House Price Trigger and Infusion Trap

Authors Yi Kun Huang and Xin Janet Ge

Abstract

Rapid movements of house prices bring concerns about affordability when house prices go up and of crisis when they fall below their trend value. Many factors such as demographic changes, income levels, local and international economic conditions contribute to house price movements. In addition, land scarcity and supply rigidity add up frost to the great volatility of house price movements. This paper begins by reviewing house prices which have the potential to deviate significant from market fundamentals in the short term, especially when supply is rigid. The paper then establishes a house price trigger model under the assumption of supply rigidity in order to explain fluctuations in house prices. The model is tested by on time series data from Hong Kong and explains that the changes of quantity demand, the level of increase and decrease in the market place, are triggers that induce fluctuations in house prices. The behaviour of developers, investors and consumers in the property market and the housing market of mainland China is also analysed using the concepts developed.

Keywords: supply rigidity, housing price trigger, infusion trap, China, Hong Kong

Introduction

Both the scarcity of land for housing and the high cost of real estate investment, Contribute to the supply rigidity of housing, especially in cities with high population Density. Supply rigidity is when changes in supply (increase or decrease) lags changes in demand and brings disequilibrium to the housing market. This condition occurs because of long construction periods required for housing. With rapid population growth more and more housing is needed. With increases in demand and a rigid supply, the demand for housing often exceeds supply. Neoclassical economics explains that the cyclical fluctuations of house prices are a phenomenon under conditions of rigid supply. If the increase in supply can not satisfy the demand, the house prices will rise. Conversely, a fall of demand will result in a correspondingly greater fall in

house prices. A model to simulate this dynamic process is necessary due to deal with this kind of fluctuations that create short-term disequilibria. Thus, this paper establishes a housing price trigger model under the assumption of supply rigidity and employs the Hong Kong time series house price index to test the model. In addition, we present an infusion trap and analyse the behaviour of the developers using the concept developed. The paper starts with a literature review to build a fundamental base for the model development. We then establish the trigger model and present empirical evidence using Hong Kong data. Finally, we analyse the infusion trap and real estate market in mainland China before concluding remark.

Literature Review and Theoretical Background

Megbolugbe *et al.* (1991) stated that the neoclassical consumer theory of housing demand is the only fully developed economic theory of housing markets that is used for analysing housing decisions. Other researchers (Browning and Chiappori, 1998; Follain and Jimenez, 1985; Hardman and Ioannides, 1998; Ruming, 2003; Smith et al., 1988) have modified the neoclassical theory to construct housing market models because of the unique characteristics of housing. Equilibrium between supply and demand is the core of neoclassical economics, in long- as well as short-term. If there is a shift of supply or demand in a comparative static situation, a new equilibrium is yielded (Bumas, 1999; Harvey, 1998; Maclennan, 1982). In the short term, the goods and services market brings the quantity demanded and the quantity supplied toward a market-clearing price. If any force moves price from its equilibrium position, instantly there will be brought into play forces tending to push it back into equilibrium (Bumas, 1999), meaning that equilibrium is stable. And in long-term, the equilibrium depends on the short-term equilibria of different periods, costs and expectations of the market.

The equilibrium can be continually disrupted by unanticipated changes such as

unavailability of resource, improved technology or changes in consumer confidence. The unanticipated changes in demand for and supply of housing influence prices and outputs in the goods and services markets. Responses to such unanticipated changes depend on characters of decision makers, ability to adjust, and time (Gwartney et al., 2000). Under the assumption of supply rigidity, an unanticipated change of housing demand breaks up the equilibrium position and will soar up or put down the housing prices, more than what decision makers could reasonably foresee. Thus, modelling the dynamic adjustments of housing prices is significant in order to study the effect of changes of demand for housing when supply doesn't adjust immediately to meet the change in demand.

In real estate markets, supply rigidity does exist. Land resources for housing are limited. The long lead time for housing development and the durability of housing mean that the supply of houses is inelastic. The net supply of houses every year only accounts for a small proportion of all the houses in the market (Floyd and Allen, 2005), and the construction time means that initially, the market appears to be more sensitive to changes in demand (Omar and Ruddock, 2002).

Hardman (2000) pointed out that Germany's environmental protection regulations causes the land zoned for construction to be scarce and extremely expensive. Sendi (2000) identified the missing element of Slovenia's housing market as a lack of choice because of a shortage of supply. Moreover, the control of supply by real estate companies also leads to supply rigidity. The high-cost threshold prevents many investors from entering the real estate market and enhances the domination of supply, and land resource by the developers. According to the analysis of real estate market in China, conducted by Wu, et al. (2007), the market structure can cause the supply to be controlled by a few powerful developers that may manipulate the supply of

houses. At best, the real estate market is an oligopoly.

