The Anatomy of a Housing Bubble[†]

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Abstract: The Hong Kong residential housing market index (CentaCity Index) experienced a real increase of 50 percent from 1995 to 1997, followed by a real decrease of 57 percent from 1997 to 2002. Using a panel data set of over 200 large-scale housing complexes (estates), increases in transaction volume and considerable cross-sectional variation in the size of price upswings are documented. Movements in fundamentals cannot fully justify the dramatic price upswing, the changes in turnover rate or the cross-sectional variation. The non-fundamental price component is explored. Evidence consistent with overconfidence-generated speculation is provided, based on the model in Scheinkman & Xiong (2003), which predicts both a cross-sectional variation in the speculative price component, and co-movements in turnover rates.

[†] I thank Alan Krueger, Jose Scheinkman and Susan Wachter for encouragement. I am indebted to Tsur Sommerville at the Sauder Business School for providing the Hong Kong housing price data. I also thank Joe Gyourko, Albert Saiz, Stephen Shore, Todd Sinai, Matt White and participants of seminars at the Wharton School, Fox School of Business and City University of Hong Kong for detailed comments. Eugene Brusilovskiy, Anna Huang, Elaine Huang, Alexandra Infield and Yan-Min Lee provided excellent research assistance. All errors remain mine.

1. Introduction

The Hong Kong residential housing market index (CentaCity Index) experienced a real increase of 50 percent from 1995 to 1997, followed by a real decrease of 57 percent from 1997 to 2002 (Figure 1). There is much debate about the causes of these large swings, complicated by various macro events associated with the 1997 Handover and the Asian Financial Crisis.

During the same period, transaction volume increased dramatically from around 68,000 transactions to more than 172,000 in 1997, only to fall back to the level of around 85,000 transactions in 1998. The co-movements of transaction volume and prices cannot be readily explained by standard asset theories.

Furthermore, there was considerable cross-sectional variation in the size of the upswing in housing prices. In a sample of over 200 large-scale housing estates in Hong Kong, the inter-quartile range of price movements (using average prices in 1992 as baseline) is 39.6 percentage points in 1997, compared to 27.6 in 1995. The same measure on the trough-to-peak increase in quarterly prices from 1995 to 1997 is equal to 23 percentage points (Figures 2 & 3).

A comparison of the housing price movements with changes in the housing stock, public sector housing provision and land sales rules out a simple supply-side story in which a sudden decrease in housing supply or rational expectations of future supply decreases caused the observed price increases. An investigation into population growth and migration, wage trends, real interest rates and tax structure discounts the relevance of increases in the consumption component of housing demand. By considering the returns

of various investment vehicles including equity, bonds and foreign exchange, the "flight to quality" story is rejected as an explanation of the dramatic housing price increase.

Adding to the lack of dramatic movements in the underlying supply and demand fundamentals, the size of Hong Kong (with a total land area of 1102 sq. ft., about six times the area of Washington DC) implies that any macro-factor is unlikely to explain the observed cross-sectional variation in price upswings during the period 1995-1997. Different parts of Hong Kong can be thought of sharing the same pool of buyers.[1] Part of the power of a within-city analysis derives from its ability to abstract from the often complicated macro trends, including international trade and capital flow patterns. It also circumvents of the comparability problem in cross-city studies.

It is logical to investigate the possibility of speculation next. The model of speculation in Scheinkman & Xiong (2003) (speculation model henceforth) stands out because of its prediction of a cross-sectional variation in the speculative component in prices. It also relates price movements and turnover rates explicitly. This is the first application of the speculation model on housing markets. The main assumptions of the model, including short-sale constraints and the dominance of individual inexperienced market players, apply well to housing markets in general.

This paper contributes to the continuing debate on whether non-fundamental factors or psychology plays a role in asset markets. From the Tulip Craze in the Netherlands in the 17th Century to the Technology Stock Bubble in the United States in the late 1990s, the classical view of asset pricing has been challenged. Nevertheless, the literature of speculation has been limited by the difficulty of measuring fundamental

[1] From the 2002 Census, about 30% of the working population in Hong Kong travel out of their districts of residence for work. More than 60% of the students commute out of the district to school. Hong Kong is divided into 18 districts.

values of assets. This difficulty is exacerbated in housing studies because of the structural heterogeneity of the housing stock, low transaction frequency, and the importance of geographical location and local institutions (e.g., zoning laws) in determining housing values, which makes across-city comparisons challenging. This paper sidesteps these problems by performing a within-city analysis using a unique panel data set of over 200 large-scale housing complexes in Hong Kong.

Adapting the methodology in Mei, Scheinkman & Xiong (2004), I provide strong evidence consistent with the model. More specifically, a contemporaneous positive correlation between the speculative component and turnover volume, which cannot be explained by liquidity constraints, is identified. A comparison between the pre-upswing and the upswing periods shows that the price-volume correlation is more significant and robust during the latter, suggesting that it is not caused by liquidity constraints or other factors that would have been constant across the two periods. [2]

This paper is organized as follows: the next section describes the data, Section 3 provides an analysis of the fundamental economic factors, Section 4 presents the cross-sectional variation in the price upswing, Section 5 outlines the speculation model and presents the empirical results, and Section 6 offers concluding remarks and direction for future work.

2. Data

The residential housing index is publicly available and widely used. Measures of housing price determinants, including housing stock, construction cost, population growth and interest rates, are obtained from various sources (see Appendix for details).

