Pricing under asymmetrical information – A case study on Hong Kong's housing market.

by

CHOY, Lennon H.T[1*]. and CHAU, K.W.[2]

[1]Department of Building and Real Estate, The Hong Kong Polytechnic University
[2]Department of Real Estate and Construction, The University of Hong Kong

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*Please send comments to:
Lennon HT CHOY
Assistant Professor
Department of Building and Real Estate
The Hong Kong Polytechnic University
Hung Hom
Hong Kong
Email: bslennon@polyu.edu.hk

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Abstract:

The housing market in Hong Kong is characterized by the existence of asymmetrical information in the primary and secondary markets. Apartments sold in the primary markets are usually "uncompleted" units hence inspection of property would not be arranged to the prospective buyers normally. On the contrary, buyers in the secondary market can inspect the properties and obtain rather extensive information from the public sources. Generally speaking, the sellers vis-à-vis the buyers in the primary market possess more information than the ones in the secondary market. This study attempts to investigate whether the property developers can take advantage on the asymmetrical information in their pricing strategies. If they can do so, the housing market is said to be inefficient according to Fama's (1970) semi-strong and strong form tests. This study proposes a pooled cross-sectional analysis on selected housing developments in Hong Kong so as to testify if there exists any structural change of values on various housing attributes (e.g. size, floor level and views etc.) across the primary and secondary housing markets. The null hypothesis of no significant change on hedonic price parameters across the primary and secondary markets, however, is being rejected in an empirical study. This study shows that the degrees of information asymmetry will affect how efficient the property developers price the individual housing attributes. Housing attributes with a higher degree of information asymmetry (e.g. views etc.) are more prone to "mispricing" than those attributes with a lower degree of information asymmetry (e.g. size and floor level etc.).

Keywords: Information Asymmetry, Market Efficiency, Hedonic Price Model

Introduction

Under the neoclassical economics framework, the real estate market is hardly regarded as an efficient one. Imperfections, like heterogeneity, indivisibility, illiquidity, high information as well as transaction costs etc., have made the real estate market notorious for being an inefficient one. Besides, contrary to the results of some earlier studies (Gau 1984 and 1985, Linneman 1986 etc.), an increasing number of literatures (e.g. Evans 1990, Case and Shiller 1989 etc.) have found that the real estate market is hardly informationally efficient.

The housing market in Hong Kong is characterized by the existence of asymmetrical information in the primary and secondary markets. Apartments sold in the primary markets are usually "uncompleted" units hence inspection of property would not be arranged to the prospective buyers normally. On the contrary, buyers in the secondary market can inspect the properties and obtain rather extensive information from the public sources. Generally speaking, the sellers vis-à-vis the buyers in the primary market possess more information than the ones in the secondary market. This study argues that if a real estate market is truly efficient, the pricings of real properties during first public sales should be able to pass Fama's (1970) semi-strong and strong form efficiency tests. A study conducted by Chau et al (2003) unveils that taking transaction costs into consideration, arbitrage activities between the spot and future markets of real properties in Hong Kong during 1991-2000 could not make a profit. It means that property developers could have priced their products rather efficiently during first public sales.

While some forms of efficiency tests have been conducted to examine the aggregate prices of real properties, as far as the authors know, how efficient the property developers have priced the individual housing attributes (e.g. size, floor level, views etc.) remains untested. The property developers, somehow, could have priced some of the attributes accurately but not for the others. This study attempts to fill this gap by using a pooled cross-sectional analysis on selected housing developments in Hong Kong so as to reveal if there exists any structural change of value on various housing attributes across the primary and secondary housing markets. Should there is any significant change (+ve or –ve) on the hedonic price parameters across time, "mispricing" behaviors (underpricing or overpricing) during the first public sales can be acclaimed. This study shows that the degrees of information asymmetry will affect how efficient the property developers price the individual housing attributes. Housing attributes with a higher degree of information asymmetry (e.g. views etc.) are more prone to "mispricing" than those attributes with a lower degree of information asymmetry (e.g. size and floor level etc.).

