



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference "Latin America: Brazil" in cooperation with ESA RN21 "Quantitative Methods"

Determining House Prices in Low Income Neighbourhoods of North-Central Nigeria: A Categorical Modelling Approach.

Ogunbajo, R. A¹, Olabisi S. A² and Wali R.I³

¹Department of Estate Management and Valuation, Federal University of Technology, Minna.

²Department of Estate Management and Valuation, University of Ilorin.

³Department of Estate Management, Niger State Polytechnic, Zungeru.

ABSTRACT

In recent times, researchers from social and behavioural sciences in developing countries have begun to look in the direction of the quality of the influencing housing attributes on house prices. These attributes are best measured qualitatively on ordinal and/or nominal scales. As such, an important development in multidimensional data analysis is the optimal assignment of quantitative values to qualitative scales. This study utilised the categorical modelling approach to determine the contributory effect of housing attributes on rental house prices in North-Central Nigeria. The categorical regression model uses the optimal scaling methodology as developed in the Gifi system to quantify categorical variables according to a particular scaling level, thus "transforming" categorical variables into numeric variables. Having adopted $\pm 10\%$ precision and 90% confidence level, a total of 1,134 housing units were sampled by stratified and random selection. The data used were generated through questionnaire. Nine housing attributes were found to sustain residential buildings in the study area and these accounted for 45% and 61% variance in the rental prices of two major low income house types. Results suggested that the identified housing attributes significantly predicted rental values for the low income house types. The mean of predicted rental values were further computed for each house type and compared to the means of the actual rental values collated in the course of data collection and presented with line graphs. Results showed predicted values that are reasonably similar to the actual rental values of the dwelling units. Thus suggest a reasonably accurate prediction of rental house prices using the categorical regression approach.

Key words: Categorical modelling, House prices, Low income, Neighbourhoods,

Introduction

Available literature shows that the most widely used estimates of the impacts of a wide range of housing attributes on house prices are derived from hedonic models (Sirmans, *et al*, 2005; Stetler, *et al* 2010, Hoen *et al*, 2011; Boucq & Stratec, 2011; Ansah, 2012; and Neelawala, *et al* nd). The hedonic model assumes that the prices of dwelling units is composed of a number of factors, thus using a regression analysis, the impacts of each of these factors can be estimated. Wilhelmsson (2009) described the hedonic model as a regression technique used to reveal the implicit prices of various attributes. Specifically, a



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference "Latin America: Brazil" in cooperation with ESA RN21 "Quantitative Methods"

hedonic equation helps to explain house price in terms of its own characteristics such as size of the flat, age, floor, neighbourhood characteristics, and job accessibility.

However, due to a variety of reasons, this research like quite a number of other researches on social and behavioural sciences have some of the housing attributes/ independent variables measured in nominal and ordinal scales. Srijan (2009) observed that the zero point of the scales used to measure the values in such cases is uncertain, the relationships among the different categories is often unknown, and although frequently it can be assumed that the categories are ordered, their mutual distances might still be unknown. Srijan (2009) further explained that the uncertainty in the unit of measurement is not just a matter of measurement error, because its variability may have a systematic component. As such, an important development in multidimensional data analysis is the optimal assignment of quantitative values to such qualitative scales. This form of optimal quantification (scaling, scoring) is a general approach to treat multivariate categorical data (Srijan, 2009).

CATREG was developed as a method for regression when the data consist of ordered or unordered categorical variables (Van der Kooij and Meulman, 2006). It uses the optimal scaling methodology as developed in the Gifi system (Gifi 1990) to quantify categorical variables according to a particular scaling level, thus "transforming" categorical variables into numeric variables. By use of optimal scaling, numerical values are calculated to replace the categorical values, while at the same time regression coefficients are estimated. The idea behind optimal scaling is to assign numerical quantifications to the categories of each variable, thus allowing standard procedures to be used to obtain a solution on the quantified variables (Meulman and Heiser, 2012). Scaling all variables at the numerical level corresponds to standard multiple regression analysis. According to Meulman (1998), the optimal scaling process turns qualitative variables into quantitative ones. Optimality is a relative notion, because it is always obtained with respect to the particular data set that is analyzed and the particular criterion that is optimized.