[2] The pre-upswing and the upswing periods are defined in Section 4.

Raw transaction data were obtained for all real estate transactions in Hong Kong during the period 1994-1998.[3] After discarding transactions for the non-residential sectors and non-liveable space (e.g., car parks), there are 349,149 property-level observations with the settlement price, gross square footage, building name and street address.

A large proportion of the Hong Kong population live in large-scale housing complexes, called estates. These estates consist of many blocks of almost identical units, and are spread across different geographical areas in the territory. Although there is no information on the unit characteristics (e.g., view and floor level) for each transaction, average prices within each estate should be a reasonable reflection of housing values of any unit in that estate, provided that transactions are frequent.[4] To focus on the large-scale housing estates with frequent transactions, I tabulate the building names and search for those with a frequency higher than 400. To eliminate effects of primary market sales, only estates built before 1993 are included. Address labelling issues further reduce my sample size to 324 housing estates and a total of 19,044 property transactions.

The top and bottom 1 percent of price (per square foot) for each housing estate are discarded. Two panel data sets are created using the truncated price series, at monthly and quarterly frequencies, by averaging per square foot prices within each estate and month (or quarter). Results using the monthly price series are presented in this paper, but the quarterly data series provides a sanity check.

[3] Tsur Sommerville kindly provides this data, which also covers part of years 1991-1993.
[4] Units of different types or quality within an estate being sold seasonally also creates a bias in measuring movements in the true housing value. Wong (2005) documents the high correlation between averaged raw transaction prices and hedonic-adjusted transaction prices for 44 prominent housing estates in Hong Kong.

Non time-variant characteristics are hand-collected for over 200 estates. Table 1 illustrates the considerable variations among the estates in my sample in different dimensions.

3. An Analysis of the Fundamentals

The residential housing price index shows a dramatic upward trend around 1995, followed by a sharp downfall around 1997.[5] Figure 4 to 13 explore whether there were similar movements in the supply and demand conditions. Because the effects of the fundamentals and speculation are not mutually exclusive, it is important to examine the macroeconomic conditions. At the same time, it is worth keeping in mind that the economic trends considered in this section are unlikely to explain any cross-sectional variation in the price upswing.

The housing stock in Hong Kong has been growing at a remarkably smooth rate, and the share of housing units provided by the government has remained slightly less 50 percent since 1987 (Figures 4 & 5). Construction costs also shows no significant movement during the past decade (Figure 6).

On consumption demand, Figures 7 to 9 illustrate stable trends in population, wages and home ownership rate. Interestingly, returns to the non-real estate components in the Hang Seng Index were at least as high as that to holding the residential housing stock (Figure 9), which rules out a "flight to quality" explanation. Figure 10 compares movements in Hong Kong housing prices with those in the stock markets in Singapore and Japan. While all three experienced a downturn between 1996 and 1998, the foreign stock market indices fell much earlier than Hong Kong housing prices, and they did not show the sharp upward movement before the fall. While the housing market collapse

[5] Figure 1. The index is deflated using the food price index.

might have been caused or aggravated by the regional economic downturn, this suggests that the upswing before 1997 was due to factors more specific to Hong Kong.

The carrying and financing costs associated with homeownership are related to the Best Lending Rate. Because of the Hong Kong dollar peg to the US dollar, often the prime rate relates more to the economic conditions in the United States than to those in Hong Kong. The correlation between the monthly averages of housing prices and that of the prime rate shown in Figure 12 is 0.51 during 1992-1997, and 0.58 during 1992-2004. There is little evidence that interest rates were lowered, thus fuelling the housing boom.

Most residential rental leases are not required to register with the Land Registry, provided that they last for less than 3 years. The Ratings and Valuation Department, however, publishes detailed time-series data of rental prices in Hong Kong. Under the standard asset pricing model, housing prices are equal to the expected net present value of the housing service flow (Poterba 1984). Homeowners equalize the marginal costs and marginal benefits of housing services, such that optimism in the market about future returns affects the relationship between current sale prices and rental rates. To express this more precisely, the asset market equilibrium condition implies that the real rental price is equal to the difference between per-period opportunity cost of housing services and expected capital gains:

$$\dot{Q} = -R(H) + \nu Q, \tag{1}$$

where Q represents real housing prices, R rental price, H housing stock and ν the per period user cost of housing services. ν depends on depreciation rate, interest rate, property and income tax rates and inflation. The price-rent ratio increases with the

expected real house price inflation rate $\dot{Q}/Q$, and therefore serves as an indicator of market sentiments and discounting.

It is surprising how closes the price-rent ratio tracked the housing price index (Figure 13). This suggests that market beliefs about the future mirrored the price movements during that period.

4. Describing the Price Upswing

Exploiting a panel data set of over 200 housing estates, a within-city analysis is performed. Support for the hypothesis that macroeconomic factors could not fully explain price movements during 1995-1997 can be found in Figure 2. It compares the housing price changes relative to the 1992 baseline price level among housing estates across the years. While the housing estates experienced price changes relative to the 1992 level by similar percentages, they diverged since 1995. The 1995 distribution of price increases flattened substantially and shifted to the right. This contradicts the notion that territory-wide factors such as government policies and local and regional economic conditions were the main drivers of the housing price movements.

