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Research Paper

HEDONIC METHOD IN HOUSE PRICING ANALYSIS: A CRITICAL REVIEW

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ABSTRACT

Since the seminal paper by Rosen (1974), hedonic pricing method has been extensively employed to estimate housing prices. A housing unit is considered to be a heterogeneous commodity and each unit being different from others because of the different attributes. When a house is purchased or rented, the various attributes that go with it are also purchased or rented. Here, these attributes are broadly classified into structural, locational and neighbourhood characteristics. The market price (rent) of a housing unit can be influenced not only through the cost of construction, but also by the buyers' evaluations of the housing unit's bundle of innate attributes. Price of residential properties varies across space and time depending upon the characteristics of the houses as well as on the preferences of the potential buyers and their capabilities. This paper tries to trace the theoretical and empirical development of hedonic house pricing method. The various popular methods applied in house pricing is also highlighted and conclude by establishing why hedonic pricing method is the most widely used method of house pricing.

KEYWORDS: *Hedonic House Pricing, Structural Attributes, Locational Attributes,*

INTRODUCTION

According to the subjective theory of value, the value of a good is not determined by any inherent property of the good, nor by the amount of labour necessary to produce the good, but instead value is determined by the importance an acting individual places on a good for the achievement of his desired ends (Menger, 1871). Thus, there is no unambiguous meaning to the word "value" as it may denote different things to different people. The goods under consideration embody varying amounts of attributes and are differentiated by the particular attribute composition that they possess. In most cases, the attributes themselves are not explicitly traded, so that one cannot observe the prices of these attributes directly. In such a case, hedonic pricing models are useful in order to determine how the price of a unit of commodity varies with the changes in set of attributes it possesses. As the demand varies with the variation in inherent qualities or attributes of a commodity like house, it is matter of behavioural aspects of individual economic agents like buyers, which is reflected in their choices for various attributes. Both the academia and real estate professionals have therefore accepted behavioural research as a valid and appropriate aspect of real estate market analysis (Gibler and Nelson, 2003; Bello and Bello, 2007; Rahadi, et al., 2012). Much work has been done on the relative impact of factors that influence house prices in the last few decades.

The review of relevant literature has been made under the following broad themes. At first review of studies applying various techniques for house pricing has been made. Then studies related to the theoretical and empirical development of hedonic technique are reviewed. Thereafter, studies on the impact of various housing attributes on housing price have been re-examined.

1. METHODS APPLIED FOR ANALYSING HOUSE PRICING

The recent literature has been primarily concerned with estimating determinants of the demand for various housing characteristics inherent in a housing property and those are sold along with the whole property. Studies reveal how compositional and qualitative changes can affect the median or mix-adjusted measures (that adjust only for speciûc types of compositional change) of house prices. However, these methods cannot capture the impacts of qualitative changes in housing attributes and other social and environmental attributes associated with different houses on price. In order to overcome such limitations, several regression-based approaches have been proposed in the literature.

The *hedonic pricing method* uses regression technique and explains price as a function of house attributes (Freeman, 1979; Li & Brown, 1980). In many of the commonly used hedonic models these characteristics are being categorized into three groups: structural, neighbourhood, and environmental (Akpon, 1994). The second approach is *repeat sales method*, which applies changes of house selling price variation of the same housing unit at different points of time (Follain and Calhoun, 1997). The third one is a Hybrid approach, a combination of elements in the former two approaches and that was first recommended by Quigley (1995). The composition, which he imposes, result in more proficient factor estimates, if the hypothesized error is acceptable. However, only the first two approaches are commonly used. The results from a study of Australian house prices suggest that regression-based methods can provide a useful control for compositional effects (Hansen, 2006). In the present study, the hedonic approach is used because the repeat sales method is inappropriate due to two reasons. Data on house sale is not readily available and houses are not frequently transacted in the area.

