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Price discovery of property markets in Shenzhen and Hong Kong

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Hong Kong and Shenzhen, while being interrelated in many aspects, have encountered different types of demand shocks throughout the past decade. This is likely due to disparities in market conditions and degrees of government regulations. In the light of such differences in property price trends, this research first investigates the relationships between housing prices and market fundamentals for both cities; and then it explores whether a housing price bubble existed for them in 2006. The results indicate that housing prices seem to have interacted abnormally with market fundamentals in recent years, especially for Shenzhen. In addition, while Shenzhen's housing prices are mainly explained by previous housing prices and personal income, most economic indicators explain Hong Kong's housing prices well. With regard to price bubbles, a puny bubble which amounts to as much as 4.5% of the housing price was formed in Shenzhen in 2006. In the meantime, the housing price bubble for Hong Kong had been diminished. Though currently not at dangerous levels, housing price bubbles should be taken with caution especially in today's China, characterized by overinvestment and rapid policy changes.

Keywords: Price, Granger causality, generalized impulse response, property market, variance decomposition.

Introduction

Background

Since the adoption of the Open Door Policy in 1978, China has achieved rapid economic growth, accompanied by rapid development of the real estate market. Although the Asian financial crisis in the late 1990s damaged many real estate markets in Southeast and East Asia, it had little impact on the real estate markets in major cities of China such as Shenzhen. As a result of rapid economic growth and urbanization, demand for urban land and new dwellings increased accordingly, leading to the sustained growth of housing prices. Institutionally, the year 1998 saw the massive privatization process of state-owned housing units, as intended by then-Premier Zhu Ronghi to accelerate residential development and to elevate the level of urban homeownership (Yu, 2006). The development of Mainland China's property market has been further fuelled by the recent development of the mortgage market (Gibson, 2009) along with the introduction of mandatory housing provident funds.

All these measures have made home ownership more affordable to the Mainland Chinese people, and thus resulted in a booming domestic property sector and accelerating housing investments in major Chinese cities in the last decade. Nonetheless, the property housing sector has also become more volatile. For instance, the Shenzhen Composite Housing Price (SZHP) was around 6900 yuan per square metre in 1996, and it dropped by 10% to 6200 yuan in 2001. It then rose by 27.4% to 7900 yuan per square metre by 2006.

However, the same cannot be said about Hong Kong's property market. The burst of the Japanese land price bubble and the Asian financial crisis in recent years have resulted in a sharp drop in property prices in many countries and regions and their economies were badly hit. The case of Hong Kong can be used as an ideal illustration of how property prices can affect the economy as a whole.

Figure 1 shows the trend of residential property prices, household income and inflation rate in Hong Kong between 1990 and 2006. Residential property

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prices rose from 1990 to 1997 with only minor setbacks in the process. Eventually a great bubble was formed in the year 1997 and it is marked by an obvious surge in housing prices on the graph during that year. The Asian financial crisis broke out in the same year and the property prices in Hong Kong plummeted as a result. The downward trend of property prices ended in 2003; since then an upward trend started as a result of the buoyant economic performance in Hong Kong in recent years.

The property market crash had a considerable negative impact on the economy, as Hui and Shen (2006) claim. This is demonstrated in Figure 1. The average monthly household income in Hong Kong had followed a steady upward trend from 1990 to 1997, which was consistent with the trend of the property prices. However, this situation was reversed in 1997 and the household income in Hong Kong decreased during 1997–2004, also in line with the trend of the housing prices. The household income then experienced a rebound after the end of the SARS event in 2004, and attained its 1996 level by 2006.

The impact of the economic downturn on the property market can be even more vividly shown through the inflation rate. Figure 1 shows the inflation rates in Hong Kong from 1990 to 2006. The property market crash led to a reversal in price movement. Inflation used to be the norm in Hong Kong until 1999 as the general price level fell. This condition sustained until 2004.

Problem statement

There is increasing speculation that the influx of hot money, cheap debt and strong demand for investment tools, especially properties and stock securities, would inflate bubbles in share and housing prices in China. Furthermore, a collapse in house prices in Mainland China could be more disastrous than a burst in its stock market bubble because 80% of homes in China are privately owned (Gibson, 2009) while about 15% of households in China directly invested in stocks by 2003 (Dou, 2006). Given the tremendous impact of the property market on the economy, it is important to investigate whether bubbles exist in the housing market in China. Many government officials and economists have claimed that some cities in China should be wary of signs of housing price bubbles. As one of the most popular areas for real estate development in China, Shenzhen has become the one of the key cities under scrutiny, along with Beijing and Shanghai.

Even though they are interrelated in some aspects, the respective markets of Hong Kong and Shenzhen have experienced very different shocks over the past 10 years. For example, Hong Kong experienced a political shock in 1997 with her handover to China and an ever disastrous Asian financial crisis in 1998. Yet the institutional arrangement known as ‘One country, two systems’ means that not all economic reforms in the Mainland apply to Hong Kong. Meanwhile, Shenzhen, over the same period, has faced economic reform, as

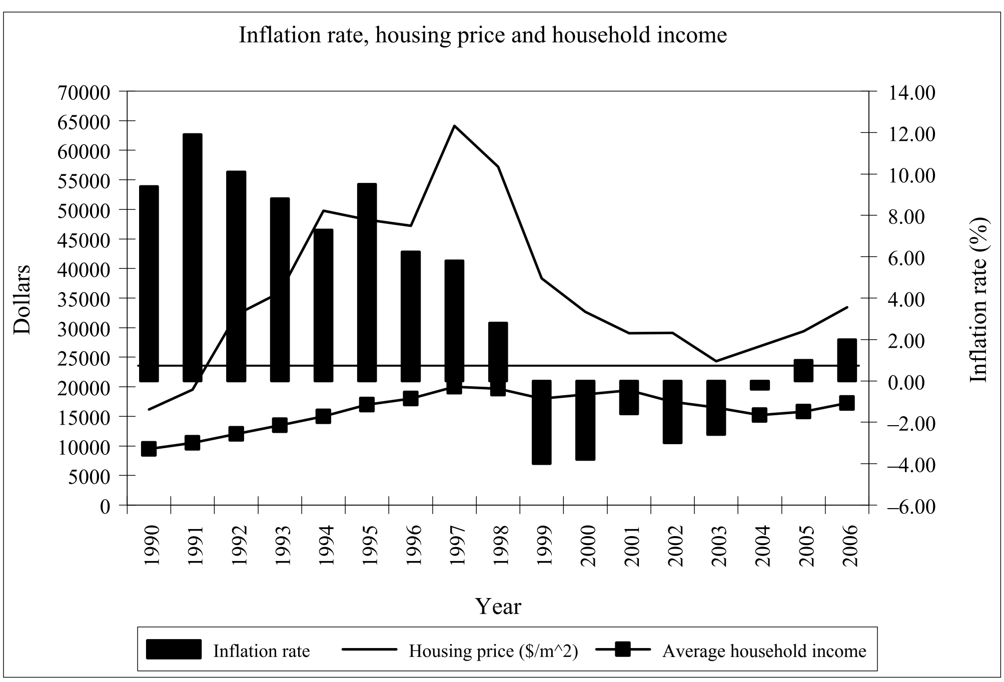


Figure 1 Housing prices, household income and inflation rate in Hong Kong from 1990 to 2006 (HKSAR Census and Statistics Department)

well as the appreciation of Renminbi. These events have stimulated a great influx of foreign capital to its property and stock markets. Nonetheless, increasing trading activities and active flows of capital across the border facilitate economic integration between Shenzhen and Hong Kong. Under such circumstances, it is an interesting study to figure out whether or not the formation of bubbles (if any) in the two cities occurs in a similar fashion.

Objectives and hypotheses for the study

The main objectives of this research are to investigate the relationships between housing prices and market fundamentals in Shenzhen and Hong Kong, as well as to find out the size of housing price bubbles in both places, if any. Two main hypotheses will be tested, which are (1) there should be positive correlations between housing prices and macroeconomic variables such as GDP and disposable income; and (2) negative correlations are expected between housing prices and supply side factors, i.e. stock of vacant new dwellings or vacancy rate.

Previous studies on price discovery and price bubbles

One major area of price discovery is the detection of asset price bubbles, which can be defined as representation of the mispricing of asset values by the market (Kroszner, 2005). Belke and Wiedmann (2005) believe that price bubbles are mainly characterized by public expectations of exorbitant future prices which trigger further price increases. In other words, the presence of a bubble can be identified as prices increasing faster than can be explained by market fundamentals, stated by Kindleberger (1987). This particular view is shared with some extensions by Stiglitz (1990) that a bubble exists if the reason that the price is high today is solely because investors believe that the selling price will be higher tomorrow, to the point where fundamental factors no longer justify such a high price. Although a bubble is straightforward from a theoretical standpoint, testing for its existence could be a difficult task. Difficulties in distinguishing bubbles and switching processes have been illustrated in a study by Driffill and Sola (1998). Another study conducted by Chen (2001) indicates the failure of a rational bubble model in explaining the movements in stock prices and property prices. Moreover, Helbling (2004) suggests that large positive price adjustments, usually known as booms, are a sufficient but not a necessary condition for bubbles. The problem in explaining bubbles is that it depends on how one looks at bubbles, for instance whether or not bubbles are merely 'rational' gambles (see Flood and Garber, 1994) or systemic problems that lead to policy intervention (for instance, Allen and Gale, 1999; Kindleberger, 2000; Shiller, 2000).

Then, how to determine whether bubbles exist in real estate assets? The most frequently used method is to compare the price and the market's 'fundamentals'. The 'fundamentals' are usually classified into two categories: fundamental value and market fundamentals. An asset's fundamental value is measured by three determinants: the cash flow received over time, the terminal value of the asset at the end of the holding period, and the discount rate to be used for translating future cash into current value (Stiglitz, 1990; Peng and Hudson-Wilson, 2002). However, it is difficult to specify the intrinsic value determined by the three determinants for the absence of data extending infinitely into the future (Flood and Hodrick, 1990). As a result, an asset's fundamental value is used in theoretical analysis rather than in empirical studies. For example, Noguchi (1994) defined the bubble as the part of land price that exceeds the theoretical land value and concluded that price bubbles were found in 54% of the land prices in Tokyo in 1987.

