Spatial Structure, Dynamic Evolution of House Prices: An Interurban Perspective

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Abstract: As a result of the housing reform in 1998, the Chinese housing market has matured. Together with the specialization of industries and regional economic integration, this results in the fact that households choose the location of their houses not only in a single urban area, but also between different cities. It is not surprising that house prices in the central and nearby cities are much higher than in distant cities in a region comprised by closely linked cities (hierarchical urban system). In this context, the purpose of this research is to investigate and explain the spatial structure of inter-urban house prices and its dynamic behavior.

After a brief review of the literature on intra-urban structure and interurban house prices determinants, as well as an introduction to the Chinese housing market, we give the research questions and hypotheses of this study. The first two hypotheses aim to explore the static spatial structure of interurban house prices and the role of spatial association in forming such structure, while the third one is related to the historical changes of such structure (such as ripple effect). The fourth hypothesis gives the theoretical explanation for the static structure and dynamic behavior based on the interaction of “centrifugal” and “centripetal” forces from the perspective of New Economic Geography. The last one is to predict the future evolution through the approach that combines prediction techniques and our theory. We also briefly introduce the quantitative approaches we will use in this study, as well as some sources for data collection.

Keywords: House prices; Interurban; Spatial structure; Dynamic evolution; Spatial association; Centripetal forces; Centrifugal forces

1. Introduction

Since the housing system reform in 1998, which aimed to thoroughly terminate the direct housing distribution as a form of welfare and create a diversified housing provision system mainly dominated by market principle, an emerging, maturing housing market in China has been developed, with dramatic increases in the unit price of houses and transaction volume. In mainland urban China, there was only 129.98 million square meters of house building sold to purchasers at the average price of 1857 yuan/m² in 1999, but these figures soared up to 933.76 million square meters and 4725 yuan/m² at the end of 2010, increasing approximate 618% and 154% respectively1. The maturation of the housing market gives us a chance to study the Chinese housing problems using the modern theory and methods.

In housing purchase decision-making process, price is a main factor. With the specialization of industries and regional economic integration, the links between cities become more and more frequent. In this context, households who are intending to purchase a dwelling not only consider the house prices between different locations within a single city, but also compare the price differences with nearby cities, or even the central city in the hierarchical urban system2. It is also generally found that the average house prices in central or nearby cities are much higher than the prices in distant cities. For example, in Yangtze River

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1 Unit price of housing here is calculated by dividing the transaction volume from total transaction amount. Data comes from Chinese Statistical Yearbook 2000, 2011 published online by National Bureau of Statistics of China.
2 Hierarchical urban system here is comprised by one or two central cities and a number of other cities with different rank, scale and function, which are linked by transportation system and have close interaction of economy and migration between each other.
Delta in eastern of China, the average house price in Shanghai, the central city, was 14213 yuan/m² in 2010, and 10331 yuan/m² in Suzhou, a city near Shanghai, but only 5987 yuan/m² in Hefei which is the capital city of Anhui province but far more distant from Shanghai (see fig.3). Numbers of empirical studies, such as in UK, suggest that the regional or inter-urban house prices tend to long-run convergence because of the ripple effect\(^3\), which means that the difference of house prices between the central city and distant cities will shrink. In 2001, the average house price ratio of Shanghai to Suzhou was 1.94, but this ratio dramatically declined to 1.37 in 2010. It seems that there is also a convergence trend of interurban housing market in newly emerging economy like China.

Such interesting phenomena occur in the interurban scale. However, the housing studies on interurban scale are usually not taking into account the spatial dimensions, while there has been a large volume of studies focusing on the spatial structure of intracity housing market and their dynamic evolution. The ambition of this study is to explore the spatial structure of interurban house prices, investigate the dynamic evolution of such structures and understand the underlying formation process.

2. Literature Review

The Intraurban House Price Structure

A well-known model to explain the urban spatial structure is the monocentric model developed by Alonso (1964), Mills (1967, 1972) and Muth (1969). Under the assumption that a city is treated as a circular residential area surrounding a central business district (CBD), where all job opportunities are located in, and a spatial equilibrium exists, the monocentric model shows that there is a trade-off between location and commuting costs, that is, such variables as land values, the per-unit price of housing will fall with the distance from CBD. Numbers of empirical studies have found the expected rent gradients, land value gradients or housing price gradients in metropolitan area or a large region with one dominating center (Colwell & Munneke, 1997; Atack & Margo, 1998; Ahlfeldt & Wendland, 2011; Osland et al., 2007).