2. HEDONIC ANALYSIS OF HOUSING DEMAND

The theoretical and empirical developments in the use of the hedonic technique in the analysis of the demand for housing characteristics have been extensive. A housing unit is considered to be a heterogeneous commodity and each unit being different from others because of the different attributes. When a house is purchased or rented, the various attributes that go with it are also purchased or rented. Here, these attributes are broadly classified into structural, locational and neighbourhood characteristics. Surrounding environmental attributes are included in neighbourhood characteristics.

Relationships between a commodity and its characteristics have been studied by Lancaster (1966), who discussed the utility-bearing characteristics of the commodity, and Rosen (1974) who later extended the study to include a market between buyers and sellers to obtain the equilibrium-implicit prices of the characteristics. Although the work of Lancaster (1966) provided an implicit theoretical base for empirical estimates of hedonic housing price equations, Rosen (1974) developed a theoretical model for the structural analysis of hedonic prices. Now a day, Rosen's approach has been frequently used in analyzing the demand for housing attributes in literature.

2.1. Theoretical and Empirical Development of Hedonic Technique:-

The first formal contribution to hedonic price theory was made by A.T. Court in 1939, although there were some other informal studies. However, more than 15 years prior to Court, Haas (1922) had conducted a hedonic study that has been ascribed to have first published the term "hedonic", which is derived from the Greek word *hedonikos*, which simply means pleasure. In the economic context, it refers to the utility or satisfaction that one derives through the consumption of goods and services. The work of Haas (1922) has been regarded as the first among the applications of hedonic indices. He determined the prices of agricultural areas in Minnesota (USA) during the time period 1916-1919 on the basis of a linear regression model (Colwell and Dilmore, 1999). In another early work, Waugh (1928) provided evidences of the factors influencing vegetable prices by using hedonic pricing model.

One of the most influential studies was done by A.T. Court (1939), who was probably the first to estimate a quality-adjusted price index based on the hedonic price model. By many standards of contemporary hedonic price analysis, Court's work stands up quite well. It deals with problems of nonlinearity and with changes in underlying goods bundles. It addresses a substantive methodological problem with circumspect analysis and interpretation. In his work, he explained that the marginal cost of the characteristics generates the prices of automobiles. Also, L.M. Court (1941) introduced the 'entrepreneurial and consumer demand theories for commodity spectra'. He derived the inverse utility function and via inverse utility function, he defined the counterparts of the Hicks-Allen elasticity of (quantity) substitution, which measures the substitutability of changes in pairs of commodity prices. He based his analysis on the linear continuum of commodities called 'commodity spectrum'. In the commodity spectrum, he considered infinite number of commodities into account. The points of the spectrum represent point-goods and the totality of point-goods within certain subinterval of the commodity spectrum that can be regarded as composing a particular grossly *differentiated* class of commodities. Housing, according to him, is considered as a good item to be used in the commodity-spectrum concept, even though the number of types of buildings is finite. But he claimed that the number is large enough to construct a continuous distribution or spectrum of such types to facilitate the treatment of any economic study of housing. Houthakker (1952) carried out a research on the 'compensated changes in quantities and qualities consumed'. He pointed out that quality variations of a commodity are ignored and the varieties (if any) of an item are evaluated as different commodities. To correct this, he introduced qualities as separate variables in the utility function, in addition to quantities. He examined compensated changes both in qualities and quantities via the Slutsky equation. However, his consumer theory was restricted in the sense that the quality of a commodity was described by one variable. However, he claimed that the methods he proposed could be easily extended to the multi-quality case.

Regression techniques were also applied to analyze the effects of quality changes on the price of cars (Griliches, 1961; and Maurer, Martin and Sebastian, 2004). Muth (1966) introduced the 'household production and consumer demand functions' for similar study. Introducing houses as intermediate inputs in the household production function, he derived the consumer demand function whose arguments are real income, relative prices of other goods and the ratios of relative prices of all commodities used to produce the final good to its price.

