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The value of the provision of a balcony in apartments in Hong Kong

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Abstract *In Hong Kong, a balcony is often perceived as a "green" provision in modern residential buildings. However, how the market values the benefits of balconies is seldom studied due to the difficulty in separating such benefits from other associated effects such as view enjoyment and security concerns. This paper attempts to study the implicit value of a balcony, the green effects of balconies on the prices of residential properties, and the effect of security concerns on balconies situated on lower floors. A sample of transactions in a private housing estate in Hong Kong has been studied. The sample contains apartments with and without balconies. A balcony is found to have a positive effect on the value of a property irrespective of the quality of the view. The negative effects of air and noise pollution on property prices are also found to be highly significant. Although security concerns are found on the low stories of a building, the provision of a balcony does not aggravate the hazard. Finally, the log-linearity assumption in the empirical price model is relaxed by applying the Box-Cox transformation to the continuous variables.*

I. Introduction

With the concept of sustainable development [1] becoming more popular world-wide, buildings attract a considerable amount of environmental concerns. Among these concerns are site environmental impact assessments, choice of building materials, energy efficiency, indoor air quality, and occupant health (Shiers, 2000). They have influenced the planning, design, construction, and management phases of a building's life. It is generally believed that green buildings are more cost-effective to run, healthier to their occupants, more socially responsible to the public, and potentially more valuable to building owners. The government of Hong Kong also grants development intensity concessions to developers so as to encourage the development of green buildings (Buildings Department, Lands Department and Planning Department, 2001) [2].

A balcony is one of the green features that could be incorporated into the design of buildings. It offers several advantages over traditional window designs. From a user's perspective, a balcony may provide a panoramic view and a more spacious indoor environment. From an environmental standpoint, Griffiths (1999) considers a balcony an integrated "environmental filter". Its projected structure can enhance energy efficiency by acting as a sun-shading device, provide a planting space, and mitigate air

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pollution and traffic noise, especially in the high-rise and high-density built environment of Hong Kong. There have been many experimental studies showing that a balcony can significantly shield dwellings from road traffic noise [3] (Mohsen and Oldham, 1977; May, 1979; Tzekakis, 1982/1983; Hammad and Gibbs, 1983; Hothersall *et al.*, 1996; Cheung *et al.*, 1997; Li *et al.*, 2003).

Since land costs are very high in Hong Kong, all developments are developed up to the maximum developable area. Until recently, balcony area was not excluded from the developable area and the provision of a balcony involved a trade-off between internal floor area and balcony area. The recent change in building regulations in Hong Kong provides more flexibility to exclude the balcony area from the developable area, but the provision of a balcony is not without cost, as an extra land premium will be charged [4]. The provision of an excessively large balcony will thus be avoided. How much the market values the provision of a balcony is therefore of significant importance for developers as well as policymakers. The purpose of this paper is to investigate the implicit value of a balcony due to its effectiveness in reducing adverse external environmental effects, and if this value is realized in market transactions. The potential security problem of balconies on low floors is also studied. Our approach is to estimate the market value of a balcony under different situations using empirical data from Hong Kong. The data allow us to estimate hedonic price models under different assumptions.

The paper is organized in the following manner. Section 2 provides a review of literature on the hedonic pricing model, in particular, an estimation of the impact of different views on the market value of a property. Data and methodology are described in Section 3. Section 4 presents the results of an estimation of a log-linear hedonic model. Section 5 examines the effect of security problems on lower floor units. Section 6 tests the results by applying Box-Cox transformation on positive quantitative variables in the hedonic price equation. Section 7 concludes the findings.

II. Literature review

A house is a heterogeneous good. Its value depends on a number of characteristics such as size, age, and location. Rosen's (1974) hedonic pricing model hypothesized that a housing market can be viewed as the interaction of implicit markets for these characteristics. As a result, regression analysis can be utilized to derive the implicit price of each housing attribute and the contribution of each attribute to the overall house price. The housing attributes used are generally classified into:

- structural attributes, such as age and floor area;
- location-related attributes, such as proximity to the CBD, floor level, and view; and
- neighborhood attributes such as the provision of social facilities (Mok *et al.*, 1995).

