

Clustering analysis of property market indicators in Hong Kong

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Tighter credit and weaker economic prospects stemming from the global credit crisis have weighed on Hong Kong's property prices and transaction volumes. This has raised concerns about the vulnerability of the domestic property market to the current downturn. This article compares the key market indicators in the HKMA's graphical framework with readings in previous cycles. It finds there were no major signs of imbalances in the domestic property market prior to the recent declines in property prices. This conclusion is also supported by statistical analysis of the key market indicators using the clustering method. Overall, the study finds the property market in Hong Kong is not likely to be as vulnerable to an economic downturn as it was in 1997.

I. Introduction

Property prices in Hong Kong declined notably in the third quarter of 2008 after sharp increases in late 2007 and early 2008. Although steady growth in household income and low borrowing costs over the past few years improved housing affordability, the rapid rise in house prices from late 2007 to early 2008 raised concerns about the possibility of an overstretched property market and the important implications this would have for the severity and length of the current market downturn. Before the recent decline in property prices, negative real interest rates (defined as nominal interest rates falling below the inflation rate) were commonly cited as contributing to speculative activities in the market. In particular, prices in the luxury segment breached the 1997 peak and the number of confirmor transactions surged in early 2008. These were seen by some market commentators as signs of overheating. But, did the substantial rise and fall in property prices suggest a vulnerable market compared with previous cycles?

The key market indicators in the graphical framework used by the HKMA for monitoring the property market suggest there was no significant vulnerability in the market in early 2008. The six indicators stayed within

their comfort zones compared with the peak in mid-1997 and the trough in mid-2003. Statistical analysis of the six market indicators using a technique called the clustering method also arrives at a similar conclusion. Overall, there were few signs of imbalances in the domestic property market before the recent fall in prices.

This article is organised as follows. Section II reviews and summarises the findings of the graphical framework for monitoring risks and vulnerabilities in the property market. Section III uses clustering analysis to classify property market conditions into distinct groups with different risk characteristics, and assesses the vulnerability of the current market compared with previous property market cycles. Section IV concludes.

II. Graphical framework for monitoring property market conditions

Developments in the property market have significant implications for economic and banking stability in Hong Kong, given that residential property is a major asset on the household balance sheet and property related loans account for the majority of bank lending in Hong Kong. Thus, the HKMA closely monitors

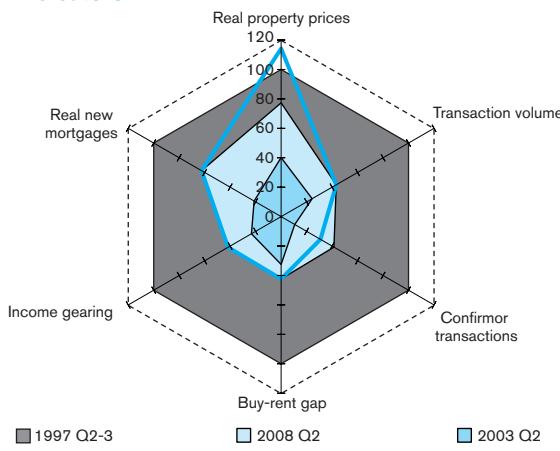
property market conditions. Over the years, the HKMA has developed a graphical framework for assessing property market risks and vulnerabilities. It consists of six market indicators covering real property prices, transaction volumes, real new mortgages, the number of confirmor transactions, the income-gearing ratio and the buy-rent gap. The definition and interpretation of the six indicators are summarised in Table 1. Basically, the graphical framework compares the values of the indicators with their values recorded in the overheated market of 1997. If the current values of the indicators are close to the 1997 levels, the risk of overheating in the property market is higher. On the other hand, if the values of the six indicators are close to their levels in the second quarter of 2003, the property market is likely to be exceptionally sluggish and weak.

