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A Hedonic Approach to Residential Rent Pricing in Kenya

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Abstract
Rapid urbanization has posed housing challenges in terms of affordable housing. The government and private sector are keen on this market albeit from a social and business standpoint, respectively. Physical characteristics, locational attributes, household characteristics and macro variables such as population may affect rent price. This paper seeks to provide empirical evidence of rent pricing in the Kenyan market using hedonic model. This is motivated by lack of an official rent index in Kenya and limited research in this area. The findings of the paper may be useful to property developers, investors and real estate regulators. It may also guide government in social housing policy and other interventions in the broader housing market.

Keywords: Hedonic model, Rent price

Introduction

The residential housing market is the largest segment of the real estate market. Rapid urbanization has continued to pose housing challenges in terms of affordable housing (Mwangi, 1997; KIPPRA, 2012). The government and private sector are keen on this market albeit for varied reasons. The government is leading the affordable housing agenda for socioeconomic benefits. The private sector's play in the residential market is for profit. There are several factors that may influence rent values. This may include house characteristics such as size, number of rooms, house type, presence of basements, number of bathrooms, house type etc. Besides, locational attributes such as distance to the city centre, shopping malls, schools and scenic views may drive rent price. Also, macro variables such as population, economic growth, and household income among others can affect rent price.

The Hedonic pricing model anchors the relationship between house attributes and rent. Hedonic model has its origin in Lancaster (1966) and further developed by Kain and Quigley (1970). The thrust of this model is the assumption that investors buy certain characteristics in a house. Therefore, these characteristics must be priced individually before getting the aggregate figures of the property. As such, the rent price is the aggregate of the prices of individual property attributes.

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As Sirmans, Macpherson and Zietz (2005) pointed out, the results of hedonic pricing are location specific therefore constraining generalization in other contexts. Some studies show positive effect of number of bedrooms on rent (Zisheng, Mats and Zan, 2020; Hoffmann and Kurz, 2002) while others no effect (Darfo-Oduro, 2020; Rezaeian, Asgari, & Heshmatolah, 2019). There are also mixed findings on the building age. Age exhibits negative effects (Malpezzi, Ozanne &Thibodeau, 1987; Guerrero, 2023). However, Darfo-Oduro (2020) found no effect. The effect of location on rent is mixed due to specification problems and context specific matters. In relation to house type, Rezaeian, Asgari, and Heshmatolah (2019) did not find any effect whereas other studies reported significant effects (Zisheng, Mats and Zan, 2020; Hoffmann and Kurz, 2002). Belete and Yilma (2020) reported that number of baths, parking and floor level did not have any effect on house rent contrary to other studies.

The importance of housing in any society cannot be discounted. The need for affordable housing is crucial. Therefore, understanding how rent is priced is welcome. There are hardly studies in Kenya that have focused on rent pricing. This has motivated this paper as it seeks to obtain empirical evidence from Nairobi the capital city of Kenya.

Literature Review

The study is anchored on the hedonic pricing model. The hedonic models were first developed by Lancaster (1966) and thereafter Kain and Quigley (1970) were the pioneers in applying to real estate. The model employs cross-sectional regression analysis using property characteristics as independent variables. The identified characteristics include size of the house, location, number of rooms, amenities available, age, parking, green space, construction type etc. The weakness of hedonic model is in the model specification due to potentially many variables involved. This includes both observed and unobserved variables. Repeat sales model is an alternative model which can be used to develop indices with fewer variable requirements. However, repeat sales model picks only those houses that have been sold more than once hence suffering bidirectional price biases. It also requires robust data tracking repeat sales which is a challenge, especially in Kenya.