According to Jacqueline and Willem (2005), the use of Categorical Regression is most appropriate when the goal of your analysis is to predict a dependent (response) variable from a set of independent (predictor) variables measured on a combination of nominal, ordinal, and/or interval scales. The goal of categorical regression with optimal scaling is to describe the relationship between a response variable and a set of predictors. By quantifying this relationship, values of the response can be predicted for any combination of predictors (Jacqueline and Willem, 2005). Srijan (2009) described categorical regression as quantifying categorical data by assigning numerical values to the categories using optimal scaling method and resulting in an optimal linear regression equation for the transformed variables. Categorical regression extends the standard approach by simultaneously scaling nominal, ordinal, and numerical variables. The procedure quantifies categorical variables so that the quantifications reflect characteristics of the original categories. The procedure treats quantified categorical variables in the same way as numerical variables. Using nonlinear transformations allow variables to be analyzed at a variety of levels to find the best-fitting model. The estimated parameters of the model reveal the significance and magnitude of effect of any housing feature. Similar to other regression analysis, it allows a researcher to estimate, on average, how specific factors (called explanatory, or independent variables) affect the price of a good (called the dependent variable), holding other key factors constant (Netusil, 2003).



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference "Latin America: Brazil" in cooperation with ESA RN21 "Quantitative Methods"

In this study, rental values of housing units are related to the amenities within neighbourhoods of Minna, Nigeria. A regression analyses was performed for the study area. The dependent variables comprised of rental values (y), while the independent variables are the amenities sustaining the housing units in the various neighbourhoods (x). Thus, a functional equation designed to capture the relationship between rental values and amenities takes the form:

$$REV = f(x) \dots\dots\dots (1)$$

Where REV = Rental value

And x consist of the following:

- | | | |
|------|---|--|
| X => | X ₁ = Shopping centres | X ₆ = Refuse disposal sites |
| | X ₂ = Educational institutions | X ₇ = Security/ Crime rate |
| | X ₃ = Health care centers | X ₈ = Electricity supply |
| | X ₄ = Recreational facilities | X ₉ = Water supply |
| | X ₅ = Major access roads | |

Methodology

The study population comprised rented residential buildings in thirteen (13) selected areas in Minna Metropolis. This research adopted $\pm 10\%$ precision (margin of error), confidence level of 90%, and sampled a total of 1,134 housing units by stratified and random selection. The data used were generated through questionnaire. Due to the unorganized and informal nature of the sampled neighbourhoods, proximities to nine housing attributes were measured on ordinal scales the and categorised as 'far', 'fair' and 'very close' based on consensus opinions of residents in the sampled neighbourhoods. The study focused on two predominant low income house types in the study area. These are multi-tenanted roomy apartments otherwise known as tenement buildings, and one bedroom apartment which are locally referred to as 'self-contain'. In order to establish the rental house prices in the study area, this research utilized the optimally scaled categorical regression analysis. This analytical tool was adopted due to the nature of the data which entailed a dependent variable measured on ratio scale, an independent variable also measured on ratio scale, and another eight independent variables measured on ordinal scales. The dependent variable is rental values of residential buildings (in Naira), while the predictors/independent variables are amenities which entailed the proximity of the residential buildings to shopping complexes, educational institutions, health care centers, recreation centers, major roads, and refuse dumps. Others are: the level of security of the neighbourhood (measured in terms of reported crime cases in each area), electricity supply (number of hours of supply per day), and sources of water supply.

The CATREG model

The categorical regression equation that describes the impact of amenities on rental values in Minna was given as:

$$\varphi_r (REV) = \sum_{j=1}^9 \beta_j \varphi_j (x_j) + e \dots\dots\dots (2)$$



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference “Latin America: Brazil” in cooperation with ESA RN21 “Quantitative Methods”

Where φ_r (REV) = the transformation for the response variable (rental value),

β_j = the regression coefficients,

$\varphi_j(x_j)$ = the transformations for predictor variables (externalities), and

e = the error vector.