Considering how difficult it is in the calculation of the fundamental value of an asset, researchers have been looking for indirect evidence of bubbles, which leads to another definition of 'fundamentals', interpreted as exogenous macroeconomic variables fundamental to the market. That is to say, the existence of price bubbles can be implied by the relationship between real estate prices and macroeconomic variables. If real estate price changes either are in line with variations of macroeconomic variables, or can be explained by both fundamentals and reasonable shifts, the assumption of the existence of price bubbles can be rejected.

A variety of methodologies have been employed in empirical studies of real estate asset price bubbles. With an equilibrium price equation including housing price index and exogenous variables, such as GDP, stock price index and urban household consumption expenditure, Kim and Suh (1993) tested the existence of growing real estate bubbles in Korea and Japan. Peng and Hudson-Wilson (2002) conducted an empirical analysis of the Tokyo office market during 1977–1999 with a pricing model that consists of two separate but related equations: income and price. The variables included net operating income (NOI), office vacancy rate, price index and general economic indicators such as GDP, CPI, interest rates and inflation rate. Over time, new econometrical methods have been developed, for instance a recent study used cointegration tests to examine the existence of real estate price bubbles in Korea (Kim and Lee, 2000).

Within the context of Mainland China, Hui and Shen (2006) incorporate econometrical methodologies into a reduced form equations structure in studying housing price bubbles in Shanghai and Beijing. However, issues related to exponentially smoothed economic indicators and non-stationary dependent variables make one question the accuracy of the bubble estimates. Besides, very few studies have been conducted on investigating housing price bubbles for these two cities. This makes the current study unique. Its findings may thus make a possible contribution to existing knowledge and in particular provide very useful information and a better understanding of the two property markets at work.

Data sources for Hong Kong and Shenzhen case studies

The reliability of housing price indices depends on the quality and appropriateness of the data. Given the need of quality control, major indices used in previous researches are those of hedonic, repeated sales and hybrid housing price indices (Henry, 1995). However, since there are always some limitations of the indices, a mismatch between the price index and the analytical objective could provide misleading results. In this study, a national uniform data source that permits quality control is needed to study housing prices in Shenzhen and Hong Kong.

The composite housing price index of Shenzhen (SZHPI) in the Statistical Yearbooks of Shenzhen Real Estate used in this paper is a form of Laspeyres Index with a base point of 100 in Shenzhen in January 2001. It is calculated on the basis of market investigations on the selling prices of dwellings in the second class market, which represents the sales market of all kinds of private dwellings. In other words, the SZHPI are fundamentally transaction-based indices reporting market price trends, whether smooth or not. Shenzhen Statistics Bureau is responsible for releasing the data regularly and controlling variations in quality with prices adjusted.

Figure 2 reports housing price indices in Shenzhen for Q1, 1996–Q1, 2007. It can be seen that Shenzhen's housing price has been increasing prominently from 2004 onwards.

Aside from housing price indices, another important variable related to the housing market is the vacancy rate (VAC), which is an indicator of market equilibrium. It is defined (in %) in China as the floor area of unsold housing units held by property developers, including that of newly built units, divided by total floor space built in the past three years. In short, it is the balance between supply and demand in the housing market. Variables on the side of economic fundamentals are the average annualized income of workers and staff (INC), local GDP and Shenzhen Stock Exchange composite index (SSECI). Among these variables, average staff and workers' income influences affordability of urban households and demand for new dwellings; and the stock of vacant new dwellings has a direct impact on the supply side. Local GDP is the major proxy of economic performance and the Shenzhen Stock Exchange composite index represents the nationwide stock market. The descriptive statistics of the variables for Shenzhen are reported in Table 1a. Nominal values of local GDP and average staff and workers' income are used in this study as inflation in Shenzhen has been minimal in recent years. Hence, there is no noticeable difference between real value and nominal value.

And for Hong Kong, the quarterly data of housing prices in terms of dollars per metre square, median household income, quarterly GDP (all three items are measured at nominal price), Hang Seng stock price index, and the number of vacant residential units at year end are gathered for this study (see Table 1b). A

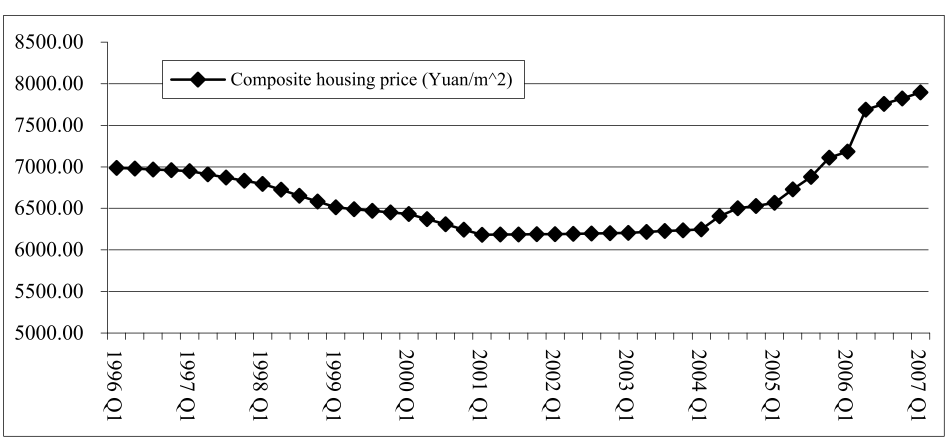


Figure 2 Composite housing prices in Shenzhen for Q1, 1996 – Q1, 2007 (Statistical Yearbooks of Shenzhen Real Estate)
Notes: The SZHPI represent quarterly composite housing price index of Shenzhen. The above figure is the housing prices extracted from the SZHPI.

Table 1a Descriptive statistics of the variables in Shenzhen, Q1, 1996 – Q1, 2007 (N=45)

Variables	Average	Standard deviation	Maximum	Minimum
Housing price (second class market, yuan/m^2)	6649	469	7895	6183
Average annualized income of staff/worker (yuan)	24 457	6878	33 550	13 114
Local GDP (billion yuan)	239	143	545	80
Shenzhen Stock Exchange composite index	418	133	826	113
Residential property vacancy rate (%)	30	10	49	17

Notes: The data on local housing markets and economic fundamentals are gathered from numerous sources. These sources include National Bureau of Statistics of China, Shenzhen Statistics Bureau, Shenzhen Stock Exchange and CEIC, Goldman Sachs Research estimates.

Table 1b Descriptive statistics of the variables in Hong Kong, Q1, 1990 – Q4, 2006 (N=68) (HKSAR Census and Statistics Department)

Variables	Average	Standard deviation	Maximum	Minimum
Housing price (HK\$/m^2)	36 042	12 221	70 077	16 186
Mean household income (HK\$)	15 538	2861	20 000	8900
Local GDP (million HK\$)	306 507	62 581	467 461	197 551
Hang Seng stock price index	10 363	4039	17 543	2791
Vacant unit	48 686	14 100	68 781	26 150

number of statistical tests will be performed in the following order: correlation analysis, Phillips–Perron (PP) tests, JJ tests, Granger causality tests, impulse response functions and variance decompositions.

Table 2 reports the correlations among the selected variables of the two cities in two different approaches. The band-pass filter (see Frankel and Rose, 1998) removes low-frequency trend variations and smoothes high-frequency irregular variations, while retaining the major features of business cycles. Theoretically, there should be positive correlations between housing prices and variables such as GDP and disposable income, and negative correlations between housing prices and the stock of vacant new dwellings or vacancy rate. In fact, weak negative correlations between housing prices and vacancy rates are found for both Hong Kong and Shenzhen. Meanwhile, a rather weak positive correlation between housing prices and average staff/worker income is found for Shenzhen only. A moderate and positive correlation between housing prices and local GDP is also found for Shenzhen, while a weak and positive correlation of that is observed in Hong Kong. The Shenzhen stock price index has shown a negative correlation with her housing prices during the past decade, which violates the stated hypothesis.

Interactions between housing prices and market fundamentals

Table 2 provides a concise view of the interactions between housing prices and market fundamentals. Although some anomalies are found, the evidence is not enough to justify the existence of bubbles. What are the causal relationships between housing prices and market fundamentals? What is the degree of impact of determinants, and what is the feedback on housing prices?

Granger causalities

Granger (1969) puts forward the definition of causality, which is based entirely on the predictability of some

Table 2 Correlations among the selected variables of the two cities

Variables	Shenzhen (Q1, 1996 – Q1, 2007; N=45) (Filtered data)				
	HP	INC	GDP	VAC	STOCK
HP	1.000	0.194	0.507	–0.126	–0.513
INC	0.194	1.000	0.944	–0.996	0.498
GDP	0.507	0.944	1.000	–0.918	0.269
VAC	–0.126	–0.996	–0.918	1.000	–0.568
STOCK	–0.513	0.498	0.269	–0.568	1.000

Variables	Hong Kong (Q1, 1990 – Q4, 2006; N=68) (Filtered data)				
	HP	INC	GDP	VAC	STOCK
HP	1.000	0.532	0.307	–0.158	0.329
INC	0.532	1.000	0.729	–0.331	0.612
GDP	0.307	0.729	1.000	–0.429	0.862
VAC	–0.158	–0.331	–0.429	1.000	–0.353
STOCK	0.329	0.612	0.862	–0.353	1.000

series, say x. If a series y contains information in past terms that helps in the predication of x and if this information is contained in no other series used in the predictor, then y is said to cause x. Generally speaking, if x and y are stationary series, unrestricted vector autoregressive (VAR) models are usually assumed to implement the Granger causality test, and Wald chi-square tests and F tests are employed to test the null hypothesis of no Granger causality. However, if the variables are cointegrated, the bivariate dynamic relation between them would be mis-specified if a researcher simply uses a traditional vector autoregressive (VAR) model to test the existence of Granger causality. As Engle and Granger (1987) pointed out, this kind of test should be carried out with vector error correction (VEC) models.