However, in a few studies, the coefficients of distance to CBD turn out to be insignificant, or even counter-intuitive. One possible reason can be explained by the fact that the value of location has been capitalized into the structure characteristics, such as size and quality, as well as into the neighbourhood amenities (Waddell et al., 1993a). The most powerful explanation for such results should be that the modern cities’ housing markets are more complicated, with many other sub-centers and city segmentation, which may submerge the effect of CBD. This view has been supported by the finding (Adair et al., 2000) that accessibility to CBD has an impact on house prices when focusing on more homogeneous sub-markets. Obviously, the assumption of monocentric model that a city only has one center is not appropriate, as many cities, such as Los Angeles, Dallas, Houston, San Francisco, New Orleans and Haifa (Israel), have been proved to have other important subcentres outside the CBD (McMillen & McDonald, 1998; Palut, 1998; McMillen, 2001). Findings of empirical studies about polycentric city showed that those subcenters could generate expected impact on rent gradient (Dubin & Sung, 1987), even swamp the influence that CBD accessibility might appear to have (Heikkila et al., 1989). Besides, other urban amenities, such as shopping center, hospitals, schools, parks, are also demonstrated to have significant effects on house price gradient (Waddell et al., 1993b; Heikkila et al., 1989). In order to shed light on the spatial patterns of residence and employment in polycentric cities, theoretical polycentric models were constructed. On one hand, given previously the location of centers, White (1988) introduced a partial equilibrium analysis of

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\(^3\)Ripple effect describes the way in which changes in the housing price first occur in developed regions and then gradually spread out to the rest regions.
cities with two job centers. Others, on the other hand, did not pre-specify any centers but derived the results that the peaks of rent gradients are always around the most accessible place in the urban space (Fujita & Ogawa, 1982; Anas & Kim, 1996).

In a more and more dispersed city context, the problem that how to treat “accessibility” appeals lots of discussion. Majority of literatures have addressed this issue by the measures of “distance to CBD”, or “Travel time to CBD”. Furthermore, in order to find the most appropriate relationship between prices and location, different function forms have been examined, such as exponential function, power function and spline function approach. However, all these accessibility measures are CBD-oriented and low effective in a city with dispersed centers. Gravity measures, as an alternative, have been suggested and proved to have powerful explanation for accessibility. Osland & Thorsen (2008) assumed that gravity-based accessibility to labor market is a better representation of the trade-off between commuting costs and housing consumption than the distance to CBD in a region with a relatively self-contained labor market, and the result turned out to support the hypothesis. The empirical results from Ahlfeldt (2011) also showed that gravity employment accessibility measures can explain the residential land gradient entirely, as the negative CBD land gradient was rendered insignificant by the introduction of this measure.

Comparative static analysis of monocentric model developed by Wheaton (1974) predicts that the price gradients become flatter over time as incomes increase and commuting costs fall, which can be understood as a decentralization process. This prediction has been strongly supported by existing empirical studies. Attack & Margo (1998) found that the price of land per square foot fell steeply with distance from CBD in 1845, but after the Civil War, this distance gradient flattened in New York. Ahlfeldt & Wendland (2011) showed the similar results based on the database of Berlin from 1890-1936. They also revealed that the evolution of travel time explains a significant proportion of approximate three quarter of the overall decentralization process in terms of distance, which supports the significant impact of rapid transport system on urban decentralization. However, as the resurgence of CBD, some cities appear to exhibit a return of centralization process, for example, house prices in the city of Chicago were not affected significantly by distance from CBD in the early 1980s, but the situation reversed in the 1990s as a deeper house price CBD gradient was established again (McMillen, 2003).

As is known to all, China has different political and economic systems compared to most of the western countries. However, due to the reform of housing marketization, a mature housing and land market is being developed in urban China, especially in mega cities such as Beijing and Shanghai. Home-purchasing decisions of households in those cities are mainly controlled by the “invisible hand” called market, which is the basic assumption of monocentric model. Therefore, it is not surprise that several studies based on Chinese housing market have found evidence to support the standard monocentric model. For example, the empirical studies based on Beijing dataset have showed significant negative house or land price gradients with the increase of distance from CBD and largely demonstrated the appropriateness of classic monocentric model in Chinese urban housing market (Zheng & Kahn, 2008; Yu et al, 2008; Ren & Zheng, 2008). Meanwhile, the supported evidence also comes from the studies on Shanghai and other big cities (Hao & Chen, 2007; Zhang & Jin, 2007).