Substituting the x parameters into equation (9) and (10), the equations are simplified as:

$$\varphi_r(\text{REV}) = \beta_1 \varphi_j(\text{SHOP}) + \beta_1 \varphi_j(\text{EDUC}) + \beta_1 \varphi_j(\text{HEALTH}) + \beta_1 \varphi_j(\text{RECRE}) + \beta_1 \varphi_j(\text{ROAD}) + \beta_1 \varphi_j(\text{REFUSE}) + \beta_1 \varphi_j(\text{SECURE}) + \beta_1 \varphi_j(\text{ELECT}) + \beta_1 \varphi_j(\text{WATER}) + e \dots\dots\dots(3)$$

Findings

The result of the optimally scaled categorical regression analysis is presented as follows:

Table 1: Model Summary (Standardized Data)

House Type	Multiple R	R Square	Adjusted R Square
Tenement buildings	0.671	0.451	0.433
One bedroom apartment	0.781	0.61	0.598

Data Analysis, 2019

The model summary in Table 1 showed a R^2 value of 0.451 for tenement buildings, an indication that the regression model explains approximately 45% of the total variation in the rental values of tenement buildings in the study area. The remaining 55% can be related to other unaccounted factors which are not included in the model such as: the size of the dwelling unit, the condition of the physical building components of the house, age of the building, and number of toilets. The model summary in table 1 also showed a R^2 value of 0.610 for one bedroom apartments and implied that amenities explained 61% of the variability in the rental values of one bedroom apartment in the study area. The remaining 39% can also be related to other unaccounted factors which are not included in the model.

Table 2: ANOVA test for statistical significance

	Sum of Squares	Df	Mean Square	F	Sig.
Tenement Buildings					
Regression	213.265	15	14.218	25.016	0.000
Residual	259.735	457	0.568		
Total	473	472			
One bedroom apartment					
Regression	215.708	11	19.61	48.495	0.000
Residual	138.292	342	0.404		
Total	354	353			

Data Analysis, 2019



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference “Latin America: Brazil” in cooperation with ESA RN21 “Quantitative Methods”

The F ratios in table 2 tested whether the overall regression models are good fits for the data. Analysis in the table showed that the independent variables can significantly predict the rental values of the sampled house types (the dependent variable) in the study area. Table 2 showed F ratios: $F(15, 457) = 25.016$ for tenement buildings, and $F(11, 342) = 48.495$ for one bedroom apartments. The corresponding p - values for each of these F ratios is 0.000. The p -values are less than 0.05, thus an indication that the regressions are good fits for the data.

The Zero-order correlations and Importance Indexes were further used in conjunction with the standardized coefficients to fully explore predictor effects. The zero-order correlation is simply the correlation between each predictor and the dependent variable, after these variables have undergone the appropriate transformations. Comparing the zero-order correlation coefficients in this research emphasizes the magnitude and direction of relationship between each of the sampled amenities and rental values of each of the house types. Negative correlation coefficients indicate that the respective amenities had negative relationships with rental values, while positive correlation coefficients implied positive relationships with rental values. Negative relationships translates to a decline in rental values as a result of closer distances to the amenities, while positive relationships translates to an enhancement or improvement in rental values as a result of closer distances to the concerned amenity. ‘Importance index’ on the other hand simply indicates the importance of each predictor using the Pratt’s measure. The importance index uniquely reflects the direct and total effects of each of the independent variables (LeBreton, Ployart, & Ladd, 2004).