Lack of supply will surely raise the house price. Land supply and development restrictions have a great impact on developers. Xing, et al. (2006) introduced regulation index to test this proposition and concluded that restrictions will induce the rise of house price. In addition, Peng and Wheaton (1994), using the theories of economics to test the data of Hong Kong, expected that the house price in Hong Kong will continue to raise because of the sale restrictions on land.

Besides, investors do not just accept the house price. Allen & Dare (2006) have indicated that listing price has a significant influence on the consumers in their research. By setting a high listing price and high discounting rate, the sellers can charm the potential purchasers. At the same time, the investors and consumers will make rational decision according to the trend of price fluctuation. For example during the financial crisis of Asia, the rapid fall of housing price drove investors away. The Price, as a signal, is a key variable in the decision process.

House Price Trigger Model Under Supply Rigidity

Because equilibrium is not reached in the short-term under the assumption of supply rigidity, we can not establish the model assuming it. Instead, we can use the gap between supply of and demand for housing as a threshold. Since the housing market facing the limited supply of land and domination of housing developing companies, as well as time required for construction, the supply of housing is rigid. On the other hand, the demand of purchasers, including the consumers and investors, will be influenced by unexpected factors. With this background, we assume that the supply of housing remains unchanged in the short-term and we may just consider the relationship between the demand and the housing price, in order to simplify our model.

Meanwhile, we suppose that the housing price trigger starts with the state that equilibrium exists between supply and demand. This means that the trigger is the price change away from the equilibrium price.

$$P = P_e + \Delta P \qquad \text{……(1)}$$

P_e is the price under equilibrium, and can be seen as a constant.

When purchasers of housing make their decisions, they will consider the trend of price fluctuation and generate their own expectations of the price in the future. Hence, the demand for housing is relative to this expectation. Friedman (1976) was the first to introduce expectation into a monetary demand model. Under Static Expectations, the speed of price increase at current time, $\frac{dP}{dt}$, is the expectation of price increase in the market (Muth, 1961). Therefore, the equation for the demand for housing and the expectation of housing price increase can be

$$\Delta D = k\frac{dP}{dt} \qquad \text{……(2)}$$

Where *k* is a non-negative constant, ΔD is the change of demand

At the same time, the supply of housing is rigid so that the rise of price depends on demand only. The change (increase or decrease) in price and the change in demand are in the same direction. The higher the demand, the higher the price will be, and vice versa. The change in price is induced by the differences between the quantity supplied and demanded. Under the assumption that the supply is unchanged, we can set the equation:

$$d\Delta P = b * d\Delta D \qquad \text{……(3)}$$

Here, *b* is a non-negative constant, $d\Delta P$ and $d\Delta D$ are differential expression of ΔP and ΔD. This equation means that the price is impelled directly by the change of demand; it's the characteristic equation. Moreover, both equation (2) and (3) imply the spring conditions of the price trigger, which

will be described in the later section.

Combine the equation (1), (2) and (3), we have the differential equation:

$$\Delta D = k' \frac{d\Delta D}{dt} \qquad \text{……（4）}$$

Here $k' = \frac{k}{b}$ is a non-negative constant.

Solving this ordinary differential equation, we have $\Delta D = ce^{\frac{1}{k'}t}$ (*c* is a constant). Since the change (increase or decrease) of price and the change of demand are in the same direction, we have the same exponent function for house prices, $\Delta P = ce^{\frac{1}{k'}t}$. Therefore, we have the housing price trigger model:

$$P = P_e + \Delta P = P_e + c\left[e^{\frac{t}{k'}} - 1\right] \qquad \text{……（4）}$$

In this equation, $\left[e^{\frac{t}{k'}} - 1\right]$ means an adjustment of the original value; that is when *t=0*, $P = P_e$.

If we consider the period between time *t* and *t'*, we have the relation:

$$P_{t'} = P_t + c\left[e^{\frac{(t'-t)}{k'}} - 1\right] \qquad \text{……（5）}$$

There is one thing we need to mention, the constant *c* above can be both positive and negative, and it depends on the direction of the original departure from the equilibrium. In addition, $|c|$ is relative to the sensitivity of housing market. Thus, we can use it to estimate the sensitivity of the market and the trend of price fluctuation.