As a preliminary step of cointegration analysis, the order of integration of the variables should be tested. If the levels of time series are non-stationary, yet stationary after first differencing, they are defined as being integrated of order one *I(1)*. The PP integration test is employed with respective variables in log form. The results of this indicate that the variables are stationary after first-differencing, as shown in Table 3.

A cointegration test is usually used to investigate the long-term relationships between non-stationary variables. The test here is employed to test whether a stable and long-run equilibrium relationship exists between housing prices and key macroeconomic variables. If an equilibrium relationship exists between the variables and there is no trend in the model specification, the possibility of a price bubble can be excluded. Although this approach is not entirely free of the problem of misspecification, the procedure is much simpler because the bubble term does not have to be estimated (Kim and Lee, 2000).

Employing the well-known Johansen and Juselius (1990) procedure, the results of cointegration tests between housing prices and other variables are presented in Table 4. With the trend term specified, housing prices have moved (or would move) away from the fundamentals, which points to the presence of housing price bubbles in Shenzhen. In contrast, the cointegration test cannot tell if housing prices in Hong Kong have moved away from other fundamentals. In addition to the pairwise cointegration tests, the multivariate cointegration tests are also deployed because there might exist some common factors affecting the trend of a set of variables such that those time series representing variables would eventually adjust to equilibrium. To identify the contemporary relationships among variables selected, a vector autoregressive model is used for a set of non-stationary variables. Table 4c below has shown that there is at least one cointegrating vector for the respective set of variables of both cities. In other words, it indicates that two sets of variables operate as a cointegrated system, i.e. there

Table 3a PP Tests of the variables of Shenzhen for Q1, 1996 – Q1, 2007 (N=45)

Variable	Level		1st difference		Results
	Model specification (lags)	PP test statistic (5%, 1% c. v.)	Model specification (lags)	PP test statistic (5%, 1% c. v.)	
lnSZHP	Intercept and trend(2)	1.66(−3.52, −4.18)	Intercept and trend(2)	−5.65(−3.52, −4.19)	I (1)**
lnINC	Intercept and trend(2)	2.54(−3.52,−4.18)	Intercept and trend(2)	−9.00(−3.52, −4.19)	I (1)**
lnVAC	Intercept and trend(2)	−2.74(−3.52,−4.18)	None(2)	−7.90(−1.95, −2.62)	I (1)**
lnGDP	Intercept and trend(2)	−1.38(−3.52,−4.18)	Intercept(2)	−2.81(−2.93, −3.59)	I (1)***
lnSSECI	Intercept and trend(2)	−3.38(−3.52,−4.18)	None(2)	−5.03(−1.95, −2.62)	I (0)***

Table 3b PP Tests of the variables of Hong Kong for Q1, 1990 – Q4, 2006 (N=68)

Variable	Level		1st difference		Results
	Model specification (lags)	PP test statistic (5%, 1% c. v.)	Model specification (lags)	PP test statistic (5%, 1% c. v.)	
lnHP	Intercept and trend(2)	−2.42(−3.48,−4.10)	None(2)	−4.43(−1.95,−2.60)	I (1)**
lnINC	Intercept and trend(2)	−1.65(−3.48,−4.10)	None(2)	−11.80(−1.95,−2.60)	I (1)**
lnVAC	Intercept and trend(2)	−1.79(−3.48,−4.10)	None(2)	−3.44(−1.95,−2.60)	I (1)**
lnGDP	Intercept and trend(2)	−4.60(−3.48,−4.10)	Intercept(2)	−9.67(−2.91,−3.53)	I (1)**
lnStock	Intercept and trend(2)	−2.33(−3.48,−4.10)	None(2)	−8.91−1.95,−2.60)	I (1)**

Notes:
1. ** denotes the 99% significance level.
2. Generally three kinds of model specification exist in the PP test: no intercept and no trend; only intercept; intercept and trend.
3. PP tests are the unit root test, similar to ADF tests.

is a long-run relationship. The results verify the existence of cointegrations for the housing prices and some variables.

Since some variables are proved to be integrated and cointegrated, error correction models (ECM) could be formulated. For the remaining variables, vector autoregressive models (VAR) are used. Each pairwise combination of housing prices and one of the fundamental variables is tested, as shown in Appendix 2. Then Granger causality tests are employed to examine the causality relationships between housing prices and market fundamentals, as summarized in Table 5.

The results of Granger tests indicate that there are causal relationships between income and housing prices in Shenzhen but the same cannot be said about Hong Kong. This means that the housing price boom in Shenzhen may possibly be based on income growth, while income growth does not suffice in explaining the recent price increases in Hong Kong. In contrast, the feedback is not discernable in Shenzhen but exists in Hong Kong, due to capital gains from persistent appreciations in housing prices. It is believed that the wealth effect with the booming property market in Shenzhen is not shared among most of Shenzhen's residents. One of the reasons is possibly the prominence of foreign investments in Shenzhen's real estate. Shenzhen's local media widely suspects that at least 30% of the purchases were by speculators from other cities of the nation, especially Hong Kong. In addition to the appreciation of Renminbi, it would stimulate much more speculation in the housing market and lead to housing price bubbles.

Although the causal relationships between housing prices and GDP are ambiguous, a high growth rate of GDP usually generates expectations of future economic growth and usually will induce a market boom especially in developing countries like China. There is a causal relationship between housing prices and GDP in Hong Kong and a one-way causality from GDP to housing prices exists for Shenzhen. Since the growth of local GDP depends more on the surge in housing prices, the real estate industry in Hong Kong

Table 4a JJ Tests of the variables of Shenzhen for Q1, 1996 – Q1, 2007 (N=45)

Variables	Lagged differences	Model specification	Trace test		Max-eigenvalue test		Results
			r=0	r=1	r=0	r=1	
lnSZHP & lnINC	4	M4	33.61**	9.39	24.22**	9.39	1
lnSZHP & lnGDP	4	M4	29.65**	8.54	21.11*	8.54	1
lnSZHP & lnVAC	4	M4	19.18	6.91	12.28	6.91	0
lnSZHP & lnSSECI	2	M4	29.61*	12.21	17.40	12.21	1

Table 4b JJ Tests of the variables of Hong Kong for Q1, 1990 – Q4, 2006 (N=68)

Variables	Lagged differences	Model specification	Trace test		Max-eigenvalue test		Results
			r=0	r=1	r=0	r=1	
lnHP & lnINC	4	M4	22.23	6.38	15.85	6.38	0
lnHP & lnGDP	4	M4	28.81*	6.43	22.38**	6.43	1
lnHP & lnVAC	4	M4	25.03	9.11	15.92	9.11	0
lnHP & lnStock	2	M4	16.19	5.83	10.36	3.64	0

Notes: *(**) denotes rejection of the null hypothesis at the 95% (99%) significance level, respectively.

Table 4c Testing of contemporary cointegration among variables

		Number of cointegrating vectors		
		None	At most 1	At most 2
Trace statistics	Shenzhen	108.1460*	56.0710*	25.7730
	Hong Kong	175.4304*	79.0740*	39.2981
Maximum eigenvalue	Shenzhen	52.0750*	30.2980*	16.8214
	Hong Kong	96.3564*	39.7759*	18.7455

Note: * denotes the 95% significance level.

Table 5 Summary of Granger causality test

	Shenzhen (N=45)			Hong Kong (N=68)		
	Chi-square	P-value	Result	Chi-square	P-value	Result
INC⇒HP	14.03	0.01	Y	7.02	0.13	N
HP⇒INC	2.74	0.60	N	22.86	0.00	Y
GDP⇒HP	16.84	0.00	Y	9.26	0.05	Y
HP⇒GDP	2.67	0.61	N	24.27	0.00	Y
VAC⇒HP	4.08	0.40	N	11.80	0.02	Y
HP⇒VAC	1.48	0.83	N	3.76	0.44	N
STOCK⇒HP	2.51	0.29	N	3.86	0.15	N
HP⇒STOCK	2.03	0.36	N	2.41	0.30	N

Notes:
1. x ⇒y means the null hypothesis that x does not Granger cause y.
2. Y means the rejection of the null hypothesis and N means the acceptance of the null hypothesis.

plays a more important role in the local economy than that in Shenzhen.

Appreciation of housing prices may mean a decline in housing affordability among households, and subsequently an increase in the amount of vacant new dwellings (or vacancy rate). A large vacancy stock indicates an over-supply in the housing market. In theory, it will then lead to a decrease in the average selling price of new dwellings. For Hong Kong the amount of vacant units Granger causes housing prices without a feedback, while there is no significant causal relationship between the two for Shenzhen. It can be deduced that the Shenzhen booming housing market might not be directly caused by reduced land supply. Also, the corresponding increase in housing prices cannot stimulate a significant rise of vacant units to cool down the unusual surge in housing prices.

For urban households, the housing market could be taken as a substitute for the stock market. A boom in housing prices sometimes accompanies a stock market boom and vice versa. The findings suggest no causality relationship between housing prices and the local stock price index for both Hong Kong and Shenzhen. That is to say, the course of housing prices in both cities is not closely related to the movement of their respective stock price indices.

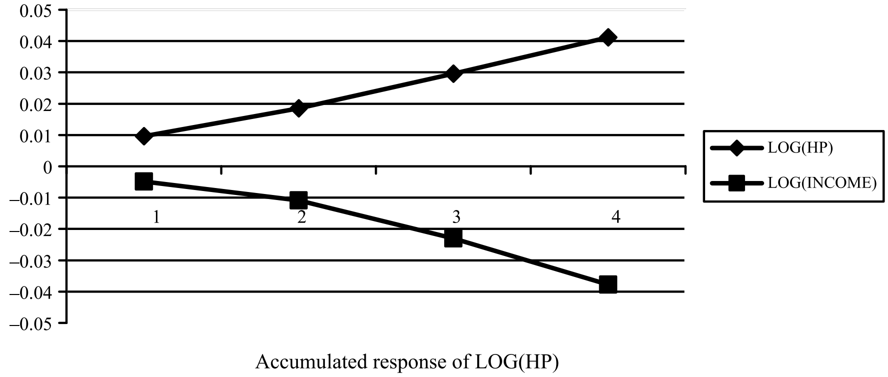
Generalized impulse response analysis

The impulse response function traces the effect of a one standard deviation shock to one of the innovations on current and future values of the endogenous variables in a VAR or VECM. A shock to the *i*-th variable directly affects the *i*-th variable itself. It is also transmitted to all of the endogenous variables through the dynamic structure of the VAR or VECM. So impulse response function can be used to describe the dynamic response of the system, which helps analyse the two-way dynamic relations of the variables.