Sirmans, Macpherson and Zietz (2005) reviewed several studies that used hedonic model in pricing houses. Age was found to have negative effect on prices in 80% of the studies. Size of the house measured by square feet always had positive effect on prices. Half of the reviewed studies indicate that number of bedrooms positively affected prices. The next quarter of those studies reported negative effect while the remaining quarter indicated insignificant effect on house prices. The effect of distance from the city centre on house prices was varied. The study findings spread uniformly among those that reported positive, negative and no effect. Besides, 75% of the studies found that presence of basement had positive effect on prices while 25% showed no significant effect on prices. The foregoing demonstrates varied findings and therefore room for further studies. This paper leverages on this with application on rent pricing as opposed to house price.

Zisheng, Mats and Zan (2020) analysed Beijing market in China. They find size and number of bedrooms and house type have significant effect on house rent. Hoffmann and Kurz (2002) studied West Germany for the period 1985 to 1998. Their finds are like those of Zisheng, Mats and Zan (2020). Rezaeian, Asgari and Heshmatolah (2019) studied Ilam city in Iran. They modelled the housing rent using hedonic model. Physical variables, neighbourhood variables and access variables significantly affected rent. Interestingly, rooms and house type were reported not to have significant influence on rent prices.

Malpezzi, Ozanne and Thibodeau (1987) studied the US market. They found that the number of rooms, bathrooms, garage, and neighbourhood have positive effects on rent. However, age of the house, persons per room and length of tenure had negative effect. Frew and Jud (1988) on the hand established that vacancy rate and number of floors positively influenced rent. While house age had negative effect on rent.
Wickramaarachchi (2016) focused on a case study of a boarding home area in Sri Lanka. She considered physical attributes, locational factors and amenities services and their effect on rental value. Size measured by floor area per person, location measured by distance to the university and number of bedrooms had significant effect on rental value.

Empirical evidence from Kenya is not extensive. Kimani, Kuria, and Ngigi (2021) analysed spatial factors affecting rental house prices in Nyeri County, Kenya. They collected data from 250 households through questionnaires and interviews. Population density, land value, proximity to towns, distance to road and slope were found to have a significant effect on rent. The current paper focuses on Nairobi with a larger sample and longer study period spanning ten years. Matete (2021) researched on the determinants of office rents in Nairobi Central Business District (CBD). He identified location, office and lease characteristics as the main factors influencing office rent. He applied multiple regression models using a sample of 156 office building to test the hypotheses. His findings indicate that size, age, and management positively affected office rent. However, the lack of parking, floor number and type of finishes negatively affected rent. The focus was on office rent, but the current paper looks at house rent.

Guerrero (2023) researched on the determinants of rental rates in Los Angeles in the US. The study period was 21 years focusing on location factors, income demographics and building characteristics. Age, size, location, building height and occupancy rates were reported to have a significant effect on rent rates. However, availability of gym had no impact on rent. Interestingly, occupancy rates had a negative effect on rent, but this could be seen as an incentive given by property owners to reduce vacancy rates.

Belete and Yilma (2020) sought to determine factors affecting market rent in Addis Ababa, Ethiopia. They selected and studied 164 apartments. They considered fifteen factors which the analyzed using multiple regression. The paper established that access to balcony, number of bedrooms, and security of compound had significant impact on market rent. In addition, access to road and parking were reported to influence rent, however, the number of bathrooms and floor level did not have significant effect on market rent. The current study enlarges the sample including multiple locations, house types and longer study periods in Nairobi, Kenya.

Darfo-Oduro (2020) provided empirical evidence from Accra Ghana regarding the determinants of house rental prices. He sampled 150 households and deployed multiple regression analysis. Distance to CBD and places of worship, access to electricity, availability of refuse dump showed significant relationship with rental price. A departure from previous studies, they found that bedroom size and age of building did not have effect on the house rent.

Methodology

The paper used quantitative research design to analyse the determinants of rent prices in Nairobi, Kenya. The paper used hedonic pricing model. The population of the study was the residential market in Nairobi. We employed purposive sampling and collected data over the period 2010Q3 to 2020Q4. Information relating to actual monthly rent, size measured in square feet, number of bedrooms, house type, location, and date was collected for each house. To provide a better understanding of rent pricing, the study specified three models as described in the ensuing paragraphs.