The regression coefficients (beta coefficients), zero-order correlation and the importance indexes which served to predict rental prices of the two house types are presented as follows:

Table 3: Beta Coefficients of the independent variables (Tenement buildings)

	Standardized Coefficients		Df	F	Sig.
	Beta	Std. Error			
Shopping centers	-.127	.039	2	10.681	.000
Educational Institutions	.088	.038	2	5.404	.005
Health care Centers	-.064	.046	1	1.990	.159
Recreation Centers	.090	.057	1	2.455	.118
Major Roads	.232	.039	2	35.829	.000
Refuse Dumps	-.115	.036	2	10.053	.000
Security of the Neighbourhood	.281	.037	2	59.340	.000
Electricity supply	.384	.037	1	104.799	.000
Water supply	.162	.036	2	20.069	.000

Data Analysis, 2019

Figures in the last column of table 3 (known as the p -values) tell whether the respective independent variables make a significant contribution to the dependent variable. Variables whose p -values are less than 0.05 imply that the variables are making a significant unique



contribution to the dependent variable. A careful look at table 3 showed that the distance of shopping centers, educational institutions, major roads and refuse dumps to tenement buildings made significant unique contributions to the rental values of these buildings in the study area. Others are: the level of security of the area, electricity supply and water supply. The listed independent variables have p-values of less than or equal to 0.05.

An examination of the standardized beta coefficients in the second column of table 3 further indicated that electricity supply makes the strongest unique contribution to explaining the rental values of tenement buildings in the study area. This is as a result of it having the highest beta coefficient (0.384). Other externalities which also contribute strongly in explaining the rental values of tenement buildings in the study area are: security of the neighbourhood (beta coefficient = 0.281), proximity to major roads (beta coefficient = 0.232), and sources of water supply (beta coefficient = 0.162). As further shown in the table, the proximity of dwelling units to health care centers and recreation centers did not contribute significantly to the rental values of tenement buildings in the study area since the p-values for these variables exceeded 0.05. The p-values for these variables are 0.159 and 0.118 respectively.

Table 4: Zero-order Correlation and Importance Index for the relationship between amenities and the rental values of tenement buildings

Independent Variables	Zero-Order Correlation	Importance Index
Shopping complexes*	-.204	.057
Educational Institutions*	.093	.018
Health care Centers	-.042	.006
Recreation Centers	.051	.010
Major Roads*	.285	.147
Refuse Dumps*	-.203	.052
Security of the Neighbourhood*	.319	.199
Electricity supply*	.492	.419
Sources of Water supply*	.256	.092

*Variables with significant impact on tenement buildings' rental values

Data Analysis, 2019

It can be deduced from table 4 that, of all the independent variables having significant impact on rental values of tenement buildings, electricity supply which had an importance index of 0.419 is the most important which affects residential rental values in the study area. A zero-order correlation of 0.492 signified a moderate and positive relationship between tenement buildings' rental values and electricity supply. Other predictors of rental values arranged in order of importance are: security, which had an importance index of 0.199 and a zero-order correlation of 0.319, proximity to major roads which had an importance index of 0.147 and a zero-order correlation of 0.285, sources of water supply (importance index = 0.092), proximity to shopping complexes (importance index = 0.057), refuse dumps (importance index = 0.052), and educational institutions (importance index = 0.018). The magnitude of the relationship between these independent variables and residential rental values is reflected in their zero-order correlations which are 0.256, -0.203, and -0.204 respectively. It was also observed from table 4 that shopping centers and refuse dumps had



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference "Latin America: Brazil" in cooperation with ESA RN21 "Quantitative Methods"

negative zero-order correlation coefficients. The negative sign implied that rental values tend to decrease with closer distance to these two externalities.

Table 5: Beta Coefficients of the independent variables (One bedroom apartments)

	Standardized Coefficients				
	Beta	Std. Error	df	F	Sig.
Shopping complexes	.085	.037	1	5.216	.023
Educational Institutions	.142	.038	1	14.000	.000
Health care Centers	-.128	.038	1	11.395	.001
Recreation Centers	.036	.052	1	.493	.483
Major Roads	.319	.036	2	78.885	0.000
Refuse Dumps	-.036	.063	1	.337	.562
Security of the Neighbourhood	.196	.037	2	28.580	.000
Electricity supply	.611	.033	1	352.148	0.000
Water supply	-.083	.063	1	1.711	.192

Data Analysis, 2019

An examination of the standardized beta coefficients in the second column of Table 5 revealed that electricity supply made the strongest unique contribution to explaining the rental values of one bedroom apartments in the study area. It had the highest beta coefficient (0.611), followed by proximity to major roads (0.319), security of the neighbourhood (0.196), and proximity to educational institutions (0.142). Proximity to shopping centers and health care centers made the least contributions to the rental values of one bedroom apartments in the study area. The two variables had standardized beta coefficients of 0.085 and 0.128 respectively.