We can see that the housing price trigger model is emanative without limit. Hence, the trigger model can explain the cause of economic bubbles of real estate market and financial crises. Both of them are impelled and exaggerated by the profiting effect and losing effect. In reality, the price in real estate market will finally meet the rational regression and the trigger will come to its ending, i.e., demand for houses reduce when house prices soar to the higher level.

Empirical Study of the House Price Trigger Model

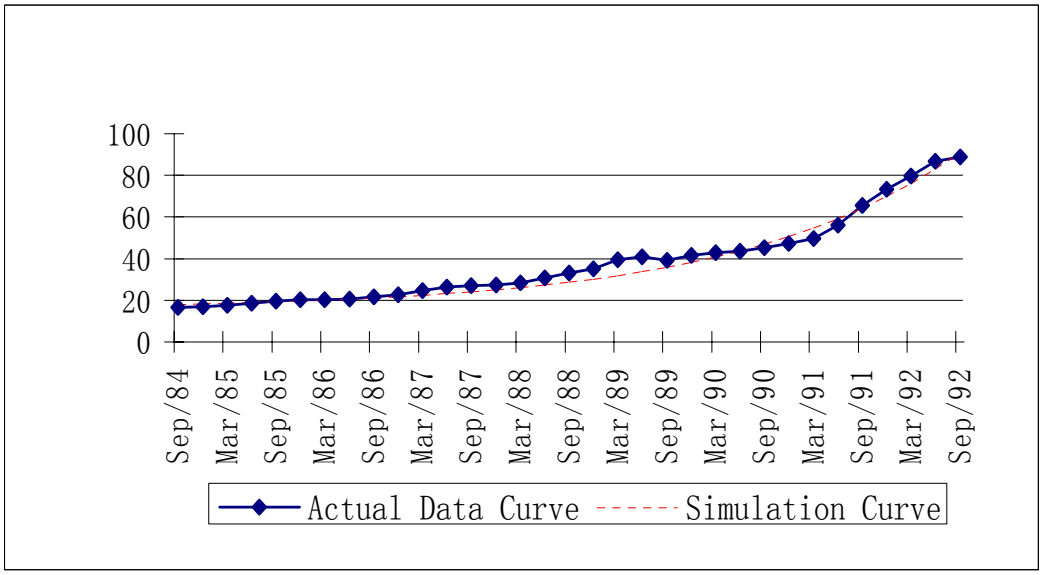
To test the trigger model, we used the Hong Kong quarterly house price index from Sept. 1984 to Dec. 2006 complied by the Rating and Valuation Department of Hong Kong. One reason for using Hong Kong data is that it has a vast population but limited land resources. Also, land acquisition, design and construction of housing developments normally take two to four years. Peng and Wheaton (1994) and Ho, Ganesan (1998) empirically examined the effect of restrictive land supply on Hong Kong house prices. However, Tse and Ganesan (1999) argued that the impact of the supply of new land by the Hong Kong government is not as important as they maintain in accounting for the volatile house prices in Hong Kong. However, the expectation of housing supply in Hong Kong will continue to be limited (Tao, 2007). Lai and Wang (1999) also summarized the characters of the real estate market in Hong Kong and emphasized that the supply of land is severely restricted and that a few developers monopolized the market. So, the assumption of supply rigidity is satisfied. Further more, the increase in population has greatly impacted on housing prices over the last two decades as demand for housing grew significantly. Hence, using Hong Kong data for testing is appropriate.

The collected time-series data has been divided into three periods: Sept. 1984 to Sept. 1992, Sept. 1997 to Apr. 1998 and Dec. 2003 to Sept. 2005. Since the trigger model is an exponent function, the logarithm and linear regression are used to calculate the trigger model. By Matlab 6.0, we get the equation of the trigger for Sept. 1984 to Sept. 1992; it's $P_{t'} = 17.93 + 2.23 * \left[e^{0.44*(t'-t)} - 1 \right]$, and time *t* stands for the Sept. 1984, and the unit of time is one year. Exhibit 1 is the house price index in Hong Kong from Sept. 1984 to Sept. 1992 and Exhibit 2 is the result of the simulation for the period. The ordinary line is the data while the dotted line is the simulation. The two lines show the same trend and are quite closely related, which indicates the model is satisfactory.

