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Is Shenzhen Housing Price Bubble that High? A Perspective of Shenzhen Hong Kong Cross-Border Integration

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In this paper, monthly data from May 2004 to December 2011 are used to calculate the equilibrium housing price predicted by the economic fundamentals of Shenzhen and additional economic fundamentals of Hong Kong under the background of the Shenzhen Hong Kong cross-border integration. Equilibrium housing price is then compared against the actual housing price to test the degree of the Shenzhen housing price bubble during the studied period. We find that aided by the economic fundamentals of Hong Kong, the Shenzhen housing price can be better explained and the gap between the actual and equilibrium housing prices can be largely reduced, thus implying a much smaller Shenzhen housing price bubble.

Keywords

Housing Price Bubble, Shenzhen, Cross-Border, Hong Kong

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1. Introduction

Shenzhen, the only bordering city of Hong Kong, is one of the first-tier destination cities of real estate investment in Mainland China. Hong Kong was returned to China by the British government in the year of 1997, and since then, has been under a special administration arrangement which makes Hong Kong appear to be a different “country” from China. One piece of evidence is that today, Mainland China citizens still need a visa to enter Hong Kong. Different administrative systems, however, will not cut off cross-border integration, especially from economic and social perspectives. During recent years, with continuously deepening Shenzhen-Hong Kong integration, a large number of Hong Kong residents marry, secure employment, and/or start businesses in Shenzhen, all of which induce or are induced by local real estate demand. Real estate demand from the other side of the border is further reinforced by the fact that there exists huge cross-border housing price gaps of several times, and the fact that the trend of the RMB appreciation against the HKD encourages even more outside investment into Shenzhen, one of the most popular real estate markets in Mainland China. Evidence from recent data released from the Shenzhen Bureau of Land and Resources shows that as high as 8% of the Shenzhen housing stock is consumed by Hong Kong residents.

On the one hand, such extra real estate demand has been leading to an even sharper rise of the Shenzhen housing price, in considering the inelasticity of the housing supply in the top cities of Mainland China. The Shenzhen housing price has witnessed rapid increases since early this century. As seen from Table 1, the housing price in almost every large city in China had at least doubled during our study period of 2004-2011. Among all of these top cities, the Shenzhen case is one of the most extreme. Its housing price more than tripled between 2004 and 2011, following only Fuzhou, Beijing and Ningbo, from about 6,700 RMB to about 21,000 RMB per square meter within only seven years.

On the other hand, however, cross-border city integration is not the same as city integration among neighboring cities within one country. Cross-border city integration, although with geographic proximity, will still expect large segmentation across the borders resultant of the different political, economic and cultural systems, etc. After all, cross-border cities are under jurisdiction of different countries (regions); we thus should not expect that there will be much effect on the local housing market from abroad factors.

Table 1 Yearly Housing Selling Price per Square Meter (in RMB) and Accumulated Growth between 2004 and 2011 for Largest 36 Cities in China[1]

City	2004	2005	2006	2007	2008	2009	2010	2011	Growth 2005:2011
NATIONAL	2714	3168	3367	3864	3800	4681	5032	5357	97%
Fuzhou	2616	3212	4397	5179	5516	6625	8414	10178	289%
Beijing	5053	6788	8280	11553	12418	13799	17782	16852	234%
Ningbo	3389	5027	5437	6251	7224	8992	11224	11032	225%
Shenzhen	6756	7582	9385	14050	12665	14615	19170	21350	216%
Hangzhou	4248	5619	6218	7616	8409	10555	14132	13286	213%
Shijiazhuang	1547	1870	2068	2452	2610	3765	3881	4741	206%
Haikou	2237	2650	2786	3516	4533	5344	8015	6635	197%
Changsha	2039	2314	2644	3305	3288	3648	4418	5862	188%
Wuhan	2516	3062	3690	4664	4781	5329	5746	7193	186%
Guiyang	1802	2169	2373	2902	3149	3762	4410	5070	181%
Tianjin	3115	4055	4774	5811	6015	6886	8230	8745	181%
Chengdu	2452	3224	3646	4276	4857	4925	5937	6717	174%
Zhengzhou	2099	2638	2888	3574	3928	4298	4957	5696	171%
Changchun	2260	2393	2558	3250	3489	4142	5178	6131	171%
Chongqing	1766	2135	2269	2723	2785	3442	4281	4734	168%
Guangzhou	4537	5366	6548	8673	9123	9351	11921	12104	167%
Hohhot	1648	2057	2368	2596	2731	3887	4105	4367	165%
Nanjing	3516	4077	4477	5304	5109	7185	9565	9311	165%
Dalian	3116	3747	4525	5568	5774	6249	7044	8052	158%

(Continued…)

[1] We exclude Lhasa, Tibet, because of missing data. Data source from National Bureau of Statistics of China.