Figure 3 shows the variation in the trough-to-peak price increase. The density of housing estates peaks around a price upswing of 60 percent, but there were still considerable cross-sectional differences. In terms of timing, however, the majority of the estates hit the trough in 1995 and peaked in 1997 (Table 2). A satisfactory explanation for this phenomenon, therefore, needs to account for the relative uniformity in timing of the price upswing, but variance in its size.

To describe the physical characteristics correlated with the size of the price upswing, as defined by the trough-to-peak percentage change, OLS regressions are performed:

$$(2) \qquad \Delta P_i = \alpha + \beta X_i + \varepsilon_i,$$

where ΔP_i is the price change, α a constant term and X_i a group of time-invariant estate characteristics. ε_i is an error term. Note that the dependent variable is measured in dollars per square foot. I experienced with numerous estate characteristics, and Table 3 presents the statistically significant results.[6] Estates further away from the city centres and with more spacious units and taller buildings are associated with larger price upswings, after accounting for district fixed effects.[7] The size of the unit and travel time to city centres might be expected to correlate with the desirability of the estate in opposite directions, which is consistent with the signs of the related coefficients.[8]

5. Testing a Model of Speculation

The appeal of the speculation model in Scheinkman and Xiong (2003) is several-fold. First, it relates price movements and transaction volume explicitly. Second, it is capable of explaining cross-sectional variation in the size of the speculative component. Third, there are directly testable implications of the model. The model explains speculation as a result of overconfidence, the belief that one's opinion is more precise than it in fact is. This model provides a framework in a continuous-time equilibrium where a non-zero speculative, or non-fundamental, price component results from the

[6] Results available upon request. The characteristics not shown include the age of the estate, baseline price, flat per floor, no of blocks and the availability of communal facilities (such as a health club). Notably, a baseline price measure is not statistically significant when controlling for average unit size.
[7] Hong Kong consists of 18 districts.
[8] The average standard deviation in travel time to city centres among estates in the same district is less than 4 minutes, however, which limits the economic significance of the correlation.

heterogeneity in beliefs. Differences in volatility of beliefs and the fundamental uncertainty associated with the asset lead to variation in the extent of speculation.

One explicit implication of the model is a positive cross-sectional relationship between the size of the speculative price component and the turnover rate. Empirically, this relationship is emphasized in this paper. To test for alternative theories predicting the same positive correlation between speculation and turnover, I control for liquidity, following the approach in Mei, Scheinkman and Xiong (2004). Moreover, the correlation is assessed both in and out of the "speculative period", which is defined as the period during which at least 100 estates were at a point between their trough and peak prices. If the positive correlation is mainly due to speculation, one expects to see a stronger and more significant relationship during the speculative period. On the other hand, if the positive correlation is caused by liquidity premium and other non-speculative factors, it should remains more or less constant in and out of the speculative period.

The following estimation provides a first pass:

$$(3) \qquad \Delta P_{it} = \alpha + \beta V_{it} + X_i + Y_t + Q_q + \varepsilon_{it},$$

where ΔP_{it} is the percentage change in prices at estate *i* during month *t*, relative to the trough price level of estate *i*. α is a constant term and V_{it} is the log turnover rate at estate *i* during month *t*. X_i, Y_t and Q_q are estate, year and quarter fixed effects respectively. ε_{it} is an error term. Table 4 shows a stronger and more robust correlation between price movements and turnover rate within the speculative as compared to the non-speculative period. To the extent that the estate-specific liquidity premium is non time-variant, these results also suggest that liquidity cannot fully explain the observed correlation.

To allow for heterogeneity in the speculative price component-turnover correlation, and to sidestep the persistence in turnover rates, a cross-sectional regression is run separately for each month T, both inside and outside the speculative period:

$$(4) \qquad \Delta P_{it} = \alpha + \beta V_{it} + L_i + \theta X_i + D_i + \varepsilon_{it},$$

where ΔP_{it} and V_{it} are defined as before, L_i is the number of no-trade months in 1993 as a measure of illiquidity, X_i time-invariant estate characteristics and D_i a set of district dummies. ε_{it} is an error term. Results and Fama-MacBeth standard errors from regressions for the 24 months during the speculative period are reported in Table 5.

The price movement-turnover rate correlation remains positive and robust in all specifications. Column (7) shows the most sophisticated model with various estate characteristics and district dummies. This contrasts with the unstable and non-robust correlation in Table 6, which reports the results from 24 months outside the speculative period.

Again the estates with larger units and taller buildings are associated with larger price upswings, as we saw in Table 3. Travel time has the same sign as before in Columns (5) & (6), but ceases to be significant when district fixed effects are included in the same regression. There is some evidence that older buildings experienced large price upswings. With the exception of age, these estate characteristics have similar relationships with the price movements. This is suggestive of differences in price trends among various types of estates, unrelated to speculation.

The coefficient on the illiquidity indicator, interestingly, remains robust and positive throughout Table 5. I posit that the number of no-trade months represent both illiquidity and the lack of information. During a speculative period, less information

might imply a higher heterogeneity in beliefs which in turns leads to a large speculative component. Comparing these results with the negative coefficients on the same indicator in Table 6, it seems that outside the speculative period, the illiquidity effect on the price-turnover relationship overwhelms the information effect.

Columns (3) to (6) in both Tables 5 and 6 control for either the log population density measures or changes in density from 1991-1996. Both indicators reflect the availability of developable land and possibly the ease of re-zoning in different parts of Hong Kong. While the issue of land supply elasticity certainly deserves a more refined analysis, these results highlight its significance.

