Public vs. Private Real Estate in Hong Kong Using Adaptive Expectations

Executive Summary. *Previous studies (Tse and Webb, 2000) have found mixed evidence for the role of the expected growth rate in real estate prices for explaining ex post real estate stock prices. This study demonstrates that the change in real estate stock prices is affected by both expected and unexpected changes in real estate prices where real estate price expectations are formed adaptively. The model presented in this study explains very well the real estate stock prices in Hong Kong for the period 1984–1998. This study indicates that both the* expected *and* unexpected *changes in residential, office and industrial real estate prices are important determinants of the change in real estate securities prices for Hong Kong.*

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Introduction

Real estate market movements are not easy to understand. Yet there is a need for portfolio analysis, and several approaches are available to the quantitative analyst. The application of investment evaluation techniques requires an understanding of the interactions between different investment tools. It has been argued that price changes for the private real estate market is, potentially, a major mechanism for affecting changes in real estate securities prices (*e.g*., Quan and Titman, 1999; and Tse and Webb, 2000). The so called real estate securities in Hong Kong represent those companies that put most of their assets in the form of real estate properties, or are involved in real estate development. Most of these developments are uncompleted properties. Thus, their stock values are not tied directly to the value of the real estate properties owned by these firms. Therefore, the stock prices of these companies may not reflect the public's evaluation of the real estate values in Hong Kong. Because of the exorbitantly high value of real estate properties in Hong Kong, this category of common stocks is an important part of the Hong Kong Stock Exchange. Because both common stock and real estate transactions in Hong Kong are very active, they provide an ideal case for studying the influences of real estate prices on stock prices.

Tse and Webb (2000), using Hong Kong real estate and common stock price data, show that real estate prices had high positive correlations with real estate securities prices. Their study indicated that the impact of private residential real estate prices on real estate stock prices is more than 170% and

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84%, respectively, of the impact for office and industrial real estate prices on stock prices, and that the changes in private real estate prices tend to lead real estate stock prices with a feedback effect. However, Tse and Webb also found that real estate stock prices do not respond to the expected change of real estate prices, where the expected change of real estate prices is based on extrapolative expectations.

However, Eichholtz and Hartzell (1996) estimated correlations of −0.09, −0.10 and −0.08, respectively, for the United States, Canada and the United Kingdom between real estate and common stock indexes. More recently, Quan and Titman (1999), using data from seventeen different countries over fourteen years, found a significant positive relation between stock returns and changes in office real estate values. They argue that real estate and stock prices are driven both up and down by the changing expectations of future economic growth that are independent of current fundamentals. However, their study does not distinguish between the impacts of *expected* and *unexpected* changes in real estate prices on real estate stock prices.

While it appears that there is a close relationship between real estate and real estate common stock prices, the impact of expected real estate prices on stock prices is mixed. Quan and Titman (1999) argue that the correlation between real estate and common stock prices would be reduced by other factors. For example, stock prices may increase because of increased investment opportunities in an economy's corporate sector. As a result, this increase in investment opportunities could lead to increases in real interest rates, thus reducing the real estate values even if their rental prices remain unchanged. On the other hand, if construction costs increase (other things being equal), then the expected profitability of real estate firms decline, and the real estate stock prices will fall. Yet an increase in construction costs can lead to an expected increase in future real estate prices. However, these impacts will only incorporate in the expected real estate prices. In other words, expectations will indeed play an important role in such analysis. It is therefore not surprising that the correlation between real estate and real estate stock prices can be reduced when the expectation factor is not taken into account.

The purpose of this study is to provide additional evidence on the impact and magnitude of the expected changes for private real estate prices on real estate stock prices (public real estate). The key assumption is that, while the model by Tse and Webb (2000) can explain the short-run impacts of the market, long-run impacts are driven by variables that do not enter into the model and thus have to be fitted into a full expectations framework. This study is based on Tse and Webb's (2000) model combined with adaptive expectations suggested by Cagan (1956). This study suggests two different ways to reexamine the impact of real estate prices on stock prices. The first approach assumes that the expected inflation rate is a proxy for the expected change in real estate prices, and the inflation rate follows adaptive expectations. The second approach simply assumes that the rate of growth in real estate prices follows the adaptive expectations. The first approach generally suffers from a weaker theoretical grounding, but an attempt is made to reconcile both approaches. This study compares the relative impacts of residential, office and industrial real estate prices on real estate stock prices.