(Table 1 Continued)

City	2004	2005	2006	2007	2008	2009	2010	2011	Growth 2005:2011
Taiyuan	2675	3575	3579	3862	4013	4830	7244	6816	155%
Xiamen	4146	5503	6340	8250	5256	7951	8883	10556	155%
Qingdao	2965	3744	4249	5201	5094	5576	6576	7495	153%
Shanghai	5855	6842	7196	8361	8195	12840	14464	14603	149%
Hefei	2550	3006	3110	3307	3592	4228	5905	6326	148%
Urumqi	2147	2373	2166	2667	3244	3446	4524	5254	145%
Nanchang	2430	2587	3126	3558	3461	3774	4566	5939	144%
Xian	2624	2851	3317	3379	3906	3890	4453	6156	135%
Jinan	3056	3133	3525	3776	4179	4897	6259	6698	119%
Harbin	2494	2700	2703	3053	3793	4226	5333	5398	116%
Xining	1725	1877	2022	2421	2900	2900	3328	3646	111%
Lanzhou	2282	2590	2614	2967	3145	3624	4233	4747	108%
Shenyang	2911	3187	3376	3699	4127	4464	5411	5884	102%
Yinchuan	2177	2593	2399	2408	2828	3523	3792	4376	101%
Kunming	2474	2640	2903	3108	3750	3807	3660	4715	91%
Nanning	2761	2605	2872	3404	3952	4557	5135	5196	88%

Following Beijing and Shanghai, Shenzhen is the next most important GDP giant in Mainland China. However, a comparison of the GDP growth of Shenzhen (236%; from RMB 342 billion in 2004 to RMB 1150 billion in 2011) to its housing price growth within the same period (216%) shows that over 90% of the GDP growth comes from housing price inflation based on the fact that housing price is not included in either the consumer price index (CPI) or producer price index (PPI) calculation in China [2]. The Shenzhen local government, real estate industry and academia should be aware of the evolution of a housing price bubble which could be potentially caused by soaring housing prices that have deviated from a reasonable level. The bursting of the housing price bubble will trigger a series of fiscal and financial problems and exert long-term negative effects on the economy and social development of the affected regions. Timely preventive measures are thus necessary for ensuring the healthy and sustainable development of the real estate market. Under this consideration, it is of practical importance to make sound judgments on the status of the Shenzhen housing market.

There is, however, almost no published research on the Shenzhen housing price bubble, not to mention from the novel perspective of a Shenzhen Hong Kong cross-border integration. The existing literature provides several ways to test real estate price bubbles. For example, Li and Qu (2002) use an efficacy coefficient method to test the housing market in China, in which three variables (money supply, stock price, and land price) are selected as indicators; the evaluation of each is then weighted and summed to obtain a comprehensive judgment of the housing market status. They find that from 1986 to 1989, the housing market in China was continuously at the risk of a serious housing price bubble. Han (2005) uses model specification testing and the principle that reasonable real estate prices should be the capitalization of housing rent per West (1987) to investigate whether housing price bubbles existed during 1991-2003 in Beijing, Shanghai and Shenzhen. He finds mixed results. Ye and Wang (2005) use the Ramsey model to derive the equilibrium value for real estate as the marginal return to real estate asset under equilibrium, which is determined by interest rate, inflation, and population. They propose an interval for the equilibrium value of real estate by applying the upper and lower bounds of the interest rate, and then check whether the actual housing price was outside the proposed interval, which is defined as a bubble. They find that the housing market experienced a progression of negative bubble, no bubble, and then positive bubble during 2000-2004. Yang and Liu (2005) add technical advancement and capital depreciation to the formula derived by Ye and Wang (2005), and re-test the housing market in China over an extended period of 1999-2006. They find that the market has experienced a cycle from no bubble, negative bubble to positive bubble. Mikhed and Zemčík (2009) apply the unit root and cointegration tests to US metropolitan housing price and rental fee data between 1978 and 2006. The

[2] Data source from the National Bureau of Statistics of China.

failure to find a cointegration relationship between housing price and rental fee indicates the existence of a housing price bubble from the late 1980s to early 1990s in US major cities.

Abraham and Hendershott (1996) utilize growth variables of economic fundamentals to explain the growth of the equilibrium housing price. Their fundamentals include real construction cost, real per-capita income, employment, and real after-tax interest rate. The housing price bubble could be captured in the deviation of the actual price from its equilibrium price. Other studies that have applied the same method to measure housing price bubbles include McCarthy et al. (2004), Hong et al. (2005), Zhou (2005), Pu and Chen (2006) , and Wu and Wang (2006), among others. This paper adopts the method per Abraham and Hendershott (1996) to derive the growth of the equilibrium housing price in Shenzhen, the deviation of the actual price, which is then calculated as the input in the measurement of a housing price bubble.

