Third International Conference on Construction in the 21st Century (CITC-III)
"Advancing Engineering, Management and Technology"
15-17, September 2005, Athens

Analysis of Discontinuous Housing Prices

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Abstract
This paper studies the relationship of changes in housing demand and changes of lagged supply, in order to analyze discontinuous changes of housing prices using cusp catastrophe model. Lagged supply makes housing price fall due to decreasing in demand for housing. Four phases of housing prices are defined in order to understand the impacts of lagged supply on housing prices. The four phases are the stable, the bubble, the unstable and catastrophe phase, and the recovery phase. Yearly data of private housing price index, take-up and vacant units collected from the Hong Kong government publication have been used to test the model. The analysis suggests that it is important to manage the lagged supply to meet the current demand requirements in order to minimize housing price fluctuation.

Keywords
Housing prices, Cobweb theorem, Discontinuous changes, Cusp, Lagged supply

1. Introduction

In 1999, new supply units of private domestic property and vacant units increased and reached the highest level, while housing price index fell to 299 (1989=100) from the peak in 1997. The number of vacant units has increased a great deal since 1992. The average vacancy rate was 4.15 percent during the period 1980 to 2000, and the highest was 5.9 percent. Table 1 shows the relationship between take-up units, supply of housing units and vacant units during the period 1996 to 2002. By looking at 1996 to 1999, we can see that housing supply increased a great deal. Despite a contraction of the economy in Hong Kong during that period, housing supply increased considerably from 1997 to 1999. The effects of the large number of vacant units negatively affected the housing market in Hong Kong.

Table 1: Take-up Units, New Supply and Vacant Units of Private Property

Year	Price Index	Take-up (Units)	New Supply (Units)	Vacant (Units)
1996	273	20480	19870	34050
1997	299	15090	18200	35980

1998	420	13050	22280	43820
1999	299	19560	35320	59140
2000	257	29180	25790	54950
2001	189	19320	26260	60410
2002	160	19930	34040	74200

[Source: Hong Kong Property Review, various issues]

The literature states that the housing supply is inelastic in the short term because of the time lag for the construction period, i.e., the period for commencing building and the buildings being completed (Tse, 1998). Lagged construction produces a greater supply of housing. A portion of new units may be taken up by house purchasers. The unsold units become vacant units available for the market. The excess supply over demand makes the housing price move, as housing prices should not increase because of supply constraints (Blackley, 1999). The fluctuation of prices in markets with a production lag has been studied by the cobweb theorem. This theorem explains the path followed in moving towards an equilibrium price and quantity in the long term when there are time lags in the adjustment of either supply or demand to changes in price (Nellis & Parker, 2002). The cobweb theorem indicates an effect of the change in current price and housing supply in the opposite direction (Hua & Chang, 1999). In the case of demand shock, housing prices may be changed discontinuously because of lagged construction. Discontinuous change in housing prices, i.e., price crash, reflects a sharp decline in price. Kim and Kim (1999) suggest that the main reasons for the housing price crash may be misinformed expectations and speculation. The lagged supply adds to vacant units that influence people's expectations and the housing price system. The property market plays a very important role in the economy as a whole. Housing prices can surge to levels incompatible with economic fundamentals, creating bubbles that inevitably collapse. It is important to study discontinuous change in housing prices to understand why they happen, when they happen, and how to avoid them. For this reason, a cusp catastrophic theory for analyzing housing price change is used.

2. Cusp Model of Housing Prices

Catastrophe illustrates those situations in which minor changes in one variable provoke an abrupt change in another variable (Gilmore, 1981). A cusp is one types of catastrophe model, commonly used, which has two control variables and one state variable with a surface in a three-dimensional space. The surface is a sheet that is folded to create an upper level, a lower level, and a cusp or fold.

The diagram in Figure 1 describes the housing price behaviour in the catastrophe model. The vertical direction is the change in housing price, denoted (x) as the behaviour or state variable. The two directions in the surface, (p) and (q), are the two control variables that represent the changes in take-up units and changes in vacant units. The principle is that the higher the take-up of units, the more is the pressure on housing prices. The vacant units increase because of decreased demand and lagged supply of housing units. The unstable point is the slope of take-up units and vacant units crossing the bifurcation set.