One potential benefit of the provision of a balcony is the enhancement of view. A number of studies have included view amenities as a housing attribute in their regression analysis. Their focuses were mainly on types of view and the quality of each view.

Rodriguez and Sirmans (1994) found that a good view added about 8 percent to a home's value in Fairfax County, Virginia, although the type of view was not specified.

Kendree and Rauch (1990) divided views into four types (none, marsh, lake, and golf course fairway), and noted that home purchasers were willing to pay more for a better view in South Carolina. There was also one study on bad views by Tse and Love (2000), who showed that home values were lower for flats with a cemetery view in Hong Kong.

Brown and Pollakowski (1977), on the other hand, focused on the quality rather than the type of view. They found that a greater distance from the waterfront significantly reduced the selling price of a house in Seattle. Benson *et al.* (1998) conducted a similar study on ocean views in Bellingham, Washington, and divided ocean view quality into four levels, ranging from a full view to a poor partial view as judged by the extent of obstructions. Their findings suggested that full views and poor partial views increased property prices by about 60 percent and 8 percent, respectively. As admitted by Benson *et al.* (1998) the division of quality levels was subjective.

While an accepted objective classification of view remains unsettled, the effect of a balcony on the quality of a view has largely, if not completely, been ignored. One possible reason is that the provision of a balcony is often associated with a good view, which makes their effects on value indistinguishable [5]. In fact, a balcony, being a green feature, provides more than just a better view. This study extends the literature on view as well as exploring the transaction value of a green attribute by the hedonic pricing model.

In constructing the hedonic model, the linearity assumption on the relationship among variables has generally been found to be unsustainable in literature. Based on Stigler's (1987) Law of Diminishing Utility, Wolverton (1997) found that the size and view of a property exhibited a diminishing rate of change. Similarly, Tse and Love (2000) also observed a decreasing marginal elasticity of house price to building age. The other frequently violated assumption is homoskedasticity. It has been commonly suggested that observations of larger units or older buildings tend to have larger error terms than those on smaller units or newer buildings (Goodman and Thibodeau, 1995, 1997, 1998; Tse and Love, 2000). In view of this problem, So *et al.* (1997) tried to reduce it by confining the range of unit size, whereas Tse and Love (2000) made use of a heteroskedasticity-consistent covariance matrix estimator for the variances. These two problems are considered in this study.

III. Methodology and data

In order to control the effects of the location-related factors, one of the largest housing estates in Hong Kong, Mei Foo Sun Chuen (MFSC), has been chosen for analysis. It consists of more than 2,000 apartment units of different sizes and layouts, but with a relatively homogeneous design. The sample provides a very high variation in terms of the characteristics of a balcony. More than one-third of the units are provided with a balcony. More importantly, the size and orientation of the balconies [6] vary across different units. The sizes range from 4.65 to 11.15 square metres, and the orientations of the balconies include road-facing and garden-facing views. This allows us to separate the green effects from other effects of the balcony. A total of 859 transactions from July 1999 to June 2000 in the estate were taken into consideration. We have chosen a period where price levels were relatively stable so that any error in the property price index that is used for deflating the transaction could be minimized. We began by estimating the following log-linear model (Model 1) using the ordinary least squares (OLS) technique:

$$\ln(\mathrm{RP}) = a_0 + a_1\ln(\mathrm{AGE}) + a_2\ln(\mathrm{FLR}) + a_3\ln(\mathrm{SIZE}) + a_4\mathrm{LVB} + a_5\mathrm{BAL} + a_6\mathrm{RD} + a_7\mathrm{RB} + \varepsilon \quad (1)$$

where:

RP is the real property transaction price in HK$1,000;

AGE is the building age in years old;

FLR is the floor level;

SIZE is the total area in square feet;

LVB is an interactive dummy variable (LB• or ·LV) that equals 1 if a flat possesses a large balcony with a landscaped view, and zero if otherwise;

BAL is a dummy variable that equals 1 if a flat possesses a small balcony with a normal view, and zero if otherwise;

RD is a dummy variable that equals 1 if a flat without a balcony has a road view, and zero if otherwise;

RB is a dummy variable that equals 1 if a flat possesses a small balcony with a road view, and zero if otherwise;

a_is are the coefficients to be estimated; and

ε is the stochastic term.