**Study of house prices: the interurban scale**

Following the framework of reviewing intra-urban house price studies, we, again, classify the house price studies upon interurban scale into two parts: cross-sectional analysis and time series analysis. The empirical works based on the cross-sectional dataset mainly focused on the determinants of intercity house price variation. Considering the failures of hedonic model in intercity location problem caused by
the complexity of interurban housing market, “derived demand models” were developed based on the assumption of equilibrium between housing demand and supply (Witte, 1975; Ozanne & Thibodeau, 1983; Manning, 1988; Potepan, 1996). Though some determinants from these empirical results based on the US data turned out to be conflict, they reached the consensus that differences in income, construction costs, population growth have significant influence on aggregated house prices variation. The impact of some determinants on house prices, such as population, wage earning, has been confirmed by the empirical studies in European countries (MÖller, 2009; de la Paz, 2003).

Another line of studies on interurban housing market, using time series data, is to analyze the dynamic behavior. One hypothesis of house prices behaviour, which is still not conceivably demonstrated, is the ripple effect, which means that changes caused by shock in house prices always start in one region and then spread to other regions. The existence of ripple effect can be demonstrated by testing the casual links or cointegration relationships between house prices of different regions. Alexander & Barrow (1994), using the technique of Engle-Granger test and Johansen multivariate cointegration test, found that house prices in the south of UK do cause price movements in the north and midlands. By using the same method, the ripple effects were also proved at Scottish and Taiwan’s housing market (Jones & Leishman, 2006; Lee & Chien, 2011). The methods mentioned above are not the only techniques to examine ripple effect, and some other methods have been developed. Just as mentioned by Meen (1999), one implication of ripple effect is the existence of a long-run constancy or stationary in the house price ratio of a given region to the national figure. Though he failed to find the long-run constancy in his study, number of tests have been conducted following the unit-root test method, such as ADF test, momentum threshold autoregressive, non-linear unit roots test, and the results of which have showed significant convergence of house price ratios in UK and US housing market (Cook, 2003; Holmes & Grimes, 2008; Canarella et al, 2012). Many reasons for long-run convergence or ripple effect are put forth but not demonstrated. Meen (1999) discussed four possible explanations for ripple effect: migration, equity transfer, spatial arbitrage and spatial patterns in the determinants of house prices. Meen’s study found that a ripple effect can be generated by structural differences between the regions through the model simulation, while others (Alexander & Barrow, 1994; Jones & Leishman, 2006) uncovered strong evidence that supports the linkage between ripple effect and migration.

However, it is difficult to reach a consensus that whether ripple effect or convergence do exhibit in regional house prices. Significant differences of house prices between different regions are supported by empirical findings. Drake (1995), employing the state space model and kalman filter, found clear regional differences in the pattern of UK house price movements and a greater divergence of house prices between north and south. Ashworth & Park (1997) tried to discover whether cointegration between house prices and explanatory variables occurs in the regions and found that there are some significant differences in the regional structure of house prices, which findings are consistent with the results of the study carried out by Meen (1999). However, while the simulation of Meen’s study is in favor of the ripple effect, the Lagrange multiplier test in this study casts doubt on the ripple effect.

Given that we have uncovered the long-run relationship of regional housing prices, we would also like to find how the adjustments of short-run result in the long-run relationship. Error Correction Model (ECM) (Meen, 1999; Ashworth & Park, 1997; Holmes & Grimes, 2008) and Half-Lives model (Lee & Chien, 2011) are frequently used in short-run relationship studies. The findings suggest that different regions differently respond to the shocks or changes in housing prices. Those advanced regions or the nearby regions may have a faster adjustment speed than those undeveloped regions.