Abraham and Hendershott (1996) and others estimate the equilibrium housing price by only using economic fundamentals of the subject region itself. In realizing that there is strong social and economic cross-border integration between Hong Kong and Shenzhen, this work adds to the Hong Kong economic fundamentals as foreign prompters of the Shenzhen local housing demand help to explain the equilibrium housing price in Shenzhen.

The next section introduces the method used by Abraham and Hendershott (1996). Section 3 discusses our variables and data, followed by a few tests to examine the variable and model properties in Section 4. Section 5 presents the empirical result, and Section 6 concludes.

2. Housing Price Bubble Measurement Method

According to Abraham and Hendershott (1996), the growth of the equilibrium housing price is determined by the growth of some of the economic fundamentals as follows:

$$hp_t^* = \beta_0 + \sum_{i=1}^{k} \beta_i x_i \tag{1}$$

where hp_t^* is the growth of the equilibrium housing price and explanatory vector x_i includes the growth of economic fundamentals, such as construction cost, loan interest rate, per capita disposable income, population, etc.

The actual housing price growth, however, is additionally determined by uncertain factors, such as market expectation. The actual growth consists of two parts:

$$hp_t = hp_t^* + e_t \tag{2}$$

where hp_t is the actual housing price growth and e_t is the error part, which is beyond capturing by economic fundamentals. By expecting housing price to continue to inflate, investors ignore the intrinsic consumption and value maintaining function of real estate, while targeting speculative returns from buying low and selling high. This leads to so called positive-feedback trading whereby investors make investment decisions in the next period merely based on the past price trend. This positive-feedback trading causes further deviation of the actual housing price from its equilibrium price, a development mechanism of a housing price bubble.

The error part e_t can be expressed as:

$$e_t = \phi_0 + \phi_1 hp_{t-1} + \phi_2(\ln HP_{t-1} - \ln HP_{t-1}^*) + \varepsilon_t \tag{3}$$

where hp_{t-1} is the actual housing price growth in the previous period, $HP^*_{t\text{-}1}$ and HP_{t-1} are the equilibrium and actual housing price levels of the previous period, respectively, ϕ_1 is the bubble growth coefficient while ϕ_2 is the bubble reduction coefficient. If ϕ_1 is positive, the actual housing price growth of the previous period is to some extent maintained into the current period, which is a positive-feedback trading mechanism. The difference inside the parenthesis is defined as the forecasting error in the previous period, that is, the deviation of the actual housing price level from its fundamental level. If ϕ_2 is negative, the previous forecasting error is corrected in the current period towards the equilibrium housing price. ε_t is the random error. By combining Equations (1)-(3), the actual housing price growth is derived as:

$$hp_t = (\beta_0 + \phi_0) + \sum_{i=1}^{k} \beta_i x_i + \phi_1 p_{t-1} + \phi_2(\ln HP_{t-1} - \ln HP_{t-1}^*) + \varepsilon_t \tag{4}$$

The estimation of Equation (4), however, requires that the sequences be determined, which themselves depend on the estimation of Equation (4). Abraham and Hendershott (1996) provide the following steps to solve this problem: 1) Equation (4) is estimated without the $\phi_2(\ln HP_{t-1} - \ln HP_{t-1}^*)$ term and coefficients are obtained for other terms; 2) coefficient estimates are applied from 1) to estimate the HP^* in Equation (1); 3) the sums of $hp_{t-1} = \ln HP_{t-1} - \ln HP_{t-2}$, $hp_{t-2} = \ln HP_{t-2} - \ln HP_{t-3}$,…… are calculated to get:

$$\ln HP_{t-1} = \ln HP_0 + \sum_{i=0}^{t-1} hp_i \tag{5}$$

4) hp_i is replaced with hp_i^* to obtain $\ln HP_{t-1}^*$, and a time series $\{\ln HP_{t-1} - \ln HP_{t-1}^*\}$; 5) the results in 4) are used to estimate Equation (4)

again to obtain the updated coefficients; this process is iterated until the coefficient estimates converge; 6) the finalized coefficient estimates are applied in 5) to calculate $\ln HP^{*}_{t-1}$ and $HP^{*}_{t\text{-}1}$; and 7) the housing price bubble is measured at time *t* as $(HP_t - HP_t^*) / HP_t^* \times 100\%$.