Exhibit 1 The House Price Index (HPI) in Hong Kong from Sept. 1984 to Sept. 1992

Date	1984.9	1984.12	1985.3	1985.6	1985.9	1985.12	1986.3	1986.6	1986.9
HPI	16.7	16.9	17.6	18.5	19.6	20.3	20.4	20.6	21.6
Date	1986.12	1987.3	1987.6	1987.9	1987.12	1988.3	1988.6	1988.9	1988.12
HPI	22.7	24.6	26.2	27.1	27.3	28.3	30.8	33	35.3
Date	1989.3	1989.6	1989.9	1989.12	1990.3	1990.6	1990.9	1990.12	1991.3
HPI	39.4	40.8	39.2	41.4	42.8	43.7	45.3	47.3	49.6
Date	1991.6	1991.9	1991.12	1992.3	1992.6	1992.9			
HPI	56	65.5	73.2	79.6	86.8	88.7			

Exhibit 2 House Price Trigger 1 (Sept. 1984 to Sept. 1992)



Same method applies to calculate the trigger for the other two periods (Exhibit 3 and 5).

Exhibit 3 The House Price Index (HPI) in Hong Kong from Sept. 1997 to Apr. 1998

Date	1997.9	1997.10	1997.11	1997.12	1998.1	1998.2	1998.3	1998.4
HPI	170.3	172.9	160.5	155.0	143.7	136.6	138.7	134.3

The house price trigger model is $P_{t'} = 170.41 - 3.49 * [e^{4.35*(t'-t)} - 1]$. Time t is Sept. 1997, and Exhibit 4 is the result of the simulation.

Exhibit 4 House Price Trigger 2 (Sept 1997 to April 1998)

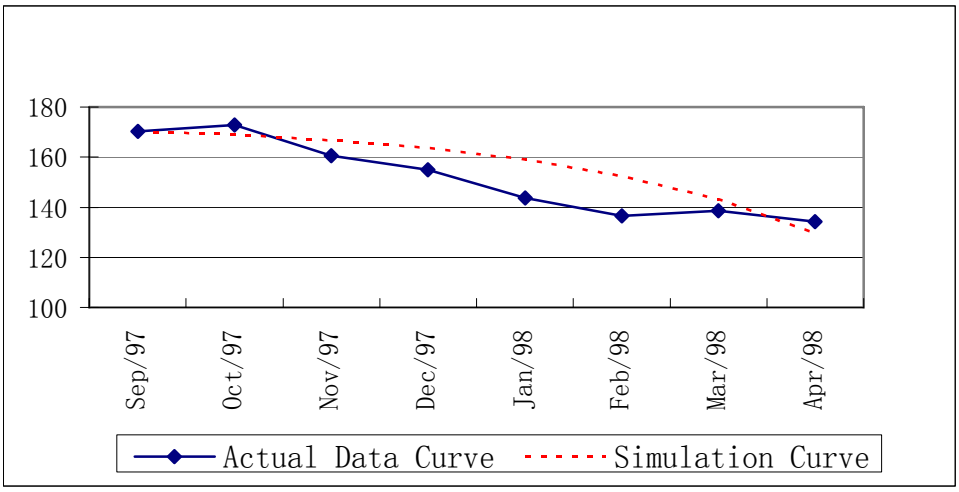
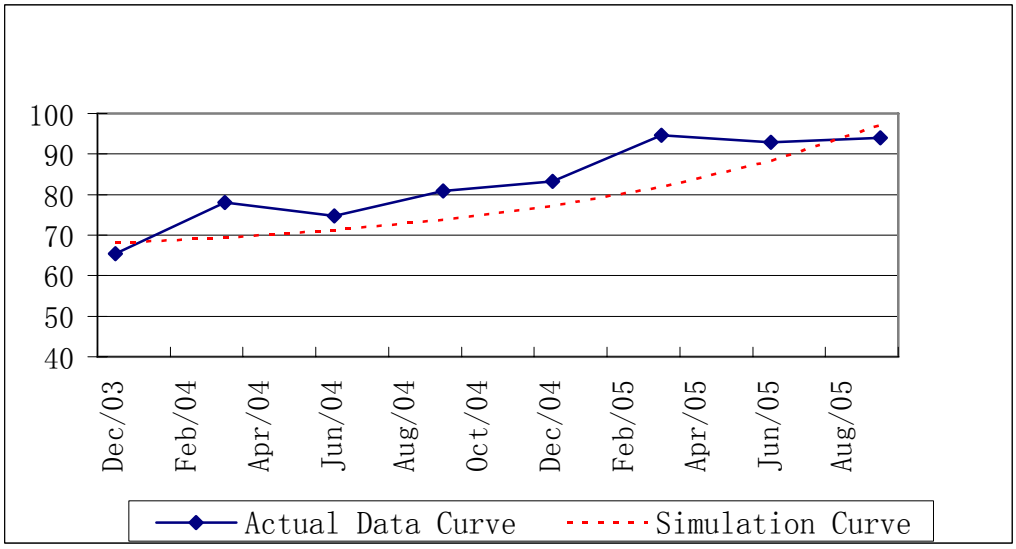