Methodology

A product is said to be mispriced during initial public offerings (IPO) if, on top of the movements of general price level, the price of the product shows an upward or downward movement shortly after the IPO exercise. Assessment on mispricing of IPO stocks is straight forward because resell of the stocks can be made immediately on the IPO date. An IPO stock is said to be underpriced if the share price goes up on the first date of trading, and vice versa. Similar assessment, however, is a luxury in

the property market. According to local regulations, no resell of pre-sale uncompleted properties is allowed until the properties have been completed. Usually, resell of pre-sale properties can only be made after 9 to 18 months from the first public sale date. Technically speaking, it is difficult to acclaim which proportion of the change in property prices is attributed by the effect of general price level movements or by the mispricing behaviors.

Instead of investigating the aggregated prices, this study looks into whether the property developers have under or overpriced the major housing attributes during initial public sales. By doing so, a more microscopic perspective of analysis can hence be produced. Major housing attributes under study include size, floor level and view etc. The pricings of the individual housing attributes can be derived by the hedonic price models advocated by Rosen (1974). Since hedonic price model is a cross-sectional analysis, the pricings of attributes in two different periods require two separate equations. In the primary market (time t_0), the pricings of the individual housing attributes stipulated by the developers are depicted in Equation 1.

$$P_d = \alpha_d + \beta_{d1}X_1 + \beta_{d2}X_2 + \beta_{d3}X_3 + ... + \beta_{dk}X_k + \varepsilon_d$$

(Equation 1)

Where
P_d is the property price set by the developer
α_d is the intercept
$X_{1...k}$ are the major attributes of the properties such as size, floor and view
$\beta_{d1..k}$ are the parameters of the attributes $X_{1...k}$
ε_d is the residual of the equation

Equation 1 unveils the pricing philosophy of the property developer over the major housing attributes. Log and semi-log forms of the equation are used whenever appropriate and the quadratic functions of the attributes will be considered so as to address the problem of diminishing marginal effects (non-linearity). Cautions are taken on the usability of data, which include a cross check on the Land Registry records to ensure that all units are sold out at the pre-released list prices.

In the secondary market (time t_1), Equation 2 illustrates the pricings of individual housing attributes in the open market.

$$P_m = \alpha_m + \beta_{m1}X_1 + \beta_{m2}X_2 + \beta_{m3}X_3 + ... + \beta_{mk}X_k + \varepsilon_m$$

(Equation 2)

Where
P_m is the property price of the open market
α_m is the intercept
$X_{1...k}$ are the major attributes of the properties such as size, floor and view
$\beta_{m1..k}$ are the parameters of the attributes $X_{1...k}$
ε_m is the residual of the equation

Equation 2 unveils the collective wisdom of the market in pricing the major attributes in the secondary market. Again, log and semi-log forms of the equations and the quadratic functions of the attributes will be used whenever appropriate. There is one

major assumption embedded into Equation 2 - the housing development must undergo no substantial change of physical environment from t_0 to t_1.

It is tempting to directly arrive the difference between $\beta_{d1..k}$ and $\beta_{m1..k}$ so as to show if there is any structural change of value on the housing attributes across time. However, Wooldridge (2003) argues that the change of standard errors between two equations (Equation 1 and 2 in our case) may not allow for a meaningful significance test. So a pooled cross-sectional analysis is called upon to reveal the changes of parameters across time.

To conduct a pooled cross-sectional analysis, all the data obtained in t_0 and t_0 will be pooled together. A dummy variable, M, with a value of 1 if the data is obtained at t_1, and with a value of 0 if the data is obtained in t_0, will be added into the new equation (Equation 3).

$$P_{ur} = \alpha + \delta_0 M + \gamma_1 X_1 + \delta_1 X_1 M + \gamma_2 X_2 + \delta_2 X_2 M + \gamma_3 X_3 + \delta_3 X_3 M + ... + \gamma_k X_k + \delta_k X_k M + \varepsilon$$

(Equation 3)

Where
P_{ur} denotes the property prices of the full unrestricted model
α denotes the intercept of the full unrestricted model
M denotes the dummy with a value of 1 and 0 if the data is from t_1 and t_0 respectively
δ_0 denotes the change of property values due to time factor (i.e. from t_0 to t_1)
$X_{1...k}$ are the major attributes of the properties

The parameter value of X_1 in t_0 is γ_1 and the parameter value of X_1 in t_1 is $\gamma_1 + \delta_1$, hence δ_1 denotes the structural change of value of attribute X_1 across the two periods of time. The same principle applies to other attributes, hence $\delta_{1....k}$ denote the structural changes of values of attributes $X_{1...k}$.

