HEDONIC PRICE MODELLING OF ENVIRONMENTAL ATTRIBUTES: A REVIEW OF THE LITERATURE AND A HONG KONG CASE STUDY

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Contents

Summary

This chapter surveys leading works on hedonic price modelling of the impact of pollution, amenities and zoning regulations on urban property values in western jurisdictions and in particular Hong Kong, as an example of a high-density high-rise urban system that characterises developing world urban morphology. This chapterer examines the relevance of hedonic pricing studies for urban planning and development policies.

1. Introduction

The Coasian firm-market distinction (Coase 1937) is one where the institutional choice is between an organised and a spontaneous mode of exchange. This distinction is mirrored in the broad political debate on the institutional choice between socialism and democracy, and by the Austrian school discussions of the central economic plan-free market dichotomy (Authors' Note 1). Actual experimentation with central economic planning in the last century, at huge human and material costs, has shown that central economic planning is unsustainable and the market is a more preferred mode of coordinating exchanges and division of labour. The crowning victory of the libertarian economists occurred when the Soviet Union collapsed in 1992 without a heated war; it simply crumbled due to internal forces. At a micro level, however, the triumph of the libertarian economist, who has never approved of welfare economics in terms of methodology or policy, is inconclusive. In fact, some prominent figures in the libertarian camp seem to have made a number of concessions concerning government regulation of externalities, a pillar of the welfare economic thesis of market failure. The emergence of the idea of sustainable development, involving maximisation beyond the present generation, appears to provide a chance for the resurrection of welfare economic analysis. It is in this broad institutional context that this article is written; it aims to summarise the empirical findings about the impact of externalities on urban land values. Such information should put into perspective the analytical works collected for this topic of the EOLSS.

One crucial question in the determination of policies for sustainable urban development is the evaluation of the potency and limitations of the land market in internalising externalities or environmental spillovers. Another question is, where the land market fails to internalise externalities, what types of policy instruments are best suited for addressing these externalities? This article surveys a method to ascertain whether and to what degree the land market is capable of internalising externalities—hedonic pricing, and discusses some policy implications of the survey results for addressing externalities. In particular, the review includes a survey of hedonic pricing studies on urban Hong Kong, which is an extremely high-density and high-rise urban environment. The Hong Kong studies provide an excellent basis for comparison of theoretical arguments about market failure with empirical observations of actual land markets.

Hedonic price modelling is a useful econometric tool to analyse the price of a heterogeneous good. It is highly relevant to measuring the value of externalities empirically because they are, by definition, not *separately* transacted in the market—they are not sold on their own. However, the non-existence of a separate market for externalities does not prevent them from being internalised or priced. This is because externalities can be traded jointly with other goods, such as property attributes in the land

market. In such a case, Rosen (1974) postulates that individual attributes, including externalities, of a joint product could be thought of as being separately traded as if *implicit* markets for them existed. This underpins the theory of the hedonic pricing model, which measures the implicit price of property attributes from observed property prices. It is often expressed as a multiple regression model in which property attributes such as size, location, and neighbourhood characteristics are used to explain property prices (see Chapter 4 of DiPasquale and Wheaton 1996 for more details).

The review examines three categories of hedonic pricing studies (a summary of the literature is shown in Table 1). The first category involves 46 studies of the impact of air pollution, noise, views and neighbourhood facilities respectively on land values. Air pollution and noise are negative environmental attributes whereas neighbourhood facilities are positive attributes. 'Views' can be negative or positive, depending on the situation.

The second category of studies involves 32 econometric studies from the urban planning literature, reporting empirical findings on the potency of zoning, as a means to address environmental concerns

(Lai 1994).

Type of Externality	Researches (year)		Effects on Property Values
Air pollution	1	Ridker & Henning (1967)	Negative and significant
	2	Anderson & Crocker (1971)	Negative and significant
	3	Wieand (1973)	Negative but insignificant
	4	Deyak & Smith (1974)	Negative and significant
	5	Smith & Deyak (1975)	Negative but insignificant
	6	Harrison & Rubinfeld (1978)	Negative and significant
	7	Nelson (1978)	Negative and significant
	8	Diamond (1980)	Negative and significant
	9	Li & Brown (1980)	Negative but insignificant
	10	Murdoch & Thayer (1988)	Negative and significant
	11	Graves *et al.* (1988)	Negative and significant
	12	Chattopadhyay (1999)	Negative and significant
	13	Zabel & Kiel (2000)	Mostly negative but insignificant.
Noise	1	De Vany (1976)	Negative and significant only when the airport distance is within 1 mile
	2	Mieszkowski & Saper (1978)	Negative and significant
	3	Nelson (1979)	Negative and significant