In Model 1, nominal transaction prices have been deflated to give real prices (RP) at 1995 price levels using the "Monthly Price Indices for Selected Popular Private Domestic Developments" published by the Rating and Valuation Department of the Hong Kong Government. Building age (AGE) in years is the period between the date of building completion to the date of the transaction[7]. The total area (SIZE) is the saleable area including the balcony area, if any. FLR is the floor level on which the unit is located. Table I shows the summary statistics of the data for the quantitative variables.

Binary dummy variables are used to model the effects of different attributes of balconies on transaction prices. The balconies are categorized into two types by size: one is the bigger type of about 120 square feet or (11.15 square metres) (large balcony), whereas the other one is about 50 square feet or (4.65 square metres) (small balcony). Their heights are the same and their areas have been included in the variable of total area (SIZE). There are also flats without balconies. Because of the limited variety of balcony sizes in MFSC, it is modeled as a discrete rather than a continuous variable.

	Maximum value	Minimum value	Mean	Standard Deviation
RP	9,381.31	1,004.46	2,762.28	1,124.19
AGE	31.77	21.19	26.58	2.57
FLR	20	1	11.31	5.27
SIZE	1,450	400	712.72	199.27

Table I. Summary statistics of the data of continuous variables

As for views, they are classified into three types, namely landscaped view, road view, and normal view (Figure 1). Landscaped view refers to flats having a panoramic scenic view of a garden situated to the west of the estate. Road view refers to units facing the heavily-trafficked Kwai Chung Road Fly-Over. This variable serves as a proxy for traffic noise and air pollution effects. All other flats are regarded as having normal views.

Ideally, three types of balcony and three types of view could give nine possible combinations. However, large balcony and landscaped views are perfectly correlated in the sample (i.e. only flats with a large balcony have landscaped views). Therefore, we used a dummy LVB to represent this unit category (units with a large balcony and a landscaped view). The remaining categories of units in the sample are:

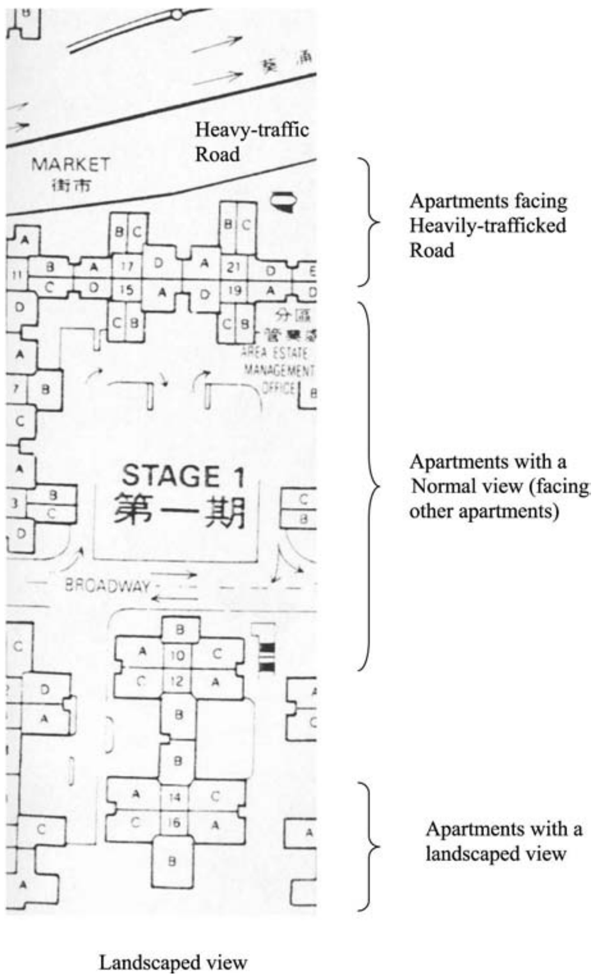

Figure 1.
Extract of the location plan of the estate

- a normal view with a small balcony (BAL);
- a road view without a balcony (RD); and
- a road view with a balcony (RB).