Summary of literature
According to the literature, we could find a large body of studies focusing on the intracity structure, including the influence of CBD on price gradient, the effect of other subcenters or important knots, the measure of accessibility, and the price dynamic behaviour over time. Contrasting to the fruitful findings on intraurban spatial structure, there is not so much attention concentrating on the interurban spatial structure of house prices apart from the studies on convergence of regional housing price. In our study, the focus is on the interurban housing market and we will gradually investigate the static structure of interurban house prices and their dynamic behavior, theoretically explain the underlying process which will generate such structure and drive such dynamics, and predict the future trend. Our study will contribute to the literate of the spatial structure of housing market. On the other hand, the empirical studies on Chinese housing market are still rare. This research will give a comprehensive analysis and the results will provide theoretical implications for policy makers.

3. Housing Market in Urban China

*Urban Area in China*

Before giving an introduction into the interurban housing market in mainland China, we will provide some background information about the administrative division system in China and the corresponding urban area. The hierarchy of the administrative division system of China consists of five different levels: central government; province; prefecture city; county; town. A prefecture city (municipality) in China usually consists of several sub-unit divisions, including city (municipal) districts under the prefecture (municipality) government, county-level cities or counties, which are all comprised by the high densely populated urban area and surrounding rural area with low population density. By a prefecture city’s housing market we mean the market associated with the urban area of the city districts. The interurban housing market refers to the integration of different cities’ housing markets.

*Housing Market in Urban China*

The housing supply in urban area of China is mainly provided by housing developers and some other organizations. For example, universities or state-owned companies sometimes develop dwellings and sell them to their employees. Before 1988, the housing supply in urban China was welfare-oriented, whereby the households could rent dwellings from the employers or governments with a really low price which was determined by a set of non-monetary criteria, such as job rank, job seniority and household size. After the nationwide reform of housing market which aimed to privatize the rental housing in 1988, numbers of workers became homeowners and the tenure transferred from rental to homeownership. This period from 1988 to 1998 was characterized by the mixture of welfare-oriented and market-oriented housing provision system (Huang, 2004). The most profound housing market reform was launched in 1998, and aimed to thoroughly terminate the policy of housing distribution and construct a diversified provision system with three distinctive types of housing in order to meet the housing demands of different incomes and affordability (Wang et al, 2012):

1. Commercial housing;
2. Government supported affordable housing (*jingji shiyong fang*); and
3. Government subsidized social rental housing (*lianzu fang*)

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4 In practice, we also have other titles for each level of government. We have “autonomous regions”, “municipalities” and “special administrative region” in province level; “autonomous prefecture” and “league” in prefecture city level; “county-level city” in county level.
The commercial housing market is completely dominated by market principles and supplies the majority of housing. In a typical housing project development cycle, housing developers first purchase the right to use residential land parcels from local governments through public bidding or auction, and then dwellings, like apartments in most western countries, are built and sold to the households. Government supported affordable housing, aiming to cater for low to middle-income households, enjoys privilege in obtaining the right of use of state-owned urban land and the developers’ profits are limited, so this type of housing can be sold at relatively low prices. But there are limits on the size and standards of housing units, and the transaction of these housing is strictly controlled and limited. Government subsidized social rental housing, which is designed for very low-income households, is still characterized as ‘welfare-oriented’. Though affordable housing in particular has been encouraged and supported by governments in recent years, the last two types of housing still remain relatively unimportant.

We always tend to use the data from the homogenous housing market, that is, it will be better to sort the data according to the type of dwellings. When registering in the housing management bureau, we generally sort dwellings into three types: house, townhouse and apartment. The former two types are usually regarded as large and luxury houses and the development of these houses is limited by government policies. The apartment, called ordinary commercial housing, is the most common dwelling type in China, which is strongly encouraged to develop, especially the higher density, smaller and low priced ordinary housing (total construction floor space to land plot ratio above 10, and individual unit smaller than 90m² of construction floor space).

In most western countries it is quite common for workers to live in one city and work in another. In China, on the other hand, most workers still live and work in the same city because of a number of reasons, including the traditional culture, the long distance between two cities, and the high traveling costs.

4. Research Questions and Hypotheses

The main purpose of this study is to investigate and explain the spatial structure of interurban house prices and their dynamic behaviour over time from the perspectives of economics and geography, and then to predict the future trend of such structure.

Static Analysis: Spatial Structure of Interurban House Prices

In the static analysis, we will answer the following questions. How can we properly describe the interurban house price structure? What does such structure look like in a hierarchical urban system? Do the spatial autocorrelation and spatial heterogeneity exist in the regional housing market? Two hypotheses are advanced according to the research questions.