The p-values in the last column of table 5 tell whether the contributions of the respective independent variables to the dependent variable are significant. Variables whose p-values were less than 0.05 implied that the variables made a significant unique contribution to the dependent variable. A careful look at the table showed that the proximities of dwelling units (one bedroom apartments) to shopping centers, educational institutions, health care centers, and major roads made significant unique contributions to the rental values of this category of residential dwellings in the study area. Others are: neighbourhood security and electricity supply.

Table 6: Zero-order Correlation and Importance Index for the relationship between rental values of one bedroom apartments and amenities

Independent Variables	Zero-Order Correlation	Importance Index
Shopping complexes*	.017	.002
Educational Institutions*	.262	.061
Health care Centers*	-.066	.014
Recreation Centers	.112	.007
Major Roads*	.333	.174



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference “Latin America: Brazil” in cooperation with ESA RN21 “Quantitative Methods”

Refuse Dumps	-.074	.004
Security of the Neighbourhood*	.269	.087
Electricity supply*	.670	.673
Sources of Water supply	.157	-.021

*Variables with significant impact on rental values of one bedroom apartments

Data Analysis, 2019

Results in table 6 revealed that the rental values of one bedroom apartments reduced with closer distances to health care centers and refuse dumps. This is emphasized by their zero-order correlation coefficients which are -0.066, and -0.074 respectively. The Table further showed that, of all the amenities having significant impact on rental values of one bedroom apartments, electricity supply which had an importance index of 0.673 was the most important. A zero-order correlation of 0.670 further signified a strong and positive relationship between the rental values of one bedroom apartments and electricity supply, thus rental values improved with an improvement in electricity supply.

Other predictors of the rental values of one bedroom apartments arranged in order of importance were: proximity to major roads, with an importance index of 0.174 and a zero-order correlation of 0.333, security of the neighbourhood (importance index = 0.087), and proximity to educational institutions (importance index = 0.061). Results further established a weak but positive relationship between rental values and neighbourhood security, and between rental values and proximity to educational institutions. Both indices had zero-order correlations of 0.269 and 0.062 respectively.

Rental Value prediction model

By substituting the coefficients (ie. coefficients with corresponding p-values that are less than 0.05, indicating significant impacts) generated from the regression analysis into equation 3, the prediction models developed to predict residential rental values for the study area are given as:

i. Tenement buildings

$$\varphi_r (REV) = -0.127_{SHOP} + 0.880_{EDUC} + 0.232_{ROAD} - 0.115_{REFUSE} + 0.281_{SECURE} + 0.384_{ELECT} + 0.162_{WATER} + e \dots\dots\dots(5)$$

ii. One bedroom apartments

$$\varphi_r (REV) = 0.085_{SHOP} + 0.142_{EDUC} - 0.128_{HEALTH} + 0.319_{ROAD} + 0.196_{SECURE} + 0.611_{ELECT} + e \dots\dots\dots(6)$$