Compared with Granger causality tests, this methodology offers an advantage that it may indicate whether the impacts are positive or negative, and are temporary or long term. Assuming that the endogenous systems just comprise housing prices and one of the four fundamental variables, and the impacts of other economic and political forces are ignored, accumulated responses are calculated on the basis of the VAR and VECM in Appendix 2.

Figures 3 to 6 report the two-way generalized responses between housing prices and selected endogenous variables for both Hong Kong and Shenzhen. In all of the figures the standard deviation of housing prices itself would lead to positive adjustments in future housing prices in the next year. This indicates that current changes in housing prices do affect peoples' expectations in the short run in both cities. The accumulated response of housing prices in Shenzhen is less sensitive than that in Hong Kong. The findings suggest that the fluctuation of response in the 12 months under study is between 1% and 7% in Shenzhen, while that in Hong Kong is between 5% and 35%. The rate in Hong Kong is much larger than that in Shenzhen, indicating that housing prices fluctuations do greatly affect peoples' expectations in Hong Kong.

The response of housing prices to the standard deviation of the selected fundamental variables noticeably differs. Generally speaking, the increase of disposable income has a positive effect on housing prices, indicated in the Hong Kong case (Figure 3b). But the opposite is found in Shenzhen (Figure 3a). The only possible explanation is that housing prices are not increasing quite in parallel with disposable income. Figures 4a and 4b indicate that in Shenzhen the response of housing prices to GDP is not large, while that of Hong Kong is large. Both cases are consistent



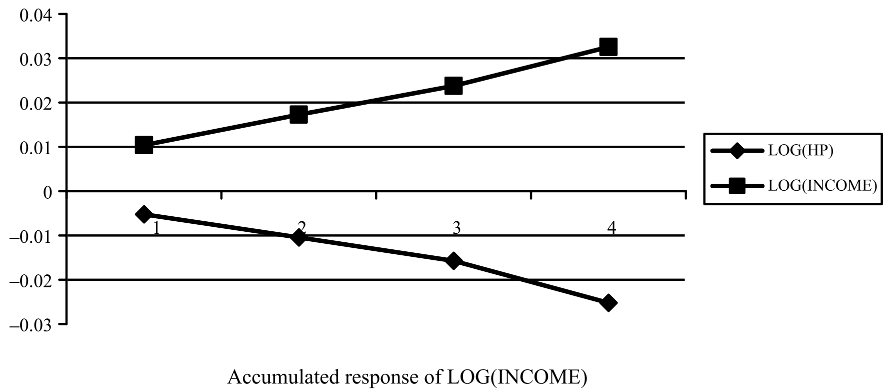
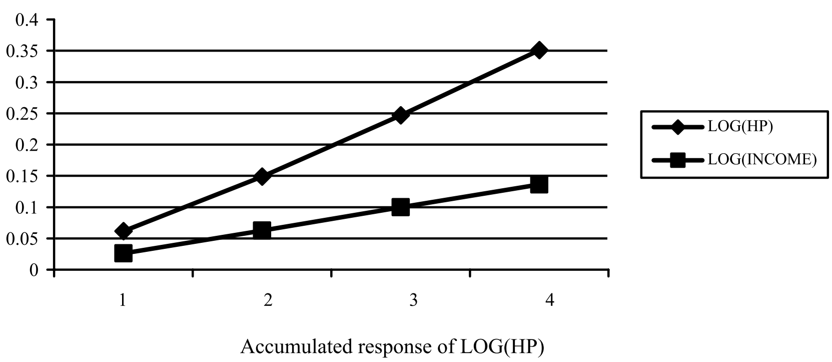


Figure 3a Impulse response analyses between Shenzhen's housing prices and average annualized income



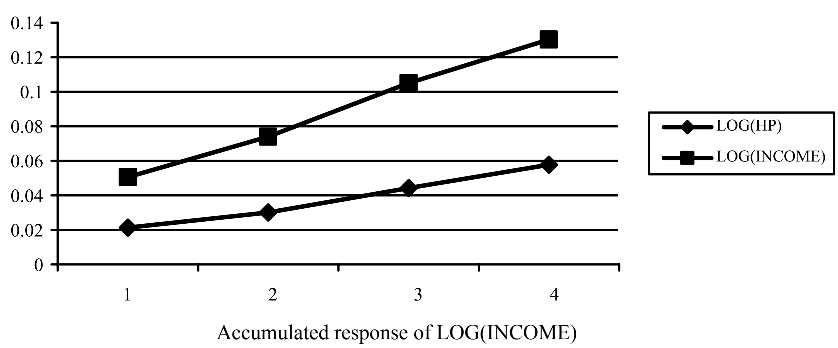


Figure 3b Impulse response analyses between Hong Kong's housing prices and disposable income

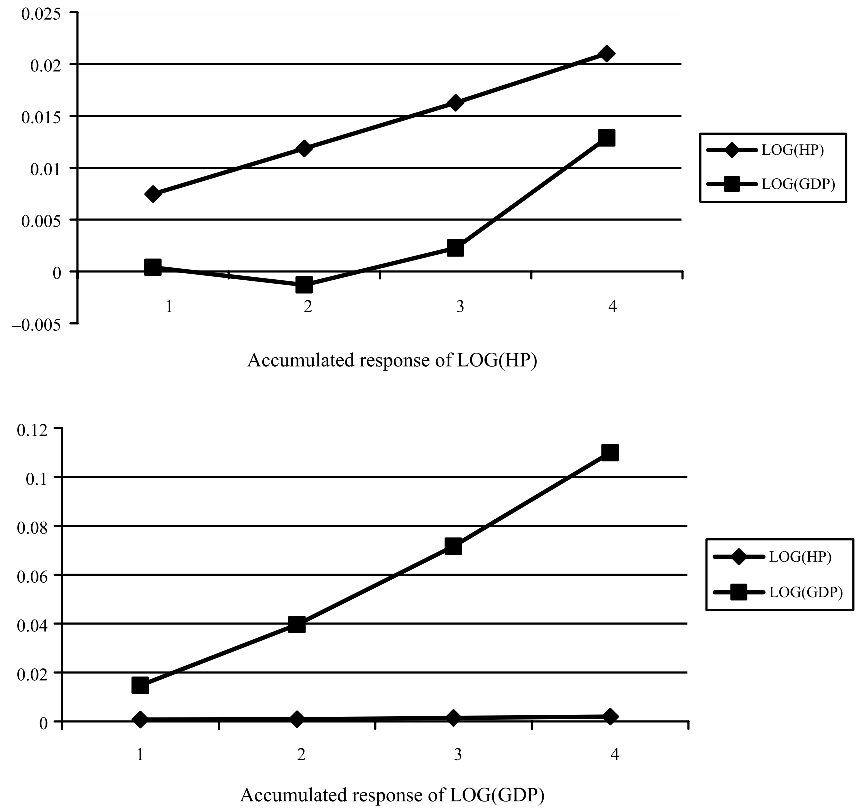


Figure 4a Impulse response analyses between Shenzhen's housing prices and local GDP

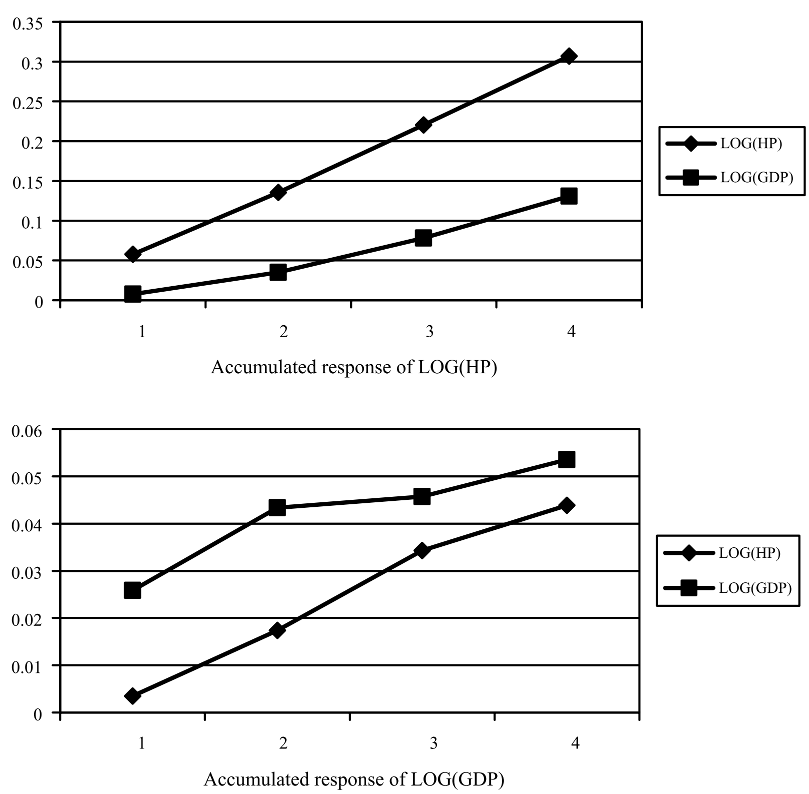


Figure 4b Impulse response analyses between Hong Kong's housing prices and local GDP