Finally, a unit without a balcony but with a normal view is the control or reference case represented by having all LVB, BAL, RD, and RB equal to zero. The categorization of balconies according to a combination of size and view is summarized in Table II.

The coefficients of ln(SIZE), ln(FLR), and LVB are expected to be positive as those flats with larger sizes, higher floor levels, and better views should command higher market prices. On the other hand, the coefficients of ln(AGE) and RD are expected to be negative, as an older building and a noisier and more polluted environment should result in lower property values.

In this study, two hypotheses are tested. The first is that the provision of a balcony will add value to a property, all other factors being constant. Therefore, the coefficient of BAL is expected to be positive. The second is that the noise-shielding property of a balcony is valuable. This hypothesis is confirmed if the coefficient of RB is expected to be larger than that of RD.

The coefficient of AGE is expected to be negative due to the depreciation of a building structure over time. Since units on upper floors have better views, less noise, and fresher air, the coefficient of floor level (FLR) should be positive. Furthermore, the larger the floor area is, the higher the price will be, and the coefficient of SIZE is expected to be positive. Since a unit with a larger balcony also has a better view, it will be sold at a higher price than a unit with a small or no balcony, and the coefficient of LVB should be positive and larger than that of BAL. The expected signs of the coefficients are shown in Table III.

One of the major assumptions when applying the OLS technique is homoskedasticity. This assumption requires the variances of error terms to be constant across observations; otherwise, the OLS estimators will be inefficient

	Landscaped view	Road view	Normal view
Large balcony	LVB = 1 and 0 otherwise	Does not exist	Does not exist
Small balcony	Does not exist	RB = 1 and 0 otherwise	BAL = 1 and 0 otherwise
No balcony	Does not exist	RD = 1 and 0 otherwise	Reference

Table II. Combinations of view and balcony

Variable	Coefficient	Expected sign
Ln(AGE)	a_1	− ve
Ln(FLR)	a_2	+ve
Ln(SIZE)	a_3	+ve
LVB	a_4	+ve and $> a_5$
BAL	a_5	+ve
RD	a_6	− ve
RB	a_7	$> a_6$

Table III. Expected sign of the coefficients in Model 1 and the t-statistics cannot be interpreted in the usual manner. One of the reasons for using the natural logarithmic transformation on the dependent variable is that such a transformation can remove heteroskedasticity. However, there is no guarantee that this will succeed. It is thus important to test whether the homoskedasticity assumption holds. In this study, we have performed White's (1980) test to check for heteroskedasticity. It is a test for the existence of some unknown and general form of heteroskedasticity. The test statistic is computed by an auxiliary regression, which regresses the squared residuals on all (non-redundant) first moments, second moments, and cross products of the regressors.

Other assumptions of Model 1 have also been examined and are tested later (see later sections). Other models with less restrictive assumptions are then estimated. The purpose is to see whether the hypotheses can be confirmed when the assumptions are relaxed.

IV. Results

Table IV shows the OLS estimates of Model 1. All estimated coefficients are significant at the 5 percent level except RB. The result of White's test cannot reject the null hypothesis of homoskedasticity (p-value close to 0.95), and so the variances of error terms are likely to be constant.

The regression results indicate a reasonably high adjusted R^2 of 0.76, and the signs of all the coefficients are as expected. The coefficients of the quantitative variables can be interpreted as the elasticities of the independent variables. For example, a 1 percent increase in size will lead to 1.03 percent increase in property value, while a 1 percent increase in age will lead to a decline in property value by 0.26 percent.

The interpretation of dummy variables needs more elaboration. The coefficient of LVB indicates that a flat with a landscaped view and a big balcony is expected to sell at a 24 percent higher price than one with a normal view and no balcony. The 24 percent premium is paid for a large balcony and a landscaped view. Due to the inseparable effects of a landscaped view and a big balcony in our sample, the independent effects of large balconies and landscaped views cannot be assessed. However, the coefficient of BAL is positive and significant, confirming our hypothesis that the provision of a balcony increases the value of a residential property, *ceteris paribus*. With the provision

	Model 1 – log-linear model	
Variable	Coefficient	t-statistic
Constant	1.872995	6.651906*
Ln(AGE)	−0.264355	−4.229628*
Ln(FLR)	0.036271	3.743951*
Ln(SIZE)	1.034275	35.53519*
LVB	0.218073	6.518455*
BAL	0.036157	2.353756*
RD	−0.098095	−4.534916*
RB	−0.023124	−0.671423
Adjusted R^2	0.759343	
No. of observations	859	
Dependent Variable	ln(RP)	

Note: * Significant at the 5 percent level

Table IV.
Regression results of Model 1

of a small balcony, the value of the property will increase by 3.7 percent. The large difference between the coefficients of LVB and BAL indicates that a landscaped view may have played an important part in determining property price.