However, the two main approaches which contributed greatly to the theoretical development of hedonic prices are based on the works of Lancaster (1966) and Rosen (1974). The first approach was derived from Lancaster's (1966) consumer theory, and the second comes from the hedonic price model postulated by Rosen (1974). The chief technical novelty of Lancaster's theory lies in breaking away from the traditional approach that goods are the direct objects of utility and, instead, supposing that it is the properties or attributes of the goods from which utility is derived. Both approaches aimed to impute prices of attributes based on the relationship between the observed prices of differentiated products and the number of attributes associated with these products. Their models surmised that goods possess a myriad

of attributes that combine to form bundles of characteristics (or objectively measurable, utility-affecting attributes), which the consumer values. However, these models have some fundamental differences.

The Lancastrian model presumes that goods are members of a group and that some or all of the goods in that group are consumed in combinations, subject to the consumer's budget. It also assumes a linear relationship between the price of goods and the characteristics contained in those goods. Implicit prices are constant over ranges of characteristic amounts. They can only change when there is a change in the combination of goods consumed. In comparison, Rosen's model assumes that there is a range of goods, but that consumers typically do not acquire preferred attributes by purchasing a combination of goods. Rather, each good is chosen from the spectrum of brands and is consumed discretely. The hedonic price approach also does not require joint consumption of goods within a group. Rosen postulated that unless it is possible for consumers to arbitrage attributes by untying and repackaging them, a nonlinear relationship between the price of goods and their inherent attributes would be more probable. A nonlinear price function implies that the implicit price is not a constant, but a function of the quantity of the attribute being bought, and, depending on the actual functional form of the equation, on the quantities of other attributes associated with the good as well. Thus, Lancaster's approach is more suited to consumer goods, whereas Rosen's model can be associated with durable goods like housing.

Over the past four decades, the hedonic-based regression approach has been employed extensively in housing market literature to investigate the relationship between house prices and housing characteristics. Specifically, the technique has been employed to achieve three main goals: (i) to explain the price formation of property assets (mainly residential) by identifying the main determinants of property prices, (ii) to isolate and quantify the impact of different structural (physical), locational and neighbourhood characteristics on property prices, and (iii) to account for changes in the price formation process across regions or over time (Lorenz, 2006).

2.2. Impact of Housing Attributes on Housing Price:-

Residential properties are multidimensional commodities characterized by durability, structural inflexibility, and spatial fixity (Chau, Ng and Hung, 2001). Typically, housing attributes are classified into locational attributes, structural attributes, and neighbourhood attributes. These attributes encompass both quantitative and qualitative attributes (Goodman, 1989). The market prices of the property can, therefore, be expressed as a function of locational, structural, and neighbourhood variables. The implicit price of each housing attribute, *ceteris paribus*, can be derived from the regression coefficients (Rosen, 1974). Several empirical studies have been conducted to examine the relationship between attribute preference and housing price. The marginal implicit values of the attributes are obtained by differentiating the hedonic price function with respect to each attribute (McMillan, Reid and Gillen, 1980). This function is known as the hedonic price function; hedonic because it is determined by the different qualities of the differentiated good and the pleasure (in economic terms utility) these would bring to the purchaser.

2.2.1. Locational Attributes:

With respect to the locational attributes, distance to the central business district (CBD) and job accessibility has been found to significantly affect housing prices. Accessibility variables define the ease with which local amenities can be reached from the property where the individual live or is expected to stay. The early model developed by Kain and Quigley (1970) included distance to Central Business District, but it was not statistically significant. Waddell (2011) challenged the familiar assumption that a workplace is determined prior to the residence location. He endorsed for some interaction between these two variables by using a joint model specification. Moreover, he asserted that the degree to which residence location is driven by workplace location (or the opposite) depends on the degree to which workplace locations are distributed in a city, as well as on individual's socioeconomic characteristics. One drawback of Waddell's study is that it does not incorporate transit and highway accessibility measures.

