Determining the impact of low-cost housing development on nearby property prices using discrete choice analysis

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Abstract

This paper presents an application of the conditional logit model to a small, Nelson Mandela Bay neighbourhood housing data set, with the objective of determining the impact of proximity to a low-cost housing development on nearby property prices. The results of this pilot study show that the average household in the neighbourhood of Walmer is willing to pay between R27 262 and R195 564 to be located 86m further away from an existing low–cost housing development. In addition to this, the probability of choosing a specific house increases if the house has a swimming pool, an electric fence, the lower its price and the closer it is to the nearest school.

1 INTRODUCTION

Social housing can be defined as "a rental or co-operative housing option for low income persons at a level of scale and built form which requires institutionalised management and which is provided by accredited social housing institutions or in accredited social housing projects in designated restructuring zones" (Social Housing Policy for South Africa, 2005). It is widely reported in the international literature that the development of this form of housing has been plagued by "local opposition", who argue that these structures may lead to reductions in existing property values (Baird, 1980; Guy, Hysom and Ruth, 1985; Goetz, Lam and Heitlinger, 1996; Galster, Tatian and Smith, 1999; Lee, Culhane and Wachter, 1999). This is commonly referred to as the not-in-my-backyard syndrome (NIMBY) (Iglesias, 2002). Negative preconceptions about social housing form the basis of this argument (Cummings and Landis, 1993). Although many studies have been conducted to assess the effect of social housing developments on nearby property prices, the results remain inconclusive. Some studies have found a negative impact (Goetz, et al., 1996; Lee et al., 1999), while others have found a positive impact (Lyons and Loveridge, 1993; Galster et al., 1999). Finally, Cummings and Landis (1993) found no significant relationship between an existing social housing establishment and nearby property values.

The provision of social housing in South Africa has received lots of attention recently (A Toolkit for Social Housing Institutions, 2010). This is mainly due to two reasons: first, there is a shortage of affordable low cost housing in the major urban areas in South Africa, and second, housing developments of this nature have the ability to reconnect residents to resources within cities. Not unlike similar housing developments overseas, the proposed low cost ones in South Africa have been met with substantial resistance, mainly from those who believe that the prices of properties adjacent to the low-cost developments will be negatively affected.

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A review of available literature revealed that there are currently no studies in South Africa that deal with the effect of social housing developments on residential property prices. The aim of this pilot study is to fill this gap. More specifically, using an existing housing establishment catering for low income earners (the Walmer or Gqebera Township) this paper seeks to determine its effect (if any) on property values in the adjacent neighbourhood of Walmer[1]. The Walmer neighbourhood is an affluent one, with the average house trading at R1 631 608 (2009 prices). The reason why an existing housing development is used instead of a new one is that the latter is still being constructed. It is believed that the Walmer Township is a good proxy for the social housing developments currently underway in Nelson Mandela Bay. The reason for this belief is based on the fact that typical social housing units (the ones proposed for the Nelson Mandela Bay area) and existing properties in the Walmer Township are very similar in terms of price and structure. More specifically, an analysis of the traded properties in the Walmer Township for the period 2005 to 2009 reveals an average price of R80 720 (South African Property Transfer Guide, 2011). The latter value is slightly above the estimated cost per unit of R66 900 for the proposed New Brighton low cost housing project (Housing Project Launched in New Brighton, 2010). Furthermore, proposed social housing units (see for example, Project Review Series, 2011) typically consist of one, two or three bedrooms, with each unit consisting of an open plan living area and kitchenette, which includes a sink and preparation area. The existing properties in the Walmer Township are almost identical to the structure and layout of the proposed social housing units (South African Property Transfer Guide, 2011). In addition to this, social housing developments are aimed at low-income earners. This target group has been doubly discriminated against, as they are deemed to be too high earning to qualify for housing subsidies and too low earning to qualify for bank finance (Social Housing, 2010). The Walmer Township caters for residents within a similar income bracket to the one mentioned for social housing development recipients.