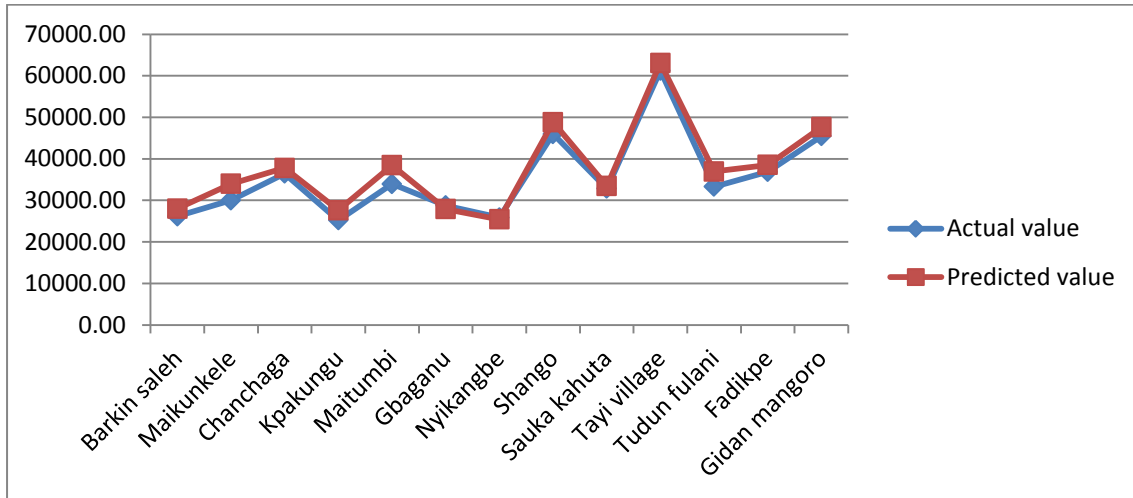
Model Testing (Comparing predicted rental values with the actual rental values)

The mean of predicted rental values were computed for each house type across the neighbourhoods and compared to the means of the actual rental values collated in the course of data collection. Line graphs showing the actual Vs predicted rental values for each house type are shown in figures 1 and 2.

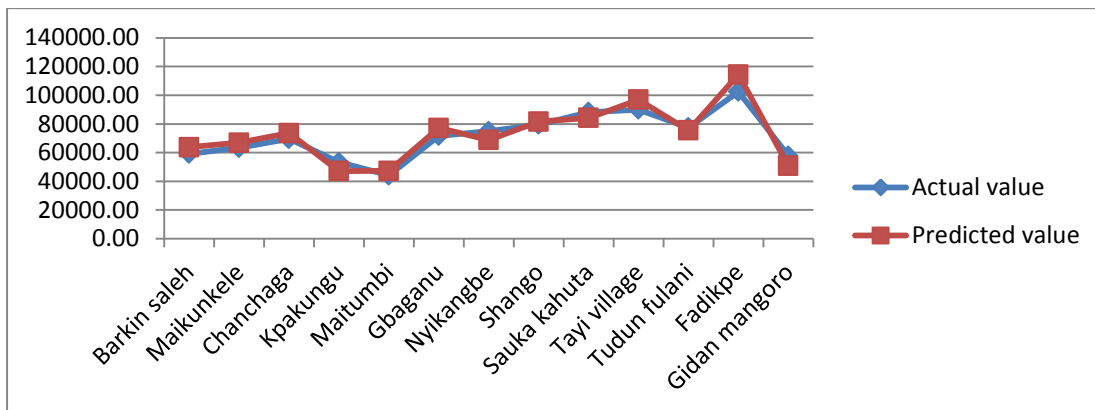


SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference "Latin America: Brazil" in cooperation with ESA RN21 "Quantitative Methods"



**Figure 1. Actual Vs Predicted mean rental values of tenement buildings
Data analysis, 2019**



**Figure 2. Actual and Predicted rental values of one bedroom apartments
Data analysis, 2019**

Figures 1 and 2 showed predicted mean rental values that are reasonably similar to the means of the actual rental values of the dwelling units.

Conclusion

It is important to note that each of the amenities made distinct contributions to the rental values of each of the house types. For tenement buildings, closer distances to shopping centers and refuse dumps brought about a decline in rental values, while closer distances to educational institutions and major roads enhanced the rental values. Other amenities that enhanced the rental values of tenement buildings in the study area were: improved neighbourhood security, electricity supply, and water supply. Findings also revealed that for one bedroom apartments, closer distances to shopping centers, educational institutions, and major roads, as well as improved security and electricity supply resulted in a significant improvement / enhancement in rental values. On the contrary, closer distances of one bedroom apartments to health care centers resulted in a significant decline in their rental values.