But several later studies found significant negative impact of distance to city or job centre on house prices. For instance, Soderberg and Janssen (2001) using the market as the city centre in Stockholm found significant negative impact on property price with increasing distance. Frew and Wilson (2002) found a significant connection between apartment location and rents in Portland Oregon Metropolitan Area in USA during 1993. They showed that rental values drop substantially for the first ten miles outside of the city centre, indicating that the downtown area is the central urban hub. Frew and Jud (2003) also estimated the value of a sample of apartment properties sold during 1996–99 in the greater Portland, Oregon area and found that property values decline with increasing distance from the city centre. Grimes and Liang (2007) also found that land is highly valued near the city centre, declining (non-linearly) as distance from the CBD increases. In the same way, Zou (2015) found house prices to decrease with distance from the CBD and walking distance to the nearest transit station. Nunns, Hitchins & Balderston, (2015) further found evidence of spatial dependence in Auckland's housing market. In other words, the sale price of a single house is significantly correlated with neighbouring property values.

Hedonic price methods can be applied to separate parts of metropolitan areas to measure price differences both within and among such submarkets. It was observed that judicious subdivision of the metropolitan market using separate equations reveals valuable information about price variation within the metropolitan area (Goodman, 1978). McMillen and McDonald (1998) used distances to multiple employment centres in models to predict both population and employment densities in Los Angeles and suburban Chicago, respectively. Orford (cited in Ottensmann, Payton and Man, 2008) also combined distances to multiple employment centres with distances to other regional amenities in predicting housing prices (Orford Op cit).

Cost of travel, travelling time, availability and convenience of different modes have all been employed to measure accessibility to CBD. Vessali (1996) consolidated the empirical evidence of 37 studies on accessibility and concluded that accessibility to transit tends to appreciate residential property value by 6 to 7 per cent. So, Tse and Ganesan (1997) showed that the accessibility to minibuses

emerges as the most influential in determining house prices based on a sample of a large residential area of the middle income class in Hong Kong. In this case, the use of minibuses as a daily transport mode is important because minibuses pick up commuters close to their homes and are widely used for connecting to other transport modes. Welch (2010), in a study of Atlanta, reaffirmed that accessibility to rail station appreciates property value. However, he found that property located in economically strong area benefit much more as compared to those located in economically weak area for similar transit proximity.

Changes in accessibility were found to affect total property prices significantly – both in a statistical and practical sense. Kockelman (1997) found that changes in accessibility and travel costs affect land and dwelling-unit values in highly significant ways both statistically and economically. Srour, Kockelman and Dunn (2002) used location accessibility as a major explanatory variable for property-valuation and residential location modelling. Access to jobs, shopping centre and parks were found to be statistically and practically significant. They also reveal relations of interest with land rent estimates, which are calculated based on normalized residuals of property-valuation models. Such an association has not been made so clear before, and it suggests that rent formulations may prove an important measure of access, since they follow consumers' willingness to pay for location. Savings in transportation costs and the frequency of transport services appear to have positive impacts on housing prices. However, Kain and Quigley (1970) found that better educated and higher income households tend to reside farther away from CBD, which may be due to preference for tranquillity and cleaner environment.

There are studies that used the hedonic price model to estimate the implicit price of views. Li and Brown (1980) asserted that higher on-site visual quality is strongly associated with higher sales price of residential properties. They estimated that the implied price differential between the highest and the lowest index amounts to $2520. Rodriguez and Sirmans (1994) examined the role of scenic view in housing market in Fairfax County, Virginia and found that a good scenic view adds about 8 per cent to the value of a single-family house.