The negative sign of the coefficient of RD reflects the noise and air pollution coming from the heavily-trafficked road. A flat facing this road without a balcony is expected to sell for 9 percent less than one that is not facing it, *ceteris paribus*. This is a rather substantial negative effect. This effect can be counteracted with the provision of a balcony, as indicated by the coefficient of RB. Since the coefficient of RB is not significantly different from zero, it must be larger than the coefficient of RD, which is negative and significant. This result confirms our hypothesis that the adverse effect of facing a road can be counteracted by the provision of a small balcony. This study concludes that the environmental filter function of a balcony is significantly valued in the property market of Hong Kong.

V. Security hazards on lower floors

The previous section demonstrated the positive effect a balcony has on property values. However, this positive effect may diminish on lower floors due to an increased security hazard. As a balcony projects outside and is partially unenclosed, it is reasonable to suspect that flats with balconies on lower floors are more vulnerable to burglary and theft.

To test whether this is true, a dummy variable LFLR is introduced to represent units on lower floors. In our analysis, a demarcation line has been drawn at the fourth floor level, so that LFLR equals 1 if a flat is situated on the fourth floor or below, and 0 if otherwise. Rather than demarcating arbitrarily, the choice is dictated by the Chow breakpoint test (Chow, 1960), which fits the regression equation separately for sub-sample and checks whether there are significant differences in the estimated equations. The results of the test suggested that there is a structural change in the effects of FLR on RP at the fourth floor level ($p < 0.05$). Therefore, to model the potential security hazard effect, we add the interaction terms between LFLR and other dummies variables, namely LVB, BAL, and RB in Model 2:

$$\begin{aligned}\ln(\mathrm{RP}) = a_0 &+ a_1\ln(\mathrm{AGE}) + a_2\ln(\mathrm{FLR}) + a_3\ln(\mathrm{SIZE}) \\ &+ a_4\mathrm{LVB} + b_4\mathrm{LVB}\cdot\mathrm{LFLR} + a_5\mathrm{BAL} + b_5\mathrm{BAL}\cdot\mathrm{LFLR} \\ &+ a_6\mathrm{RD} + a_7\mathrm{RB} + b_7\mathrm{RB}\cdot\mathrm{LFLR} + \varepsilon\end{aligned} \tag{2}$$

The results of Model 2 are presented in Table V. Among the newly-added terms, only the coefficient of LVB × LFLR is significant at the 5 percent level. Its negative sign implies that there is a discrete decline in property value from the fifth to the fourth floor. That is when two identical units, both with a large balcony, are compared, the unit on the fourth floor or below is likely to have a lower value than the fifth floor after taking into account the height effect. This could be a result of the security hazard of units with large balconies on lower floors. This is, however, not conclusive, as it is not clear whether such a decline in property value is due to the potential security hazard of a balcony on a low floor, a landscaped view obstruction, or both. The insignificant results in the coefficients of BAL·LFLR and RB·LFLR indicate that there is no change in flat values on lower floors. In other words, there are no perceived security problems

Variable	Model 2: log-linear model with interaction terms Coefficient	*t*-statistic
Constant	1.846826	6.558389*
Ln(AGE)	−0.255686	−4.086943*
Ln(FLR)	0.028032	2.630810*
Ln(SIZE)	1.036788	35.51461*
LVB	0.240647	6.892951*
LVB·LFLR	−0.197613	−2.353056**
BAL	0.040197	2.527136**
BAL·LFLR	−0.038774	−0.839737
RD	−0.098307	−4.552480*
RB	−0.024672	−0.689142
RB·LFLR	0.032094	0.254460
Adjusted R^2	0.760199	
No. of observations	859	
Dependent variable	ln(RP)	

Notes: * Significant at the 1 percent level; ** Significant at the 5 percent level

Table V.
Regression results of Model 2

with balconies on lower floors. The signs of other coefficients remained the same as those in Model 1, and the results of hypothesis testing have remained intact after taking into account the potential impact of security hazards on lower levels.