The Walmer Township is one of South Africa's oldest townships, dating back to 1905. This township was designated to be inside a "whites only" area under the Apartheid Groups Area Act of 1955. The regime tried to remove the township, but due to the strong resistance from residents of the township, along with resistance from the residents of Walmer, this attempt was unsuccessful. The Walmer Township is attractive to low income earners and the township has grown rapidly (Masifunde Learner Development, 2010). Roughly 100 000 people inhabit the township today, which enjoys a vibrant formal property market.

In order to carry out the analysis, the random utility model of site choice is employed. It was assumed that individuals make discrete choices about houses instead of continuous choices about the attributes of houses (Palmquist and Israngkura, 1999). More specifically, consumers choose some dwelling out of a large set of discrete alternatives, taking into account the prices at which the dwellings are offered and evaluating the physical characteristics, the neighbourhoods in which they are located and the public services provided to them (Quigley, 1985).

The results of this study show that proximity to a low-cost housing development has a negative effect on residential property prices. In this case study, the average household in the neighbourhood of Walmer is willing to pay between R27 262 and R195 564 to be located 86m further away from an existing low–cost housing development.

The paper is organised as follows: section 2 describes the theoretical framework applied in this study, section 3 describes the data, section 4 discusses the empirical results of the study and section 5 concludes the paper.

[1] The Walmer neighbourhood and the Walmer Township are two distinct areas (they simply share the name "Walmer").

2 THEORETICAL FRAMEWORK

There are numerous international studies that have applied the hedonic pricing method[2] to determine the effect of proximity to social housing developments on local property prices (see for example, Cummings and Landis, 1993; Lyons and Loveridge, 1993; Goetz et al., 1996; Galster et al., 1999; Lee et al., 1999; Santiago, Galster and Tatian 2001; Nguyen, 2005). According to Freeman (2003), the "hedonic price model is based on the assumption that each housing attribute of the housing bundle is a continuous variable and that an individual can choose any point on the continuous and differentiable hedonic price function in the n – dimensional attribute space". This assumption is not completely realistic, and "in some respects it may seriously misrepresent the problem of choosing a bundle of housing attributes" (Freeman, 2003). An alternative to the hedonic pricing method involves the analysis of discrete choices. In a seminal paper, McFadden (1978) suggested that a random utility model (RUM) can be applied to housing choices. Since then the discrete – choice framework has been commonly applied (Quigley, 1976, 1985; Friedman, 1981; Longley, 1984; Cropper, Deck, Kishor and McConnell, 1993; Nechyba and Strauss, 1998; Chattopadhyay, 2000).

It has been shown that the RUM is preferred over the hedonic pricing method when single market data is used (Cropper et al., 1993). Moreover, Cropper et al. (1993) also found that the discrete choice model yielded better benefit estimates of non-marginal changes compared to those obtained from the hedonic pricing method. Another merit of the discrete choice model is that the generation of welfare measures for non–marginal changes is relatively easy (Bartik and Smith, 1987; Palmquist, 1991; Freeman, 2003). To the authors' knowledge, this method has not been used in South Africa to analyse housing choices.

2.1 THE RANDOM UTILITY MODEL OF HOUSING CHOICE

2.1.1 The conditional logit model

This study applies the RUM of house choice. The RUM allows the researcher to analyse choices among many alternatives. The individual's decision to buy a specific house, for example, as opposed to other substitute houses is treated by the RUM as a stochastic, utility-maximising choice (Parsons, Massey and Kealy, 1999; Haab and McConnell, 2003).

The utility derived from buying house, j may be described by the indirect utility function,

$$V_{ij} = V(z_{ij}) \tag{1}$$

where: z_{ij} = a vector of attributes of house j.