Tse (2002) affirmed that there is a strong preference for a sea view in Hong Kong indicating that residents are willing to pay a higher price for a sea facing house with a readily sea view. Fleischer (2011) calculated the room prices of hotels situated along the Mediterranean Sea and found that hotels charge higher prices (by about 10 per cent) for a room with a sea view compared to a room without sea view. Lansford and Jones (1995) in their study of the implicit price of recreational and aesthetic benefits found proximity to Lake Travis (with better view of the lake) in Texas command a high premium on residential property prices. Kruse and Ahmann (2009) also observed that Lake Adjacency does have a positive and significant impact on residential property values and that, all else being equal, properties with lake proximity or with a lake view are worth more than properties without these characteristics. Benson, Hansen, Schwartz and Smersh (1998) employed a detailed classification system that categorizes views on the basis of both type and quality of view to estimate the value of the view amenity. They estimated that ocean view and lake view command a high premium in single-family residential prices in Bellingham, Washington and the study also found a positive relationship between the quality of view and property prices.

Corell, Lillydahl and Singell (1978) found that green views have a significant positive impact on adjacent property values. They estimated that distance from the greenbelt has a statistically significant negative impact on the price of residential property. Other things being identical, there is a $42 decrease in the residential property price for every 10 feet distance away from the greenbelt. Jim and Chen (2006) also estimated that view of green spaces and proximity to water bodies increase housing price, contributing notably at 7.1 per cent and 13.2 per cent, respectively in Haizhu district in the core area of Guangzhou (China). Rohani (2012) on the other hand combined view and access to amenity and found that views and amenity of the Hauraki Gulf together has significant impact on property prices in the study area. On an average, other things remaining the same, a broad water view increased the mean land value by 50 percent while locations on the coastline increased land value by 43 per cent. Similarly, Bourassa, et al. (2003) found that the hedonic value of aesthetic externalities increased more rapidly than house prices from 1986 to 1996 in Louisville's neighbourhoods. On the other hand, Tse and Love (2000) found that the attribute of a cemetery view has a significant negative impact on property value in the Hong Kong real estate market.

Interestingly, the hedonic price model has also been employed in the study of the influence of superstitious beliefs on housing prices, especially in the Chinese community. It has been observed that apartments with lucky number (example, numbers 3, 6, 8 or 9) have been found to be sold at significantly higher prices in comparison to those with unlucky numbers such as 4 (Bourassa and Peng, 1999; and Fortin, Hill and Huang, 2013). Although Chau, Ma and Ho (2001) found that a lucky floor number is a valuable housing attribute, the demand for flats with lucky numbers is found to highly volatile in another study by Ho (2008).

2.2.2. Structural Attributes:

Structural variables define the fabric of each building and the plot upon which it is built. A wide range of structural variables were calculated for each property including ground floor area, garden area and property type. Several empirical studies have found that structural attributes such as floor area or size has a significant positive impact on house prices (Carroll, Clauretie and Jensen, 1996; Selim, 2008; Zou, 2015; and Nunns, Hitchins & Balderston, 2015). Interestingly, prices seem to be more responsive to building size (floor space) than they are to land area (Bourassa, et al., 2003; Samarasinghe and Sharpe, 2010). Rodriguez and Sirmans (1994) also estimated that number of rooms; bedrooms and bathrooms significantly affect the house prices positively. So, Tse and Ganesan (1997) in their study of seven housing estates for 1994 in Hong Kong found that the valuation of a higher level floor turns out to be more expensive than that of a middle floor. This observation was reaffirmed by Conroy, Narwold and Sandy (2013). The results of their study also suggest that there is a higher-floor premium for condominiums in San Diego. Specifically, an increase in the floor level is associated with about a 2.2 per cent increase in sale price. But the higher-floor premium appears to be quadratic in price, suggesting that price increases at a decreasing rate above the mean floor level. However, Wong et al., (2006) based on a sample of highly homogeneous housing units in buildings of varying heights, found that (1) the floor-level premium was not constant, but diminished as floor level increases; and (2) there was a positive and significant premium for units in low-rise

buildings over those in high-rise ones. Chau, Wong and Yiu (2004) established that a balcony has a value enhancement effect on high-rise residential properties, regardless of the view outside.