VI. The log-linearity assumption

In Model 1 and Model 2, the log-linear functional form has been chosen for convenience and ease of estimation. However, there is empirical or theoretical justification for this functional form. The log-linear hedonic price equation assumes that the elasticities of the attributes are constant. This may not be a valid assumption. A simple test of the linear elasticity assumption is to add log-square terms as shown in Model 3:

$$\begin{aligned}\ln(\mathrm{RP}) = a_0 + a_1\ln(\mathrm{AGE}) + b_1\ln^2(\mathrm{AGE}) + a\ln(\mathrm{FLR}) + b_2\ln^2(\mathrm{FLR}) + a_3\ln(\mathrm{SIZE})\\ + b_3\ln^2(\mathrm{SIZE}) + a_4\mathrm{LVB} + a_5\mathrm{BAL} + a_6\mathrm{RD} + a_7\mathrm{RB} + \varepsilon\end{aligned} \tag{3}$$

The results are given in Table VI. All coefficients are significant at the 5 percent level, except the intercept and RB. The coefficients of ln(AGE), ln(FLR), and ln(SIZE), together with the dummies, also remained the same as Model 1. More importantly, the coefficients of the log-square terms are all significant at the 5 percent level or lower, which rejects the constant elasticity assumption. Model 3 therefore provides a better functional form than the log linear model.

In this model, elasticity is given by $a_k + 2b_k\ln(X_k)$, where $k = 1$, 2 or 3 and $X_1 = \mathrm{AGE}$, $X_2 = \mathrm{FLR}$ and $X_3 = \mathrm{SIZE}$. The elasticity of a variable is not constant, but changes as the magnitude of the variable changes. Since the signs of b_1, b_2, and b_3 are opposite to those of a_1, a_2, and a_3, respectively, the effect of these variables on price diminishes as the variables increase. This is a typical phenomenon resulting from the law of diminishing returns. As the sign of the coefficients of dummy variables remains

Variable		Model 3: log-squared model Coefficient	*t*-statistic
Constant	A_0	4.363803	0.720230
Ln(AGE)	a_1	7.471025	2.446931**
Ln^2(AGE)	b_1	−1.183176	−2.525497**
Ln(FLR)	a_2	0.199095	4.543086*
Ln^2(FLR)	b_2	−0.040978	−3.714192*
Ln(SIZE)	a_3	−3.652725	−3.473075*
Ln^2(SIZE)	b_3	0.359308	4.482257*
LVB	a_4	0.118134	2.944791*
BAL	a_5	0.041154	2.679657*
RD	a_6	−0.098737	−4.615144*
RB	a_7	−0.032705	−0.967173
Adjusted R^2	0.769139		
No. of observations	859		
Dependent variable	ln(RP)		

Note: * Significant at the 1 percent level; ** Significant at the 5 percent level

Table VI. Regression results of Model 3

unchanged, the results further confirm that the provision of a balcony can mitigate the adverse effects associated with facing a heavily-trafficked road.

Since there is no prior knowledge about the functional form of the hedonic price model, the validity of Model 3 can also be challenged. Hence, more flexible functional forms will be considered with the help of Box-Cox transformation and maximum likelihood estimation technique.

Box and Cox (1964) suggested a transformation of strictly positive variable Z in the model to $Z^{(\lambda)} = (Z^{\lambda} - 1)/\lambda$, where λ is a parameter to be empirically determined by the maximum likelihood estimation (MLE) technique. This specification is highly flexible because it includes, but is not limited to, the following special cases of functional forms:

- when all λ_is are equal to 1, it is reduced to a linear specification;
- when all λ_is are equal to 0, it is reduced to a log-linear specification [8];
- when the λ of the dependent variable is equal to 0 and all λ_is of the independent variables are equal to 1, it is reduced to a semi-log specification; and
- when the $\lambda\lambda$ of the dependent variable is equal to -1 and all λ_is of the independent variables are equal to 1, it is reduced to a reciprocal specification.