A comparison of the readings of the six indicators with their levels in previous property market cycles reveals the healthiness of current market conditions. Based on the figures in the second quarter of 2008, when house prices reached their most recent highs, the graphical framework does not point to an

overheated property market (Chart 1). Specifically, average house prices were still notably below the peak in real terms. The proportion of confirmor transactions to total transactions, an indicator of speculative activity, remained small at 3-4% versus the 6-8% levels recorded in mid-1997. While the prices of luxury flats increased rapidly and broke

CHART 1

Graphical framework with key property market indicators



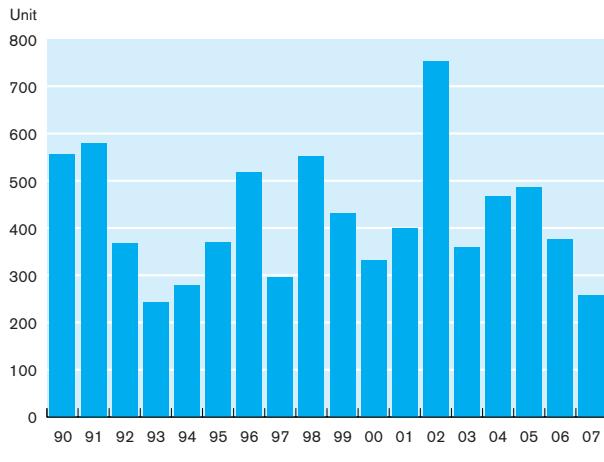
Sources: R&VD, Centaline and staff estimates.

TABLE 1
Indicators used in the graphical framework

Indicator	Definition	Interpretation
Real property prices	<ul style="list-style-type: none"> The price index for private domestic premises adjusted by the rateable values of the residential property and deflated by the Composite CPI. 	<ul style="list-style-type: none"> The most direct and simple indicator of the demand and supply conditions in the property market.
Transaction volume	<ul style="list-style-type: none"> Transaction volume is measured by the ratio of the number of sales and purchase agreements to total private housing stock, i.e. the turnover rate. 	<ul style="list-style-type: none"> Indicates the buoyancy of the property market.
Real new mortgages	<ul style="list-style-type: none"> New mortgages refer to the amount of new loans for private residential properties provided by authorized institutions, deflated by the Composite CPI. 	<ul style="list-style-type: none"> Experience shows that bank credit can amplify property price swings.
Confirmor transactions	<ul style="list-style-type: none"> Confirmor transactions are those in which a buyer re-sells the residential unit to a sub-purchaser before the legal completion of the original sale. It is expressed as a percentage share of total transactions. 	<ul style="list-style-type: none"> An indicator of the extent of speculative activity in the property market.
Income-gearing ratio	<ul style="list-style-type: none"> The ratio of mortgage repayment to household income. 	<ul style="list-style-type: none"> A measure of housing affordability of private housing owners.
Buy-rent gap	<ul style="list-style-type: none"> The ratio of the cost of purchasing and maintaining a flat to the rental cost. 	<ul style="list-style-type: none"> Compares the cost of owning a flat relative to renting a flat.

through their historic 1997 highs, the increases were largely driven by growing demand for, and tight supply of, large residential units at the higher end of the property market (Chart 2).

CHART 2

New completion of large (over 160m²) residential units


Source: R&VD.

Entering the second half of 2008, Hong Kong's property market experienced a significant downturn as the domestic economy was hit by the global credit crisis. A deterioration in the near-term economic outlook and tighter credit restrained home-buyer demand. Residential property prices in the mass market declined by almost 5% in September from their June high, while the transaction volume contracted by 40% (Chart 3). Weakened economic

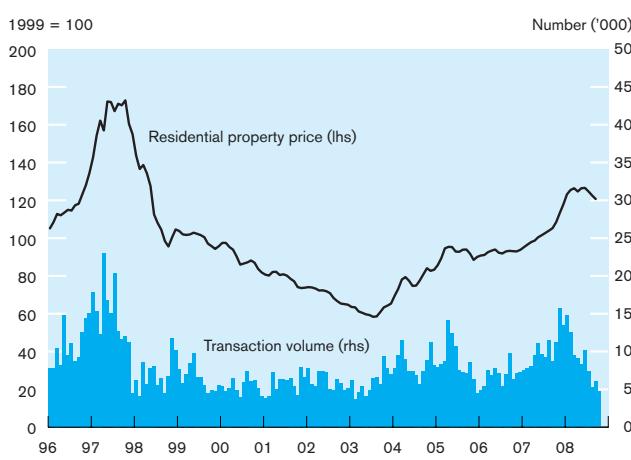
sentiment and less favourable labour market conditions will continue to weigh on property market activity in the coming months. That said, the extent of the correction in house prices this time could be less severe than the property market downturn following the Asian financial crisis in 1997-98. Economic fundamentals and household balance sheets have strengthened, and there was no build-up of overheating pressures prior to the recent property market decline. Low interest rates and improved household income also helped housing affordability, with the ratio of mortgage repayment to household income declining to 26% in 2008 Q3, much lower than the peak of 65% in 1997 Q2 (Chart 4).