Good architectural design also commands a price premium (Millhouse, 2005). Ahlfeldt and Maennig (2011) have also shown that large architectural structures, like arenas, emanate positive externalities that improve location desirability in their neighbourhoods. Researchers also concluded that age of house is negatively related to the prices of properties (Kain and Quigley, 1970; Rodriguez and Sirmans, 1994; and Zou, 2015). However, Li and Brown's (1980) study found a positive effect of age on some buildings due to historical significance or vintage effects of the buildings. Nunns, Hitchins & Balderston (2015) also pointed out that people place a higher value on 'heritage' buildings (pre-1940) in Auckland, Australia.

The provision of other housing attributes such as garage significantly appreciates housing prices (Forrest, Glen and Ward, 1996). Moreover, Samarasinghe and Sharpe (2010) pointed out that provision of more garages is associated with higher housing sale prices. Garrod and Willis (1992) also pointed out that presence of patio, air and water heating systems, and the numbers of fireplaces positively affect house prices. Other empirical works found that structural quality, such as exterior structure, condition of floors, windows; walls and levels of housekeeping have an impact on housing prices (Kain and Quigley, 1970; Morris, Woods and Jacobson, 1972; and Nunns, Hitchins & Balderston, 2015). Improved quality of infrastructural facilities associated with the house such as water, electricity, access road, drainage, fence, etc also enhance the rental values of residential properties (Augustina, 2015).

2.2.3. Neighbourhood Attributes:

Neighbourhood variables describe the characteristics of local area (surrounding) in which the property is located. The hedonic pricing approach has also been used to explore the impacts of neighbourhood attributes on the property prices. However, the concept of 'neighbourhood' is contentious and there is no consensus in the literature regarding, which variable best proxy neighbourhood quality, an unobservable variable.

Several empirical studies have found that the qualities of schools in the neighbourhood tend to appreciate the value of residential property (Haurin and Brasington, 1996; Black, 1999; and Max, 2004). However, it was pointed out in some other studies that there are also negative externalities of 'year-round school' on the residential properties in the neighbourhood areas (Clauretie and Neill, 2000). Proximity to shopping complexes generates both positive and negative externalities (Des Rosiers, Lagana, Theriault and Beaudoin, 1996). But the size of a shopping centre is found to have a positive contributory effect on the values of surrounding residential properties (Sirpal, 1994; and Des Rosiers, Lagana, Theriault and Beaudoin, 1996). Also, places of worship, such as churches, appears to affect residential houses in a positive way (Carrol, Clauretie and Jensen, 1996). Urban forests also exert positive externalities (Tyrvainen, 1997).

On the other hand, despite beneficial effect of easy access for treatment, availability of hospital in the neighbouring area is found to have a negative impact due to superstitious beliefs of house buyers in Seoul, South Korea (Huh & Kwak, 1997). As opposed to this, Tatt, Yi & Lin (2015) found that condominium price is increased for every kilometre nearer to a hospital in Kuala Lumpur. However, Peng and Chiang (2015) asserted that hospitals exert both positive and negative impacts of residential property prices and suggested that hospitals would only be highly evaluated in a 'close-but-not-too-close' geographic location. From urban planning perspective, hospitals, which are crucial in ageing societies, may reduce its negative externalities by creating spatial barriers such as scenic roads to keep distance from adjacent properties.

Ambient air quality also comes into play in the determination of house prices or rents of apartments. Ridker and Henning (1967), Anderson and Crocker (1971), Chay and Greenstone (1998), Chattopadhyay (1999), Zabel and Kiel (2000), and Murty and Gulati (2004) using hedonic technique examined the relationship between air quality and property values and established that air pollution turns out to be relatively significant variable in explaining residential property values. All these studies found significant willingness to pay for improvement in ambient air quality and thus the increased house prices. Thus, preference for environmental or natural resource quality can be reflected in the variation in house prices, and would be suitably estimated by using hedonic pricing techniques, as shown by Ketkar, 1992 (cited in Kiel,1995), Leggett and Bockstael (2000), and Hoehn and Deaton (2002).