The first model incorporated all the variables for all locations and house types. The model was specified as follows in keeping with standard hedonic models (Wolverton & Senteza, 2000; Sirmans, Macpherson & Zietz, 2005)

$$Ln\ Rent_i = \propto + \beta_1 Ln\ Size_i + \beta_2\ Hse\ Type_i + \beta_3 Location_i + \beta_4 Bed2_i + \beta_5 Bed3_i + \beta_6 Bed4_i + \beta_7 Bed5_i + \beta_8 Bed6_i + \beta_9 Bed7_i + \beta_{10} Before2015Q4_i + e_i \dots\dots\dots\dots [1]$$

Where:

Ln Renti = Log of the monthly rent for house i

Size = Measured in square feet

Hse Type = Value of 1 if Apartments and 0 if standalone house

Location = Value of 1 if the house is in upmarket area and 0 if located elsewhere

Bed2 = Value of 1 if two bedroom and 0 if otherwise

Bed3 = Value of 1 if three bedroom and 0 if otherwise

Bed4 = Value of 1 if four bedroom and 0 if otherwise

Bed5 = Value of 1 if five bedroom and 0 if otherwise

Bed6 = Value of 1 if six bedroom and 0 if otherwise

Bed7 = Value of 1 if seven bedroom and 0 if otherwise

Before2015Q4 = Value of 1 if rent date is before 2015Q4 and 0 if otherwise

ei = error term

The one-bedroom house is the benchmark. The study period was split into two 2010Q3 – 2015Q3 and 2015Q4 - 2020Q4. To estimate the change in rent over the two periods we introduced a dummy variable. As such “Before2015Q4” variable operationalized the first of the two periods. This is assigned value of “1” if rent date is before 2015Q4 and “0” if otherwise.

The second model focused only on houses located in upmarket areas of Nairobi. These are residential areas for upper middle class and above. The model was specified as follows:

$$Ln\ Rent_i = \propto\ + \beta_1 Ln\ Size_i +\ \beta_2\ Hse\ Type_i + \beta_3 Bed2_i +\ \beta_4 Bed3_i +\ \beta_5 Bed4_i +\ \beta_6 Bed5_i$$
$$+\ \beta_7 Bed6_i +\ \beta_8 Bed7_i +\ \beta_9 Before2015Q4_i$$
$$+ e_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. [2]$$

Where:

Ln Renti = Log of the monthly rent for house i

Size = Measured in square feet

Hse Type = Value of 1 if Apartments and 0 if standalone house

Bed2 = Value of 1 if two bedroom and 0 if otherwise

Bed3 = Value of 1 if three bedroom and 0 if otherwise

Bed4 = Value of 1 if four bedroom and 0 if otherwise

Bed5 = Value of 1 if five bedroom and 0 if otherwise

Bed6 = Value of 1 if six bedroom and 0 if otherwise

Bed7 = Value of 1 if seven bedroom and 0 if otherwise

Before2015Q4 = Value of 1 if rent date is before 2015Q4 and 0 if otherwise

ei = error term

The third model focused only on houses located outside of the upmarket areas of Nairobi. These are residential areas for lower middle class and below. Bed 6 and Bed 7 were dropped due to lack of observations. There were very few houses with 6 and 7 bedrooms. The model was specified as follows:

$$Ln\ Rent_i = \propto\ + \beta_1 Ln\ Size_i +\ \beta_2\ Hse\ Type_i + \beta_3 Bed2_i +\ \beta_4 Bed3_i +\ \beta_5 Bed4_i +\ \beta_6 Bed5_i$$
$$+\ \beta_7 Before2015Q4_i$$
$$+ e_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. [3$$

Where:

Ln Renti = Log of the monthly rent for house i

Size = Measured in square feet

Hse Type = Value of 1 if Apartments and 0 if standalone house

Bed2 = Value of 1 if two bedroom and 0 if otherwise

Bed3 = Value of 1 if three bedroom and 0 if otherwise

Bed4 = Value of 1 if four bedroom and 0 if otherwise

Bed5 = Value of 1 if five bedroom and 0 if otherwise

Before2015Q4 = Value of 1 if rent date is before 2015Q4 and 0 if otherwise

ei = error term

The three models were estimated with robust standard errors to mitigate the problem heteroskedasticity. The first model was used to determine the overall effect of the selected house characteristics and location factors on rent prices in Nairobi. Besides, the price change over two periods with cut-off at 2015Q3 was determined. Models 2 and 3 allowed for market segmentation to capture variations if any.

Findings and Results Discussions

A summary of the descriptive statistics of the data used to estimate model one is in Table 1.

Table 1: Descriptive statistics - Model 1

Item	**Observations**	**Mean**	**Min**	**Max**
Rent (KSH per month)	1,318	97,102	8,750	580,000
Area (Sq. ft)	1,318	1,981	215	8,994
House Type:				
Apartments	837	64%	0	1
Stand alone	481	36%	0	1
Location:				
Upmarket	682	52%	0	1
Other location	636	48%	0	1
Number of bedrooms				
Bed1	76	6%	0	1
Bed2	309	23%	0	1
Bed3	495	38%	0	1
Bed4	313	24%	0	1
Bed5	98	7%	0	1
Bed6	21	2%	0	1
Bed7	6	0%	0	1
Before2015Q4	701	53%	0	1
After2015Q3	617	47%	0	1

Table 2 shows the summary of model 1. The model is significant at ($F=679.75$; $P<0.05$). House and location attributes explain 81.01% (R^2 = 0.8101) of the rent price.

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Table 2: Summary – Model 1

Robust Regression Rent		
Number of obs.	=	1,318
F (10, 1,307)	=	679.75
Prob > F	=	0.0000
R-squared	=	0.8101
Root MSE	=	.36094

Table 3 shows the results of robust regression for model 1. All the independent variables are significant. The results indicate that a 1% increase in housing surface area will result in 0.594% in rent price. The house type co-efficient (-0.091) indicates that rent for apartments are 9.1% below stand-alone house types such as bungalow and maisonette. Houses located in upmarket attracted rent at 70.7% above those in other locations. One-bedroom house was the benchmark. As such the outcome shows that the rent for a 2-bedroom house was 21.3% above the 1-bedroom house. The rent difference for 7-bedroom house relative to 1-bedroom house was 79%. Finally, rent prices for the period before 2015Q4 were 22.4% below those of the subsequent periods. Therefore, on average rent increased by 22.4% in the last five years in relation to the previous five years controlling for the effects of house attributes.

Table 3: Robust Regression Results – Model 1

Rent	**Coef.**	**St. Err.**	**t-value**	**p-value**	**Sig**
Area	.594	.037	15.98	0	***
Hse. Type	-.091	.03	-3.00	.003	***
Location	.707	.026	27.63	0	***
Bed2	.213	.056	3.82	0	***
Bed3	.329	.058	5.64	0	***
Bed4	.498	.072	6.88	0	***
Bed5	.624	.092	6.80	0	***
Bed6	.741	.115	6.47	0	***
Bed7	.79	.115	6.88	0	***
Before2015Q4	-.224	.021	-10.69	0	***
Constant	6.19	.247	25.10	0	***
Mean dependent var		11.131	SD dependent var		0.825
R-squared		0.810	Number of obs		1318
F-test		679.751	Prob > F		0.000
Akaike crit. (AIC)		1065.090	Bayesian crit. (BIC)		1122.112

**** p<.01, ** p<.05, * p<.1*

We now look at the results for model 2. A summary of the descriptive statistics of the data used to estimate model 2 is in Table 4.