In our study, all continuous variables in Model 1 are transformed according to the Box-Cox model. Dummy variables are not transformed because they are not strictly positive. The transformed model becomes:

$$\begin{aligned}\mathrm{RP}^{(\lambda_L)} = b_0 + b_1\mathrm{AGE}^{(\lambda_1)} + b_2\mathrm{FLR}^{(\lambda_2)} + b_3\mathrm{SIZE}^{(\lambda_3)} \\ + b_4\mathrm{LVB} + b_5\mathrm{BAL} + b_6\mathrm{RD} + b_7\mathrm{RB} + \varepsilon\end{aligned} \tag{4}$$

where λ_L, λ_1, λ_2, and λ_3, together with $b_k (k = 1, 2, \ldots, 7)$ and the variance of error term are parameters to be estimated by the MLE technique. Since the estimators cannot be determined analytically, numerical optimization is required. The iterative algorithms described by Berndt *et al.* (1974) have been adopted. The results of estimating the Box-Cox model are reported in Table VII.

For practical purposes, some special case models are tested against the above optimal Box-Cox model using the log-likelihood ratio (LR) test. If a special case model is not significantly different from the optimal Box-Cox model, it can be used as a good approximation. The test statistic is:

$$\mathrm{LR} = 2\left[\mathrm{MLO} - \mathrm{ML}(\lambda_i)\right]$$

where MLO is the maximum value of the log-likelihood function of the optimal model and ML(λ_i) is the maximum value of the log-likelihood function of the special case model. Since the optimal model has four different λs, LR follows a Chi-squared distribution with four degrees of freedom. The critical value at the 10 percent level is 7.779. We have tested the special cases for all combinations of λ s equal to -1, 0.5, 0, and 1. With the exception of one special case where $\lambda_L = 0.5$, $\lambda_1 = 4$, $\lambda_2 = -1$, and $\lambda_3 = 1$, all special cases are rejected at the 10 percent level (LR = 7.628). The LR statistics for all other cases are larger than 50. Since this special case is not significantly different from the optimal Box-Cox model, we can estimate the special case model by using the OLS technique:

$$\begin{aligned}\mathrm{RP}^{0.5} = b_0 + b_1\mathrm{AGE} + b_2\mathrm{FLR}^{-1} + b_3\mathrm{SIZE}^1 + b_4\mathrm{LVB} \\ + b_5\mathrm{BAL} + b_6\mathrm{RD} + b_7\mathrm{RB} + \varepsilon\end{aligned} \tag{5}$$

Table VIII shows the results of estimating Model 5. The direction of influence of the variable on price remains unchanged (i.e. signs of the variables are as expected), but the levels of significance are improved. With the exception of RB, all variables are significant at the 1 percent level. Once again, the results confirmed the benefit of the provision of a balcony.

Our analysis suggests that holding other factors constant and given two flats of equal size (total floor area), the one with a balcony is more valuable than the one without it. The implication is that it is more valuable to sacrifice some internal floor

Variable		Parameter	Standard error	*p*-value
RP	λ_L	0.500123	0.027519	0.0000
AGE	λ_1	4.222142	3.681853	0.2515
FLR	λ_2	-1.051559	0.385723	0.0064
SIZE	λ_3	1.094573	0.151635	0.0000
Constant	b_0	42.56903	10.66874	0.0001
AGE	b_1	-1.31×10^{-5}	0.000160	0.9347
FLR	b_2	13.60504	8.266453	0.0998
SIZE	b_3	0.041457	0.042529	0.3297
LVB	b_4	9.427034	3.221399	0.0034
BAL	b_5	2.048855	0.850416	0.0160
RD	b_6	-4.632742	1.737840	0.0077
RB	b_7	-2.053402	2.872010	0.4746