The questions of hazards, security, etc., are also important criteria in case of people's preference of residential houses. There is a clear indication that crime has a statistically significant negative impact on house prices (Thaler, 1978; and Frischtak and Mandel, 2012). Though crime is predominantly a local issue, Pope and Pope (2012) pointed out that a nationwide decrease in crime has a statistically significant impact on property prices and suggested that decreasing crime leads to increase in property values.

Over time, with population growth and technological development coupled with higher living standards, travel frequency has tremendously increased. This has also resulted in increase in noise pollution across all urban areas. Nelson (1982) reviewed nine empirical studies conducted previously in Canada and United States and concluded that the price of a house located adjacent to a major highway depreciates on an average by 8 to 10 per cent. Wilhelmsson (2000) also found significant negative effect of noise pollution on house prices in Angby, a suburb of Stockholm, Sweden. He estimated that a single-family house of SEK975000 would sell for SEK650000 if located near a road where noise is loud. Theebe (2004) estimated that noise levels above 65 db appear to be capitalized into house prices, with a maximum discount of approximately 12 per cent. However, the discount varies across sub-markets and is a non-linear function of the noise level. Several other empirical studies have also specifically analyzed the impact of airport noise and found significant negative impact of airport noise on housing prices (Nelson, 1980; Pennington, Topham and Ward, 1990; Espey and Lopez, 2000; Bell, 2001; and Cohen and Coughlin, 2008). However, Rahmatian and Cockerill (2004) pointed out that there exist two distinct measurable price gradients that distinguish large airports from small airports. They estimated that houses located near a large airport have a price gradient that is significantly larger than houses located near small airports.

Researches on hedonic method also indicate that residential property values are reduced by increased proximity to hazardous waste sites (Deaton and Hoehn, 2002, 2004; Braden, Feng and Won, 2011). However, it was also shown

that people's perception about hazardous waste sites might also change sometimes. Kohlhase (1991) pointed out that a significant discount in the price of houses in Houston's housing market located close to toxic waste dumps. The result was found only after the sites have been identified and publicized by the Environmental Protection Agency (EPA). Before that knowledge coming to public, neighbouring people hardly gave any importance to it. Vor and Groot (2011) also found industrial sites to have a statistically significant negative impact on property values.

Inter-dependence of various attributes has also been highlighted in some studies. It was found that consumers of rented house consider floor area, water supply and power supply to be complementary to each other and the other characteristics of house as substitutes of the floor area (Mishra and Ngullie, 2008). But the study suffers from the limited sample size with many coefficients to estimate and they found the coefficients of most of the relevant explanatory variables insignificant.

Besides, hedonic pricing technique has also been applied to the valuation of a wide variety of products including durable consumer products such as computers and cars, agricultural commodities and wildlife related recreation resources too while other applications have involved the estimation of the benefits of environmental improvements.

3. LIMITATIONS OF HEDONIC MODELS

Despite its wide and popular uses, hedonic measures are not without their limitations. In particular, the use of regression techniques implies that hedonic models are only as good as the speciûcations used to derive them, and often depend on the quality of the data available. If hedonic regressions omit variables that have signiûcant impacts on house prices that can result in biased estimates of pure price changes. Analogously, if the relationships between the attributes of houses and their effect on prices are incorrectly speciûed, for instance through an incorrect functional form, this could also result in biased estimates (Hansen, 2006). Meese and Wallace (1997) said that drawbacks to the hedonic regression approach are ignorance of both the functional form of the relation and of the appropriate set of house characteristics to include in the analysis, which can result in conflicting estimates in the model. However, the functional form issue is resolved by taking different techniques. Even if this model has been widely used, misspecification of models, multicollinearity, independent variable interactions, heteroskedasticity, non- linearity and outliers can affect the efficiency of hedonic price model in real estate appraisals (Limsombunchai, 2004). Els and Fintel (2008) also pointed out that difficulty in identifying the neighbourhood characteristics due to similarity in a specific neighbourhood is an important drawback of hedonic pricing method. Moreover, these characteristics are measured based on the willingness to pay of the buyer for that specific attribute provided that the buyer is aware of its existence. They further noted that hedonic method considers the combined characteristics of the property transacted. This method is more complicated than other methods and needs skill in statistics on interpreting variables and selecting functional forms, which are not a direct process.