Individual i will buy house j if the utility of house j exceeds the utility of all other houses k in the choice set, where $k = (1, 2, \ldots, n)$. The utility consists of the sum of two parts, a systematic or observable element (V_{ij}), observable to both the researcher and the decision-maker, and a random or unobservable element (e_{ij}), unobservable to the researcher, but known to the decision-maker,

$$U_{ij} = V(z_{ij}) + e_{ij}. \tag{2}$$

This model may be specified in terms of a conditional logit (CL) (Haab and McConnell, 2003). The CL model assumes that e_{ij} is independent and has a type I extreme value distribution. The probability, $Pr_i(j)$, that individual i chooses house j out of n houses is given by

$$Pr_i(j) = exp(V_{ij}) / \sum_{j=1}^{n} exp(V_{ij}) \tag{3}$$

where: $\exp(\cdot)$ = the antilog function.

[2] A variant of the hedonic pricing technique is the repeat sales model. This type of approach relies on a time series of house prices whose structural characteristics have remained constant over time (Freeman, 2003).

The conditional logit model is based on the assumption of "independence of irrelevant alternatives" (IIA) (Uyar and Brown, 2005). This principle states that the relative probabilities of choosing between any two alternatives are unaffected due to the introduction or removal of other options (Haab and McConnell, 2003; Quigley, 1985). The validity of the IIA assumption can, however, only be tested if the dataset allows for this (Quigley, 1985; Chattopadhyay, 2000). For example, if you had city, regional and housing data, one could estimate a nested logit model[3] in order to check whether it fits the data better (Quigley, 1985). In a study by Chattopadhyay (2000), in which a nested logit model was estimated, it was shown that the IIA assumption holds at the dwelling level but it is inappropriate at the neighbourhood level. If panel data were available, a random parameters logit could be estimated which would allow for the testing of whether the parameters follow a non-degenerate distribution[4].

2.1.2 The sampling strategy

In order to make the conditional logit model empirically cooperative, the number of alternative choices should be small. This is a disadvantage of the model that limits its application, as typically a consumer selects a house from a large number of alternatives (Chattopadhyay, 2000). Previous studies have thus had to resort to arbitrary aggregation of dwellings to represent dwelling types (Quigley, 1976; Lerman, 1977). This may lead to biased valuations of attributes in terms of magnitude and sign. In order to alleviate this problem a sampling rule originally devised by McFadden (1978) can be followed. According to this rule, the researcher randomly selects a small subset of dwellings from a large number of alternatives for each consumer. The subset will thus contain the chosen dwelling and a few randomly selected dwellings not chosen by the consumer (McFadden, 1978). At the dwelling level (the only level in this paper), out of N alternatives, a subset, s, is selected which contains n alternatives, such that s contains the chosen alternative and (n-1) rejected alternatives (Chattopadhyay, 2000). If this sampling rule is adhered to, the "uniform conditioning property" is satisfied which leads to consistent parameter estimates (Bayer et al., 2002; Uyar and Brown, 2005).

3 DATA DESCRIPTION AND SOURCES

The neighbourhood of Walmer, Nelson Mandela Bay was the residential market considered for this study. Figure 1 below shows a map of the Walmer neighbourhood as well as the location of the Walmer Township. Average pricing bands for the properties in the Walmer neighbourhood are also shown – these indicate how market prices rise the farther away the property is situated from the Walmer Township. More specifically, the average residential property price (in 2009 rands) located within buffer 1 (0m - 999m) is R1 131 284. The average price increases to R1 590 012 for homes

[3] Under this approach, individuals' housing decisions can be partitioned into several components, for example, different neighbourhoods and cities (Lerman, 1977; Friedman, 1981; Quigley, 1985; Nechyba and Straus, 1998; Bajari and Kahn, 2001; Bayer, McMillian and Rueben, 2002, Chattopadhyay, 2000). Generally, characteristics such as property taxes remain the same within a city but vary across different cities. Similarly, general living standards may vary across different neighbourhoods, but remain the same within a given neighbourhood (Chattopadhyay, 2000). These differences across cities and neighourhoods produce the "nesting structure" necessary for the nested logit model. This leads to an extension of Equation 2 and a conditional logit model under a three-level nested structure can be written as follows:

$P(i,j,k) = \exp(V i\, jk)/\sum_{i'=1}^{I}\sum_{j'=1}^{J}\sum_{k'=1}^{K}\exp(V i' j' k')$ (3)

where:

$P(i,j,k)$ = the probability of selecting the kth dwelling in the jth neighbourhood in the ith city.