Exhibit 5 The House Price Index (HPI) in Hong Kong from Dec. 2003 to Sept. 2005

Date	2003.12	2004.3	2004.6	2004.9	2004.12	2005.3	2005.6	2005.9
HPI	65.4	78.1	74.7	80.9	83.3	94.6	92.9	94.0

The house price trigger model is $P_{t'} = 68.07 + 3.67 * \left[e^{1.25*(t'-t)} - 1\right]$. Time t is Dec. 2003, and Exhibit 6 is the result.

Exhibit 6 House Price Trigger 3 (Dec. 2003 to Sept. 2005)



The simulations of the last two periods show the effects of the Asian Financial Crisis. By testing the values of $|c|$ and k', we can see how sensitive the market was during these periods and different expectations by different people

created uncertainty. Therefore, the simulations are - to some extent - distorted.

Infusion Trap and Real Estate Market in China

Infusion trap in the housing market

The house price trigger model describes a process which springs from equilibrium to disequilibrium in the short-term. During this process, both purchasers and developers can earn high profits. So, the equation (2) and (3), are important to the housing market.

In the equations, $\Delta D_1 > 0$, implying the positive increase of demand, comes from the expectation of house prices increasing, namely $\frac{dP_1}{dt} > 0$, which is also the appreciation rate of house price. Then, equation (3) will take the place, and impels the price to a higher level. After that, equation (2) and (3) will work together in turn and raise house prices. We refer to the first expectation of increase in house price, which is $\frac{dP_1}{dt} > 0$ above, as a spring condition of the house price trigger. Analogously, from equation (3), we have another spring condition, $\Delta D_1 > 0$.

On the other hand, we can consider the spring conditions of the house price trigger model to be the purchasers' psychology. According to Liang and Ning (2007), demand, motivation and inducement are three psychological factors which usually influence the behaviour of purchasers. Motivation and inducement are key factors for the house price trigger, because house purchasers pursue profit. Potential buyers are divided into two subgroups: residents who buy and sell houses for personal use, and speculators and property developers who make money by selling and buying property (Roehner, 1999). Individuals view housing not merely as a consumption good,

but as an investment good to hold in their portfolios (Case and Shiller, 1988; Dusansky and Wilson, 1993; Lin and Lin, 1999). Lin and Lin (1999) held a similar view, that buying a house usually satisfies housing consumption and housing investment demands simultaneously. Uncertainty and expectations play a crucial role in housing price models, as expectations of future prices influence current consumption, including housing choice and future consumption. Capital gain is another attraction inducing the demand for housing. However, for most purchasers, depreciation can not be ignored, especially in China, because the value of second-hand houses is vastly different from new ones. Therefore, when persuading the purchasers, the developers have to make them believe that the rise of house price will cover the depreciation. In addition, the purchasers have to offer a price above the equilibrium price when the trigger works, and this continue to impel the trigger. So, we call this phenomenon the Infusion Trap.

Since there are two spring conditions for the house price trigger model, $\Delta D_1 > 0$ and $\frac{dP_1}{dt} > 0$; there will be two kinds of infusion trap. One is called Depreciating Infusion and the other is called Appreciating Infusion.

The first one, Depreciating Infusion corresponds to $\Delta D_1 > 0$. It means that the developers can use depreciation as a method of sales promotion to enlarge the demand in the real estate market. Then, they attract many buyers to get the positive deviation of demand for housing at the first periods. The Appreciation Infusion corresponds to $\frac{dP_1}{dt} > 0$. It means that the developers can raise the house price more quickly by themselves and stimulate the real estate market. This positive deviation implies that the house price will begin to rise for potential purchasers. Thus, induces the trigger. For example, the developers

can use the media to promote the conclusion of researchers that the rise of house prices will be faster.

These two infusion traps indicate that the developers and sellers can employ two completely different measure, both depreciation and appreciation to induce the trigger and receive high-profit. However, it doesn't mean these two measures work at any time. Rather, they depend on the structure of the real estate market.

