Paper to be presented to the 16th Annual Conference

of Pacific Rim Real Estate Society

to be held on 24th to 27th January, 2010

Wellington, New Zealand

Effect of road traffic noise on housing price - Hong Kong Evidence

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Abstract

It is generally accepted that certain physical attributes of residential flats in Hong Kong contribute to the prices that they achieve on the market. Noise, however, has been ignored in the literature. This study attempts to examine the effect of noise on the price of residential flats in Hong Kong.

A hedonic pricing model was employed to determine whether noise affects the pricing of residential flats in Hong Kong. The CRTN method was used to determine the actual traffic noise level in individual residential flats for a selected residential neighborhood and to estimate the impact of noise levels on housing prices.

Based on data from 571 transactions over a time span of seven years, it is found that whether a residential flat directly affected by road traffic has a statistically significant effect on its price, with the price decreasing by 8.6%. Upon closer examination, it is found that for every 1 dBA increase in the noise level, the corresponding price of residential flat decreases by 0.31%.

Keywords – noise effect, housing prices.

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Introduction

Hong Kong is one of the most congested metropolitan cities in the world, and has a large-scale traffic network. It is hence unavoidable that the road traffic network creates a serious noise pollution problem in the city (Leung and Mak 2008). The effect of road traffic noise on housing prices has, however, not been examined. This is probably due to the fact that Hong Kong is a generally noisy environment, and also the difficulty in obtaining access to measure road traffic noise levels in residential flats in high-rise buildings. In addition, noise pollution stemming from road traffic noise is complicated, and depends on site-specific environmental conditions.

The objective of this study is to carry out a quantitative (statistical) study on the effect of noise on the price of residential flats in Hong Kong. We selected a medium-rise residential neighborhood in Kowloon, Hong Kong as the setting for the research. A total of 571 transactions, over a time span of seven years, from the chosen neighborhood were analyzed.

Literature review

It is generally held that physical attributes such as building age and height, floor size, view, and aspect may affect the price of residential units in Hong Kong. Chau (2004) carried out an empirical test of this hypothesis and obtained positive results. Studies on the effect of environmental quality, including air quality, on housing prices have also been recently conducted by Chau et al. (2006). Boyle and Kiel (2001) conducted a detailed survey of the existing literature on air, water, and undesirable land-use in relation to housing prices. Luttik (2000) performed an empirical study using the hedonic pricing method on environmental amenities such as trees, water, and open space on housing prices, and identified significant increases in housing prices when these amenities were of higher quality.

The earliest study of the impact of noise on single-family housing prices was conducted by Hughes and Sirmans (1992). They examined the price effects on housing of traffic within a residential neighborhood in the United States, and found a negative relationship between the two. The magnitude was, however, location specific. Wilhelmsson (2000) studied single-family houses in Sweden, and found that noise pollution caused housing prices to be discounted by 30%.

Another line of related research concerns the impact of airport and ancillary noise on the price of adjacent housing. Espey and Lopez (2000) found that airport noise had a statistically significant negative effect on the price of residential homes, with noise levels of 65 decibels or above causing a drop of $2,400 in price compared with similar homes in quieter places. This is in direct contrast to the results of Tomkins et al. (1998), who found that proximity to an airport improved access and employment opportunities, and was thus highly valued by local residents. The findings on this topic are thus mixed. Strand and Vagnes (2001) reported that proximity to a railway line was not appealing to local residents. Their empirical study showed that doubling the distance from the railroad line, provided it was within a 100-meter bound, increased property prices by about 10%.

The Environmental Protection Department (EPD) of the Hong Kong SAR Government has taken many proactive measures to reduce traffic noise. However, despite their efforts some roads still generate noise of greater than 70 decibels (L_{A10} in 1 hour) in residential buildings. It is highly likely that this level of noise affects the price of such flats. The EPD published a guidance note on the preparation of Road Traffic Noise Impact Assessments (RTNIA) under the Environmental Impact Assessment Ordinance (EIAO) in December 2005. This guidance pinpoints mitigation measures for traffic noise and makes reference to a traffic noise prediction model that has been used by the authority for some years, known as the Calculation of Road Traffic Noise (CRTN) model (UK Department of Transport, Welsh Office 1988). The CRTN model is a mathematically based method of estimating the traffic noise level L_{A10} based on physical conditions and the surrounding environmental characteristics of the traffic roadway concerned. Although its accuracy has been challenged, the CRTN prediction method, which originated in the United Kingdom, has retained its position as the sole instrument for traffic noise estimation in Hong Kong.