In this study, it was not possible to apply the nested logit model as the paper seeks to investigate the effect of a localised social housing project on surrounding property values. Due to this fact, it was not possible to formulate an appropriate nesting structure.

[4] We would like to thank an anonymous referee for pointing this out to us.

situated within the second buffer (1000m – 1999m), and finally, the average price is R1 774 328 for homes situated within the third buffer (2000m – 3000m) (SAPTG, 2011).

Historical sales price data for residential property stands in the neighbourhood that were traded at least once during the past 15 years were collected from the South African Property Transfers Guide (SAPTG) database. All transactions that were not arms-length ones[5] were excluded from the analysis. Data from the Absa house price index (Port Elizabeth and Uitenhage region) were then used to adjust house prices to constant 2009 rands to control for real estate market fluctuations. Originally, municipal data were purchased in order to obtain the relevant structural variables for each dwelling. Unfortunately, most of the data were incomplete which necessitated the physical collection of data on the structural characteristics of each dwelling. Data on four characteristics, namely erf size, the presence of absence of a swimming pool, the absence of an electric fence, and the number of stories were collected. Data on two neighbourhood characteristics namely, the distance to the Walmer Township and distance to the nearest school were collected. The distances of these properties from the Walmer Township and the nearest school were measured (to the nearest meter) using Google Maps. All township distances were measured from the same point, on the outer border of the Walmer Township. The operational definitions of all the variables[6] are provided in Table 1.

4 EMPIRICAL ANALYSIS

This section analyses the data collected in order to determine the effect, if any, on proximity to a low-cost housing development on nearby property prices.

4.1 The sampling methodology

Due to the relatively large number of house sales that occurred over the study period (1326) and the unavailability of house specific data, McFadden's (1978) sampling technique was used to reduce the number of alternatives used in the model estimation. More specifically, in addition to the chosen house, two rejected houses were also selected. The two rejected houses were selected on the basis of temporal proximity to the chosen house. In other words, two rejected houses that were sold within a prior six month period[7] to the chosen house were selected. This selection was clustered random by area (Walmer neighbourhood). This is similar to the approach adopted by Palmquist and Israngkura (1999). In the end, the sample consisted of 154 chosen dwellings and 308 rejected dwellings (154*2). Although the number of alternatives in the narrow choice set (3 dwellings) used in this study may appear small, Parsons and Kealy (1992) have shown that a three alternative choice set is acceptable for randomly drawn opportunity sets in RUM applications. Moreover, Chattopadhyay (2000) applies a two alternative choice set at the dwelling level in a nested logit estimation, and Earnhart (2002) uses three alternatives in a multinomial logit analysis.

4.2 Descriptive statistics of selected houses

Table 2 presents the descriptive statistics of the chosen and rejected houses that were selected by applying McFadden's (1978) sampling rule.

The average chosen house is located on a 1737m^2 erf, has 1.19 stories and sells for R1 598 624. On average, households tended to select dwellings with a swimming pool and an electric fence and also tended to select houses that were further away from the township and closer to the nearest school.

[5] Some property transactions are conducted for reasons other than profit maximization. In the SAPTG database three pieces of information are provided which could reveal property deals that were not at arms-length, namely the price, the seller, and the buyer. For example, a property was sold by a person to his trust for an amount of R40.

[6] Not unlike many international studies, the number of house characteristics included in the RUM estimation is less than would be included in a standard hedonic pricing application (see for example, Palmquist and Israngkura, 1999).

[7] The authors were unable to consider a narrower window (less than 6 months), since there was a lack of sales data.