CHART 4

Housing affordability


Source: Staff estimates.

CHART 3

Residential property price index and transaction volume


Sources: R&VD and Land Registry.

III. Clustering analysis for assessing property market vulnerabilities

While the graphical framework is a useful tool for analysing property market conditions, it is largely qualitative and judgemental. Sometimes the judgement is difficult because the distinction between a healthy expansion and overheating may not be obvious; also it may not be easy to determine how close the readings of the six indicators to their peak levels in 1997 should be to be regarded as overheating. In view of these shortcomings, it is desirable for the six indicators to be jointly analysed

using a statistical technique that distinguishes different types of market conditions. These conditions can be analysed along two dimensions: (1) whether the property market is rising, stable or decreasing; and (2) whether the property market is over-valued, fairly-valued, and under-valued. The two dimensions together give rise to nine possible market scenarios, with the “rising and over-valued property price” scenario representing an overheating market.

The nine scenarios can be distinguished by the statistical technique called clustering analysis, which groups data with similar characteristics together by minimising the distance between the group mean and its members and maximising the distance of the group means between two adjacent clusters.¹ On a sample of monthly data from January 1996 to March 2008, nine different groups are classified, based on the data characteristics of the six indicators used in the graphical framework. Table 2 summarises the key statistics of the nine groups.

In general, higher readings of the indicators suggest an increased risk of overheating in the property market. A cursory look at the data suggests that group 9 probably represents a sluggish property market where the readings of four out of six indicators are the smallest (except for real house prices and confirmor transactions). In contrast, the means of four out of the six indicators in group 1 are the highest (except for real house prices and the buy-rent gap), suggesting an overstretched property market. To visualise the distribution of observations in each group across the whole sample period, we calculate the cluster score of each group, defined as the ratio of the difference between the group mean and the whole sample to the standard deviation of the whole sample, for each of the six indicators. The cluster scores of each indicator are then summed together to arrive at a total score for each group. Table 3 shows the cluster scores arranged in descending order, with group 1 yielding the highest score of 13.4, versus the lowest score of -3.3 for group 9.

TABLE 2
Summary statistics of individual clusters/groups

Group	No. of Observations	Proportion	Group mean					
			Real house price	Transaction volume	Mortgage loans	Confirmor transaction	Income-gearing ratio	Buy-rent gap
1	5	3%	8.7	1.9	7.9	7.5	63.2	245.1
2	3	2%	14.7	1.6	6.2	4.7	56.0	222.7
3	6	4%	-4.7	1.0	3.9	2.5	60.6	256.0
4	30	20%	1.7	0.9	3.5	1.5	42.5	192.5
5	4	3%	-13.2	0.7	2.6	1.3	60.7	267.7
6	17	12%	4.0	0.8	2.6	2.9	23.5	116.8
7	5	3%	-14.9	0.7	2.1	0.7	46.2	232.9
8	39	27%	-0.3	0.7	2.1	1.4	28.1	147.7
9	38	26%	0.8	0.6	1.6	1.7	17.1	89.1

Notes: Real house price = House-price appreciation (% three-month-on-three-month)

Transaction volume = Transaction volume as a share of housing stock (%)

Mortgage loans = New mortgage loans as a share of outstanding mortgage loans (%)

Confirmor transaction = Number of confirmor transactions as a share of total transactions (%)

Income-gearing ratio = Monthly mortgage repayment as a share of household income (%)

Buy-rent gap = Ratio of the cost of buying a flat to rental cost (%)

Source: Staff estimates.

¹ The methodology of clustering analysis is described in Annex A.

TABLE 3

Cluster scores of individual groups

Group	Real house price	Transaction volume	Mortgage loans	Confirmor transaction	Income-gearing ratio	Buy-rent gap	Total
1	1.3	2.8	2.9	3.1	1.9	1.5	13.4
2	2.1	2.2	2.0	1.5	1.4	1.1	10.3
3	-0.7	0.5	0.7	0.3	1.7	1.7	4.1
4	0.2	0.2	0.4	-0.3	0.6	0.6	1.7
5	-1.9	-0.3	-0.1	-0.4	1.7	1.9	0.8
6	0.6	0	-0.1	0.5	-0.6	-0.6	-0.2
7	-2.2	-0.1	-0.4	-0.8	0.8	1.3	-1.4
8	0	-0.3	-0.4	-0.3	-0.3	-0.1	-1.6
9	0.1	-0.4	-0.6	-0.2	-1.0	-1.1	-3.3

Source: Staff estimates.