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference "Latin America: Brazil" in cooperation with ESA RN21 "Quantitative Methods"

References

- Ansah, A.O. (2012). Examination of the Determinants of Housing Values in Urban Ghana and Implications for Policy Makers. Paper presented at the African Real Estate Society Conference in Accra, Ghana from 24th -27th October 2012.
- Boucq, E. and Stratec, S.A. (2011). Estimating the Impact on Housing Price brought by a Light Rail Infrastructure in France. Association for European Transport and Contributors., Available at www.abstracts.eatransport.org/paper/.../id/3604.
- Gifi, A. (1990). "Nonlinear Multivariate Analysis." Chichester: John Wiley and Sons (First edition 1981, Department of Data Theory, University of Leiden.
- Hoen, B., Wiser, R. Cappers, P., Thayer, M. and Sethi, G. (2011). Wind Energy Facilities and Residential Properties: The Effect of Proximity and View on Sales Prices. *Journal of Real Estate Research*, 33 (3), 280-316.
- Jacqueline, J.M. and William, J.H. (2005). SPSS Categories 14.0. Available at www.spss.com and assessed on 1st January, 2017.
- Kieti, R.M. and Ogolla, W. (2020). Hedonic valuation of apartments in Kenya. *Property Management*. Emerald Publishing Limited. doi: 10.1108/PM-04-2020-0022.
- LeBreton, J. M., Ployhart, R. E., & Ladd, R. T. (2004). A Monte Carlo comparison of relative importance methodologies. *Organizational Research Methods*, 7(3), 258-282. doi: 10.1177/1094428104266017
- Meulman, J.J. (1998). Optimal Scaling Methods for Multivariate Categorical Data Analysis. SPSS White Paper. Available at www.citeseerx.ist.psu.edu, and accessed on 17th April, 2017.
- Meulman, J.J. and Heiser, W.J. (2012). SPSS Categories 21. University of Sussex. Available at www.sussex.ac.uk/, and accessed on 15th April, 2017.
- Moss, S. (2016). Categorical regression analysis. Available at www.sicotests.com/psyarticle.asp?id=160, and assessed on 19th October 2016.
- Nathans, L. L., Oswald, F. L. and Nimon, K. (2012). Interpreting Multiple Linear Regression: A guide book of variable importance. *Practical Assessment, Research and Evaluation*. 17 (9), 1 – 19.
- Neelawala, P. Clevo, W., and Robinson, T. (nd). Impacts of Major Roads on Property Values: An Analysis of an existing and a proposed Road Corridor Project. Available at <https://editorialexpress.com/.../download> and assessed on 7th April 2015.
- Sirmans, G. S., Macpherson, D. A. and Zietz, E. N. (2005). The Composition of Hedonic Pricing Models. *Journal of Real Estate Literature*, 13(1), 3-43.
- Srijan, L.S. (2009). Categorical Regression Models with Optimal Scaling for Predicting indoor Air Pollution Concentrations inside Kitchens in Nepalese Households. *Nepal Journal of Science and Technology*, 10 (2009), 205 – 211.



SMUS

BRAZIL 2nd International and Interdisciplinary Conference on Spatial Methods for Urban Sustainability (SMUS Conference) and the 1st RC33 Regional Conference “Latin America: Brazil” in cooperation with ESA RN21 “Quantitative Methods”

Stetler, K.M., Venn, T.J., and Calkin, D.E. (2010). The Effects of Wild Fire and Environmental Amenities on Property values in Northwest Montana, USA. *Ecological Economics*, 69, 2233-2243.

Van der Kooij, A.J. and Meulman, J.J. (2006). Prediction Accuracy of Regression with Optimal Scaling Transformations: The .632 Bootstrap with CATREG. Available at <https://openaccess.leidenuniv.nl/03.pdf>, and accessed on 17th April, 2017.

Wilhelmsson, M. (2009). The Impact of Traffic Noise on the Values of Single-family Houses. *Journal of Environmental Planning and Management*, 43(6), 799–815.