The Model

Following Tse and Webb (2000), it is assumed that the rate of change for real estate stock prices (xp) is affected by expected and unexpected changes in the growth rates of real estate prices:

$$xp_t = \alpha(x_{it} - E_t x_{it}) + \beta E_t x_{it}, \qquad (1)$$

where $xp_t = (XP_t/XP_{t-1} - 1)$, represents the rate of growth for a real estate stock price index (XP), which is the Properties Class Index of the Hong Kong Hang Seng Index. The hypothesis is that the unexpected and expected changes in real estate prices are positive, if $\alpha > 0$ and $\beta > 0$, respectively. This study uses residential, office and industrial real estate prices. Note that residential and office real estate are the most important and popular investment targets for Hong Kong investors (Tse and Webb, 2000).

The difference between the expected and realized (ex post) growth rate of real estate prices is the unexpected growth rate of real estate prices ($x_{it} - E_t x_{it}$), where x_{it} is the growth rate of real estate prices in class i. In equilibrium, the rate of growth for real estate prices would equal rental growth rates and inflation rates (Tse and Webb, 1999). Thus, in the first model, it is assumed the expected rate of growth of real estate prices is simply the actual inflation rate:

$$E_t x_{it} = E_t \rho_t, \tag{2}$$

where ρ is the inflation rate, which is simply the growth rate in the Consumer Price Index (CPI). This implies that:

$$xp_t = \alpha(x_{it} - E_t \rho_t) + \beta E_t \rho_t. \tag{3}$$

The next step is to estimate expected inflation rate ($E_t P_t$). The basic problem is that, in the absence of index-linked securities, the expected inflation rate is simply not observable. Expected inflation can be derived from the differences between the yield on comparable index-linked and nominal securities. In the absence of index-linked securities, expectations of inflation can be obtained using time-series methods or from the rates of inflation forecast by econometric models. Fama and Gibbons (1984) use the Fisher equation and time-series analysis to estimate real returns for Treasury bills. From the Fisher equation, the difference between the Treasury bill rate and the fitted expected real return provides a measure of the expected inflation rate. Using Box-Jenkins analysis, the realized real return can also be represented as an integrated first order MA process. Alternatively, inflation rates can be weighted to compute an average measure of expected inflation over the term to maturity. For example, Chadha and Dimsdale (1999) use a three-year weighted backward-looking moving average. However, interest rates help to depress inflation. Hence, nominal interest rates may be important to the market's evaluation of the inflation situation.

Empirical testing of the behavior of the expected rate of growth for real estate prices ($E_t x_{it}$) is the focus of this study. Tse and Webb (2000) assume that nominal interest rates are important to the market's evaluation of the inflation situation and thus play a central role in the formation of inflation expectations. Thus, they assumed that the expected inflation rate is determined by the past interest rate and inflation rate (Fama, 1975). In addition, they have to assume that ex post inflation rates represent a proxy for the expected growth rates in real estate prices. Specifically, Blanchard and Summers (1984) suggest that expected inflation is represented in an ex post manner as a distributed lag of actual inflation rates. However, it has been argued that since Hong Kong interest rates follow U.S. interest rates, rising interest rates may not accompany rising inflation. As a result, the influence of interest rates on inflation rates is smaller than expected, and the expected growth rate of real estate prices is too volatile to be represented by the ex post inflation rates. Harris (1989) argues that the interest rate is often slow to reflect changes in expectations. The slow adjustment of interest rates to inflation has been examined by Friedman and Schwartz (1982). It is very difficult to verify the statistical properties of the expected rate of growth for real estate prices because expectation is unobservable. Recognizing the importance of the expected real estate price growth rate on the model, the time series model is reexamined by incorporating Cagan's expectation model. The expectational model that Cagan (1956) developed eventually became well known as the model of adaptive expectations:

$$E_t x_{it} - E_{t-1} x_{it} = \gamma(x_{i(t-1)} - E_{t-1} x_{it}). \tag{4}$$

Equation (4) also implies that:

$$E_t x_{it} = \gamma(1 - (1 - \gamma)L)^{-1} x_{i(t-1)}, \tag{5}$$

where L denotes the lag operator, then $LE_t x_{it} = E_{t-1} x_{it}$. If $\gamma = 0$, then $E_t x_{it} = E_{t-1} x_{it}$. If $\gamma = 1$, then $E_t x_{it} = x_{i(t-1)}$.

The expected real estate price is adjusted upward, relative to its previous value, when the last real estate price exceeds its own previously expected value ($E_{t-1} x_{it}$). Correspondingly, if $x_{i(t-1)}$ were smaller than $E_{t-1} x_{it}$, the value of $E_t x_{it}$ would be lowered relative to $E_{t-1} x_{it}$. The extent of the adjustment is indicated by γ: if the parameter γ is close to 1.0, the adjustment is relatively strong (and weak if γ is close to zero).

In Hong Kong, the inflationary spiral began in the mid-1980s, rising from about 3% in 1986, to 12% in 1991, and then stabilizing at an average of 9% for the 1992 through 1995 period. Inflation rates declined to 1986 levels and real estate prices moderated in 1996. In Cagan's (1956) expectation model, it can be shown that the expected inflation rate can be expressed as a weighted average of all current and past actual inflation rates. More weight is attached to recent, as opposed to distant, values. It can be shown that inflation expectations tend to slow down, even if current inflation was escalating. Thus, Cagan's adaptive expectation model can explain very well the inflation movement in Hong Kong.

In this study, two models are employed. First, Equation (2) is used which assumes that the inflation rate follows the adaptive expectations:

$$E_t\rho_t - E_{t-1}\rho_t = \gamma(\rho_{t-1} - E_{t-1}\rho_t). \tag{6}$$

If both sides of Equation (3) are multiplied by $(1 - (1 - \gamma)L)$ and substituting for $E_t\rho_t$, we obtain:

$$xp_t = b_1xp_{t-1} + b_2x_{it} + b_3x_{i(t-1)} + b_4\rho_{t-1}, \tag{7}$$

where: $b_1 = (1 - \gamma)$, $b_2 = \alpha$, $b_3 = -\alpha(1 - \gamma)$, and $b_4 = (\beta - \alpha)\gamma$.

Solving for α, β and γ, we have: $\alpha = -b_3/b_1$, $\beta = b_4/(1 - b_1)\ b_3/b_1$ and $\gamma = 1 - b_1$.

Equation (7) is a linear function of four coefficients, but a nonlinear function of the three structural parameters, α, β and γ. However, using expected inflation rates to proxy expected growth rates of real estate prices is somewhat controversial. It might be argued that expected growth rates of real estate prices do not resemble the expected inflation rates in the short run. The volatility of the real estate stock index is much larger than the CPI, at least in the short run. Alternatively both sides of Equation (1) are multiplied by $(1 - (1 - \gamma)L)$, thus obtaining:

$$xp_t = c_1xp_{t-1} + c_2x_{it} + c_3x_{i(t-1)}, \tag{8}$$

where: $c_1 = (1 - \gamma)$, $c_2 = \alpha$ and $c_3 = \gamma(\beta - \alpha) - \alpha(1 - \gamma)$.

Solving for α, β and γ, we have: $\alpha = c_2$, $\beta = (c_2 + c_3)/(1 - c_1)$ and $\gamma = 1 - c_1$.

Thus, Equation (8) is a linear function of three coefficients but a nonlinear function of the three structural parameters, α, β and γ. The advantage of this equation is that the assumption of E_tx_{it} being equal to $E_t\rho_t$ is not required.