In a recent study, Leung and Mak (2008) took traffic noise measurements in 29 sites in 16 locations in Hong Kong and compared them with predicted noise levels generated by the CRTN model. They found that the noise levels predicted by the CRTN model closely correlated with the measured noise levels in buildings and at roadsides, with an overall R^2 of 0.7742 and a mean difference of only +0.4 dBA. This indicates that the accuracy of the CRTN model is satisfactory. They also compared the predicted results of three other regression models proposed by local researchers in Hong Kong with the CRTN model, and found the latter to be the most reliable and suitable traffic noise prediction model. This study further affirms that the CRTN model remains a reliable prediction model for Hong Kong. Due to the aforementioned difficulty in obtaining access to residential flats in buildings to take road traffic noise measurements, this study adopted the CRTN method to predict the noise levels in the residential flats under study. The objective was to study the effect of road traffic noise on the price of residential flats in Hong Kong and to establish a quantified relationship between road traffic noise levels and housing prices.

Methodology

This study consists of two parts.

Part 1: The well-established hedonic pricing methodology (see Rosen, 1974) was used to determine whether a residential flat that is directly affected by road traffic has a statistically significant impact on its price. The hypothesis tested was that if a residential flat is directly affected by road traffic, it does have a statistically significant effect on its price. A sample residential neighborhood situated near a busy road in Hong Kong was used to test whether the prices of residential flats in the neighborhood exhibited the expected characteristics. An extract of the location plan of the estate is shown in Figure 1. The subject estate consists of eight tower blocks each of about 30 floors, four of which (Blocks 6, 7, 8, and 9) front onto a major trunk road and the remainder of which are set back from the trunk road.