3. Data, Variable and Model

This paper uses monthly data between May 2004 and December 2011 for a total of 92 observations. Data sources include the National Bureau of Statistics of China, Shenzhen Municipal Bureau of Statistics, China Real Estate Index System, China Economic Information Network Statistics, Hong Kong Census and Statistics Department, Hong Kong Monetary Authority, and Hong Kong Rating and Valuation Department.

The dependent variable is the growth of the housing sale price in Shenzhen (*hp*). The explanatory variables include both Shenzhen and Hong Kong fundamentals. The former include in Shenzhen, housing investment in RMB (*Invest*), completed housing area (*Area*), housing construction cost (*Cost*), sold housing area (*Sales*), per capita disposable income (*Income*), interest rate for loans 5 years or longer (*Rate*), and resident population (*N*). The latter include in Hong Kong, the median income of the working population (*Income_HK*), loan interest rate (*Rate_HK*) and working population (*N_HK*), as well as the HKD exchange rate against the RMB (*Exchange*). To eliminate the inflation effect on housing price, all monetary variable and interest rates are deflated by the current local CPI. Except for the interest and exchange rates, the variables are calculated as growth from the previous period.

The price of houses, like that of any other commodity, is basically determined by supply and demand, and also affected by the price of substitute goods. Here in this research, *Invest*, *Area*, *Cost* and *Sales* are either local supply variables or variables that affect local supply while *Income* and *N* are variables that affect local demand. Local *Rate* affects both the supply and demand of houses in Shenzhen since an increased (decreased) loan rate discourages (encourages) both. The overall effect direction from *Rate* relies on the mutual competition between the supply and demand. Housing located in Shenzhen is a (partial) substitute for Hong Kong housing. *Income_HK*, *N_HK*, and *Rate_HK* are all variables that affect the Hong Kong local housing demand. Changes in housing demand in Hong Kong are (partially) absorbed by the Shenzhen housing market. RMB appreciation (depreciation) against the Hong Kong dollar prompts more (fewer) investors to hold more (less) RMB assets, including real estate in popular investment destinations of China, like Shenzhen, which increases (reduces) the local housing price.

By observation, our time series in housing investment (*Invest*) and completed housing area (*Area*) in Shenzhen show strong seasonal trends. We apply the X12 procedure provided by *Eviews* for seasonal adjustment. The raw yearly data of Shenzhen per capita disposable income (*Income*) and Shenzhen resident population (*N*) are applied with the interpolation method to obtain monthly data by assuming that the population and income are stably growing over time. Our dataset has no information on the per capita disposal income in Hong Kong, so we use the median income of the working population (*Income_HK*) as the proxy. Again, we apply the interpolation method to obtain monthly data from its quarterly raw data. Hong Kong only releases yearly information on its resident population, while data on the Hong Kong working population (*N_HK*) is provided on a monthly frequency which suits our usage. For a robustness check of this interpolation method, we compare and find high consistency between the empirical results by using actual monthly *N_HK* and those by using hypothetical monthly data from the Hong Kong working population interpolated from its observed yearly growth[3].

As mentioned in the beginning, this paper develops and compares two models: Model I, an equilibrium housing price model based on Shenzhen economic fundamentals versus Model II, an equilibrium housing price model based on both Shenzhen and Hong Kong economic fundamentals, as Equations (6) and (7) below, respectively. The Δ sign in front of each variable indicates growth. The lagged dependent variables on the right hand side of both models are to capture the potential auto regressive property of the housing price itself.

$$\begin{aligned} hp_t &= (\beta_0 + \phi_0) + \beta_1 \Delta Invest_t + \beta_2 \Delta Area_t + \beta_3 \Delta Cost_t + \beta_4 \Delta Sales_t + \\ &\beta_5 \Delta Income_t + \beta_6 Rate_t + \beta_7 \Delta N_t + \phi_1 hp_{t-1} + \phi_2 (\ln HP_{t-1} - \ln HP^*_{t-1}) + \varepsilon_t \end{aligned} \tag{6}$$

$$\begin{aligned} hp_t &= (\beta_0 + \phi_0) + \beta_1 \Delta Invest_t + \beta_2 \Delta Area_t + \beta_3 \Delta Cost_t + \phi_4 \Delta Sales_t + \\ &\beta_5 \Delta Income_t + \beta_6 Rate_t + \beta_7 \Delta N_t + \beta_8 \Delta Income\_HK_t + \\ &\beta_9 Rate\_HK_t + \beta_{10} \Delta N\_HK_t + \beta_{11} Exchange_t + \beta_{12} hp\_HK_{t-1} + \\ &\phi_1 hp_{t-1} + \phi_2 (\ln HP_{t-1} - \ln HP^*_{t-1}) + \varepsilon_t \end{aligned} \tag{7}$$

4. Test for Variable and Model Properties

We apply the augmented Dickey–Fuller (ADF) test to each time series in Equations (6) and (7). The Schwarz criteria are used to determine the lag order in the ADF tests. The ADF test results in Table 2 show that all of the growth or ratio time series used in Models I and II are stationary.