6. Concluding Remarks

The residential housing market in Hong Kong displayed unusual price behaviour during the 1990s. Not only did we see dramatic price increases followed by sharp downfalls, a careful look also reveals co-movements in turnover rates and considerable cross-sectional variation in price movements. A metropolitan city with homeownership at 50 percent, well-developed capital markets and low information cost within the territory, Hong Kong is not unlike many major cities in other parts of the world.

Due to the prevalence of large-scale housing complexes, Hong Kong provides the unique opportunity to adopt an empirical framework usually impractical in housing studies due to the lack of transactions and easily comparable housing units. By studying a panel data set of housing prices for more than 200 housing complexes, I am able to include various important controls and compare the speculative and non-speculative periods. The value of the within-city analysis also comes from the ability to abstract from

the macroeconomic conditions and institutional factors, which are often complicated and difficult to measure.

While this paper does not assert the unimportance of the fundamentals during the upswing, it does show that they are unlikely to be the complete story. The debate over the existence of a non-fundamental price component in asset prices has long been heated, and there is an often-asked question as to whether certain housing markets experienced or are experience a "bubble". This paper provides evidence for the overconfidence-generated speculation model as proposed by Scheinkman & Xiong (2003). To further understand the source of speculation, I suggest that future research can explore the land supply conditions within cities. Both natural and manmade conditions, such as topography and zoning restrictions, might be related to the heterogeneity in beliefs.

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Poterba, J., 1984. Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach.

Scheinkman, J. and W. Xiong, 2003. Overconfidence and Speculative Bubbles, Journal of Political Economy 111, 1183-1219.

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Figure 1: Real housing price movements, 1992-2004

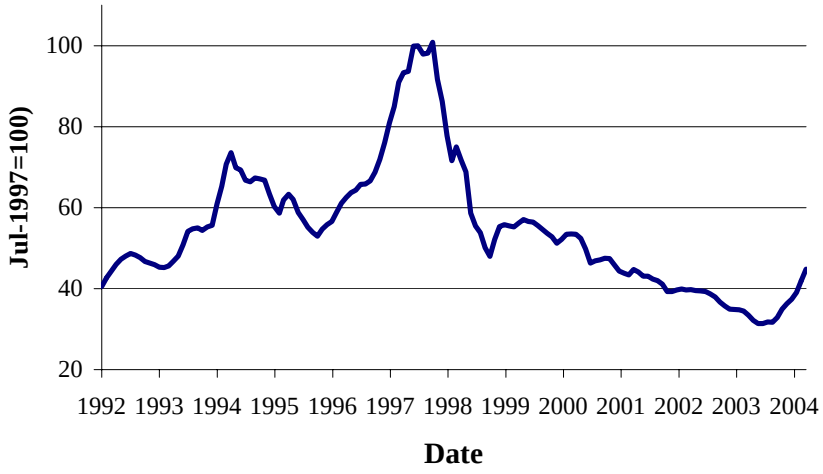
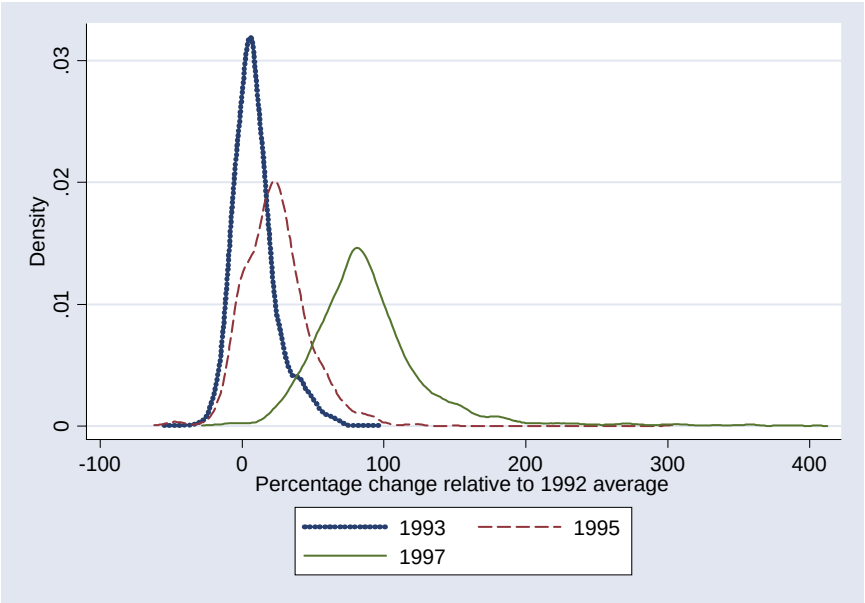
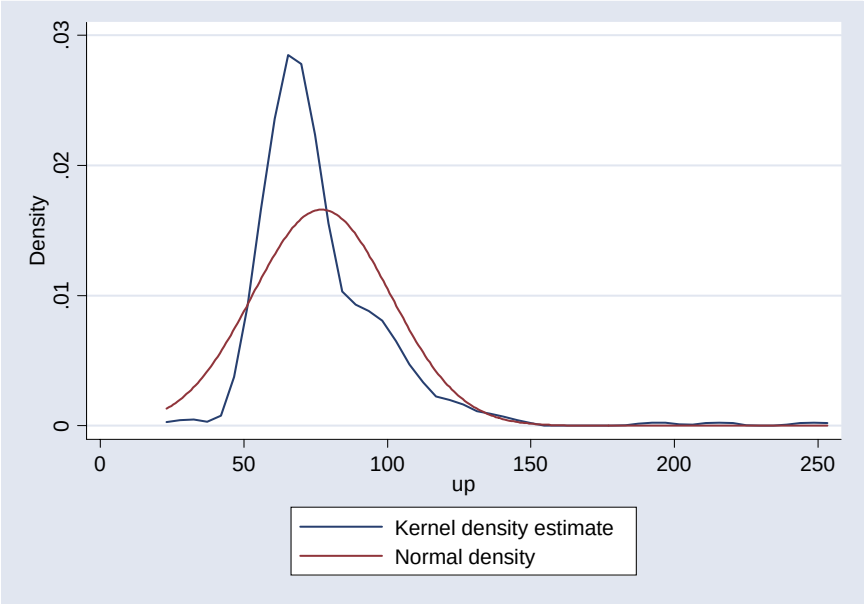