**Hypothesis 1: There is a negative central-city-oriented house price gradient in a hierarchical urban system, which is more related to the spatial structure of regional economic activities.**

The basic idea under this hypothesis is that “location” plays an important role in the process of determining the cities’ average house prices and there will be a negative relationship between the house prices and the distance to the central city in a hierarchical urban system. However, the influence of location on interurban house prices structure may be caused through the evolution of regional economic

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Footnote: According to the land system in China, the State retains the ownership of urban land and the local governments are authorized to manage the use of those land. Land users can acquire the land-use right for a fixed period by bidding or auction, usually 70 years for residential uses, 50 years for industrial uses, and 40 years for commercial uses.
activities. Thus, the negative gradient will vanish after controlling the variables related to economic situation, such as income, mortgage. Further, we will investigate if the subcentral cities have significant effect on house prices gradient under the polynuclear context.

*Hypothesis 2: The spatial autocorrelation and spatial heterogeneity exist in the interurban housing market and (partly) determine the spatial pattern of house prices.*

Spatial association, containing spatial autocorrelation and spatial heterogeneity, has been widely verified in the intracity housing market. This convinces us that spatial association also plays an important role in forming the interurban house prices structure. Spatial autocorrelation, relating to “Tobler’s First Law of Geography”, indicates that the average house price of a city depends on not only the explanatory variables in that city, but also the house prices and influencing factors in the adjacent cities. Spatial heterogeneity refers to the systematic variation of geographic process and means that the same housing market conditions may yield different house prices in different cities. Here, we will measure the spatial association in the interurban housing market and examine whether we can acquire robust estimators after considering such spatial association.

**Dynamic Analysis: Evolution of Interurban House Prices**

The purpose of this section is to shed light on the dynamic behavior of interurban house prices. We will gradually ask the questions: Does the house price changes in one city relate to the changes in other cities? How does the interurban house price discrepancies change over time, become larger (divergence) or smaller (convergence)? Which process will drive such change and does location affect such process? The corresponding hypothesis is that:

*Hypothesis 3: The house price changes in one city is the causal reason for other cities’ house price behavior so that there is a diffusion (ripple effect) or polarization effect in the interurban housing market to drive the house price differences to be convergence or divergence, and such process is influenced by location.*

Most of the papers focusing on the regional house prices diffusion use the cointegration analysis and Engle-Granger causal test, both of which are not considering the spatial dimensions. In this study, we will compare the interurban house price gradient in different years through comparative analysis to see whether there is a convergence or divergence tendency. Then, we will turn to model the processes which drive such changes, i.e. that the diffusion or polarization effect. Under the belief that the house prices dependences among cities are related to both the temporal and spatial factors, we will use the spatial-temporal model, like the model built by holly *et al* (2010,2011), to test the diffusion effect or polarization effect in Chinese interurban housing market.

**Theoretical model: Explanation of the Spatial Structure and Dynamic Behavior**

A more general theoretical model will be developed to explain the relatively static spatial structure of house prices and their dynamic behavior. The emergence of New Economic Geography (Krugman, 1991; Fujita *et al.*, 1999) dedicated to explain how the economic activities aggregate to formulate a “core-periphery” structure and then evolve to a hierarchical urban system, that is it is a science to explain and simulate the distribution of economic activities among cities. This theory gives us a good insight into the spatial structure of interurban house prices. For the theoretical analysis, the questions are: how does the

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6 The first law of geography created by Waldo Tobler means “Everything is related to everything else, but near things are more related than distant things”. It is synonymous with the concept of spatial dependence that forms the foundation of spatial analysis.
negative central-city-oriented house price gradient formulate? When will the house price discrepancy become larger or smaller?

**Hypothesis 4:** The spatial structure of house prices and the dynamic evolution are the results of the interaction between “centrifugal” and “centripetal” forces which are generated by a few key factors of economic activities, such as price index, wage rate and transportation costs.

Fujita, Krugman & Mori (1999) have developed a model to simulate how the cities within an economy endogenously formulate the hierarchical urban system. We will extend this model to explain the interurban house price structure. The first step is to define the key parameters in the model, and then the model will be constructed based on the interaction of “centripetal” and “centrifugal” forces. We can derive the interurban house price structure through analyzing the equilibrium of the model. This model can also tell us the evolution of such structure, for example, under what condition the diffusion or polarization process will occur.