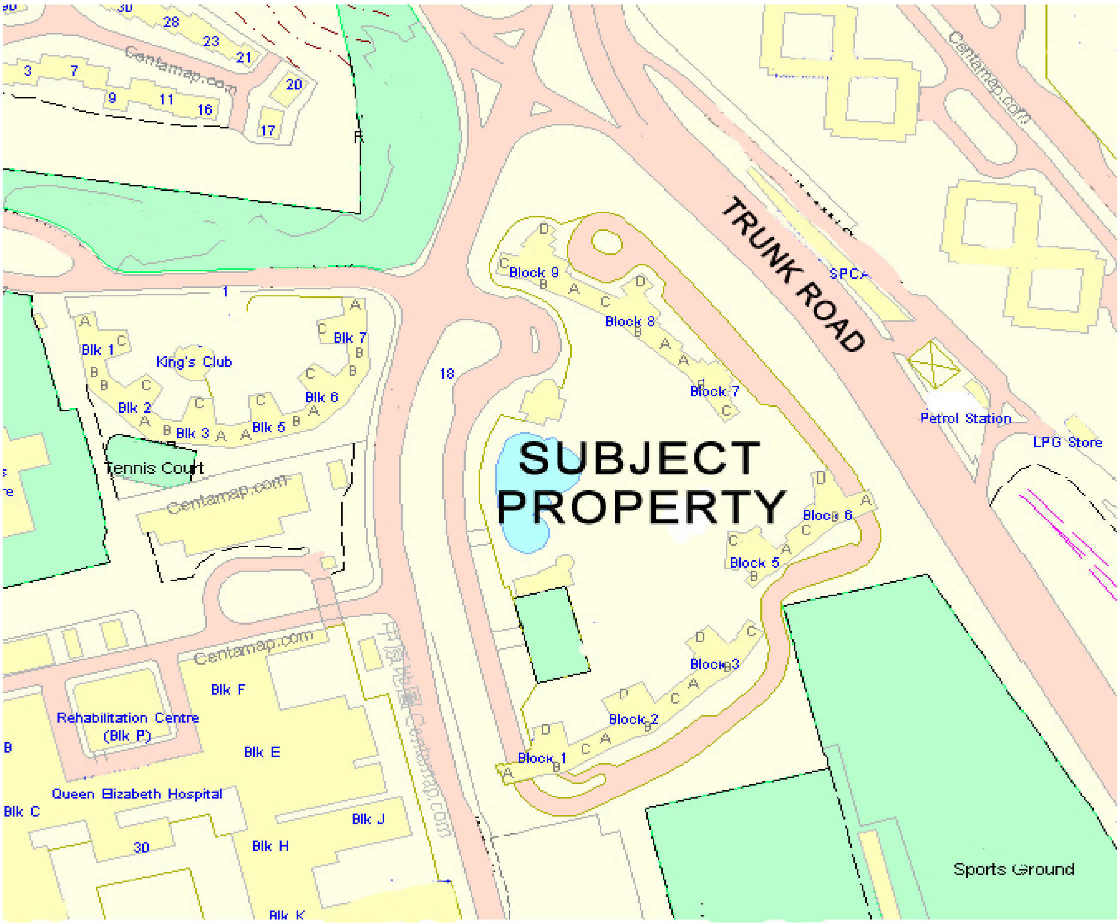

Figure 1: Location plan of the selected neighborhood

Part 2: An attempt was then made to establish a regression relationship between the actual road traffic noise level (measured in dBA) and housing prices. In this part, the CRTN prediction model was adopted to estimate the noise level in dBA (L_{A10}) in different residential flats (on different floors) in the selected housing estate.

At a reception point with a reference distance of 10 meters away from the kerb (which is defined as the edge of the traffic lanes, excluding hard shoulders, hard strips, and bus lay-bys), the CRTN method suggests that the basic noise level L_{A10} can be calculated by

$$L_{A10} = 10 \log \boldsymbol{Q} + 33 \log (\boldsymbol{V} + 40 + 500/\boldsymbol{V})$$

$+ 10 \log (1+5\boldsymbol{P}/\boldsymbol{V}) + 0.3\boldsymbol{G} - 26.6,$

$$(1)$$

where:

Q is the total number of vehicles (vehicles per hour);

V is the traffic speed (kilometers per hour);

P is the percentage of heavy vehicles (those that weigh over 1,525 kg); and

G is the road gradient ***G*** (expressed as a percentage).

The CRTN model assumes that the traffic concerned is a long-line source with a constant speed (no account is taken of vehicle acceleration) and a height of 0.5 meters at the center of the road. Additional corrections to the actual assessment point and other topographic data are necessary for the estimation of L_{A10}. These include corrections for road surface, distance, view angle, ground attenuation, screening, the reflection effect of barriers, and geometrical dispersion (the use of segments). As shown in Figure 2, for the calculation of LA10 at different floor levels of a building, the distance correction in Chart 7 of the CRTN method is based on the shortest slant distance **d’** and the shortest horizontal distance **d** for a reception at a relative height **h** from the source line. The shortest horizontal distance **d** is assumed to be not less than 4 meters; **d’** is therefore the shortest slant distance from the source position given by $\mathbf{d'} = [(\mathbf{d} + 3.5)^2 + \mathbf{h}^2]^{1/2}$, and the distance correction is given by $-10\log(\mathbf{d'}/13.5)$. The predicted LA10 noise level is therefore obtained by combining the basic noise level shown in Equation (1), propagation corrections, including distance correction, and site layout corrections, including the correction for building façade reflection given in the CRTN method.