Figure 2: Cross-sectional variation in price changes by year



* Kernel density plot of monthly price movements of 266 housing estates within each year relative to the average price in 1992.

Figure 3: Cross-sectional variation in trough-to-peak price changes



* Trough-to-peak price changes are are calculated using quarterly price averages for 266 housing estates over the period 1994-1998. Normal density distribution is included for comparison purposes.

Figure 4: Growth in Housing Stock

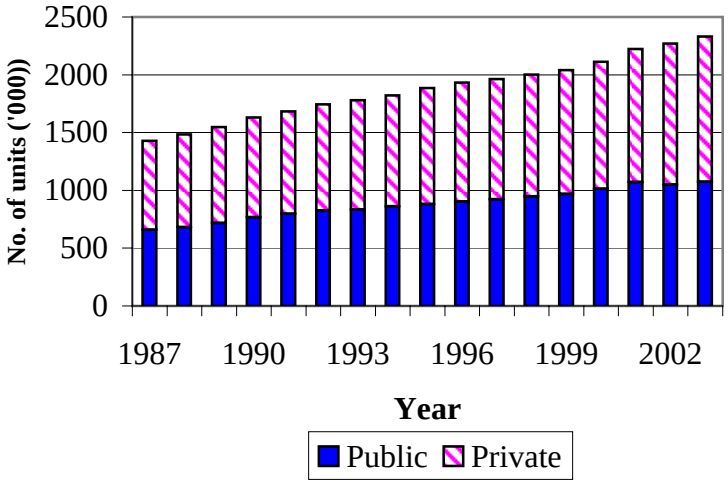


Figure 5: Government Participation in Housing Services Provision