The average household also tended to select a dwelling with more than one story and generally opted for the cheaper house in the choice set. Interestingly, the average household generally selected dwellings with a smaller erf size. This does not conform to *a priori* expectations and a possible reason for this is the fact that the price, swimming pool, electric fence, distance to the nearest school and distance to the Walmer (Gqebera) township were seen as more important than erf size when selecting the dwelling.

4.3 Estimation results

LIMDEP Nlogit Version 4.0 was used to estimate the conditional logit model. Table 3 presents the coefficient estimates of all variables and their significance.

The signs all conform to a priori expectations, with the exception of erf size. The probability of selecting a specific house increases if the house has a swimming pool, an electric fence, the lower the price, the further away from the township and the closer the house is to the nearest school. The negative erf size coefficient implies that the probability of choosing a house actually decreases if the house is situated on a larger erf. This anomalous result could be explained by potential collinearity (Freeman, 2003). Furthermore, the ceteris paribus condition of maximum likelihood estimation may change the sign of a covariate's coefficient from its expected effect if it were considered in isolation (Earnhart, 2002) . With regard to the significance of the coefficients, the price coefficient is significant at the 10-percent level and the distance to the Walmer Township coefficient is significant at the 5-percent level. This is very encouraging, since the price coefficient is very important for marginal value estimation and also allows for an estimation of willingness to pay for a non – marginal change. None of the other coefficients are statistically significant. This result is not unusual. In a study by Palmquist and Israngkuru (1999), most of the coefficients of the housing characteristics (even ones they deemed important) were statistically insignificant when single market data were used.

4.4 Benefit estimates of a non-marginal change

Once the conditional logit has been estimated, implicit prices for each housing attribute can be estimated directly from the utility function. This is done by dividing the attribute coefficient (α) of interest by the price coefficient ($\beta price$). Since only the "distance to Walmer Township" coefficient was statistically significant, only its implicit price is estimated. This implicit price was estimated to be R1 225 per meter (0.00049/0.0000004). In other words, distance away from the Walmer Township is valued at R1 225/meter. An anonymous referee suggested that this value is very large and requested that the precision of this WTP estimate be investigated. To do this, the parameters' (price and distance to Walmer Township) mean values and their estimated derived standard deviation values were used to create 6000 draws (random and normally distributed) in Microsoft Excel for each parameter. These draws produce a distribution of implicit price figures. The implicit price estimates presented in Table 4 below show the mean and confidence interval of the distributions.

The bootstrapping procedure, as described above, produced a mean of R1243.79, which is slightly higher than the one derived from the estimation output (see Table 3). The variance around the mean, as indicated by the confidence interval, is relatively high. A possible explanation for the wide confidence interval is the small sample size used in this study.

In order to estimate a typical household's willingness to pay (WTP) for a finite increase in distance to the Walmer Township, impact zones were estimated by creating a dummy variable to indicate whether the typical household's chosen dwelling was located in the impact area (the area where proximity to the Walmer Township has a statistically significant, negative effect on Walmer house prices) (Tu, 2005).

The impact area was estimated as a 1999m radius around the Walmer Township (starting from the outer limit of the township) . At a mean distance away from the Walmer Township of 1913m for the average chosen dwelling in Walmer, the finite change was estimated to be 86m (1999m –

1913m). The non-marginal WTP values, based on the mean and confidence interval obtained for the implicit price using the bootstrapping procedure, is shown in Table 5 below. The non-marginal WTP value using the implicit price calculated from the estimation output is also shown in Table 5.

An explanation of non – marginal willingness to pay is that, everything else remaining the same, the average household is willing to pay between R27 262 and R195 564 to move 86m further away from the Walmer Township.

The results of this estimation are subject to four qualifications. First, the Walmer Township is not a recognised social housing development but merely a proxy for one. Future studies should ideally incorporate an existing social housing development. Second, a relatively small data set was used in this study. More accurate parameter estimates and welfare measures could possibly be obtained from a study which uses a substantially larger data set. Third, international studies have produced inconclusive evidence as far as the impact of proximity to low cost housing developments on residential property prices are concerned. To gain a better understanding of this issue other social housing developments in South Africa should be studied to check whether the results remain consistent across different locations. Four, it has been argued that the reduction in residential property prices can be mitigated (Cummings and Landis, 1993). Two specific issues deserve attention here: first, every effort should be made to ensure that social housing developments are of high quality and that their designs match, as far as possible, those of houses in surrounding areas; second, social housing developments should also be carefully managed by the government.