[3] Results of the comparisons are available by request.

The presence of heteroscedasticity may have consequences, such as meaningless significance tests for variables, invalid parameter estimation, failure in model prediction, etc. It is, therefore, advisable to carry out a heteroscedasticity test. The null hypothesis is that random disturbances have equal variance in the linear regression (homoscedasticity), and rejection of the null hypothesis indicates the existence of heteroscedasticity. We run the White heteroscedasticity test (excluding the White cross terms) for Models I and II, respectively. The results in Tables 3 and 4 show that both models cannot reject the null hypothesis, that is, no heteroscedasticity exists.

Table 2 Time Series Stationary Test Results

Variable	Difference Order	Lag Order	ADF statistic	Prob.
hp	0	0	-5.2513	0.0000
ΔInvest	0	0	-5.2689	0.0000
ΔArea	0	0	-13.7489	0.0001
ΔCost	0	0	-13.0793	0.0001
ΔSales	0	0	-10.8053	0.0000
ΔIncome	0	0	-12.7720	0.0001
Rate	0	0	-10.0171	0.0000
ΔN	0	0	-6.8738	0.0000
ΔIncome_HK	0	0	-12.4739	0.0001
Rate_HK	0	0	-5.2939	0.0000
ΔN_HK	0	0	-8.0821	0.0000
Exchange	0	0	-5.3812	0.0000
hp_HK	0	0	-11.2118	0.0001

Table 3 Heteroscedasticity Test Results for Model I

White Heteroskedasticity Test			
F-statistic	1.7572	Probability	0.1445
Obs* R-squared	6.8819	Probability	0.1423

Table 4 Heteroscedasticity Test Results for Model II

White Heteroskedasticity Test			
F-statistic	1.6626	Probability	0.1806
Obs* R-squared	4.9365	Probability	0.1765

Table 5 Autocorrelation Test Results for Model I

Lag Order	AC	PAC	Q-Stat	Prob
1	-0.023	-0.005	17.877	0.094
2	-0.037	-0.032	18.028	0.115
3	0.000	-0.031	18.028	0.156
4	-0.025	-0.045	18.101	0.202
5	-0.017	0.007	18.133	0.256
6	0.004	0.014	18.135	0.316
7	0.007	-0.005	18.141	0.380

8	-0.008	-0.011	18.148	0.446
9	-0.021	-0.019	18.201	0.509
10	-0.036	-0.022	18.357	0.564

Table 6 Autocorrelation Test Results for Model II

Lag Order	AC	PAC	Q-Stat	Prob
1	-0.084	-0.125	4.271	0.118
2	-0.127	-0.090	5.893	0.117
3	-0.172	-0.146	8.882	0.064
4	0.004	0.048	8.884	0.114
5	0.106	0.061	10.056	0.122
6	-0.091	-0.161	10.916	0.142
7	0.023	0.075	10.972	0.203
8	-0.067	-0.097	11.457	0.246
9	-0.064	-0.021	11.897	0.292
10	-0.001	-0.036	11.898	0.371

Next, we carry out autocorrelation tests for the residuals, with lag order 1 to 10. The null hypothesis is that the model has no autocorrelation, and rejection of the null hypothesis indicates the existence of autocorrelation. The test results in Tables 5 and 6 show that in both models, the probabilities are greater than 0.05. We thus cannot reject the null hypothesis, which indicates that autocorrelation does not exist in our models.

5. Empirical Results

The ordinary least squares method is applied to both Models I and II. The regression results of Model I which are only based on the Shenzhen economic fundamentals are shown in Table 7 (statistically insignificant variables are excluded). The adjusted R^2 is 0.70, which implies that our selected explanatory variables are powerful in explaining the variation in the housing price growth of Shenzhen. The growth of the real construction cost ($\Delta Cost$) has positive predicting power on housing price growth with a coefficient of 0.49, thus indicating that a 1% increase in growth in real construction cost leads to a 0.49% increase in the housing price growth in Shenzhen. This result is slightly higher than that of Hong et al. (2005) who use a national sample.

The growth of per capita real disposal income ($\Delta Income$) has a significantly positive effect on housing price growth, but the effect magnitude is relatively small. The estimated coefficient is 0.12, thus indicating that a 1% increase of the disposal income growth causes a 0.12% increase of the housing price growth in Shenzhen during our studied period. Xiao (2009) finds that per capita disposable income does not significantly affect Shanghai housing price, which implies that Shanghai housing price is not mainly driven by consumption demand, but very likely by speculation, a possible reinforcing factor of the housing price bubble.