Note: Maximum log-likelihood value (MLO) = -6396.197

Table VII.
Results of Model 4 (Box-Cox Model) by MLE

Variable	Model 5: transformed model Coefficient	*t*-statistic
Constant	31.50070	18.831*
AGE	−0.254897	−4.4281*
FLR^{-1}	−6.168642	−5.5068*
SIZE	0.038587	40.507*
LVB	5.081158	5.8420*
BAL	1.005806	2.7443*
RD	−2.358676	−4.5275*
RB	−1.017840	−1.2272
Adjusted R^2	0.8162	
No. of observations	859	
Dependent variable	$RP^{0.5}$	

Note: * Significant at the 1 percent level

Table VIII. Regression results of Model 5

space to build a balcony. The construction cost of a balcony per unit area is likely to be similar to that of internal floor space. Furthermore, due to high land prices in Hong Kong, the benefit of a balcony (a 3.7 percent increase in the property value) is likely to be a lot larger than the cost (extra cost, if any, for the provision of a small balcony).

A balcony has been found to be a value-added "green" feature. However, its value enhancement effect is likely to diminish as its area increases. In practical terms, the optimization of balcony size with respect to internal floor area is pivotal from a developer's perspective. Although the sample data do not provide a sufficient variety in balcony size for the optimization analysis, the sample was tested by separating the internal area and balcony area effects (not shown). The result shows that a balcony exerts a value enhancement effect only when its size is less than 10 percent of the internal area.

VII. Conclusion

Environmental issues are now a key consideration and have a far-reaching influence on property investment and development. A balcony is, among others things, a proposed "green" provision that acts as an integrated "environmental filter" for mitigating traffic noise, a provider of planting space, and an enhancer of energy efficiency. This paper empirically examines the market perception of these "green" effects in terms of their impact on house prices, and the effect of balconies on security concerns on low floors.

The results suggested that a balcony has a value enhancement effect on high-rise residential properties, regardless of the view outside. It also helps to mitigate adverse environmental impacts, such as noise and air pollution and their effects on property values. In addition, conventional variables, including physical structure variables, have also been found to have significant effects on house prices.

Security concerns on low floors were found to be valid, but the provision of a balcony on low-floor apartments does not worsen the situation. The price elasticity of a balcony does depend in the floor level.

The assumption of log-linearity of the functional form was relaxed through the performance of the Box-Cox Transformation. The signs of coefficient as well as the patterns of change were found to be in line with the log-square model.

Since this study was restricted to data within an estate that provided a limited variety of balcony characteristics, an optimization of balcony size cannot be directly obtained. Along with more balcony provisions in future developments, the feasibility of further study on optimization is envisaged.

This study also suggests that the government should lower the land premium for the provision of an additional balcony area. This will grant developers more flexibility in the design of buildings and thereby allow them to achieve an optimal level for the provision of balcony areas in the longer term.

Notes

1. The term "sustainable development" is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission for Environment and Development, 1987).
2. For example, in Hong Kong, the Buildings Department, Lands Department and Planning Department (2001) encouraged the incorporation of green and innovative features in building developments by exempting the following features from gross floor area (GFA) and site coverage calculations: (a) balconies; (b) wider common corridors and lift lobbies; (c) communal sky gardens; (d) communal podium gardens; (e) acoustic fins; (f) sunshades and reflectors; and (g) wing walls, wind catchers and funnels.
3. The mechanism of noise shielding in a balcony has been pointed out by Li *et al.* (2003), who stated that the internal area is partially shielded by the balcony parapets, and a complex sound field has been set up due to the possible reverberant ray paths between the balcony ceiling, floor, parapets and façades.
4. The Lands Department (2001) provided a practice note on the assessment of the premium which developers have to pay the government for the exemption of balconies from GFA calculations.
5. Furthermore, the value of a balcony may also depend on the geographical location of the studies. The insufficiency of variations of balcony characteristics within a confined geographical location makes it difficult to study the value of a balcony.
6. To distinguish a window from a balcony, an external opening is regarded as a balcony only if it is open on at least two sides and is floor-to-ceiling in height.
7. The date of the government's issue of an occupation permit is taken as the date of a building's completion. The date of the registration of the sales and purchase transaction of the apartment in the Lands Register is taken as the date of the transaction.
8. By L'Hospital rule: $\lim_{\lambda\to 0}\left(\left(Z^{\lambda}-1\right)/\lambda\right)=\ln(Z)$.

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