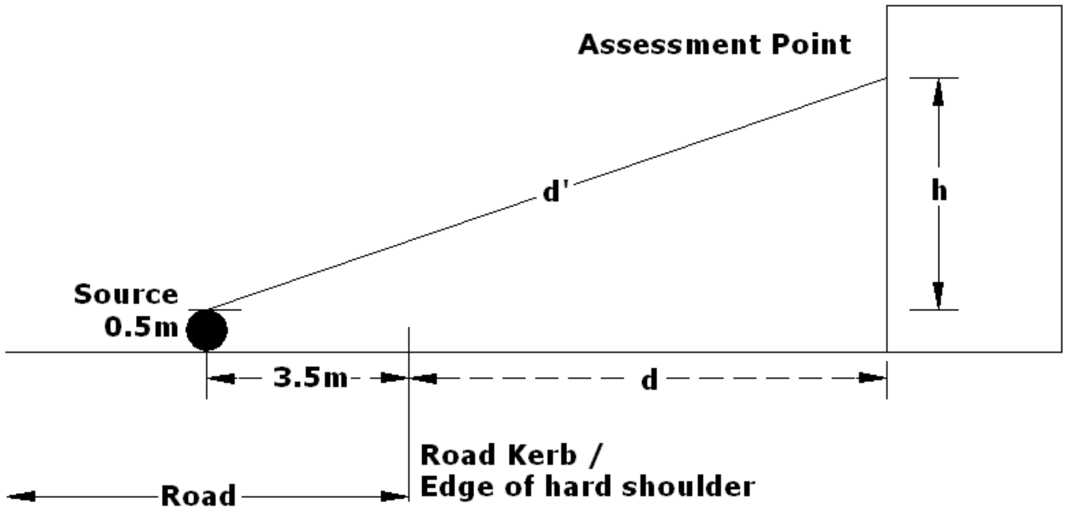

Figure 2 Illustration of the shortest slant distance **d'** and the shortest horizontal distance **d** for a reception at a relative height **h** from the source line

Data Analysis and Interpretation

The housing price data were obtained from the database of the Economic Property Research Centre (EPRC). The traffic noise data in the residential flats were predicted by using the CRTN method based on measured data from actual buildings. A sample dataset consisting of 571 transactions over a time span of seven years were used for the study.

Part 1:

The aim of this part of the study was to determine whether a residential flat directly affected by road traffic has a statistically significant effect on its price. The hypothesis tested was that direct exposure to road traffic adversely affects housing prices. The chosen sample consists of a small deluxe residential neighborhood on the Kowloon peninsula of Hong Kong.

The specification of the equation (Model 1) takes the following form.

$$Ln\_Adj\_P = c(1) + c(2)*Area + c(3)*Floor + c(4)*Road\ nuisance, \quad (2)$$

where Ln_Adj_P is the logarithmic value of housing prices adjusted for market level changes over time,[1] Area is the gross floor area of the residential unit, Floor is the floor on which the flat is located, and Road nuisance (RN) is a dummy variable that measures whether the subject flat (unit) is directly affected by road traffic, where 1 indicates yes and 0 no.

The regression results for this equation are presented in Table 1.

[1] Housing prices are adjusted by the residential sector price index compiled on a monthly basis by the Rating and Valuation Department of the HKSAR government. This adjustment effectively controls the changes in market level over time.

Dependent Variable: LN_ADJ_P
Method: Least squares

Sample: 1 571
Included observations: 571

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.01612	0.031719	473.4103	0.0000
FLOOR	0.011588	0.000763	15.17987	0.0000
AREA	0.000765	2.70E-05	28.34811	0.0000
RN	-0.086280	0.012028	-7.173484	0.0000

R-squared	0.657591	Mean dependent var.	16.02200
Adjusted R-squared	0.655779	S.D. dependent var.	0.230394
S.E. of regression	0.135173	Akaike info criterion	-1.157541
Sum squared resid.	10.36008	Schwarz criterion	-1.127087
Log likelihood	334.4781	F-statistic	362.9712
Durbin-Watson stat.	1.590204	Prob(F-statistic)	0.000000

Table 1: Regression results for Model 1

The results indicate that, at a 1% level of statistical significance, facing a major road has an adverse effect on the price of residential flats. Moreover, the correlation coefficient for the independent variable RN is -0.08628, which implies that if a residential flat in the selected residential neighborhood is directly affected by road traffic, then its price will decrease by 8.628%, ceteris paribus.