Equations (7) and (8) are then estimated using nonlinear least squares, which minimizes the sum of squared residuals with respect to the parameters. The nonlinear restriction will also be tested. In order to estimate a nonlinear model, consider a general form of the regression model $y_t = h(x_t, \mu) + \xi_t$. The nonlinear model determines the values of the parameter (μ) that minimize the sum of the squared deviations,

$$S(\mu) = \sum_{t=1}^{n} (y_t - h(x_t, \mu))^2. \tag{9}$$

The nonlinear least squares estimators will be the maximum likelihood estimators. This general case will generate a set of nonlinear equations that do not have an explicit solution. This will therefore require an iterative procedure in order to solve it.

Data

The data cover the 1984Q1 through 1998Q4 period and were obtained from the *Hong Kong Property Review* (various issues) and *Hong Kong Monthly Digest of Statistics* (various issues). Both data sets are used in this study. They are the real estate stock price data and the real estate price data. As mentioned, the Property Index, a sub-index of the Hang Seng Index, is used to represent real estate stocks. For quarterly data, the index is measured as the first month of each quarter. Monthly indexes refer to the positions at the end of month. The real estate price indices are based on an analysis made of transactions scrutinized by the Hong Kong Department of Rating and Valuation for stamp duty purposes. In effect, by utilizing rateable value, allowance is made, not only for floor area, but also other qualitative differences between properties. These indices are generated from market-based data.

Estimation Results

Exhibit 1 summarizes the results from estimating the nonlinear regression functions given in Equations (7) and (8) using the observations on real estate prices in Hong Kong. All the signs are significant and as expected. This model suggests that real estate stock prices are responding to the expected, as well as the unexpected changes in real estate prices.

For residential and industrial real estate, the standard deviation of regression residuals (*SE*), is relatively lower in Equation (8). The relative weights of unexpected and expected growth rates in real estate prices (per quarter) are given by α and β, respectively. For Equation (7), the coefficient α (representing the unexpected effects of real estate prices) is 1.701 for residential, 0.621 for office and 0.955 for industrial real estate. Thus, the impact of unexpected residential property price changes on real estate stock prices is about, respectively, 174% and 78% higher than the impact of office and industrial property prices on real estate stock prices. However, if Equation (8) is used, the coefficient for α is 2.204 for residential, 0.734 for office and 1.581 for industrial real estate. In this case, the impact of unexpected residential property price changes on real estate stock prices is about, respectively, 200% and 39.4% higher than the impact of office and industrial property prices on real estate stock prices. The results are consistent with the work of Tse and Webb (2000) that the effect of the unexpected growth rates in residential real estate prices is noticeably larger than that for office and industrial real estate prices. However, with Equation (8), the impact of residential real estate prices on real estate stock prices appears to be relatively more pronounced (174% vs. 200%).

In contrast to Tse and Webb (2000), who found that the effect of the expected growth rate for real estate prices on real estate stock prices is insignificant, this study indicates that the parameters are highly significant for all three types of real estate (residential, office and industrial). Furthermore, this study indicates that the impact of the expected growth rate for residential real estate prices on the rate of growth for real estate stock prices is also larger for residential than for office and industrial real estate. For Equation (7), the coefficient β (representing the expected effects of real estate prices) is 1.497 for residential, 0.915 for office and 1.294 for industrial real estate. Thus, the impact of expected residential property price changes on real

Exhibit 1
Regression Results

	Residential		Office		Industrial	
	Eq. (7)	Eq. (8)	Eq. (7)	Eq. (8)	Eq. (7)	Eq. (8)
α (unexpected)	1.701***	2.204***	0.621***	0.734**	0.955*	1.581***
	(3.32)	(4.33)	(1.77)	(2.32)	(1.98)	(3.33)
β (expected)	1.497***	1.160***	0.915***	0.620*	1.294***	0.759*
	(3.99)	(3.13)	(2.76)	(1.87)	(2.89)	(1.64)
γ	1.073***	1.080***	1.113***	1.056***	1.031***	1.036***
	(7.45)	(7.83)	(7.70)	(7.11)	(7.10)	(7.31)
Adj. R^2	0.165	0.228	0.034	0.016	0.050	0.098
S. E.	17.01	16.36	18.41	18.60	18.15	17.68