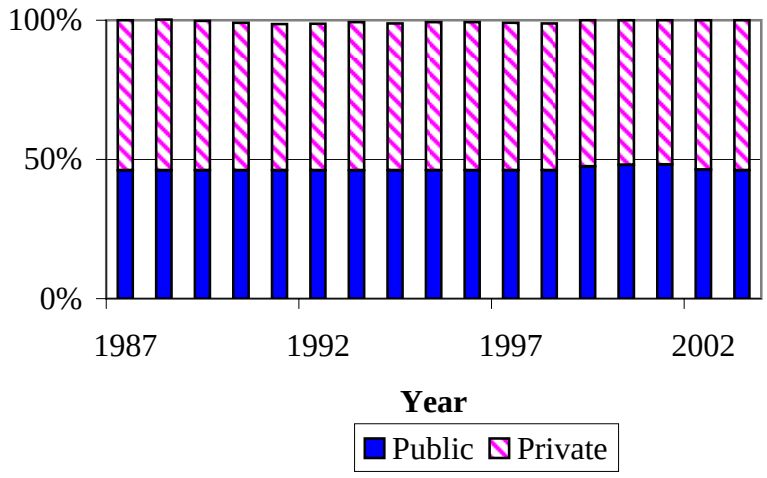


Figure 6: Construction Cost vs. Housing Prices

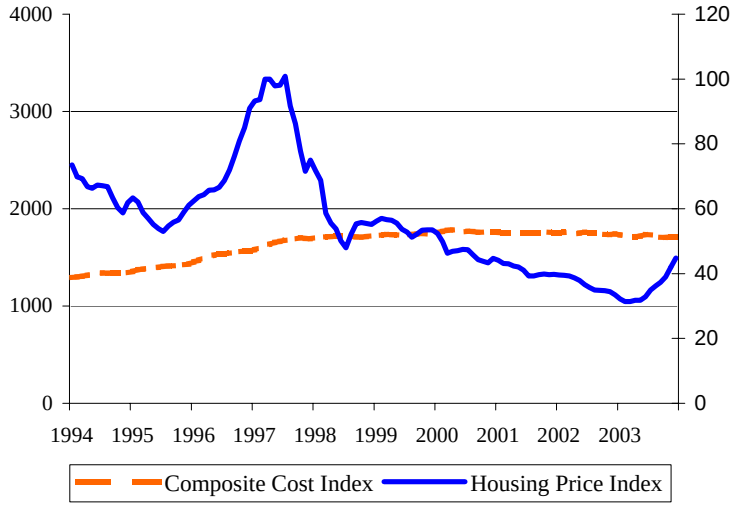


Figure 7: Wage Index vs. Housing Price Index

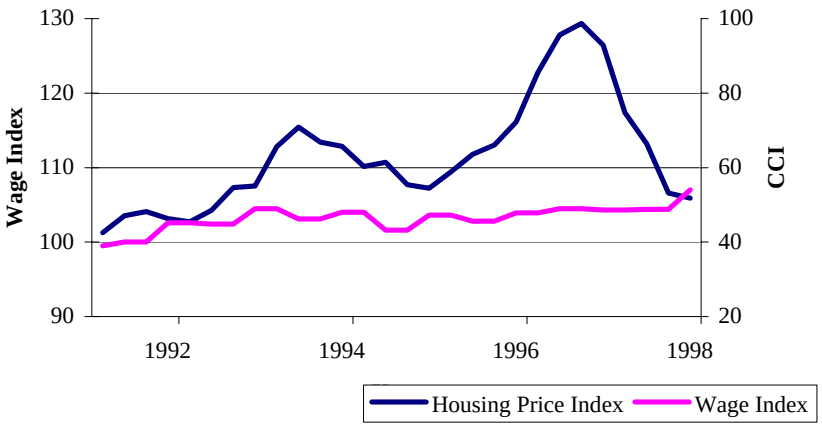


Figure 8: Number of Housing Unit Per Capita

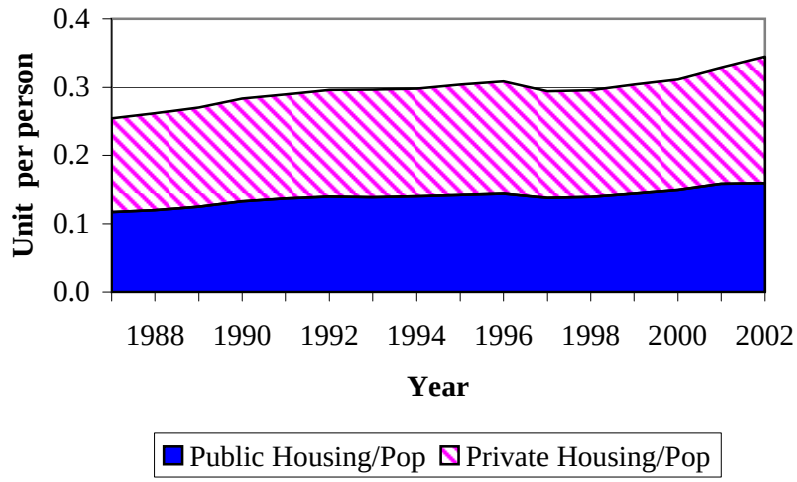


Figure 9: Ownership and Household Formation

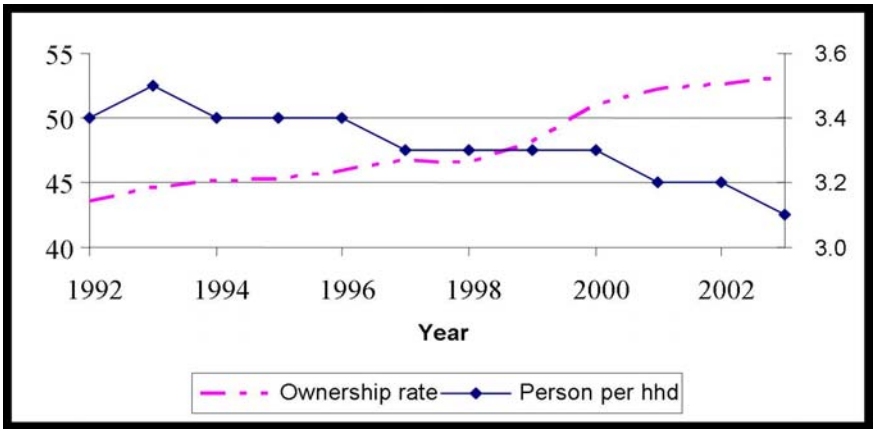


Figure 10: Returns to Housing and Non-Housing Assets

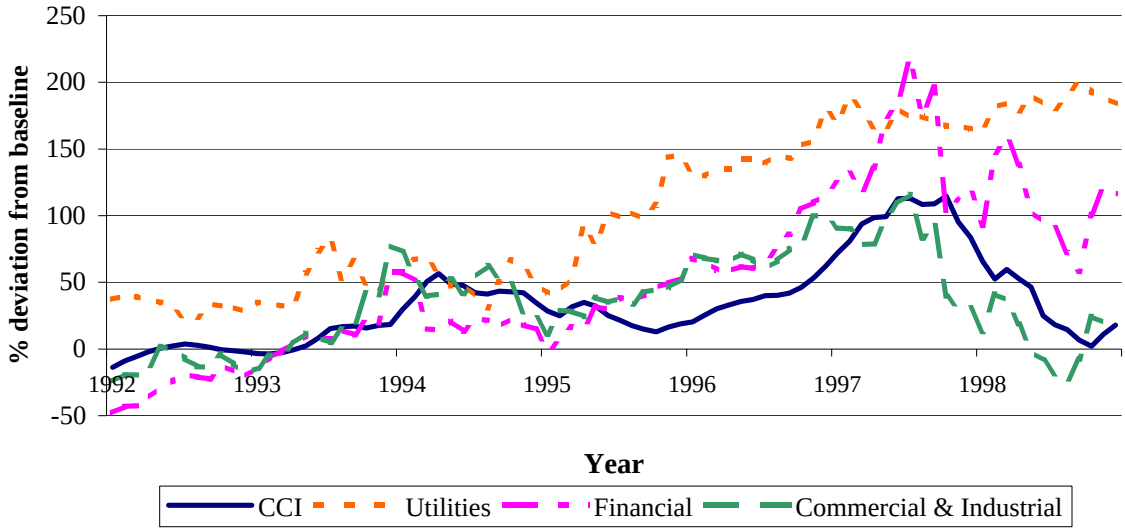


Figure 11: Returns to Asian Stockmarket Indices

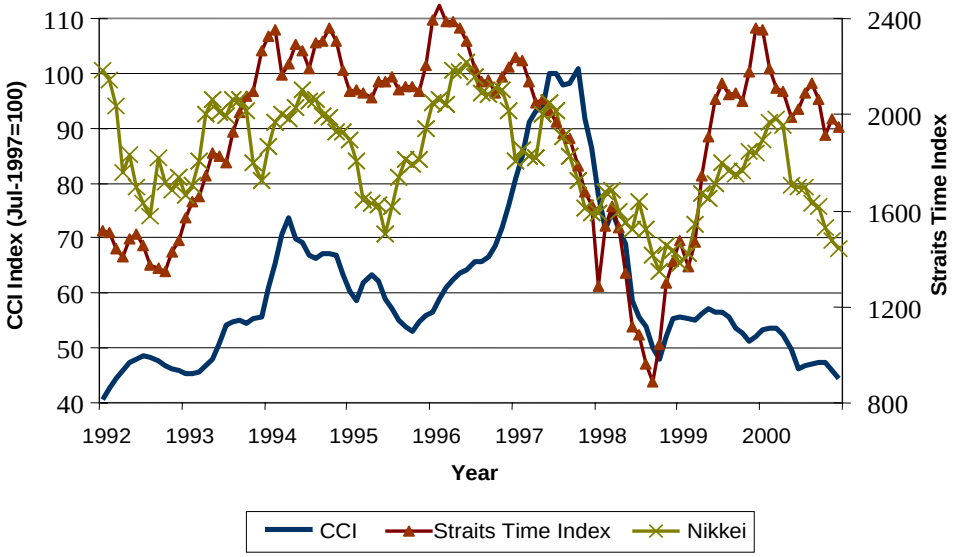


Figure 12: Cost of Capital