The loan interest rate (*Rate*) negatively affects housing price growth. A 1% increase of the interest rate lowers the housing price growth by 0.68%, which shows that the former is an important fundamental tool that can help to curb the housing price fever in Shenzhen. Housing supply is relatively inelastic compared to housing demand in China. An increase in the loan interest rate thus reduces more demand than supply, which leads both housing price and transaction volume to decrease. Iacoviellos (2002) has studied housing price determinants in six major European countries (United Kingdom, Germany, France, Italy, Spain, Sweden), and finds that over the past 25 years, housing prices in all six countries decline whenever the interest rate increases. The empirical results from Abraham and Hendershott (1996) also show a negative relationship between interest rates and property prices.

Finally, the population growth (ΔN) has a strong positive relationship with housing price growth, which is consistent with our expectations and the previous literature.

Table 7 Regression Results of Model I with Shenzhen Fundamentals Only

Variable	Parameter	Estimate	t-Statistic
Constant	$\beta_0+\varphi_0$	0.02	0.86
Δ*Cost*	β_3	0.49***	4.30
Δ*Income*	β_5	0.12*	2.32
Rate	β_6	-0.68**	1.72
Δ*N*	β_7	1.18**	2.49
hp_{t-1}	φ_1	0.56***	6.44
$(\ln HP_{t-1} - \ln HP_{t-1}^*)$	φ_2	-0.23**	1.67
Adjusted R^2	0.70	D-W	1.75
F-statistic	18.41	Prob (F)	0.00

Note: ***, **, and *denote significance at the 1%, 5% and 10% levels, respectively.

The φ_1 is positive and both statistically and economically significant, which show that most of the housing price growth in the previous period is sustained into the current period; a 1% increase in the previous period drives up the current housing price growth by 0.56%. The significantly negative φ_2 (error correction or bubble reduction effect) indicates that once housing price in the previous period deviated from its fundamental price, it is partially corrected towards the fundamental price in the current period. Numerically, if the actual housing price in the previous period was 1% higher (lower) than its equilibrium level, the housing price growth in the current period is reduced (increased) by 0.21%. A smaller magnitude of φ_2, compared to φ_1, indicates that the Shenzhen housing market has a relatively weak self-correcting capability, which is a possible channel of forming a housing price bubble.

The implementation of the method per Abraham and Hendershott (1996) introduced in Section 2 solves the sequence of equilibrium housing price in Shenzhen, HP_t*, as shown in Figure 1. The lower line is the equilibrium housing price calculated, while the upper line is the actual housing price during the period from May 2004 to December 2011. The actual housing price in Shenzhen had been rising, from RMB 8,830 in May 2004 to RMB 21,891 in December 2011 per square meter. The fundamental price is consistently lower than the actual observed market price during that period (positive deviation of market price from its equilibrium), an implication of a positive housing price bubble.

Figure 1 Actual and Equilibrium Housing Prices Based on Shenzhen Fundamentals Only

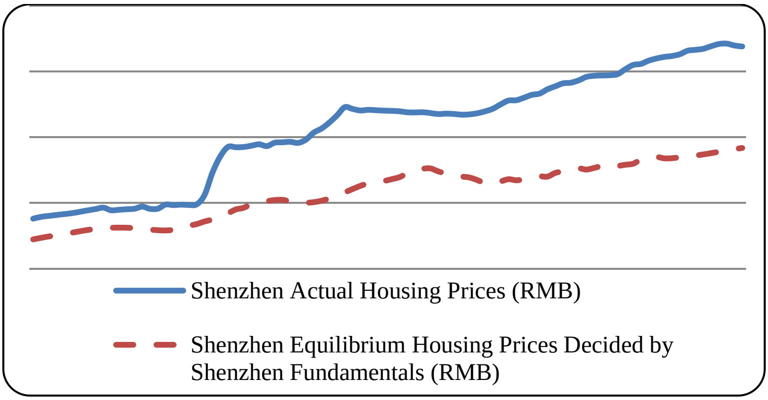


Figure 2 presents the prospect of a housing price bubble in Shenzhen from May 2004 to December 2011, calculated as $(HP_t - HP_t^*) / HP_t^* \times 100\%$. It is observed that a positive housing price bubble had rapidly and continuously increased in recent years. The bubble increased from about 20% in 2004 to 55% in 2009, and maintained a very high level of around 60% up to 2011.

The results from Model II with additional Hong Kong explanatory variables are shown in Table 8 (insignificant variables are excluded). For the convenience of illustration, we also place the regression result from Model I into Table 8. Aligned with Model I, the four Shenzhen economic fundamentals (construction cost, income, interest rate, and population) still exert the same-direction influence on housing price growth, although the effect magnitudes are all slightly reduced.