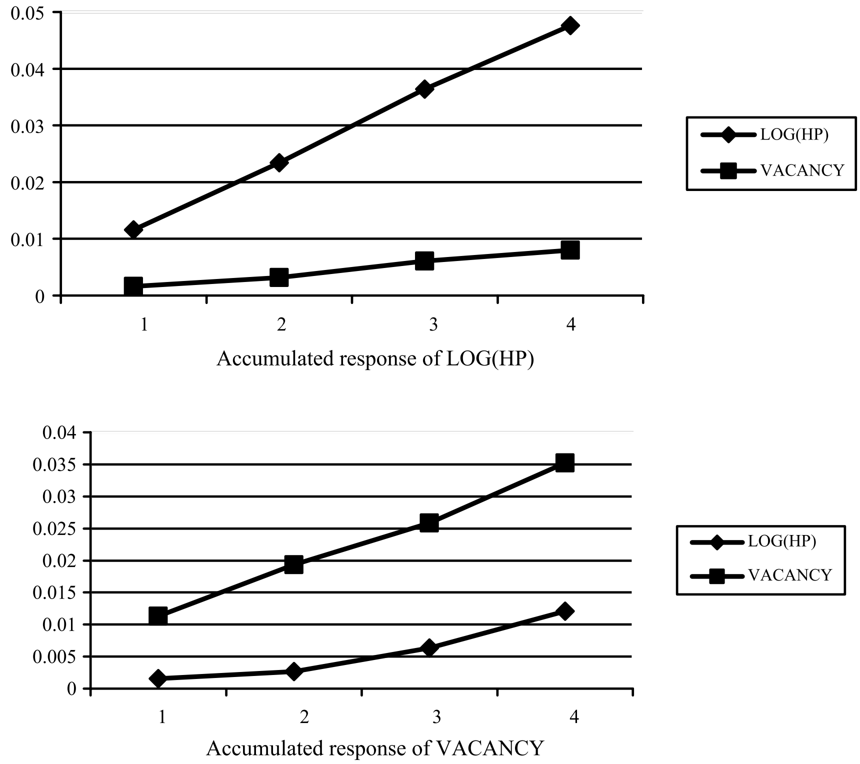


Figure 5a Impulse response analyses between Shenzhen's housing prices and vacancy rates

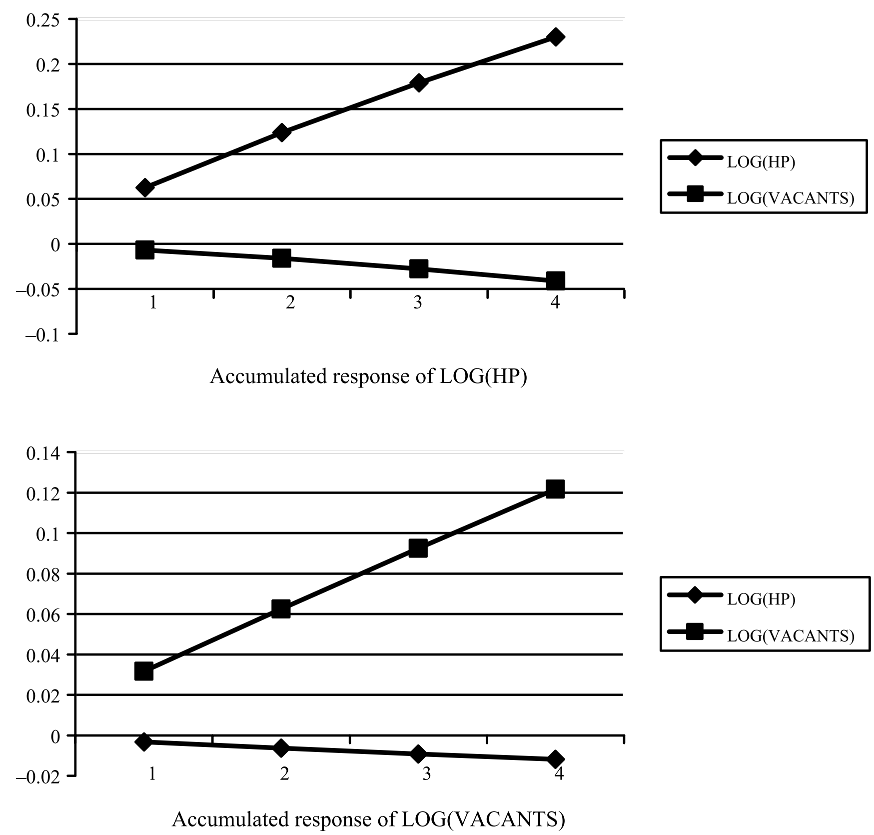


Figure 5b Impulse response analyses between Hong Kong's housing prices and vacant new dwellings

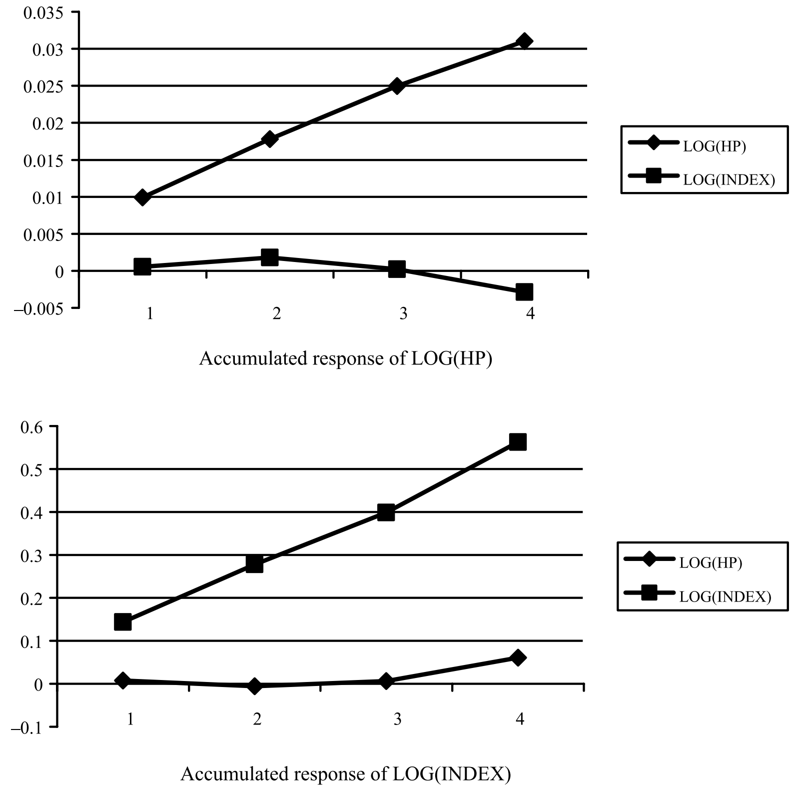


Figure 6a Impulse response analyses between Shenzhen's housing prices and Shenzhen stock price index

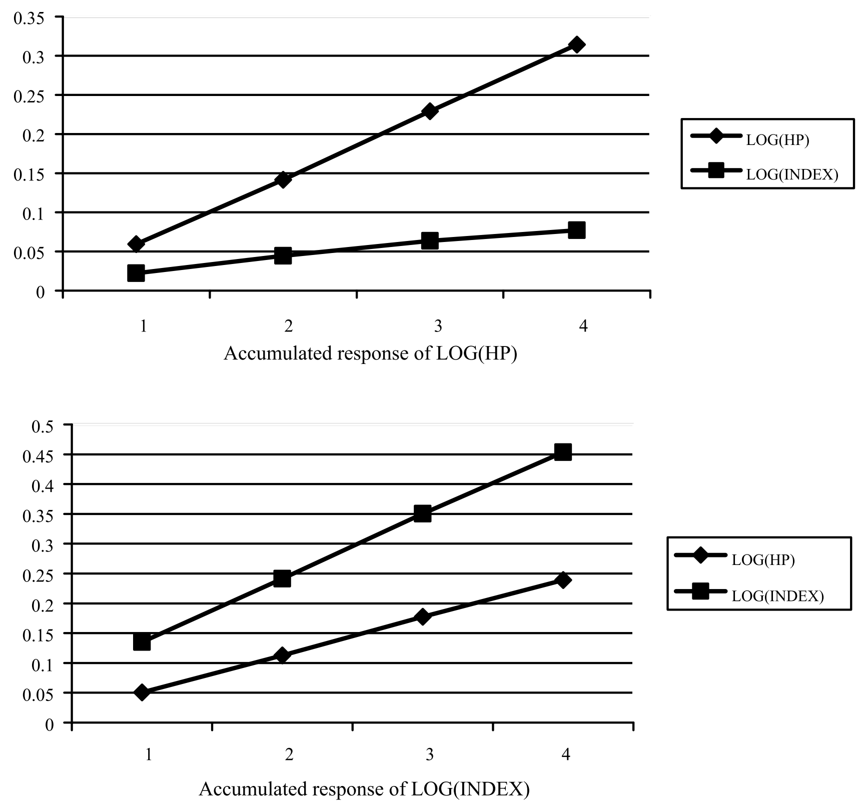


Figure 6b Impulse response analyses between Hong Kong's housing prices and Hong Kong stock price index

with the findings of Granger causality analysis. In Figures 5a and 5b, the responses of housing prices to vacant units for both cities are not strong, which is also consistent with the Granger causality test. Figures 6a and 6b indicate that the accumulated response of housing prices to the stock price index in Hong Kong is larger than that of Shenzhen.

The wealth effect of the housing price boom in Shenzhen is not apparent as the response of average income to the standard deviation of housing prices is negative. It means that income level is not moving in parallel with housing prices in recent years. In contrast, the positive wealth effect is evident in Hong Kong. The maximum response of GDP to housing prices for Hong Kong, at 5.0%, is twice as much as that for Shenzhen.

The accumulated responses of vacant new dwellings to the stimulus of housing prices for Hong Kong and Shenzhen are somewhat similar. They reach the first maximum value of 2% and 0.5% in the 12th month (see Figures 5a and 5b). As speculation activities are stimulated by the price booms, the stock of vacant new dwellings just slightly rises to meet the needs of speculators.

Also, responses of Shenzhen Stock Exchange's composite stock index to the standard deviation of housing prices in Shenzhen can be measured, as presented in Figure 6a. The stimulus from housing prices in Shenzhen produces a response in Shenzhen stock prices from the 9th to 12th months, without the impact of other economic forces. It is significantly smaller than the response of the Hang Seng index to housing prices in Hong Kong. The results indicate a big difference in the relationship between housing prices and stock price indices of the two cities. It is widely believed that the huge influx of foreign capital to the housing market in Shenzhen does not facilitate a parallel booming effect in the Shenzhen stock market. In other words, although housing prices in Shenzhen have ascended noticeably more than its stock price index has in recent years, most local residents do not benefit much from it.