To testify if there is a structural change on the whole model between t_0 and t_1, two restricted models are constructed:

$$P_1 = \alpha_1 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + ... + \gamma_k X_k + \varepsilon_1$$

(Equation 4)

$$P_2 = \alpha_2 + \delta_0 M + \delta_1 X_1 M + \delta_2 X_2 M + \delta_3 X_3 M + ...\delta_k X_k M + \varepsilon_2$$

(Equation 5)

Then a Chow's Statistics Test can be performed by using the following formula:

$$F = \frac{(SSR_{ur} - (SSR_1 + SSR_2))/k + 1}{(SSR_1 + SSR_2)/(n - (2k+1) - 1)}$$

(Equation 6)

Where

n is the number of observations
k is the number of independent variables
SSR_{ur} is the sum of squared residuals of Equation 3,
SSR_1 is the sum of squared residuals of Equation 4, and
SSR_2 is the sum of squared residuals of Equation 5

If the F statistics is larger than the corresponding critical value, or Prob>F suggests an insignificant value, the null hypothesis suggests no significant difference between the two groups (i.e. property values at t_0 and t_1) will be rejected.

This study argues that if the property developers have priced the housing units efficiently, then there should have no significant changes on the values of individual attributes between t_0 and t_1.

Two null hypotheses are thus set as:

i) H_0: $\delta_1=0, \delta_2=0, \delta_1=0, \ldots \delta_k=0$ (in Equation 3)

ii) H_0: $Prob<F$ (in Equation 6)

If the two null hypotheses cannot be rejected, it suggests that the major property attributes have not been under or overpriced during the first public sales.

The Case Study and Results

To conduct a case study, the authors have chosen a mass housing development in the Tusen Wan District - a high-density urban area northwest to the Kowloon Peninsula. The development comprises 12 blocks of 40-storey apartment buildings erected upon a podium garden. Underneath the podium garden is a shopping centre serving the whole Tsuen Wan District. The whole housing estate was split into 3 development phases, which comprise 3,360 apartment units in total. The subject premises of this study are the 980 apartment units under the second phase of development. Unit sizes range from 610 to 808 sq. ft. These units either possess a greenery view or a garden view. The development was completed in 1998 and a pre-sale exercise was conducted in March 1997. Almost all units were sold out within a short period of time.

It is conceived that the transaction prices of the first assignment records under the Land Registry are not usable to derive the hedonic price model in the primary market since the prices varied with the payment methods chosen by the buyers. Instead, we have used the list price figures as the values of the dependent variable in Equation 1, which consistently reflect the pricing intentions of the developer. The average unit price is HKD$4.03 million. A multinational surveying firm has helped inputting the housing attribute figures for this analysis. To avoid perfect collinearity problem, we have only put one of the two dummy variables of views into the hedonic price equation. We use EViews 5.0 to produce the statistical analysis. The following depicts the hedonic price model for Equation 1:

$$LN\_price = \underset{(1831.54^*)}{14.12} + \underset{(27.65^*)}{0.0023}floor + \underset{(152.42^*)}{0.0016}gfa - \underset{(-31.56^*)}{0.061}v\_green + \varepsilon$$

where

LN_price	list price (logged)
floor	floor level
gfa	size of apartment in sq. ft., and
v_green	unit with greenery view

(Brackets contain the t-statistic figures, * significant at 5% level, Adjusted R^2 – 0.965, F-Statistic – 8,974)

Equation 1 takes a semi-log form of which the dependent variable has taken a log transformation. Quadratic functions of the independent variables have been removed from the model since the performance of the model will be deteriorated otherwise. The model suggests that the unit price of an apartment increases 0.23% for every floor level increment. Every square foot of space contributes 0.16% of the unit price or HKD$6,448 psf, which is pretty close to the average selling price. A unit with greenery view is about 6% lower in price than a unit facing the podium garden. All the t-statistic figures are significant at the 5 percent level. Furthermore, the result of a White (1980) test suggests that the model is free from heteroskedasticity problem.