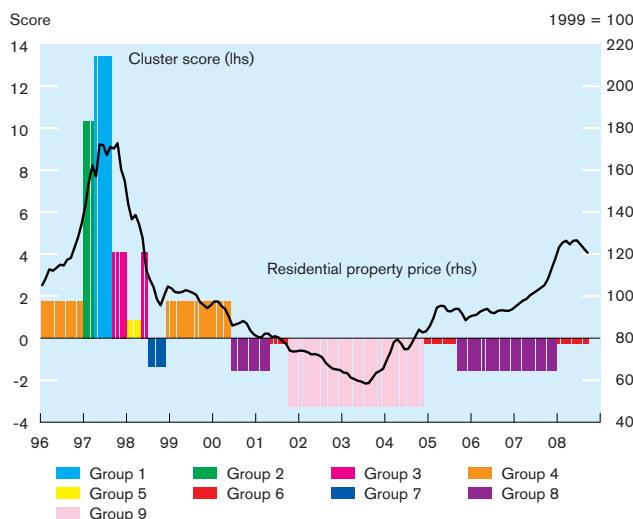
Plotting the cluster score of each group against the residential property price index suggests a relatively strong co-movement between the two (Chart 5). It can be seen that groups 1 and 2 capture the property price bubble during the first half of 1997. Groups 3 and 5 capture the subsequent bursting of the property bubble. Groups 4, 6, 7 and 8 represent relatively stable market conditions, while group 9 represents a sluggish and undervalued property market. It is noted that on the six indicators used in the graphical framework, clustering analysis suggests that overall property market conditions in the first half of 2008 resembled the observations in group 6, which represents a relatively stable market. While the classification results appear to be at odds

with the general perception of relatively high property valuations during this period, the indicators of housing affordability (the income-gearing ratio), the buy-rent gap and the number of confirmor transactions suggest little overheating pressure in the property market.

Reflecting tighter credit and worsening economic prospects, property market conditions deteriorated in the third quarter of 2008. The graphical framework shows that the transaction volume, confirmor transactions and new mortgage loans declined markedly between the first and the third quarters; and real property prices, the income-gearing ratio and the buy-rent gap also moderated somewhat (Chart 6).

CHART 5

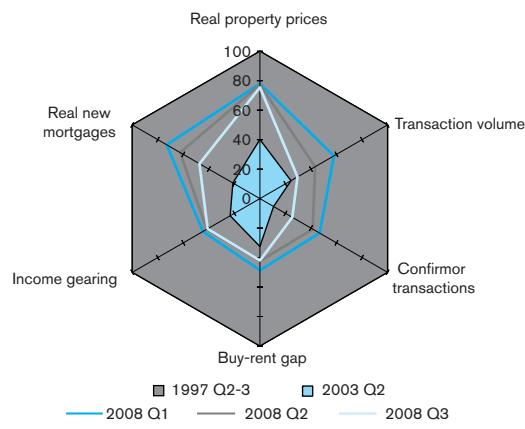
Cluster score and residential property price



Source: Staff estimates.

CHART 6

Graphical framework: changes in property market conditions



Sources: R&VD, Centaline and staff estimates.

Although overall property market conditions weakened, they were stronger than during the SARS epidemic in the first half of 2003. Based on the nine individual groups classified by the clustering method, the readings of the six indicators in the third quarter were close to the mean value of group 6. This suggests no significant imbalances in the domestic property market, and the fall in property prices largely reflected deteriorations in economic fundamentals. This finding is consistent with the qualitative assessment using the graphical framework (Chart 7).

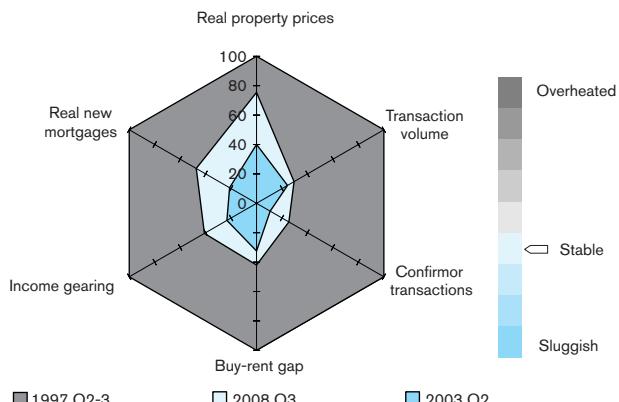
IV. Conclusions

This article reviews recent developments in the domestic property market and assesses its risks and vulnerabilities in the face of an economic downturn. A qualitative analysis of six property market indicators, using the graphical framework, indicates there were few signs of overheating pressure in the market in the first half of 2008. This suggests that recent decreases in house prices and transaction volumes largely reflect a deterioration in economic fundamentals rather than corrections for economic excesses as in 1997-1998.