We assume that direct exposure to heavy traffic road will not only cause higher decibel levels (more noise) but also poorer air quality (air pollution), less attractive views, and, to some buyers, bad *fung shui*. Hence, flats having direct exposure to trunk road are worth less than flats that do not, all others being equal. The signs of the two other independent regressors – floor and area – are as expected.

Part 2:

Our second empirical test attempted to establish an empirical formula for the relationship between the actual noise level (as measured in dBA) and housing prices, using the CRTN method to predict the traffic noise level for the different buildings in the sample.

The specification of the equation (Model 2) takes the following form.

$$Ln\_Adj\_P = c(1) + c(2)*Floor + c(3)*Area + c(4)*NN \quad (3)$$

where Ln_Adj_P is the logarithmic value of housing prices adjusted for market level changes over time,[2] Area is the gross floor area of the residential unit, Floor is the floor on which the flat is located, and NN is the noise nuisance level (in dB), as predicted by the CRTN method, at the flat. The results obtained from the regressing of the 571 data points are presented in Table 2, which also displays the statistical significance of the actual noise level and the logarithmic value of housing prices.

Dependent Variable: LN_ADJ_P
Method: Least squares

Sample: 1 571
Included observations: 571

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.20632	0.071538	212.5642	0.0000
FLOOR	0.012580	0.000835	15.05760	0.0000
AREA	0.000704	2.70E-05	26.06004	0.0000
NN	-0.003064	0.001037	-2.955085	0.0033
R-squared	0.632180	Mean dependent var.		16.02200

[2] Housing prices are adjusted by the residential sector price index compiled on a monthly basis by the Rating and Valuation Department of the HKSAR government. This adjustment effectively controls the changes in market level over time.

Adjusted R-squared	0.630234	S.D. dependent var.	0.230394
S.E. of regression	0.140099	Akaike info criterion	-1.085954
Sum squared resid.	11.12893	Schwarz criterion	-1.055499
Log likelihood	314.0398	F-statistic	324.8381
Durbin-Watson stat.	1.580928	Prob(F-statistic)	0.000000

Table 2: Regression results for Model 2

The results in Table 2 indicate that the actual traffic noise in residential flats has a negative effect on their price, with a coefficient of -0.003064 at a 1% level of statistical significance. This means that for every increase in noise level of 1 dBA, the corresponding housing price decreases by 0.3064%. For a residential flat with a HK$5 million capital value, this equates to a price difference of $15,000. In our example, the maximum difference in noise levels is more than 20 dBA, which equates to $300,000. This is a large sum of money, particularly as physical remediation of the noise pollution might be possible for a smaller sum. The signs of the floor and area variables are again as expected.

The main contribution of this part of the study is the derivation of a more quantitative measure of the preference of homebuyers in the selected residential neighborhood for quietness.

Conclusion

Two main conclusions can be drawn from the results for the particular sample used in this study. First, facing a busy road has a negative effect on the price of the flats due to noise pollution. The difference in price between a flat subject to direct noise from road traffic and a flat shielded from such pollution can amount to 8.6%. This finding is in line with previous studies (Chau, Wong and Yiu 2004). Second, the actual noise level (as measured in dBA) has a direct detrimental effect on the price of residential flats in this neighborhood in Hong Kong. In the particular case examined here, the relevant coefficient is 0.003064, which translates as a price drop of HK$15,000 for every 1 dBA increase in noise for a residential flat worth HK$5 million. This can be used as a measure of the preference of homebuyers in this particular neighborhood for quietness. As the residential real-estate market is highly segmented, potential purchasers in different neighborhood may have different preferences for quietness, and may be willing to pay a different price for securing it.

Based on our findings, we posit that it is worth investing in noise barriers near busy roads to provide a quieter environment for adjacent residential flats. This is likely to have a positive effect on property values.

Future studies could carry out case studies of the impact of noise on housing prices for different types of housing, such as mass residential housing and luxury housing, and in different residential neighborhoods to verify the findings and methodology of this study.

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