When the demand elasticity of the purchasers in the real estate market is high, the price depreciation will cause more demand for houses, the developers should use the Depreciating Infusion strategy. The affordability of purchasers is necessary, and they become the potential purchasers of the market. Generally, it's a time when the house price is at a low level steadily for a long period. This is propitious for potential purchasers. Conversely, at a time of Appreciating Infusion developers would asks for a low elasticity in the market. Normally, it's a time when the price is high and many people can not afford a house. Purchasers are inclined to wait. Without suggestions of a house price rise, they won't enter the housing market. This appreciation can also be an explanation for price rigidity.

Analysis of the real estate market in China

Using the concepts developed above, we can analyse which condition is satisfied and find out some problems in the housing market.

Firstly, elasticity is easier to observe; developers and the researchers can understand the housing market by studying the change of price and demand so that they can analyse which spring condition is satisfied to a particular housing market. These conditions are essential for both the developers and policy makers to determine whether to apply Depreciating infusion or

Appreciation infusion in order to formulate strategies and policies.

According to Chinese Statistical Yearbook, from 1997 to 2002, the increase in house prices for each year remain below 100/m^2; it means that the housing market satisfied the Depreciation Infusion. At 2003, the house price began a rapid increase that lasted to 2007. During this period, though there were some adjustments of the house price, the general trend didn't change. Li, et al. (2005) observed a phenomenon which seems to contradict economic theory, that is, the quantity of houses taken up by purchasers increased when house prices continued to rise. This phenomenon show that the house price trigger worked. There are great arguments on whether economic bubble in real estate market took place since the house price trigger induced by the higher demand for housing can increase price rapidly. Jiang (2005) similarly suggested that when price of and demand for houses deviated from the equilibrium in his empirical analysis of real estate market in China, he anticipated that the bubble would continue to grow. If we take the adjustment of house prices recently as the end of the trigger, we can conclude that the house price is at a high level.

Secondly, recent studies and investigations indicate that high-prices and high housing vacancy rates coexist in China, some developers insist on high-prices although they face an increasing vacancy rate (Chen, 2006). Further more, house prices decrease together with the lower quantity transactions in some major cities, such as Shanghai, Shenzhen and Guangzhou. It implies that purchasers are not as sensitive as before towards the house price, and the demand elasticity is low. Therefore, we conclude that the spring condition of Appreciating Infusion is more valid. From the view of developers and sellers, they should continue to raise the house price in order to spring a new trigger.

Thirdly, however, the satisfaction of the Appreciating Infusion indicates that house prices deviate from the equilibrium price and the problems of bubbles in

real estate markets have to be solved. Li (2007) reported that many properties have been sold over prices which create a space for speculation in China; as fewer families can afford to purchase houses. Hence, immediate measures should be taken by the policy makers to formulate proper strategies in order to prevent the developers who tend to raise the price and spring a new trigger. Measures should be taken prudently to keep the house price level or make it descend slowly is an ideal result, and elasticity is the key variable we can refer to. If the developers depreciating actively, the downward trigger maybe occur and induce a collapse of the house price system.

Conclusion

Neoclassical economics emphasize that the equilibrium of demand and supply decide the price in market. This equilibrium is stable, once deviation occurs, adjustment will happen automatically that brings the price back. But in the short-term, disequilibria exists in real estate markets, especially these with supply rigidity. Under the static expectation, the house price trigger model has been established to estimate the house price fluctuation during a short-term disequilibrium. The house price index of Hong Kong is employed as an empirical study to test the models. The simulation results suggest that the developed models are satisfied for modelling the trend of house prices. Furthermore, using the spring conditions of the trigger, we induce Depreciation and Appreciation, two kind of infusion trap in real estate.

Finally, this paper analyses the real estate market in China with the trigger model and infusion trap. We found that house prices in China were controlled by a trigger until recently, and the condition for Appreciation Infusion Trap is satisfied; developers tend to raise the price in order to spring the trigger again. Whereas, the house price in China is at high-level; measure should be taken to handle the problem of a price bubble. Elasticity is a key variable and we suggest that the house price remains stable or drop slowly is an ideal result.

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Mr. Huang Yikun, Address: RM 4-4087 Lantian College, Zi Jingang Campus, Zhejiang University, Tel: 86-571-88201514, E-mail: huangyikun1118@163.com

Dr. Ge, Xin Janet, PO Box 123 Broadway, NSW 2007, Australia. Tel: 061 2 9514 8074, Fax: 061 2 9514 8777, email: xinjanet.ge@uts.edu.au