A statistical method called clustering analysis is used to supplement the graphical framework in assessing the current status of the residential property market. Based on the six indicators used in the graphical framework, the clustering method classified the data set into nine distinct groups, representing different property market conditions ranging from overheating to sluggishness. Clustering analysis shows that the domestic property market was neither overstretched during the first half of 2008, nor overly sluggish in the third quarter of 2008. This conclusion is consistent with the qualitative judgement based on the graphical framework.

CHART 7

Clustering analysis and graphical framework, 2008 Q3



Source: Staff estimates.

ANNEX A

Methodology of clustering analysis

Clustering analysis is a multivariate method for classifying a complex set of data into a few groups or clusters. No assumptions are made regarding the group structure, and grouping is done on the basis of similarities or distances (dissimilarities). There are different methods for grouping data or variables using the clustering analysis.² The method adopted in this paper is known as the K-means method, which assigns each observation to the cluster with the nearest mean. The procedure for using this method for grouping data consists of three steps:

1. Partition the data set into K initial clusters.
2. Assign each observation to the cluster whose mean is the nearest. Recalculate the mean for the cluster receiving the new item and for the cluster losing the item.
3. Repeat the process until all observations are classified into different clusters.

In practice, the number of clusters (the value of K) has to be determined for preliminary grouping, and adjusted until a satisfactory result is obtained. The final assignment of observations to clusters will be, to some extent, dependent on the initial choice of the number of partitions or clusters. The following example illustrates how the K-means method assigns different observations to clusters.³

Suppose there are two variables X and Y with four observations A, B, C and D. The data are shown in the following table.

Observation	Variable X	Variable Y
A	5	3
B	-1	1
C	1	-2
D	-3	-2

Suppose the initial number of clusters is set to two ($K=2$), and the data are arbitrarily partitioned into two groups, namely cluster (AB) and cluster (CD). The means of these two clusters are calculated and shown in the following table.

Cluster mean	Variable X	Variable Y
(AB)	$(5-1)/2 = 2$	$(3+1)/2 = 2$
(CD)	$(1-3)/2 = -1$	$(-2-2)/2 = -2$

The next step is to compare the squared distance between observation A and the mean of cluster (AB) and cluster (CD) respectively.

$$\begin{aligned} \text{Distance } (A - \text{cluster (AB)})^2 \\ = (5-2)^2 + (3-2)^2 = 10 \\ \text{Distance } (A - \text{cluster (CD)})^2 \\ = (5+1)^2 + (3+2)^2 = 61 \end{aligned}$$

As observation A is closer to the mean of cluster (AB), no reassignment is needed. Next, we calculate the squared distance between observation B and the mean of cluster (AB) and cluster (CD) respectively.

$$\begin{aligned} \text{Distance } (B - \text{cluster (AB)})^2 \\ = (-1-2)^2 + (1-2)^2 = 10 \\ \text{Distance } (B - \text{cluster (CD)})^2 \\ = (-1+1)^2 + (1+2)^2 = 9 \end{aligned}$$

Since observation B is closer to the mean of cluster (CD), it is reclassified as a member of cluster (CD). Reflecting the change in the number of members in both clusters, cluster (AB)

² For an introduction to various methods used in clustering analysis, refer to Johnson and Wichern (1992).

³ The example is adopted from Chapter 12 of Johnson and Wichern (1992).

is renamed as cluster (A) and cluster (CD) is renamed as cluster (BCD). Their new cluster means are calculated and shown in the following table.

Cluster mean	Variable X	Variable Y
(A)	5	3
(BCD)	$(-1+1-3)/3 = -1$	$(1-2-2)/3 = -1$

The squared distances are computed again between each observation A, B, C, D and cluster (A) and cluster (BCD) respectively. The results are summarised as follows.

Squared distance to cluster	Observation			
	A	B	C	D
(A)	0	40	41	89
(BCD)	52	4	5	5

Since observations B, C and D are closer to cluster (BCD), and observation A is the only member in cluster (A), no reassignment is needed and the final grouping is achieved.

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