents the descriptive analysis of the variables used in the regression model. The average price over the period is around Kshs 8.2 million. The standard deviation is around 39.5% of the average price, suggesting that
property values are not so volatile in the city. The lowest transaction price over
the period is as low as Kshs 5,000,000 and the highest transaction price (the most
expensive house) over the period is around Kshs 14,000,000. Each house
transacted over the period has an average of 3.8 numbers of bedrooms. The
houses with the lowest and highest number of bedrooms have 1 and 5 rooms
respectively. The average of distance from CBD, age, interest rate and inflation
are 6.5, 8.12, 15.9 and 5.86 respectively.

4.3 Unit root test

Table 4.2 Unit root tests

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>ADF TEST STATISTIC</th>
<th>ADF CRITICAL VALUES</th>
<th>PHILLIP PERRON STATISTIC</th>
<th>PP CRITICAL VALUES</th>
<th>CONCLUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG P</td>
<td>-3.730652</td>
<td>*** =1%</td>
<td>-4.083437</td>
<td>*** =1%</td>
<td>Stationary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>** =5%</td>
<td></td>
<td>** =5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* =10%</td>
<td></td>
<td>* =10%</td>
<td></td>
</tr>
<tr>
<td>AGE</td>
<td>-13.28807</td>
<td>*** =1%</td>
<td>-13.28807</td>
<td>*** =1%</td>
<td>Stationary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>** =5%</td>
<td></td>
<td>** =5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* =10%</td>
<td></td>
<td>* =10%</td>
<td></td>
</tr>
<tr>
<td>AVI</td>
<td>-4.131973</td>
<td>*** =1%</td>
<td>-8.080165</td>
<td>*** =1%</td>
<td>Stationary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>** =5%</td>
<td></td>
<td>** =5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* =10%</td>
<td></td>
<td>* =10%</td>
<td></td>
</tr>
<tr>
<td>DCBD</td>
<td>-8.785444</td>
<td>*** =1%</td>
<td>-8.785444</td>
<td>*** =1%</td>
<td>Stationary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>** =5%</td>
<td></td>
<td>** =5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* =10%</td>
<td></td>
<td>* =10%</td>
<td></td>
</tr>
<tr>
<td>INF</td>
<td>-6.691313</td>
<td>*** =1%</td>
<td>-6.691313</td>
<td>*** =1%</td>
<td>Stationary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>** =5%</td>
<td></td>
<td>** =5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* =10%</td>
<td></td>
<td>* =10%</td>
<td></td>
</tr>
<tr>
<td>INT</td>
<td>-4.853885</td>
<td>*** =1%</td>
<td>-4.853885</td>
<td>*** =1%</td>
<td>Stationary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>** =5%</td>
<td></td>
<td>** =5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* =10%</td>
<td></td>
<td>* =10%</td>
<td></td>
</tr>
<tr>
<td>NOB</td>
<td>-9.674451</td>
<td>*** =1%</td>
<td>-9.674451</td>
<td>*** =1%</td>
<td>Stationary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>** =5%</td>
<td></td>
<td>** =5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* =10%</td>
<td></td>
<td>* =10%</td>
<td></td>
</tr>
</tbody>
</table>
All the variables were stationary at first difference as shown in the table above.

4.4 Heteroskedasticity test
Heteroskedasticity has long been recognized as a potential problem in hedonic house price equations. The semi-log has been used to reduce the occurrence of heteroskedasticity and also allow for interdependence among variables. The standard errors have been corrected by using the White’s (1980) heteroskedasticity consistent coefficient covariance matrix.

Table 4.3 Heteroskedasticity test

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>Probability</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.448914</td>
<td>0.000020</td>
<td></td>
</tr>
<tr>
<td>Obs*R-squared</td>
<td>33.84422</td>
<td>0.001271</td>
</tr>
</tbody>
</table>

Due to the nature of the study, unequal variances among the variables is expected and heteroskedasticity has been encountered considering the F-statistic value of 5.45 with a p-value of 0.00002 meaning that we reject the null hypothesis at 5% significant level.

4.5 Testing for normally distributed errors
The regression run the Jarque-Bera test for normality. The p-value is 0.154; indicating that the errors are normally distributed at 5% significance level.

To test for the joint significance of the variables, a Wald test is conducted;

Table 4.4 Joint significance of variables

<table>
<thead>
<tr>
<th>F-statistic</th>
<th>Probability</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>5945.592</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>Chi-square</td>
<td>41619.14</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

The resulting p-value of 0.0000 implies that the null hypothesis is rejected and conclude that the variables do have a jointly a significant effect on our dependent variable.
We however fail to reject the null hypothesis that a unit root is present at 1% significance level but reject the null hypothesis that a unit root is present at 5% and 10% significance level.