Variance decompositions

Generally, variance decomposition is a complementary analysis to the generalized impulse responses analysis. It helps analyse how our selected fundamental variables transmit shocks to the dependent variable. This section employs two vector autoregressive models to investigate the respective impact of macroeconomic and financial variables across the property markets in both cities, similar to what Brooks and Tsolacos (1999) did in their investigation of the UK's property market. As an international financial centre, Hong Kong plays an intermediate role in facilitating the Mainland's external trade and flows of foreign investment. As Shenzhen is arguably considered the most popular area for Hong Kong residents to purchase properties either for self-use or as an investment, this analysis is to investigate how housing prices in Shenzhen are affected by its own economic performance, as well as housing prices in Hong Kong, and vice versa. Two structural vector autoregressive models are constructed, based on a typical SVAR model. However, the choices of variables are different.

A typical SVAR model in standard form is denoted as:

$$\Delta y_t = \alpha_0 \varepsilon_t + \alpha_1 \varepsilon_{t-1} + \alpha_2 \varepsilon_{t-2} \ldots = \alpha(L)\varepsilon_t$$

where $\Delta y_t = [\Delta hp_t, \Delta income_t, \Delta gdp_t, \Delta index_t, \Delta vacants, \Delta hp'_t]$, hp' represents a foreign factor. And shocks $\varepsilon = [\varepsilon_{hp}, \varepsilon_{income}, \varepsilon_{gdp}, \varepsilon_{index}, \varepsilon_{vacants}, \varepsilon_{hp'}]$, assumed to be serially uncorrelated and have a covariance matrix normalized to the identity matrix; Δ denotes the first difference operator. For our analysis, $\alpha(L)$ represents a 6×6 vector matrix. This SVAR model contains five separate equations which are estimated using the seemingly unrelated regression method (SUR) over the sample period from the first quarter of 1996 to the last quarter of 2006 with the number of lags set to five.

To investigate the transmission of shocks from Hong Kong's economy to the Hong Kong property market, the following variables are chosen: HKHP, HKINCOME, HKGDP, HKINDEX, HKVACANTS and SZHP. For the decomposition analysis of Shenzhen, the following variables are chosen: SZHP, SZINCOME, SZGDP and SZINDEX, SZVACANTS and HKHP. Since some of them are non-stationary series, these variables are first-differenced before plugging into the SVAR models. The numbers of lags in the VAR models are selected by minimizing the value of Akaike's information criterion. Table 6a below presents the variance decomposition of Shenzhen's housing price to the extent to which it can be explained by its local economy and Hong Kong's housing price. Table 6b presents the variance decomposition of Hong Kong's housing price.

Shenzhen's housing prices are mostly affected by its own prices and its personal income over the short term (one year) to the medium term (three years). In the medium term, 34% and 30% of Shenzhen's housing prices, respectively, can be explained by its past housing prices and personal income. In contrast, Hong Kong's property prices have an insignificant effect on those of Shenzhen in the medium term. Likewise, a similar situation is found for Hong Kong. Hong Kong's housing prices are mainly explained by the level of household income and its own prices and largely by the local GDP in the medium term. For the

Table 6a Impact on Shenzhen's housing price

Period	SZHP	SZINCOME	SZGDP	SZINDEX	SZVACANTS	HKHP
First quarter	100.00	0	0	0	0	0
One year	50.80	15.37	15.70	3.84	13.75	0.54
Two years	17.60	44.40	12.04	4.47	21.13	0.36
Three years	33.51	30.40	11.34	6.72	17.57	0.46

Table 6b Impact on Hong Kong's housing price

Period	HKHP	HKINCOME	HKGDP	HKINDEX	HKVACANTS	SZHP
First quarter	100.00	0	0	0	0	0
One year	31.79	13.03	18.28	5.93	26.30	4.67
Two years	21.41	29.81	23.38	5.56	15.35	4.49
Three years	20.62	26.27	33.82	3.71	11.50	4.08

medium term (three years), shocks from the local household income and housing prices account for about 26% and 21% of Hong Kong's housing prices, and shock from its local GDP contributes about 34%. Similarly, Shenzhen's property market has only an insignificant effect on the Hong Kong property market over the years. It explains about 4% of Hong Kong's housing price variations. In addition, Shenzhen's and Hong Kong's vacancy rates show their moderate impact on their property markets, at 18% and 12% respectively in the medium term.

Estimation of the bubble term in 2006

In a competitive housing market, prices are determined by the housing supply and demand, proposed by Quigley (1999). The interactions can be represented by

$$PH = f(H^D, H^S) \tag{1}$$

where P^H is the housing price, and H^D and H^S are the quantities of housing demanded and supplied. Housing demand is a function of housing prices, annualized income, local GDP, Shenzhen stock price index and a vector of exogenous variables X, and housing supply is a function of prices and vacancy rate as well as a set of exogenous variables Y. The supply and demand functions for housing can be expressed as

$$H^D = d(PH, INC, GDP, SSECI, X) \tag{2}$$

$$H^S = s(PH, VAC, Y) \tag{3}$$

Substituting Equations 2 and 3 into Equation 1 and solving for housing prices, we can get the reduced form Equation 4 of housing prices determination, where Z represents a vector of exogenous variables and $L()$ is the lag operator.

$$PH = f(L(PH), INC, GDP, SSECI, VAC, Z) \tag{4}$$

The additional bubble term in the i^{th} month (ΔPH_{i}^b) can be defined as the difference between actual measured housing prices (PH_{i}) and predicted housing prices ($PH^{\star}{}_{\mathrm{i}}$). The accumulated housing price bubbles (in percentage) (PH_{i}^b) could be represented as follows:

$$\begin{aligned} PH_{\mathrm{i}}^b\% &= \Delta PH_i^b / PH_i \pounds^{1/2} (PH_i - PH_i^*) / PH_i \\ &= 1 - PH_i^* / PH_i \end{aligned} \tag{5}$$

Table 7 reports the fundamental-factor models based on Equation 4 for Shenzhen (Q1, 1996–Q1, 2007), and Hong Kong (Q1, 1990–Q4, 2006). The models created are parsimonious and their parameters are suitably chosen to be proxies for some omitted variables, such as rates of return on other investments, etc. Yet these models are not perfect, since there are always some omitted variables which could better explain price movements. However, each added parameter creates some uncertainty to the system and adding too many parameters leads to a severe curve-fitting which results in weak predictability.

The strong autocorrelation in prices is consistent with prior studies (e.g. Case and Shiller, 1990; Quigley, 1999). With the two regression models we can predict the trends in housing prices of both cities. Then, by the use of Equation 5, the bubble term could be estimated. The parameters of the two models are estimated recursively using ordinary least squares. This allows us to simulate the actual real-time forecast by constantly updating the information set. The numbers of lags in the two models are chosen by minimizing the Bayesian Information Criterion over the full sample.

The performance of our forecasts is assessed by measuring the forecast errors, the root mean squared errors (RMSE) of the potential models. In general, the smaller the relative RMSE, the better the performance of the model we choose. The models below are well specified and pass the selected diagnostic tests.

Figure 7 compares the extent of property price bubbles in Shenzhen and Hong Kong respectively for 2006. It is shown that the price bubbles account for 4%–4.5% of the housing price for Shenzhen starting from the second quarter of 2006. In comparison, the bubble term for Hong Kong has attenuated from more than 4.5% in the first quarter to less than 1% in the fourth (Figure 7).

Table 7 Models of housing price determination for Shenzhen and Hong Kong

Dependent variable: *lnhp*	Shenzhen (N=45)	
Variables	Coe.	t-ratio
lnhp(-1)	0.827	10.47***
lnINC	−0.140	0.04**
lnGDP	0.102	0.00***
lnSSECI	−0.002	−0.33
lnVAC	0.071	0.67
Constant	2.383	0.04**
R^2	0.98	
Adjusted R^2	0.98	
Diagnostic tests for the residuals:		
LM test for serial correlation:	F-statistics = 0.90 (0.48)	
ARCH test for heteroskedasticity:	F-statistics = 0.10 (0.98)	
RESET test for model specification:	F-statistics = 0.07 (0.79)	
Dependent variable: *Dlnhp*	Hong Kong (N=68)	
Variables	Coe.	t-ratio
Dlnhp(-1)	0.402	3.47***
lnINC	0.163	0.967
lnINC(-1)	−0.210	−1.55*
lnGDP	−0.163	−1.03
lnGDP(-1)	0.297	1.84*
lnSTOCK	0.138	2.41**
lnSTOCK(-1)	−0.176	0.01***
lnVAC	−0.013	−0.06
lnVAC(-1)	−0.022	−0.10
Constant	−0.372	−0.295
R^2	0.53	
Adjusted R^2	0.46	
Diagnostic tests for the residuals:		
LM test for serial correlation:	F-statistics = 1.50 (0.21)	
ARCH test for heteroskedasticity:	F-statistics = 0.02 (0.89)	
RESET test for model specification:	F-statistics = 0.20 (0.94)	

Notes: *, ** and *** denote significance at the 90%, 95% and 99% level respectively. The bracket () denotes p-value of statistics. Owing to the limited sample data for Shenzhen, the regression model with a lag term for each variable is found to be a spurious one. Instead, the one shown above is less susceptible to spurious problems since it has passed the required diagnostic tests.

The accuracy of the model can be verified by its application to the past data of both Hong Kong and Shenzhen. Figures 8 and 9 show the actual and predicted housing price and the estimated housing price bubbles for the two cities. The pattern and magnitude of the estimated bubbles conform quite well to the discrepancies between actual and predicted prices. Therefore, it is reasonable to say that our model is reliable. It is safe to state that a bubble begins to form in the housing market of Shenzhen. Yet the housing market will not face imminent risk of downward housing price adjustments due to strong demand, courtesy of foreign investment in the short-term period.

Conclusion

A panic has been circulating among economists that China's property market bubble might burst sooner or later, owing to the abundant liquidity and fast growth of housing prices. In view of this, both the relationships between housing prices and market fundamentals, and the potential existence of housing price bubbles in 2006 for Hong Kong and Shenzhen have been investigated.