Note: Figures in parenthesis are *t*-Statistics.
*Significant at the 0.1 level.
**Significant at the 0.05 level.
***Significant at the 0.01 level.

estate stock prices is about, respectively, 64% and 15.7% higher than the impact of office and industrial property prices on real estate stock prices. However, if Equation (8) is used, the coefficient β is 1.160 for residential, 0.620 for office and 0.759 for industrial real estate. In this case, the impact of expected residential property price changes on real estate stock prices is about, respectively, 87% and 52.8% higher than the impact of office and industrial property prices on real estate stock prices. The stronger impact of residential prices on real estate stock prices may be due to the fact that most developers in Hong Kong focus more on residential, than on office and industrial real estate.

The adjustment coefficient (γ) in the adaptive formation model for expected inflation is highly significant and very close to one in all cases. This suggests that the expected real estate prices appear to exhibit similar behavior between the different types of real estate. Using the Wald test, one can test for $\gamma = 1$. The results indicate that the hypothesis of $\gamma = 1$ cannot be rejected in all cases, implying that the expected rate of growth for real estate prices is simply based on its own previous value: $E_t x_{it} = x_{i(t-1)}$. In this case, if higher prices appear in the previous period, current prices appear more favorable. Harris (1989) argues that during the period of price appreciation, the real cost was declining, making housing actually less expensive. Thus, buyers may be responding to declining real capital costs, rather than rising nominal costs. While the inflation rate and interest rate are the mechanism for affecting change in real estate price levels, past real estate prices would seem to play an important role in the formation of appreciation expectations.

Conclusion

This study re-examines the impact of residential, office and industrial real estate prices (private real estate) on real estate stock prices (public real estate) in Hong Kong. One of the main objectives of this study was to examine the proposition that the relationship between real estate and real estate stock prices is orderly, rather than random. One way of doing this was to estimate, statistically, the interaction of private real estate prices on real estate stock prices (public real estate). If it fit the data well, even under the extreme volatility of the real estate market in Hong Kong, this would be evidence supporting the notion that the interaction of private real estate on public real estate prices is well behaved. Since the expected real estate price was unobservable, a model of expectation formation developed by Cagan (1956) was used.

When the expected inflation rate was used to proxy for the expected rate of growth for real estate prices, where the inflation rate expectations are formed adaptively, the findings suggest that inflation expectations are one of the important determinants for changes in real estate stock prices. However, the expected rate of growth for real estate prices remains a significant determinant of the change in real estate stock prices, when the real estate price expectations are formed adaptively (without using the inflation rate as a proxy). Previous studies (Tse and Webb, 2000) have found mixed evidence on the role of the expected growth rate in real estate prices for explaining ex post real estate stock prices.

It should be noted that the parameters in all regressions were significant. The results indicate that the impact of unexpected private residential real estate price changes on real estate stock prices is more than 200% and 40% of the impact for office and industrial real estate prices on the real estate stock prices, respectively. The results also indicate that the impact of expected residential real estate price changes on real estate stock prices is about 87% and 53% of the impact for office and industrial real estate prices on the real estate stock prices, respectively. Interestingly, the models suggest that the strongest expectations are formed by adaptation to past price changes. A measure of expected real estate prices based on its own previous value helps explain how real estate stock prices are responding to the expected and unexpected real estate prices.

The results obtained are robust because we do not have to use the inflation rate data to proxy the expected growth rate of real estate prices. The model performs well even when both the Hong Kong real estate and stock markets experienced dramatic movements in 1987 (the Stock Crash) and 1989 (the political disturbance in China). Although the study focuses on Hong Kong, the model can also be applied to real estate markets in other economies. The procedure helps to indicate how the markets view past real estate price as an indicator of expected future real estate price.

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