To derive the hedonic price model for Equation 2, we have used the transaction records between the first quarter of 2001 to the second quarter of 2002 (18 months). There are 104 transaction records during this period of time. Average market price of the units is about HKD$2.4 million. All the transaction prices have been deflated to the price level of the first quarter in 2001. We have not deflated the figures to 1998 price level since a dummy variable, *M*, will be added to denote the secondary market transactions in the pooled cross-sectional analysis. By so doing, the difference on price levels between 1998 and 2001 will be indicated by the coefficient of the dummy variable *M*. The hedonic price model of Equation 2 takes the following form:

$$LN\_price = \underset{(267.00^*)}{13.62} + \underset{(4.33^*)}{0.0025}\,floor + \underset{(21.11^*)}{0.0015}\,gfa - \underset{(-2.38^*)}{0.031}\,v\_green + \varepsilon$$

(Brackets contain the t-statistic figures, * significant at 5% level, Adjusted R^2 – 0.836, F-Statistic – 169.8)

At first glance, most of the coefficients on the housing attributes at t_1 carry similar values to the ones at t_0. For instance, the coefficients on *floor* are 0.0025 and 0.0023 at t_1 and t_0 respectively while the coefficients on *gfa* are 0.0015 and 0.0016 at t_1 and t_0 respectively. To interpret the results of Equation 2, the unit price of an apartment increases 0.25% (c.f. 0.23% in Equation 1) for every floor level increment in the secondary market. Every square foot of space contributes 0.15% (c.f. 0.16% in Equation 1) of the unit price or HKD$3,408 psf, which is also pretty close to the average market price. However, the coefficient on *v_green* has caught our attention. It suggests that a unit with greenery view was only selling 3% (c.f. 6% in Equation 1) less than a unit facing the podium garden in the after market. On the face of it, the property developer could has underpriced the units with a greenery view for 3%.

As mentioned before, it is inappropriate to compare two hedonic price models directly without going through proper statistical procedures. Now we proceed to a pooled

cross-sectional analysis so as to depict whether there are any structural changes of values on the housing attributes across time. To conduct a pooled cross-sectional analysis, a dummy variable *M* will be added to distinguish the transaction records in the secondary market from the primary market. The coefficient of *M* will tell the change of price levels between t_0 and t_1. Three interaction terms, *M_floor, M_gfa and M_v_green*, are used to indicate the structural changes of values on the three housing attributes across time. Altogether there are 1,084 records (980 in the primary market and 104 in the secondary market) in the pooled cross-sectional analysis. The results of the model are shown as the following:

$$LN\_price = \underset{(1573.40^*)}{14.1195} - \underset{(-17.71^*)}{0.5045}M + \underset{(23.76^*)}{0.0023}floor + \underset{(0.649)}{0.0002}M\_floor$$
$$+ \underset{(130.93^*)}{0.0016}gfa + \underset{(-2.60^*)}{0.0001}M\_gfa - \underset{(-27.11^*)}{0.061}v\_green + \underset{(4.08^*)}{0.0298}M\_v\_green$$

(Brackets contain the t-statistic figures, * significant at 5% level, Adjusted R^2 – 0.977, F-Statistic – 6580)

The model unveils that the prices of the subject premises have dropped 50% from 1998 to 2001. The coefficient on the interaction term *M_gfa* indicates that there is only a negligible structural change of value (+0.01%) on unit size across time. Though it does not pass the 5% level significance test, the coefficient on the interaction term *M_floor* also suggests that there is a negligible structural change of value (0.02%) on floor level across time. The coefficient on the interaction term *M_v_green* is noteworthy, it suggests that there is a significant structural change on the value of greenery view across time. Somehow, the property developer could has underpriced the subject premises with a greenery view for 3% during the first public sale. Furthermore, following Equation 4, 5 and 6, a Chow Test for structural change across time has been conducted. The F-statistic has a value of 6024>3.72 (4,1083 df), which means the null hypothesis of no significant difference between the two groups (i.e. values at t_0 and t_1) is being rejected at 0.5% significance level.