	4	Li & Brown (1980)	Negative and significant
	5	Taylor *et al.* (1982)	Negative and significant
	6	O'Byrne *et al.* (1985)	Negative and significant
	7	Lake *et al.* (2000)	Negative and significant
	8	Pennington *et al.* (1990)	Negative but insignificant
	9	Uyeno *et al.* (1993)	Negative and significant
	10	Levesque (1994)	Negative and significant
	11	Tomkins *et al.* (1998)	Negative and significant
	12	Espey & Lopez (2000)	Negative and significant
View	1	Li & Brown (1980)	Positive and significant
	2	Cassal & Mendelsohn (1985)	Positive and significant
	3	Kendree & Rauch (1990)	Positive and significant
	4	Rodriguez & Sirmans (1994)	Positive and significant
	5	Wolverton (1997)	Positive and significant
	6	Benson *et al.* (1998)	Positive and significant
Zoning	1	Crecine *et al.* (1967)	Insignificant
	2	Harris *et al.* (1968)	Positive and significant
	3	Reuter (1973)	Insignificant
	4	Ohls *et al.* (1974)	Negative and Significant
	5	Peterson (1974)	Significant
	6	Stull (1975)	Significant
	7	Maser *et al.* (1977).	Insignificant
	8	Lafferty & Frech III (1978)	Significant
	9	Hamilton (1978)	Positive and significant
	10	Correll *et al.* (1978)	Positive and significant
	11	Jud (1980)	Positive and significant
	12	Grether & Mieszkowski (1980)	Insignificant
	13	Mark & Goldberg (1981)	Insignificant
	14	McDonald (1981)	Significant
	15	Richey & Hendrick (1982)	Insignificant
	16	Asabere & Colwell (1984)	Significant

	17	Frech & Lafferty (1984)	significant
	18	Knapp (1985)	Significant
	19	Mark & Goldberg (1986)	Inconsistent sign and magnitude, but significant
	20	Katz & Rosen (1987)	Significant
	21	Wallace (1988)	Negative and significant
	22	Pollakowski & Wachter (1990)	Significant
	23	Henneberry & Barrows (1990)	Significant
	24	Asabere & Huffman (1991)	Significant in industrial zone but not residential
	25	Brownstone & DeVany (1991)	Little difference between land values in different zones
	26	Lai (1991)	Rail improvement did not significantly affect the office rent gradient
	27	McMillen & McDonald (1993)	Insignificant
	28	Cheshire & Sheppard (1995)	Positive and significant
	29	Lai (1996)	insignificant
	30	Thorson (1997)	Negative and significant
	31	Lai (1997)	Insignificant
	32	Groves & Helland (2002)	Distributive zoning effects
Neighbouring facilities	1	Oates (1969)	Positive and significant
	2	Kain & Quigley (1970)	Significant
	3	Wilkinson (1973)	Significant
	4	Grether & Mieszkowski (1974)	By and large significant
	5	DeSalvo (1974)	Significant
	6	Mark (1980)	Negative and significant
	7	McMillan *et al.*(1980)	Positive and significant
	8	Diamond (1980)	Negative and significant
	9	Mann (1982)	Positive and significant
	10	Weicher & Hartzell (1982)	Positive and significant
	11	Richardson *et al.* (1990)	Significant in 1970 but insignificant in 1980
	12	Sirpal (1994)	Positive and significant

	13	Des Rosiers *et al*. (1996)	Positive and significant
	14	So *et al*. (1997)	Positive and significant
	15	Dunse & Jones (1998)	Significant
	16	Chau & Ng (1998)	Significant
	17	Woo (1999)	Significant
	18	Tse & Love (2000)	Negative and significant
	19	Chau *et al*. (2001)	Significant
	20	Orford (2002)	Significant
	21	Chau *et al*. (2002a)	Significant
	22	Chan (2002)	Significant
Total number of works: 85			

Table 1. Relationship between environment and property values by type of environmental attribute as found in the hedonic pricing literature

The third category of hedonic pricing studies involves studies of land values in Hong Kong, a high-density high-rise urban environment (Lai 1993). This discussion of Hong Kong is meaningful for two reasons. On the one hand, the extremely dense form of urban development in Hong Kong would seem to suggest that property values cannot register the impact of various types of pollution or amenities, as avoidance or capturing of them is difficult. On the other hand, this is the mode of urban development that characterises many developing world countries, notably China.

2. Air pollution and property values

Air pollution has long been regarded as a negative environmental attribute which jeopardises human health and thus productivity. Much literature has investigated the negative effects of air pollution on property values. The results generally support the hypothesis that the market can price the impact of air pollution. Most studies confirm that air pollution has a negative effect on property values.

Ridker and Henning (1967) found a significant negative relationship between air sulphation level and property values in the St. Louis metropolitan area in 1960. Anderson and Crocker (1971) used suspended particulate level as a measure of air pollution and produced similar results for Washington and Kansas City. Wieand (1973) repeated the test by Ridker and Henning using the level of suspended particulates, SO_2 and SO_3, but found no significant relationship. This is possibly due to the high correlation between the air pollution measures.