The weaknesses of the hedonic method and the assumptions behind it relate to problems of individual perception, subjectivity, continuity, aversion behaviour, market segmentation and the assumption of equilibrium (Maddison, 2001). Another weakness of hedonic pricing method (HPM) is that it can only estimate user benefits, in particular with respect to the recreation value of the area (Garrod and Willis, 1999). HPM also suffers from several analytical problems such as omissions of important characteristics, doubts about the correct mathematical specification of the model, and so on (Garrod, 1994). However, if the limitations of HPM are properly taken into account, the method can be useful in revealing valuable information about the values of attributes. Therefore, these limitations need to be addressed prior to confronting the model with real-world data (Vanslembrouck, Huylenbroeck and Meensel, 2005).

4. ADVANTAGES OF THE HEDONIC APPROACH

The primary problem related with the evaluation of real estate price is its "heterogeneity" (Follain and Calhoun, 1997). In housing market, it is not easy to get many houses with similar quality. The facilities provided and the standard of construction may vary greatly between houses. They also added that bigger heterogeneity is more complicated in valuing, due to variation in quality. Even if buildings have the same facilities, the rate of usage depends on the building's age. Besides, the house price has complex individuality (Shimizu & Nishimura, 2007). As a result, we need to adapt a method in order to manage change in quality of real estate through time. One way to avoid these difficulties is to estimate quality differences using regression analysis (Rosen, 1974).

Several empirical studies show that hedonic approach is more preferable relative to other methods. Mark and Goldberg (1984) evaluated hedonic and repeat sales methods for neighbourhoods in Vancouver and concluded that hedonic approach is better relative to repeat sales that become visible to undervalue increase in price. Meese and Wallace (1997) also argued in favour of the hedonic approach when they applied it for US housing market. The reason is that it is less affected by sample-selection bias and captures better the inherent prices of housing attributes compared to repeat sales approach. Clapham et. al. (2006) also discovered that indices developed by Swedish data set using hedonic approach are less prone to adjustments than repeat sales. Moreover, hedonic approach is less sensitive to tiny segmented markets (Francke, Vos and Janssen, 2000). A study by Wilhelmsson (2008) to construct a price index for the segmented housing market also shows that hedonic regression method is more suitable than the repeated sales method.

The main advantage of hedonic price method is that it is based on real market selection by professionals and theoretical background (Els and Fintel, 2008). Besides, real estate data tend to be easily available, as real estate is a huge investment in many countries, which requires appropriate record keeping. Limsombunchai (2004) also added that managing property attributes is one of the advantages of hedonic method. He further noted that this allows a person to differentiate the impact of the real property appreciation and changing observation composition.

The main advantage of the hedonic pricing method is that one only needs to have certain information, such as the property price, the composition of housing attributes, and a proper specification of the functional relationships. The marginal attribute prices are obtained by estimating the parameters of the hedonic price function. It is a straightforward

approach because only the coefficients of the estimated hedonic regression are needed to indicate the preference structure.

Despite the disputable assumptions associated with hedonic approach, which involve substantial simplification and abstraction from a complex reality, the hedonic price model has been deployed extensively in housing market research (Freeman, 1979; Leggett & Bockstael, 2000; Chau, Ma and Ho, 2001). As astutely observed by Freeman (1979), the data may be inadequate; variables are measured with error; and the definitions of empirical variables are seldom precise, but these do not render the technique invalid for empirical purposes.

Thus, in spite of the limitations of the hedonic pricing method, it is also seen that this method has several advantages especially in the housing market. It has been found to be most widely accepted and hence used method in estimation of housing prices.

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