Policymakers can benchmark the findings in evaluating the healthiness of housing market, as well as determining key driving factors of housing prices. The methods used, Granger causality test, generalized impulse response function and variance decomposition are widely used and recognized statistical tools, with well-established theories to support their consistency, completeness and accuracy. Various methods have been applied to realize the interaction between housing prices and the underlying driving factors (both demand and supply). The results could confirm the consistency of evaluated results and provide the best possible conclusion.

If a housing price bubble exists, the market will display abnormal interactions between housing prices and market fundamentals. The results from the Granger causality test and impulse response analysis are that housing prices seem to have interacted abnormally with market fundamentals, for instance personal income, vacancy rate and stock price index. This is particularly so for Shenzhen in recent years. Meanwhile, Shenzhen's housing prices mainly relate to its own past house prices and to personal income, according to the output from variance decomposition analysis. In contrast, Hong Kong's housing prices can be explained pretty well by economic indicators, i.e. its

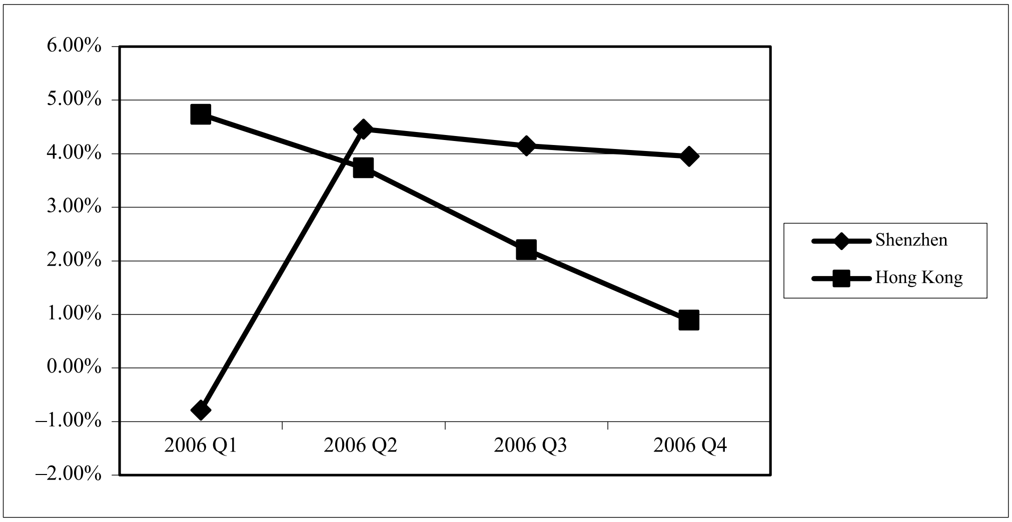


Figure 7 Estimated housing price bubbles for Shenzhen and Hong Kong in 2006

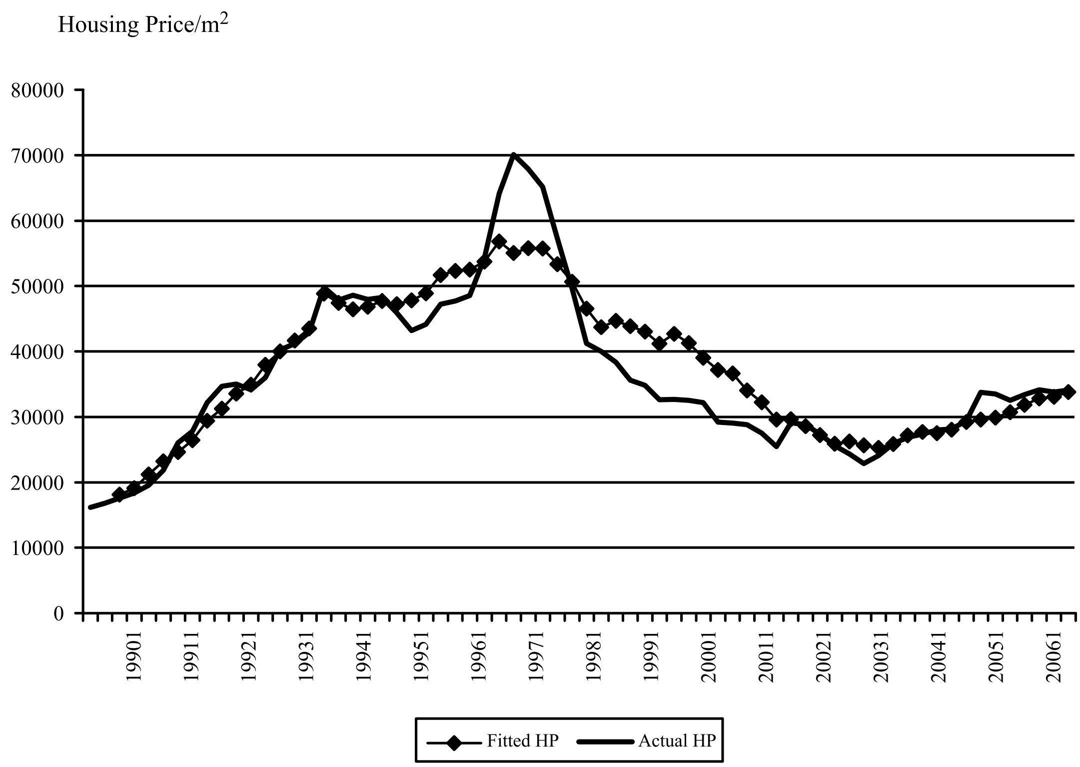


Figure 8 Actual and predicted housing price per sq. m in Hong Kong from 1990 to 2006

overall economy. One common theme shared by both Hong Kong and Shenzhen is that the two cities' property markets do not have significant impact on one another. Further, while the price bubble for Hong Kong had been getting smaller in scale, a puny bubble appeared to be formed for Shenzhen after the second quarter of 2006, amounting to as much as 4.5% of the housing price. This speculative bubble in Shenzhen is consistent with a recent article published in Stiglitz (2007), which has pointed out that China's real estate market is still relatively undervalued as its nationwide housing prices have risen much more slowly than incomes.

Investors therefore should be cautious of any possible risks involved in the Shenzhen property market, such as overinvestment and rapid policy adjustments,

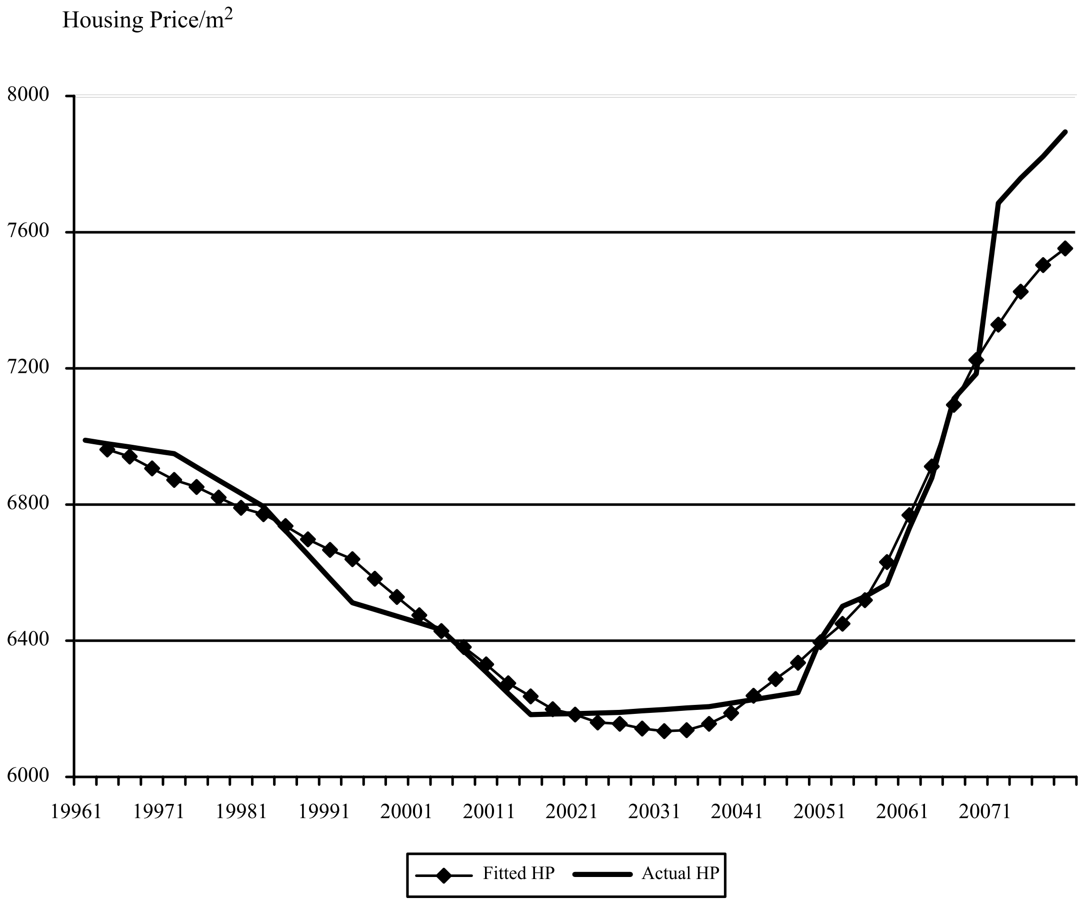


Figure 9 Actual and predicted housing price per sq. m in Shenzhen from 1996 to 2006

even though these are unlikely to happen in the medium term. On the other hand, such risks are minimal for Hong Kong as the bubble term was getting less noticeable in 2006. Attention should, however, be paid to abnormal interactions, particularly between housing prices and the vacant new dwellings in view of the decreasing availability of land.

There are some possible areas for future research in housing price relations between Hong Kong and Shenzhen, or between other closely linked cities. First, since a general picture of price bubbles for Hong Kong's/Shenzhen's residential properties has been provided, the foundation has been set for other more in-depth studies on the existence of price bubbles in various housing types. Second, future studies may further work on different model specifications for comparisons, or on direct estimations of assets' fundamental value. However, achieving these two tasks could be very difficult, if not impossible, without reliable data. Also, a larger dataset could be used, preferably covering a longer period of time. This should improve the accuracy and reliability of the findings. This research, however, is constrained by time and resources available. The current dataset is used because it is available in public domain, which means it is generally reliable and acceptable.