Table 4: Descriptive statistics - Model 2

	Observations	Mean	Min	Max
Rent (KSH per month)	682	146,513	15,000	580,000
Area (Sq. ft)	682	2,521	385	8,994
House Type:				
Apartments	443	65%	0	1
Stand alone	239	35%	0	1
Number of bedrooms				
Bed1	42	6%	0	1
Bed2	127	19%	0	1
Bed3	206	30%	0	1
Bed4	200	29%	0	1
Bed5	83	12%	0	1
Bed6	20	3%	0	1
Bed7	4	1%	0	1
Before2015Q4	328	48%	0	1
After2015Q3	354	52%	0	1

Table 5 shows the summary of model 2. The model is significant at (F=273.62; P<0.05). House and location attributes explain 75.5% (R^2 = 0.7550) of the rent price.

Table 5: Summary – Model 2

Robust Regression Rent		
Number of obs.	=	682
F (9, 672)	=	273.62
Prob > F	=	0.0000
R-squared	=	0.7550
Root MSE	=	.35576

Table 6 shows the results of robust regression for model 2. All the independent variables are significant. The results indicate that a 1% increase in housing surface area will result in 0.533% in rent price. The house type co-efficient indicates that rent for apartments is 23.3% below stand-alone house types. One-bedroom house was the benchmark. As such the outcome shows that the rent for a 2-bedroom house was 22.3%

above the 1-bedroom house. The rent for a 7-bedroom house was 92.9% above a 1-bedroom house. Besides, rent prices for the period before 2015Q4 were 22.4% below those of the subsequent periods. Therefore, on average rent increased by 25.1% in the last five years in relation to the previous five years controlling for the effects of house attributes.

Table 6: Robust Regression Results – Model 2

Rent	Coef.	St. Err.	t-value	p-value	Sig
Area	.533	.047	11.23	0	***
Hse. Type	-.233	.043	-5.43	0	***
Bed2	.223	.076	2.93	.004	***
Bed3	.433	.075	5.78	0	***
Bed4	.621	.091	6.81	0	***
Bed5	.703	.112	6.29	0	***
Bed6	.857	.119	7.18	0	***
Bed7	.929	.149	6.25	0	***
Before2015Q4	-.251	.028	-8.92	0	***
Constant	7.386	.338	21.85	0	***
Mean dependent var		11.659	SD dependent var		0.714
R-squared		0.755	Number of obs		682
F-test		273.622	Prob > F		0.000
Akaike crit. (AIC)		535.663	Bayesian crit. (BIC)		580.913

**** p<.01, ** p<.05, * p<.1*

We now look at the results for model 3. A summary of the descriptive statistics of the data used to estimate model 3 is in Table 7.

Table 7: Descriptive statistics - Model 3

	Observations	Mean	Min	Max
Rent (KSH per month)	633	43,971	8,750	195,000
Area (Sq. ft)	633	1,397	215	5,021
Hse. Type:				
Apartments	394	62%	0	1
Stand alone	239	38%	0	1
Number of bedrooms				
Bed1	34	5%	0	1
Bed2	182	29%	0	1
Bed3	289	46%	0	1
Bed4	113	18%	0	1
Bed5	15	2%	0	1
Before2015Q4	373	59%	0	1
After2015Q3	260	41%	0	1

Table 8 shows the summary of model 3. The model is significant at (F=76.17; P<0.05). House and location attributes explain 49.99% (R^2 = 0.4999) of the rent price.

Table 8: Summary – Model 2

Robust Regression Rent		
Number of obs.	=	633
F (9, 672)	=	76.17
Prob > F	=	0.0000
R-squared	=	0.4999
Root MSE	=	.35244

Table 9 shows the results of robust regression for model 3. All the independent variables are significant except house type. The results indicate that a 1% increase in the housing surface area will result in 0.562% in rent price. One-bedroom house was the benchmark. As such the outcome shows that the rent for a 2-bedroom house was 20.8% above the 1-bedroom house. The rent for a 5-bedroom house was 50.8% above a 1-bedroom house. Besides, rent prices for the period before 2015Q4 were 19.1% below those of the subsequent periods. Therefore, on average rent increased by 19.1% in the last five years in relation to the previous five years controlling for the effects of house attributes.