The addition of the Hong Kong economic fundamentals increase the adjusted R^2 of the model from 0.70 to 0.77, which is indicative of the stronger explanatory power of this augmented model[4]. The Hong Kong housing price

[4] An adjusted R^2 does not necessarily increase when adding irrelevant explanatory

growth in the previous period (hp_HK_{t-1}) positively influences the current housing price growth in Shenzhen. The estimated coefficient, however, is very small, which is 6%, compared to 54% of that of the autoregressive effect from hp_{t-1}. The rising Hong Kong housing price reduces local housing demand and the reduced demand is partially satisfied in Shenzhen, which is made possible by the cross-border integration of these two cities.

Figure 2 Housing Price Bubble Based on Shenzhen Fundamentals Only

Table 8 Regression Results of Model II with Addition of Hong Kong Economic Fundamentals

Variable	Parameter	Model II	t-Statistic	Model I
Constant	$B_0 + \varphi_0$	0.01	0.45	0.02
Δ*Cost*	B_3	0.46***	3.88	0.49***
Δ*Income*	B_5	0.11**	2.11	0.12**
Rate	B_6	-0.66*	1.69	-0.68*
ΔN	B_7	10.46**	1.67	11.87**
Rate_HK	B_{10}	-0.11*	1.82	
Exchange	B_{12}	-0.14*	1.76	
hp_HK_{t-1}	B_{13}	0.06*	1.89	
hp_{t-1}	Φ_1	0.54***	5.86	0.56***
($\ln HP_{t-1}$ - $\ln HP_{t-1}$*)	Φ_2	-0.28**	2.17	-0.22*
Adjusted R^2		0.77		0.70
D-W		1.86		1.74
F-statistic		25.35		18.41
Prob (F)		0.00		0.00

Note: ***, **, and *denote significance at the 1%, 5% and 10% levels, respectively.

variables into the model, while R^2 will never decrease when adding more explanatory variables.

The loan interest rate in Hong Kong (*Rate_HK*) negatively affects the housing price growth in Shenzhen. A 1% decrease would induce a 0.11% increase in the housing price growth in Shenzhen. As a borrowing cost for both housing providers and consumers, the interest rate is a common factor that negatively impacts housing supply and demand. In the short term, if the interest rate in Hong Kong decreases, their house price would increase because demand, being more price elastic, increases more than supply. The increased housing price in Hong Kong would push partial newly created local housing demand out into Shenzhen, which increases the Shenzhen housing price. Compared with the estimated coefficient of the Shenzhen loan interest rate (-0.66), the Hong Kong interest rate has a much smaller effect on the Shenzhen housing price.

The exchange rate (*Exchange*, HKD against RMB) negatively affects the housing price growth in Shenzhen. A 1% decrease in the exchange rate (RMB appreciation) would increase the growth of the housing price in Shenzhen by 0.14%. RMB appreciation prompts more investors to hold more RMB assets, including real estate in popular investment destinations of China, like Shenzhen, and increasing local housing price.

Table 9 summarizes the effects from cross-border variables on the housing price growth in Shenzhen. The effect magnitudes from the Hong Kong interest rate and previous housing price growth are much smaller than those from the Shenzhen local interest rate and previous housing price growth, respectively. This indicates that the Hong Kong and Shenzhen housing markets are still largely segmented in spite of their gradual integration.

Table 9 Effect from Cross-Border Variables on Shenzhen Housing Price

Variable	Shenzhen	Hong Kong
Loan Interest Rate	-0.66	-0.11
Previous Housing Price Growth	0.54	0.06
Exchange Rate	-0.14	

The φ_1 in Table 8 shows a bubble reinforcing coefficient of 0.54, thus indicating that a 1% increase in the housing price growth in the previous period would drive up current growth by 0.54%. The bubble reduction coefficient φ_2 is -0.28, which indicates that about one fourth of the previous deviation of the market price from its equilibrium is corrected in the current period. Compared with the effect magnitudes of φ_1 (0.56) and φ_2 (0.23) from Model I, the φ_1 in Model II decreases to 0.54 while φ_2 increases to 0.28. This indicates that when the Hong Kong economic fundamentals are added to explain for the Shenzhen housing price, the Shenzhen housing market is characterized by a weaker reinforcing effect of the bubble but stronger selfcorrection capability, which would predict a smaller housing price bubble in Shenzhen.