4.6 Test on auto correlation
A test on first order auto correlation of the error terms, using the ARCH Test

<table>
<thead>
<tr>
<th>Table 4.5 Test on auto correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-Statistic</td>
</tr>
<tr>
<td>Obs*R-squared</td>
</tr>
</tbody>
</table>

The results indicate little or no presence of serial correlation considering a probability of 0.000209.

4.7 Empirical results
Regressing the dependent variable against the independent variables we obtain:

<table>
<thead>
<tr>
<th>Table 4.6 Empirical results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>AGE</td>
</tr>
<tr>
<td>AVI</td>
</tr>
<tr>
<td>DCBD</td>
</tr>
<tr>
<td>FAC</td>
</tr>
<tr>
<td>INF</td>
</tr>
<tr>
<td>INT</td>
</tr>
<tr>
<td>NOB</td>
</tr>
<tr>
<td>R-squared</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
</tr>
<tr>
<td>S.E. of regression</td>
</tr>
<tr>
<td>Log likelihood</td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
</tr>
<tr>
<td>Sum squared resid</td>
</tr>
</tbody>
</table>
The F value is 101.2581 with a p-value of 0.000; indicate that the fitness of samples data to the model is meaningful statistically and that the regression equation is effective. The regression shows the significance effect the independent variables on the dependent variable; thus the null hypothesis is rejected. The Durbin Watson value of 1.8724 depicts non-serial autocorrelation.

Evaluating the model, the semi-log provides the best fit with the highest $R^2$ statistics of 99.02%. This corroborates several previous studies (Selim, 2008; Ajide and Alabi, 2010). Both the explanatory and predictive performance of the model is good as indicated by $R^2$ and adjusted $R^2$ statistics of 99.02% and 98.87% respectively. The R-squared ($R^2$) of (0.990252) reveals that about 99% of the total variation in the dependent variable ($ln P$) is explained by the regression equation while the remaining 1% is captured by the error term ($\mu$).

Most of the variables are highly significant, and sign of the coefficients are consistent with the expectations; Interest (-0.058157) with a negative sign which indicates that the theoretical statement is true such that higher interest rates have a negative effect on the price. By implication, this means that for every one unit increase in interest rate leads 5.8% reduction in the price *ceteris paribus*. In addition, the distance from the CBD has a negative effect on the price of a house, the longer the distance from the CBD the lower the price of a house and vice versa. Thus a unit increase in the DCBD causes a 0.84% unit reduction in the price of a house. Inflation rates and the age of a building have the same effect on the price of a house as interest and DCBD. As the age of the property increases *ceteris paribus*, the value of the property reduces. This is not surprising because as the age of the property increases, the economic value of the property decreases and hence the utility to be derived from the property decreases. Furthermore, homebuyers would have to spend additional money on maintenance when properties are old. They are therefore willing to pay a price lower than a new property of similar but new attributes. The average income has a positive effect on
price meaning that a rise in average income has an upward effect on the house price. This is due to the increase in demand for houses due to the extra income. However due to fixity nature of the real estate, supply may not rise rapidly as the income rises thus pushing the price upwards. The presence of a gym, swimming pool or a sauna has a positive impact on house price. This indicated by the positive sign of the dummy facility in the regression equation.

Based on model, the real sales price (expressed in natural log form) of houses in the middle income category in Nairobi is a positive function average income, number of bedrooms and the facilities such as the gym and the swimming pool and a negative function of age, interest rates, inflation and distance from the central business district.
CHAPTER FIVE
SUMMARY CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Introduction
This chapter comprises of the summary, conclusions and policy recommendations arising out of the section on data analysis.

5.2 Summary and Conclusions
The study sought to predict housing prices in Nairobi’s middle income housing estate using the hedonic model and the significance of the various attributes in the forecast. House prices are important economic indicators and hence hedonic price modelling should produce accurate, robust and reliable results for analysis. The prediction was carried out using the multiple regression analysis using seven key variables which include age, distance from CBD, interest rates, inflation, number of bedrooms, average income and a dummy variable. Overall, the hedonic model explains approximately 94% of the total variation in residential property values over the thirteen-year period, using the entire dataset. The estimated hedonic price model also showed that coefficients of the included attributes were significant and of the expected sign. Examining the variations in the price of houses, it is found that, age, interest rate, inflation and distance from the CBD cause variation in house pricing. The real sales price of a house in Nairobi over the 2000-2012 period was positively impacted by income, number of bedrooms, presence of either a gym, sauna or a swimming pool. The price was also found to be negatively impacted by age of the building, distance from the central business district, inflation and interest rates. The higher the average income, the higher the house prices under the presumption that this increases both the savings and investment part of which leads to increased demand thus pushing up prices. In addition, houses built with several bedrooms have higher prices.
It is apparent that in spite of some inherent limitations, the hedonic price model still holds promise as a very useful tool in the study of housing attributes and their impact on property prices. To date, this approach has not being utilized directly and formally by researchers in Nairobi. Perhaps the time has come for this technique to be given serious attention by researchers and all stakeholders in the housing industry. The feasibility of applying the hedonic price model to the study of the housing market in Kenya is justifiable, as buyers and sellers have perfect information on the property market. The properties too, manifest the characteristic of homogeneity. Hence, the implicit prices for attributes can be established and this information can be used to improve the planning, development, construction and management of properties in Nairobi.