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Appendix 1

Table A1 VAR/VECM of housing prices and disposable income

		Shenzhen: 1996.Q1–2007.Q1				Hong Kong: 1990.Q1–2006.Q4			
		Coe.	t-ratio	Coe.	t-ratio	Coe.	t-ratio	Coe.	t-ratio
Cointegrating Eq	lnHP(−1)	1.00							
	lnINC(−1)	1.20	12.26**						
	t	−0.03	−9.60**						
	C	−20.28							
Error correction		D(lnHP)		D(lnINC)		D(lnHP)		D(lnINC)	
CointEq1		−0.74	−3.35*	−0.36	−1.51				
D(lnHP(−1))		0.56	2.67*	0.12	0.52	1.33	9.04**	0.07	0.66
D(lnHP(−2))		0.53	2.34*	0.17	0.70	−0.32	−1.34	0.14	0.81
D(lnHP(−3))		0.38	1.82	−0.22	−0.94	0.05	0.22	0.00	0.02
D(lnHP(−4))		0.74	2.45*	−0.04	−0.12	−0.08	−0.61	−0.13	−1.43
D(lnINC(−1))		0.69	2.78*	−0.02	−0.08	0.01	0.07	0.33	2.75*
D(lnINC(−2))		0.13	0.62	0.13	0.57	−0.21	−1.15	0.07	0.59
D(lnINC(−3))		0.07	0.41	0.10	0.56	−0.17	−0.99	−0.19	−1.59
D(lnINC(−4))		0.04	0.27	0.62	3.88**	0.25	1.63	0.63	5.89**
C		−0.02	−1.43	0.00	0.03	1.41	2.94*	0.77	2.30*
t									
R-squared		0.68		0.66		0.96		0.95	
Adj. R-squared		0.58		0.56		0.96		0.94	
Granger causality test: Wald chi-square/Prob		14.03/0.01		2.74/0.61		7.02/0.13		22.86/0.00	

Notes: *(**) denotes significance at the 95% (99%) level.

Table A2 VAR/VECM of housing prices and local GDP

		Shenzhen: 1996.Q1–2007.Q1				Hong Kong: 1990.Q1–2006.Q4			
		Coe.	t-ratio	Coe.	t-ratio	Coe.	t-ratio	Coe.	t-ratio
Cointegrating Eq	lnHP(−1)	1.00				1.00			
	lnGDP(−1)	−0.73	−7.97**			−7.74	−6.14**		
	t	0.03	9.16**			0.08	6.66**		
	C	−5.64				84.26			
Error correction		D(lnHP)		D(lnGDP)		D(lnHP)		D(lnGDP)	
CointEq1		−0.40	−4.54**	−0.13	−0.73	−0.15	−3.72**	0.02	1.58
D(lnHP(−1))		0.01	0.06	−0.03	−0.12	0.44	3.64**	0.12	3.17*
D(lnHP(−2))		0.19	1.37	0.18	0.66	0.13	0.09	0.04	0.92
D(lnHP(−3))		0.36	2.73*	0.10	0.36	0.03	0.22	−0.03	−0.68
D(lnHP(−4))		0.92	3.95**	0.34	0.73	−0.18	−1.41	−0.11	−2.80*
D(lnGDP(−1))		−0.43	−3.90*	0.59	2.76*	−0.58	−1.52	0.06	0.47
D(lnGDP(−2))		0.10	0.84	−0.09	−0.36	−0.62	−1.82	−0.14	−1.31
D(lnGDP(−3))		0.09	0.74	0.03	0.14	0.01	0.02	−0.07	−0.74
D(lnGDP(−4))		−0.23	−2.04*	−0.48	−2.14*	−0.52	−1.77	0.69	7.58**
C		0.02	2.55*	0.04	2.43	0.03	1.83	0.01	1.30
t		0.00	1.79*	0.00	−0.86				
R-squared		0.81		0.58		0.50		0.90	
Adj. R-squared		0.75		0.46		0.42		0.88	
Granger causality test: Wald chi-square/Prob		16.84/0.00		2.67/0.61		9.26/0.05		24.27/0.00	

Notes: *(**) denotes significance at the 95% (99%) level.

Table A3 VAR/VECM of housing prices and vacant dwellings/vacancy rates

		Shenzhen: 1996.Q1–2007.Q1				Hong Kong: 1990.Q1–2006.Q4			
		Coe.	t-ratio	Coe.	t-ratio	Coe.	t-ratio	Coe.	t-ratio
Cointegrating Eq	lnHP(−1)								
	lnVAC(−1)								
	t								
	C								
Error correction		D(lnHP)		D(lnVAC)		D(lnHP)		D(lnVAC)	
CointEq1									
D(lnHP(−1))		1.02	5.56**	0.00	0.00	1.27	9.40**	−0.02	−0.44
D(lnHP(−2))		0.07	0.26	0.25	0.95	−0.45	2.04*	−0.04	−0.42
D(lnHP(−3))		−0.24	−0.95	−0.03	−0.13	0.15	0.71	0.11	1.22
D(lnHP(−4))		0.24	0.74	−0.28	−0.90	−0.07	−0.61	−0.04	−0.81
D(lnVAC(−1))		0.00	−0.01	0.71	4.04**	−0.45	−1.33	1.68	12.46**
D(lnVAC(−2))		0.10	0.55	0.03	0.16	0.65	0.94	−0.60	−2.22*
D(lnVAC(−3))		−0.14	−0.91	0.37	2.44	−0.65	−0.95	−0.30	−1.10
D(lnVAC(−4))		−0.09	−0.56	−0.09	−0.59	0.35	1.05	0.21	1.59
C		−0.75	−0.97	0.63	0.84	2.15	3.88**	0.08	0.36
t									
R-squared		0.98		0.99		0.97		0.99	
Adj. R-squared		0.97		0.98		0.96		0.99	
Granger causality test: Wald chi-square/Prob		4.08/0.40		1.48/0.83		11.80/0.02		3.76/0.44	

Notes: *(**) denotes significance at the 95% (99%) level.

Table A4 VAR/VECM of housing prices and the stock price index

		Shenzhen: 1996.Q1–2007.Q1				Hong Kong: 1990.Q1–2006.Q4			
		Coe.	t-ratio	Coe.	t-ratio	Coe.	t-ratio	Coe.	t-ratio
Cointegrating Eq	lnHP(−1)	1.00							
	lnSHANG(−1)	−0.96	−3.44**						
	t	0.04	3.84**						
	C	−3.88							
Error correction		D(lnHP)		D(lnSTOCK)		D(lnHP)		D(lnSTOCK)	
CointEq1		0.02	3.97**	0.11	1.17				
D(lnHP(−1))		−0.21	−1.20	−3.31	−1.25	1.45	11.88**	0.43	1.55
D(lnHP(−2))		−0.01	−0.08	0.98	0.37	−0.48	−4.00**	−0.41	−1.53
D(lnSTOCK(−1))		0.02	1.58	0.20	1.14	−0.07	−1.22	−0.70	5.17**
D(lnSTOCK(−2))		0.00	0.04	0.09	0.58	0.04	0.70	0.24	1.76
C		0.00	1.89	0.03	1.04	0.68	2.74*	0.48	0.87
t									
R-squared		0.60		0.12		0.97		0.92	
Adj. R-squared		0.54		0.00		0.96		0.91	
Granger causality test: Wald chi-square/Prob		2.51/0.29		2.03/0.36		3.86/0.15		2.41/0.30	

Notes: *(**) denotes significance at the 95% (99%) level.

Appendix 2

Variance decomposition of DLOG(SZHP)							
Period	S.E.	DLOG(SZHP)	DLOG(SZINCOME)	DLOG(SZGDP)	LOG(SZINDEX)	DLOG(SZVACANTS)	DLOG(HKHP)
1	0.005886	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.006886	75.70049	10.61803	7.216751	0.846937	5.616237	0.001553
3	0.007663	67.70220	15.69079	6.274628	0.967439	8.886297	0.478651
4	0.008867	50.79873	15.36519	15.71028	3.837711	13.75163	0.536458
5	0.009653	42.92899	26.03364	13.28262	3.991095	13.00155	0.762107
6	0.012095	30.57048	28.35998	21.12617	2.556500	16.85091	0.535962
7	0.013454	25.32473	38.36228	17.33206	4.780524	13.69931	0.501090
8	0.016366	17.61026	44.39528	12.03935	4.467914	21.13169	0.355515
9	0.018029	28.78569	36.79818	9.925218	6.056019	18.11536	0.319525
10	0.018951	26.07337	35.33906	10.90655	7.645234	19.65411	0.381670
11	0.019438	26.97854	33.68038	12.12055	7.350702	19.40698	0.462856
12	0.020730	33.51124	30.40465	11.34360	6.714574	17.56564	0.460302

Variance decomposition of DLOG(HKHP)							
Period	S.E.	DLOG(HKHP)	DLOG(HKINCOME)	DLOG(HKGDP)	DLOG(HKINDEX)	DLOG(HKVACANTS)	DLOG(SZHP)
1	0.041008	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.055615	56.66720	15.76891	5.772247	8.982950	12.23767	0.571022
3	0.060481	47.91579	14.66865	5.125784	7.991269	23.10637	1.192136
4	0.074438	31.79085	13.02538	18.27854	5.933823	26.30137	4.670026
5	0.087106	24.01497	21.47060	24.01202	5.289894	21.53112	3.681396
6	0.088144	24.03968	21.97849	23.88945	5.316383	21.02714	3.748853
7	0.103937	22.79499	22.59617	27.44720	3.929818	17.96152	5.270292
8	0.112645	21.41352	29.81423	23.37595	5.561069	15.34819	4.487045
9	0.130012	22.66479	28.14398	29.62497	4.207446	11.98303	3.375779
10	0.130439	22.65350	28.11866	29.68037	4.185019	12.00847	3.353983
11	0.136189	20.93418	26.07674	32.96036	3.841698	11.92748	4.259542
12	0.139169	20.62251	26.27449	33.81621	3.710418	11.49691	4.079459