- **Points (g) and (g–h)**

This point has a lower possibility of occurring catastrophe in housing prices because of the higher quantity demanded with gradual adjustment of supply to the equilibrium. Housing price remains at a higher level, though the vacant units increase as a portion of total housing stock.

- **(g–e) and (e)**

At the path between (*g–e)*, the number of vacant units is low; thus its slope remains high. This means that whatever the equilibrium quantity changes, housing price changes smoothly in a stable price system. At point (*e*), lower equilibrium quantity with low vacant units, the possibility of catastrophe is low.

- **(e–h)**

The path shows that the number of vacant units changes gradually and in the same way as the equilibrium

quantity and price. Thus, the slopes of both equilibrium curve and vacant units curve are from low to high, or vice versa. The system should be stable unless the path crosses the critical point *0*.

- **(e–d) and (d)**

Point (*d*) begins as unstable, because vacant units increase when the equilibrium quantity is at a lower lever. Housing prices are ready to change if there is any unexpected external event.

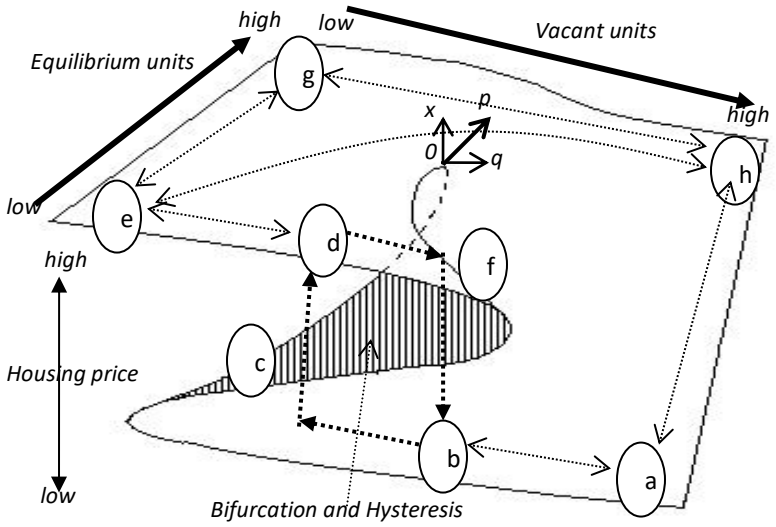

Figure 1: Descriptive Model of Housing Price Catastrophe

- **(d –f–b) and (b–c–d)**

These are hystereses as the sudden changes in housing prices. They occur because vacant units increase rapidly because of lagged supply. The instability of the housing price system is at this stage. At any external disturbance, the price drops rapidly (d–f–b) with a decrease in demand to a lower the equilibrium level. Conversely, point (*b*) may move to (*d*) through (*c*) if there is a sudden stop in housing supply.

- **(b–a)**

At the lower price level, housing price is stable between (*a*) and (*b*) unless the system has changed. At a lower equilibrium level, housing price is unable to change much, because demand change is very small and a surplus of supply is available, unless at point (*b*), housing prices change back to (d) depending on external elements.

- **(a-h)**

Path (*a*–*h*) is out of the range of the bifurcation area that indicates prices change smoothly at all paths of the equilibrium position.

The stability of housing prices is determined by the slopes of the equilibrium- and vacant units curves. To understand its impact on housing prices, four phases of housing prices are defined according to the illustration above, the stable phase, the bubble phase, the unstable and catastrophe phase and the recovery phase.

- **The Stable Phase**

This is a stable equilibrium phase in which housing prices move from one equilibrium point to another equilibrium point and markets will respond to changes in demand and supply. Increases in demand for housing will push the price upward because housing supply is inelastic in the short-term (Kauko, 2001). The increase of prices will provide producers with a stronger incentive to speed up construction of houses and units. In this phase, the housing price has a stable adjustment at a given level of housing supply in the short-term. In the long-term, housing supply is smoothly responding to the changes in demand. The number

of vacant units to the total housing stock - the vacancy rate - is stable, meaning that house prices remains stable.

- **The Bubble Phase**

This phase indicates an unstable equilibrium position. The characteristic of this phase is that the price goes up consistently. Accompanied with an increase in household income, demographic elements and economic conditions, people have expectations of higher housing prices. When the price has not reached the expected level, demand for housing as well as housing price increases. In the short-term, new housing supply can not match the rapid increasing demand for housing. The price will be under further pressure if the purchasers can see benefits of some speculation from the sale of properties. In the long term, the market achieves equilibrium accompanied with an increase of the vacancy rate, which increases rapidly.