Deyak and Smith (1974), studying several major metropolitan areas in USA, found that the level of suspended particulates did have a negative effect on property values. However, Smith and Deyak's (1975) further study showed an insignificant effect for eighty-five central cities. Li and Brown (1980) also found a negative but insignificant

effect for fifteen suburban towns in the Southeast sector of the Boston metropolitan area in 1971. They admitted that there might be some specification problems in their regression analysis. Diamond's (1980) study for Chicago found a significant negative effect by using the annual air particulate count. Murdoch and Thayer (1988) found a significant positive relationship between mean visibility (as a proxy for air cleanliness) and house prices in California's South Coast Air Basin in 1979. Graves *et al* (1988) obtained similar results for visibility and suspended particulate concentration in Los Angeles, Orange, Riverside and San Bernardino counties in California in 1979.

Some air pollution studies have undertaken estimates of the demand for clean air. Harrison and Rubinfeld (1978) showed that marginal air pollution damages increased with the levels of both air pollution and household income. Nelson (1978) reported a price elasticity of demand for clean air between -1.2 and -1.4, and an income elasticity of demand of about 1 for Washington, D.C. in 1970. More recently, Chattopadhyay (1999) revealed that households were willing to pay more for the reduction in particulate pollution than in sulphur pollution in Chicago between 1989 and 1990. Zabel and Kiel (2000) confirmed the results of the above studies using panel data for Chicago, Denver, Philadelphia and Washington, D.C. from the 1970s to early 1990s.

It can be concluded from the above empirical findings that the negative impact of air pollution has been capitalised into property values. This suggests that property markets are capable of internalising the externality of air pollution.

3. Noise and property values

Like air pollution, noise can adversely affect human health and productivity. Thus the impact of noise is another popular area of property price research. The focus is generally aircraft and road noise. Most studies agree that noise has a negative effect on property values irrespective of the noise measures used.

De Vany (1976) examined the effects of airport noise on house values based on the distance from Dallas' Love Field Airport. He found that the effects were negative for a distance of less than 1 mile but positive for more than 2 miles, implying joint effects of aircraft noise and accessibility. McMillan *et al* (1980) demonstrated that quietness was an environmental amenity with a positive market value in a study of airport noise for the Edmonton Industrial Airport.

To isolate the separate effects of noise and accessibility, Mieszkowski and Saper (1978) and Nelson (1979) suggested using aggregate measures such as the "noise exposure forecast" (NEF) index and the noise contour map. Both studies confirmed that aircraft noise produced a significant negative effect on detached houses in Canada and USA in the early 1970s. Uyeno *et al* (1993) produced similar results for condominiums located near Vancouver Airport in the years 1987 to 1988 using the NEF index. Levesque (1994) broke down the composite NEF index into three components and found that a higher variability in the loudness could compensate for a higher frequency of flights and their average loudness for Winnipeg in the years 1985 to 1986. However, Pennington *et al* (1990), using the Noise Number Index (NNI), only found a weak negative relationship between aircraft noise and property values for the area near Manchester Airport in the

mid-1980s. Tomkins *et al*'s (1998) findings for the Manchester Airport area on the other hand, showed that the noise effect was significantly negative between 1992 and 1993 despite the fact that the benefits of accessibility appeared to outweigh the noise effect. Based on the mean sound level with a penalty for noises occurring at night, Espey and Lopez (2000) also found a negative and significant effect in the Reno-Sparks metropolitan area from 1991 to 1995.

Some studies have involved measuring noise levels directly. Li and Brown (1980) measured the noise level in decibels on the A scale for the Southeast sector of Boston metropolitan area in 1971. Taylor *et al* (1982) examined the effects of road noise based on the field measurement and prediction method (traffic counts by vehicle types) in the Toronto-Hamilton region of Southern Ontario. Lake *et al* (2000) constructed a hedonic model using the Geographic Information System (GIS) to facilitate the compensation assessment for road noise that affected house values in Glasgow. All three studies identified a negative noise effect. Most importantly, O'Byrne *et al*'s (1985) study for the residential area near Atlanta International Airport showed that noise effects were negative and significant and invariant no matter whether aggregate or individual noise measures were used.

The above empirical findings provide strong evidence that the impact of noise on property values is negative and significant once the advantage of accessibility has been allowed for. This confirms that the externality of noise has been internalised by property markets.

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Authors' Notes

1. It was Steven Cheung who in his monograph *Will China Go Capitalist* (Cheung 1982) actually unambiguously integrated the Coasian and Hayekean distinction.

2. A Government body, called the Land Registry, keeps all property transaction records in Hong Kong. The records contain useful information, such as transaction prices and dates, for hedonic price modelling.

3. According to the Rating and Valuation Department (2002), 93% of the private residential stock had flat size below $100m^2$ at the end of 2001.

4. Buildings Department, Lands Department and Planning Department (2001) allow the exemption of balcony space from the gross floor area (GFA) and the site coverage calculations, subject to the payment of a land premium.

5. It aims at maximising effectiveness in the provision of housing, industry, recreation facilities and transport infrastructure, and it will take into consideration the economic and infrastructure developments in the Pearl River Delta Region and the deeper hinterland of China (Government Information Services 1994).

6. Metropolitan Area, Northeast, Southeast, Northwest and Southwest New Territories.

7. Areas are zoned for residential, commercial, industrial, open space, government/institutional/community, green belt or other specified uses.

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