Table 9: Robust Regression Results – Model 3

Rent	Coef.	St. Err.	t-value	p-value	Sig
Area	.562	.062	9.13	0	***
Hse. Type	0	.045	0.01	.992	
Bed2	.208	.081	2.57	.011	**
Bed3	.308	.091	3.37	.001	***
Bed4	.448	.115	3.89	0	***
Bed5	.508	.163	3.10	.002	***
Before2015Q4	-.191	.031	-6.23	0	***
Constant	6.365	.397	16.03	0	***
Mean dependent var		10.563	SD dependent var		0.496
R-squared		0.500	Number of obs		633
F-test		76.174	Prob > F		0.000
Akaike crit. (AIC)		484.043	Bayesian crit. (BIC)		519.647

*** *p<.01*, ** *p<.05*, * *p<.1*

Table 10 shows a comparative analysis of the three models. The effect of surface area on house rent is similar in all the three models. However, rent for apartments is 9.1% below those of stand -alone houses as per model 1. The variance is highest in the upmarket segment of the residential market (-23.3%). House type did not affect rent price in the low market segment (Model 3). The marginal prices pertaining to bedrooms is higher for the upmarket segment. For instance, the rent for a 4-bedroom house is priced at 62.1% above the 1-bedroom one in the upmarket segment. While in the other market segment (Model 3) it is 44.8%. Rent price jumped by 25.1% for the period (2015Q4 – 2020Q4) in relation to (2010Q3 – 2015Q3) for the upmarket segment. The jump was 19.1% for the other market segment over the same period.

Table 10: Comparative analysis of Models 1, 2 and 3

	Entire market Model 1	**Upmarket segment Model 2**	**Other segments Model 3**
Area	0.59%	0.53%	0.56%
House Type	-9.1%	-23.3%	0.0%
Location	70.7%	N/A	N/A
Bed2	21.3%	22.3%	20.8%
Bed3	32.9%	43.3%	30.8%
Bed4	49.8%	62.1%	44.8%
Bed5	62.4%	70.3%	50.8%
Bed6	74.1%	85.7%	N/A
Bed7	79.0%	92.9%	N/A
Before2015Q4	-22.4%	-25.1%	-19.1%

Conclusions and Recommendations

The objective of the paper was to price rent for the house market in Kenya using hedonic model. Data was collected for the period 2010Q3 to 2020Q4 for a sample of houses in Nairobi. Three models were estimated. The first model considered all the data without segmentation. Model 2 focused only on the upmarket locations while the third model focused on the remaining market segment. All the variables had a significant effect on rent prices except house type in model 3. Specifically, house surface area and number of bedrooms had significant effect. The findings agree with past studies (Zisheng, Mats and Zan, 2020; Hoffmann and Kurz, 2002). However, Darfo-Oduro (2020) and Rezaeian, Asgari, & Heshmatolah (2019) found no effect. Stand-alone houses were priced higher than apartments except in the low market segment where there was no effect. This confirmed the mixed findings in literature. Rezaeian, Asgari, and Heshmatolah (2019) did not find any effect whereas other studies reported significant effects (Zisheng, Mats and Zan, 2020;

Hoffmann and Kurz, 2002). Also, there was an increase in average rent price between the two 5-year periods confirming rent inflation.

We sought to price house rent using the hedonic approach. This has contributed to empirical evidence in Kenya which in our opinion, has scarcely been studied. Besides, by extension we hope to build to the global body of empirical evidence towards residential rent pricing. Our findings may help property developers in their pricing and investing decisions. We hope the paper provides insight to governments in their quest to provide affordable housing to catalyse socio economic growth. Tenancy decisions by owners and tenants may be informed by the findings of this paper.

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