5 CONCLUSION

This pilot study presents an application of the discrete choice model of housing choice to estimate the effect of an existing low-cost housing settlement on surrounding property values. A sampling rule which satisfies McFadden's uniform conditioning property was used to define the choice sets. The paper finds that the Walmer (Gqebera) Township has a statistically significant negative effect on property values in Walmer. More specifically, the typical Walmer household would be willing to pay between R27 262 and R195 564 to move 86m further away from the township. The results of the study also show that the probability of choosing a house increases if the house has a swimming pool, an electric fence, the lower its price and the closer it is to the nearest school.

The results of this study are subject to a number of qualifications. First, the estimation of the conditional logit model assumes independence of irrelevant alternatives, as it was not possible to apply a nested version of the model to formally test if the IIA assumption holds. Second, the study uses one residential neighbourhood in Nelson Mandela Bay as its locus – this limits the extent to which the study's results can be generalized nationally. Finally, the welfare measures developed from the results of this study use a very narrow choice set. Ideally, the full or true choice set should be used to determine welfare measures more accurately. Unfortunately, the true choice set is unknown. Future research should compare the results from a standard hedonic pricing study with the ones obtained here.

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Table 1: A description of the variables used in the study

Variable	Operational definition
Price	Sale price adjusted to constant 2009 rands.
Structural characteristics	
Erf size	Erf size in square meters.
Swimming pool	If the dwelling has a swimming pool = 1; Otherwise = 0.
Electric fence	If the dwelling has an electric fence = 1; Otherwise = 0.
Number of stories	The number of stories that the dwelling has.
Neighbourhood characteristics	
Distance to Walmer Township	In meters.
Distance to nearest school	In meters.

Table 2: Average characteristics of sampled dwellings (standard deviations in parentheses)

Characteristic	Dwelling type	
	Chosen dwellings	**Rejected dwellings**
Structural characteristics		
Price	1 598 624 (732 592)	1 664 592 (767 043)
Erf size	1737 (611)	1787 (632)
Swimming pool	0.79 (0.4)	0.74 (0.44)
Electric fence	0.27 (0.45)	0.26 (0.44)
Number of stories	1.19 (0.39)	1.17 (0.37)
Neighbourhood characteristics		
Distance to Walmer Township	1913 (613)	1809 (587)
Distance to nearest school	2223 (1228)	2316 (2319)

Table 3: Coefficient estimates for dwelling choice (standard errors in parentheses)

Variable	Coefficient
Price	-0.0000004* (0.000000233)
Erf size	-0.000012 (0.0002)
Swimming pool	0.43 (0.258)
Electric fence	0.031 (0.230)
Number of stories	0.23 (0.284)
Distance to Walmer Township	0.00049** (0.0002)
Distance to nearest school	-0.000055 (0.000077)
Log likelihood	-163.56

*Significant at the 10-percent level
**Significant at the 5-percent level

Table 4: Estimates of implicit prices

Parameter	Mean	95% confidence interval
Distance to Walmer Township	1243.79	317.03 – 2274.16

Table 5: Non-marginal WTP values

Type of implicit price estimate	Implicit price	Discrete change*	Non-marginal WTP value
Output estimated implicit price	R1225	86m	R105 350
Mean (bootstrapping)	R1244	86m	R106 984
Lower limit (bootstrapping)	R317	86m	R27 262
Upper limit (bootstrapping)	R2274	86m	R195 564

* At a mean distance away from the Walmer Township of 1913m for the average chosen dwelling in Walmer, the finite change was estimated to be 86m (1999m – 1913m).

Figure 1: The geographical location of the Walmer neighbourhood and the Walmer Township