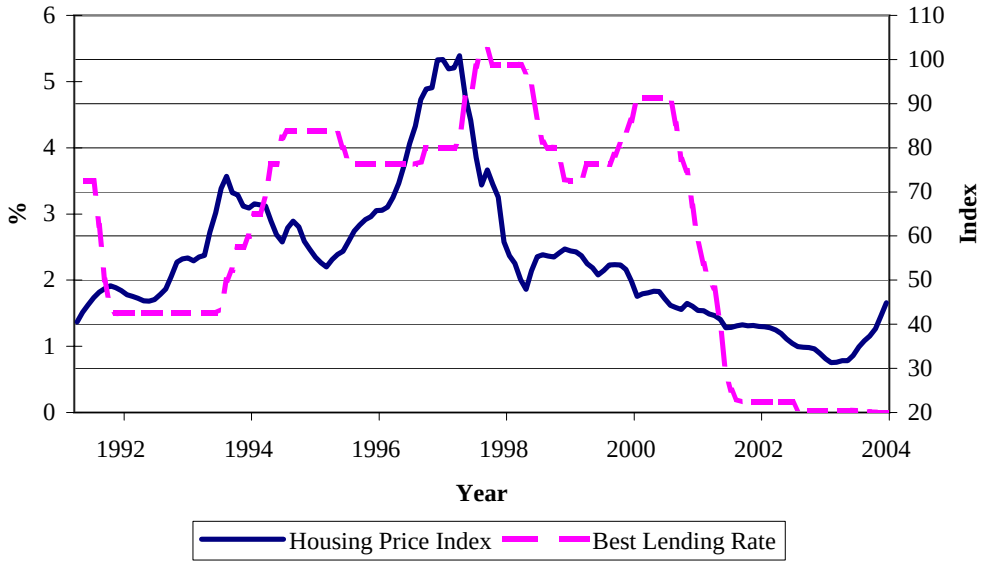


Figure 13: Price-Rent Ratio

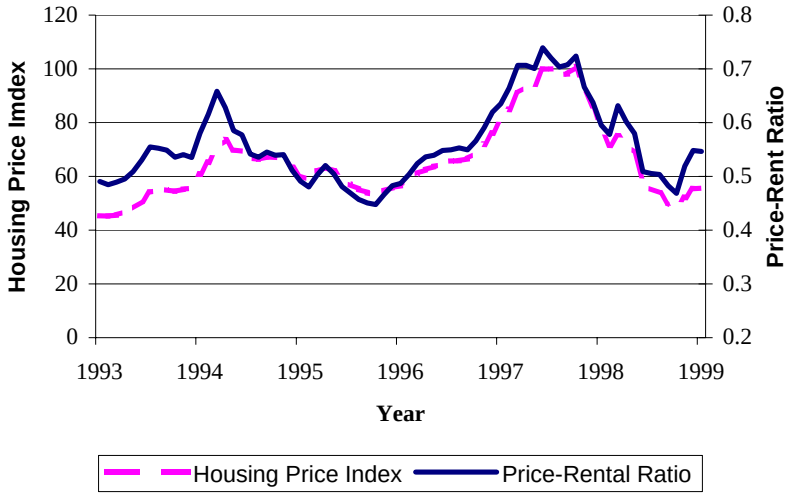


Table 1: Summary Statistics

Estate Characteristics	Mean	Std. Dev.	Obs
Age	18	6	235
Total no. of flats	291	331	235
No. of blocks	10	25	235
No. of stories	25	8	235
Flat per floor	3	4	235
Avg. flat size (sq. ft.)	590	306	231
Travel time to city centres (hour)	0.5	0.26	193
Turnover rate (%) -- pre-upswing	9	12	228
Turnover rate (%) -- post-upswing	16	25	224
Avg. price (constant USD per sq. ft.) -- pre-upswing	767	277	992
Avg. price (constant USD per sq. ft.) -- post-upswing	992	441	992