Good economic prospects and high returns from property create positive feedback leading to demand increasing faster than supply. The deviation from equilibrium is large. Its effect can have an abrupt effect in which the market crashes. Positive feedback may come from higher expectation, investors' over-confidence, imitative behaviour and herding between investors (Johansen & Sornette, 1999). Such positive feedbacks provide the fuel for the development of speculative bubbles, the so called bubbles phase. A rapid increase of the vacancy rate in this phase is a warning sign of disruptive market.

- **The Unstable and Catastrophe Phase**

A system goes critical when the price bubbles continuously accumulate as speculative activities. It is considered critical because the system becomes hyper-sensitive to a small disruption, *i.e*. different parts of the system become highly correlated. Critical points describe singularities associated with bifurcation and catastrophe theory (Johansen & Sornette, 1999). Such singularities are produced by i) usual householders' behaviour (performed today based on past data affects the future); ii) unusual householders' behaviour (speculation); iii) construction lags; and iv) nonlinearity of the system. These mechanisms produce the catastrophe phase. Any external phenomenon, such as changes in local economic conditions or global economic recession, increases in unemployment rate or changes in the financial system may create housing price catastrophe in a vulnerable system.

Housing prices rise rapidly because of the mass demand for housing with a lack of housing supply in the short-term. At higher price level, housing demand reduces; some households exit the market after making profits by selling property. The higher housing price makes some speculators pause to observe the market trend. Housing price decrease as demand is dampened. Most importantly, there is a lag in the supply of units adding new supply to the decreasing demand. The lagged supply lowers the householders' expectations of housing prices. The vacancy rate reaches a higher level. New supply increases rapidly as demand decreases.

- **The Recovery Phase**

The housing demand falls slower and the change in housing prices becomes smoother. At a lower lever of housing prices, supply reduces and demand increases smoothly. Both housing demand and supply return to a stable situation. The vacancy rate falls to an equilibrium level. The price is comparatively stable but at a lower lever, as the market returns to a stable state. This is the recovery phase of the house price model.

In reality the catastrophe change in the housing market is very complex, but this simple form reveals a system behaviour of the housing market and the principles and relationship of equilibrium quantity and vacancy rates. It describes the causes of instability in housing prices as the result of the vacancy units exceeding the equilibrium quantity of housing.

3. Evidence in Hong Kong Housing Market

Yearly data of the private housing price index, the take-up of new dwellings, housing supply and vacant units from Hong Kong have been used to test and verify the model. In 1980, housing supply was just 4,300 units more than market take-up units. There was a large increase in housing supply in 1981 to 33,500 units, but the take-up was reduced to 18,000 units. The vacant units increase around 77 percent from 1980 to 1981 (Hong Kong Property Review, various issues). Though supply was reduced in 1982 and further in 1983, housing prices fell gradually by 47.1 percent in real terms within three years. To hedge against speculation, the Hong Kong government increased housing supply in 1994, which temporary halted the demand for housing. The housing price dropped by 22 percent in real terms during the second quarter of 1994 to the fourth quarter of 1995. However, the government reduced housing supply from then until 1997. This induced high expectations of future house prices, which stimulated housing demand. The important matter was that the take-up units started to decline in 1996 and fell below the supply in 1997. It can be seen that the critical point is in 1997, an unstable point. The reason is that the lagged supply increased the vacant units in 1998 and 1999 while housing demand starting to fall. The Asian financial crisis caused a price catastrophe. The main difference in 1997 from 1981 and 1994 was a consistently increased vacancy rate caused by lagged supply and a sharp decrease in demand for housing.

4. Conlcusion

Discontinuous changes in housing prices occur because of lagged supply together with a decrease in demand for housing. Weak demand, lagged supplies, and excessive vacancy rates are the main factors in a housing price crash. A cusp-type catastrophe can be applied to develop an analytical framework for housing price determinations. Both stable and unstable housing prices can be built into the one system for analysis. The unstable catastrophe point can be detected by identifying the change of vacant unit and the equilibrium taken-up of units for the period. The analysis suggests that it is important to manage the lagged supply to meet the current demand requirements in order to minimize housing price fluctuation.

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