The abundant studies that have employed the hedonic price model tend to indicate that values of houses are positively and negatively correlated with desirable and undesirable characteristics. This generally applies to all buyers. However, the attributes preferred may not necessarily be identical because of cultural and idiosyncratic factors.

This review and the empirical example demonstrate that the hedonic price approach is particularly useful for research studies on the housing market in Kenya because properties have proliferated in the last decade, partly due to high land costs and scarcity of developable land. The hedonic price model could be used to investigate if buyers favor the current development in the property sector. The implicit prices generated from the regression analysis will help give a more accurate portrayal of the price of houses traded in the market.

The hedonic price analysis is also very useful in that the implicit prices generated have the potential to facilitate decision making by urban planners and policymakers about where to locate residential buildings, commercial buildings, and so on. It is imperative that planning should take into consideration the desired housing attributes valued by the prospective buyers. Thus, the application of the
model will help housing developers provide quality housing as they can better predict buyers’ preferences of attributes. Buildings having attributes that align with buyers’ needs and preferences will improve the reputation, image and profit margin of the developers besides enhancing customer satisfaction.

Regardless of the planning uses, buyers prefer houses that are close to the CBD, this is due to the ease of accessibility to their working areas. The government should pursue the need for improved transportation and infrastructure system; this would encourage the purchase of houses further away from the CBD thus opening up the suburbs.

Interest rates significantly affect the cost of financing and mortgage rates, which in turn affects property-level costs and thus influences values. The government should focus more toward managing interest rates as a way to stimulate the economy or stave off inflation; this policy would have had a direct effect on the property values.

5.3 Policy Recommendations

The hedonic price portrays itself as a very useful tool in the study of housing attributes and their impact on property prices. Although the approach has not been utilized directly and formally by researchers in Kenya, it’s important that this technique is given attention by researchers and all stakeholders in the housing industry. The feasibility of applying the hedonic price model to the study of the housing market in Kenya is justifiable, as buyers and sellers have perfect information on the property market. The property sub markets too manifest the characteristic of homogeneity. Hence, the implicit prices for attributes can be established and this information can be used to improve the planning, development, construction, and management of properties in Kenya.

The prediction potentials by use of hedonic model need to be harnessed in Kenya by researchers and practitioners. Valuers must not be isolated from ongoing paradigm shifts in valuation practice standards driven by factors such as globalization, developments in information technology and market dynamics.
Hedonic modelling as a method of valuation must be adopted to keep in line with global standards. The Institution of surveyors of Kenya should play a key role to enlighten its members of the "modern" method of valuation away from the norm.

There is also a vast need to invest on property research in order to draw up the utility maximizing factors that are consumed by house buyers. The research findings on utility maximizing attributes emerging from the hedonic literature need to be published into official statistics. This would help in setting a standard house pricing policy reducing chances of inaccurate predictive mechanism that has led to exaggerated prices within the property industry. The accurateness of the measure is important for efficient operation (profitability) and risk management as bank and credit institutions depend on predicted prices to award mortgages and loans.

Finally, this study results in some general implications for policy makers, mortgage lenders, appraisers. The hedonic model produces meaningful and reliable estimates which are highly suitable to inform about local housing conditions. The spatial diversity of the coefficients is of utmost importance for locally acting decision -makers, requiring explicit knowledge of the local or regional housing market. This serves to refine housing policies and gain deeper understanding about local house price anomalies. Thus, it recommends that this model should occupy a more central role in practitioner s' toolboxes and methodologies

5.4 Areas of further studies

The housing market is heterogeneous with different sub markets. The scope of this study concentrated on the middle income residential estate. The prediction of prices on the high end market needs to be put in perspective and needs further study.
The function form needs further optimization. The paper adopted the semi-log linear function form and obtained the hedonic price from the model coefficients directly. Further research can be extended using the double log and linear function to find out which is most suitable functional form in hedonic pricing.
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