Table 2: Timing of the Upswing

	Peak			
Trough	1996	1997	1998	*Total*
1994	0	25	0	25
1995	0	214	2	216
1996	1	25	0	26
Total	1	264	2	**267**

Table 3: Correlations between the Size of the Upswing and Estate Characteristics

Dependent Variable: Trough-Peak Increase in Per Square Foot Sales Prices (%), 1994-1998

	(1)	(2)	(3)	(4)
Log avg. unit size (sq. ft.)	15.10*** (2.838)	14.77*** (2.568)	15.49*** (3.29)	16.10*** (3.02)
Log travel time (hour)	-0.11 (1.85)	-6.16** (3.20)	0.27 (1.89)	-5.79* (3.23)
Log no. of stories	6.12** (2.98)	6.78** (2.74)	--	--
Log no. of units	--	--	0.75 (2.12)	2.88* (1.85)
District fixed effects	--	Yes	--	Yes
Adj. R2	0.134	0.479	0.115	0.467
No. of observations	188	188	188	188

1 All regressions include a constant term. Standard errors reported in parentheses. *** denotes statistical significance at 1%, ** at 5% and * at 10%.

Table 4: Pooled Panel Regression of Price Movements on Turnover Rates

	Dep Var: % Monthly Price change relative to trough			
	Speculative period		**Non-speculative**	
	(1)	(2)	(3)	(4)
Log turnover	22.875***	1.952***	2.823***	-0.072
	(0.933)	(0.709)	(0.750)	(0.447)
Estate fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes
Quarter fixed effects	No	Yes	No	Yes
Adj. R2	0.265	0.853	0.049	0.700
No. of obs	6,736	6,736	12,485	14,056

Table 5: Correlation between Price Movements and Turnover Rate during the Speculative Period

1995 Oct - 1997 Sept (T=24)

	Dep Var: % Price change relative to trough						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log turnover	1.278	1.486	2.124	2.144	1.782	1.795	1.298
	(0.305)	(0.316)	(0.411)	(0.416)	(0.364)	(0.371)	(0.270)
No. of no-trade months, 1993	--	0.344	0.487	0.467	0.488	0.445	0.544
		(0.085)	(0.099)	(0.095)	(0.104)	(0.098)	(0.094)
Log pop density 1991	--	--	-0.929	--	-2.260	--	--
			(0.287)		(0.403)		
Δ(pop den), 1991-96	--	--	--	6.639	--	16.510	--
				(1.983)		(2.555)	
Log avg. flat size	--	--	--	--	9.555	9.396	9.831
					(1.223)	(1.201)	(1.277)
Log no. of stories	--	--	--	--	5.777	5.346	6.368
					(1.043)	(0.969)	(1.099)
Log travel time	--	--	--	--	-2.501	-2.696	-0.753
					(0.307)	(0.284)	(0.359)
Log age	--	--	--	--	1.708	1.505	1.654
					(0.556)	(0.497)	(0.608)
District dummies	No	No	No	No	No	No	Yes
Avg. Adj R2	0.014	0.019	0.033	0.032	0.118	0.116	0.191

* Fame-MacBeth Standard Errors reported in parantheses. No. of observations varies among time periods.

Table 6: Correlation between Price Movements and Turnover Rate outside the Speculative Period

1993 July - 1995 June (T=24)

	Dep Var: % Price change relative to baseline						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log turnover	1.421	1.012	1.006	0.901	-0.214	-0.429	0.994
	(0.279)	(0.291)	(0.353)	(0.374)	(0.288)	(0.305)	(0.135)
No. of no-trade	--	-0.480	-0.926	-0.830	-1.117	-1.151	-0.769
months, 1993		(0.083)	(0.096)	(0.093)	(0.095)	(0.103)	(0.065)
Log pop density 1991	--	--	3.489	--	2.134	--	--
			(0.244)		(0.175)		
Δ(pop den), 1991-96	--	--	--	-17.065	--	1.893	--
				(1.212)		(1.617)	
Log avg. flat size	--	--	--	--	20.967	21.374	18.097
					(1.762)	(1.790)	(1.559)
Log no. of stories	--	--	--	--	2.949	3.368	2.825
					(0.699)	(0.694)	(0.675)
Log travel time	--	--	--	--	-2.199	-5.034	0.688
					(0.425)	(0.669)	(0.592)
Log age	--	--	--	--	-1.958	0.558	-5.989
					(0.768)	(0.687)	(0.941)
District dummies	No	No	No	No	No	No	Yes
Avg. Adj R2	0.006	0.008	0.086	0.052	0.383	0.371	0.539

* Fame-MacBeth Standard Errors reported in parantheses. No. of observations varies among time periods.