The implementation of the Abraham and Hendershott (1996) method solves again for the equilibrium housing price *HP** in Shenzhen between May 2004 and December 2011 as shown in Figure 3 where both Shenzhen and Hong Kong fundamentals are considered. The recalculating of the housing bubble $(HP_t - HP_t^*)/HP_t^* \times 100\%$ is shown in Figure 4 below.

Figure 3 Actual and Equilibrium Housing Prices with Hong Kong Fundamentals Included

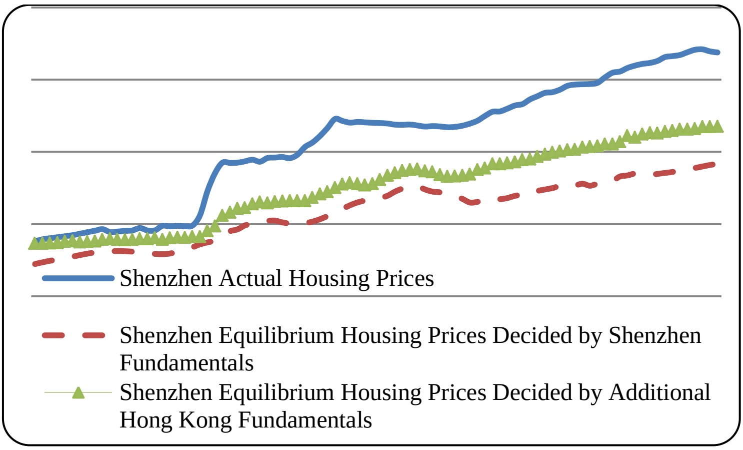
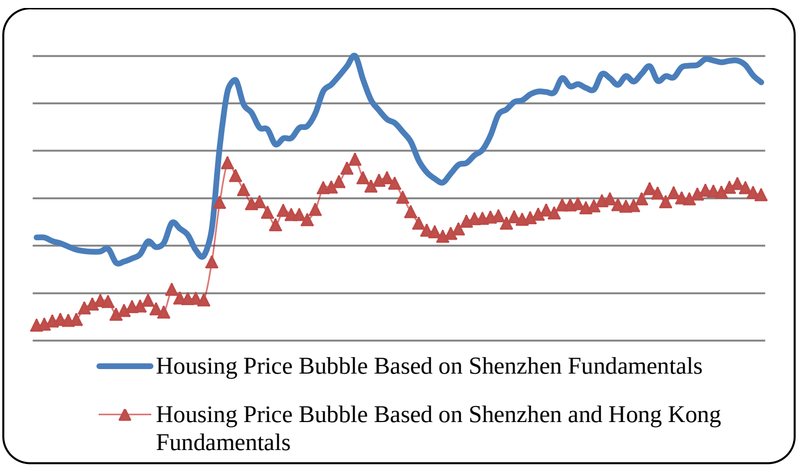


Figure 4 Housing Price Bubble with Hong Kong Fundamentals Included



The top line in Figure 3 is the actual observed housing price in Shenzhen; the middle line is the equilibrium housing price in Shenzhen predicted by both Shenzhen and Hong Kong fundamentals; and the bottom line is the equilibrium housing price in Shenzhen predicted by only using Shenzhen fundamentals. In a comparison of the two equilibrium housing price lines in Figure 3, the addition of Hong Kong determinants allows prediction of higher levels of the equilibrium housing price in Shenzhen, thus reducing the gap between the actual housing price and its equilibrium. The top line in Figure 4 is the bubble measurement which uses the equilibrium housing price from Model I, while the lower line is the bubble measurement based on the equilibrium housing price from Model II. Figure 4 shows a larger estimated housing price bubble from Model I as opposed to Model II where both Shenzhen and Hong Kong economic fundamentals are considered as the explanation factors. The housing bubble in Shenzhen measured in Model II has been stabilized at a 30% level since 2009, compared to the very high level of 60% per Model I.

6. Conclusions

This paper finds that the equilibrium housing price in Shenzhen can be additionally explained by economic fundamentals from her cross-border city of Hong Kong. The addition of Hong Kong economic fundamentals improves the model explanation power, and reduces the gap between the actual and equilibrium housing prices of Shenzhen, and thus a smaller housing price bubble is estimated.

The realization of the cross-border effect from Hong Kong fundamentals on Shenzhen housing price can improve our understanding of the Shenzhen housing market. There is much work on integrated housing markets from the perspective of city integration within the country, but research on cross-country housing market integration is, however, rare. This methodology is also applicable to real estate markets among other actively integrated cross-border cities.

Although our work establishes a relatively smaller measurement of a housing price bubble in Shenzhen, the bubble did gradually accumulate. The local government needs to issue a regulatory policy to curb the housing price fever, so as to avoid short term economic disruption and long term serious fiscal and financial crises in Shenzhen and the surrounding regions.

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