Conclusion

The findings of the case study suggest that a property developer may price various housing attributes with different degrees of efficiency. It is conceived that some attributes are more prone to "mispricing" than the others. The authors keep putting quotation marks on the wording "mispricing" because it is believed that the behaviour could be either unintentional or intentional. If the property developers unintentionally price some of the housing attributes inaccurately, for instance due to the immense information cost to reveal the buyers' preference, the real estate market can be regarded as an inefficient one according to Fama's (1970) semi-strong form test, i.e. the selling prices do not reflect all available information. In contrast, if the property developers intentionally "misprice" some of the housing attributes, for instance by taking the advantage of private information, the real estate market can be regarded as an inefficient one according to Fama's (1970) strong form test, i.e. abnormal profits are taken because of insider knowledge. The authors argue that how "inefficient" the property developer prices the individual housing attributes is subject to the degree of information asymmetry of each attribute he is facing vis-à-vis the buyers. The higher degree of information asymmetry, the higher chance of "mispricing" behaviours on a

particular housing attribute will be resulted. For housing attributes that are more homogeneous in nature, such as size and floor level, both the sellers and buyers are facing a similar set of information. These attributes are prone to be more efficiently priced. On the contrary, for those housing attributes that are more heterogeneous in nature, such as view, orientations and the physical design and environment etc., the sellers and buyers are facing a rather different set of information. These housing attributes are more prone to "mispricing" by the property developers.

Information asymmetry is about the differential information costs borne by the various players of an economic game. Generally speaking, the information costs borne by the property developers should be lower than the costs borne by the buyers in the primary market. Having said that, the authors do not suggest that the property developers will always take this advantage by overpricing the attributes that are more informational costly to the buyers. Subject to the institutional constraints, the sellers may choose an overpricing or underpricing strategy so as to maximize the total returns. One classical example of underpricing strategy under information asymmetry is the IPO exercise in the stock market. Rock (1986) proposes the "winner's curse" explanatory towards the underpricing behaviours adopted by the underwriters, who are believed to be more informative than the share subscribers. Rock argues that if all new shares are exactly priced, better informed investors will crowd out less-informed investors for good issues. Less-informed investors will always be allocated with bad issues and leave the stock market eventually. In order to make both good and bad issues fully subscribed, underwriters, at the expenses of the issuers, will tend to underprice all IPO stocks.

The primary objective of this paper is to demonstrate that the degrees of information asymmetry will affect how efficient the property developers price the individual housing attributes. The authors, however, do not attempt to explain why the property developer had chosen an "underpricing" strategy as such because it will otherwise require a detailed study on the institutional constraints that the property developer and the buyers are facing respectively. A possible explanation to this "mispricing" behaviour, however, has been proposed by Choy (2005) who looked into the issue from the new institutional economics perspective. The author attempted to explain that under information asymmetry, it is the dominant strategy for the seller to "underprice" the lemons, a terminology borrowed from Akerlof (1970), even though the seller can actually overprice them. The subject premises could possibly be considered as a lemon by the property developer since the government was planning to build a highway facing the apartments with a greenery view. This highway project, however, had yet become public information until the construction started in September 2002 (i.e. after the study period of this paper). The lemons were "underpriced" because at the margin, the "underpricing" premium would give an incentive to the marginal buyer to resell the lemons in the open market shortly after he had obtained the units. The seller would then be set free from the legal liability for selling the lemons to the marginal buyers. The total return of the property developer will be optimized by equating the marginal "underpricing" premium to the marginal saving on potential litigation and compensation costs.

The arguments put forwarded by the study can be generalized to explain the pricing of lemons under information asymmetry. In a world of positive transaction costs, the cost of delineation of a full set of property rights is astonishingly high. It can never be

technically and financially feasible to spell out all the contractual liabilities explicitly. So every contract is suffered from different degrees of incompleteness. For this reason, it is conceived that the IPO exercise, a tie-in sale of a bundle of incomplete contracts, is bound to be informational costly. Similar to other initial assignment of property rights exercise (e.g. American gold rush example by Umbeck, 1981), a firm should choose the least transaction costs arrangement to allocate the IPO stocks. Taking the potential litigation costs into consideration, the dominant pricing strategy adopted by the firms is to "underprice" their IPO stocks. By doing so, the firms and the underwriters can get rid of their legal liabilities at the margin by giving an incentive to the marginal stock subscribers to resell the stock shortly after the IPO date.

While the optimal "underpricing" premium is not observable in the real world, this study shows that the property developer had chosen to "underprice" the lemons for 3%. So far as the authors know, none of the buyers of the subject premises has sued the property developer for selling the lemons. It could mean that the property developer had priced the apartment units rather efficiently.

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