**Future evolution: Predict the Future Dynamics**

In this section, we want to predict the future dynamics of interurban house price structure based on the empirical results and theoretical model. The problem is that how can we improve the prediction accuracy.

**Hypothesis 5:** The prediction results of interurban house price structure based on the “centrifugal” and “centripetal” forces will be more accurate than those results only considering the historical house price movement.

In our theoretical model, once given the current situation of economic system, we can predict the changing direction of future interurban house price dynamics. We hope that we can get more accurate results by combining our theoretical model and prediction techniques. For example, if there is a newly-built high-speed railway in the hierarchical urban system, then we can accurately predict what the interurban house price structure will be in the future.

**5. Research Framework**

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Empirical Studies

Static Analysis:
Spatial Structure; Spatial Association

Dynamic Analysis:
Diffusion effect or polarization effect

Theoretical Studies

Theoretical model:
Centripetal forces and centrifugal forces

Empirical Studies

Future evolution:
Predict the future dynamics
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Figure 1. The Framework of Research
6. Research Approaches

There are two basic approaches to conduct the research: quantitative approach and qualitative approach. Quantitative approach uses the data in quantitative forms to study the research question by developing or employing mathematical models, statistical or computational techniques. Qualitative approach, on the other hand, is involved with subjective assessment of attitudes, options and behavior and generates results in non-quantitative forms, such as pictures and texts. In this study, we mainly use the quantitative approach.

**Multivariate Regression Model**

Multivariate regression model is a powerful instrument to investigate the causal relationship between dependent and independent variables and has been widely used in housing studies. It plays an important role in the development and application of the *hedonic price model* (Rosen, 1974) and *derived demand model* (Witte, 1975). In the static analysis, especially in exploring the static structure of interurban house prices, all the models will be established based on this technique.

**Spatial Statistics and Spatial econometrics**

Spatial statistics and spatial econometrics are developed to process the spatial association in spatial data which will undermine the effectiveness and consistency of OLS estimators. In intracity housing market, the spatial autocorrelation and spatial heterogeneity have been proved by number of studies. In this study, we will use the spatial techniques to investigate the spatial association in interurban housing market.

**Time Series Analysis**

Time series analysis will play an important role in the study of house price dynamics. A set of techniques, such as unit-root test, cointegration test, Engle-Granger test and so on, have been successfully used to investigate the convergence or divergence of interurban (regional) house prices in many countries. We will evaluate if these models can be applied in Chinese housing market, and then employ it to examine the house price behavior in China.

**Spatia-temporal model**

One task of this research is to model the spatial diffusion (or polarization) in Chinese interurban housing market and it will be more realistic to consider both the spatial and temporal dimensions. The newly developed spatio-temporal model will provide us with a comprehensive perspective of studying the house price dynamics.

**Forecasting models**

The evolution of interurban house prices is determined the evolution of economic activities, so it is not accurate to predict the future evolution without considering the other economic factors. Here we will introduce the state-space model which can solve a broad range of dynamical system problems into our study. State-space model can not only handle systems with multiple inputs and outputs, but also includes the internal state variables as well as the output variable. All these characteristics can help us take into account the socio-economic variables when predicting interurban house price evolution.

**Geographic Information System**
In the geographical study, one most difficult problem is how to efficiently manage and deal with geographical data. Fortunately, with the help of Geographic Information System (GIS), we can easily overcome this defect. Actually, the combination of GIS and quantitative model has been very popular in these years.

**Mathematical Model Analysis**

In the theoretical studies, we will describe the underlying process which generates the static structure of interurban house prices and drives the dynamic behavior by using mathematical concept and languages. The mathematical analysis can make our theory more elegant, logical and precise.

**7. Data Collection**

**Study Area**

There are spectacular disparities in economic development among different regions in China, thus the mainland China is generally divided into four regions: eastern, northeastern, central and western (see fig.2 in appendix). The eastern China, consisting of 3 municipalities directly under the central government (Beijing, Tianjin & Shanghai) and 7 provinces (Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong & Hainan), is the most developed region, in which there are the most active three growth poles: Yangtze River Delta Economic Zone, Pearl River Delta Economic Zone and Circum-Bohai Sea Economic Zone. The housing market in eastern China consequently has the highest marketization level and that is why we choose this region as our study area.

Yangtze River Delta (in the narrow sense) is comprised by Shanghai, 10 cities in southern of Jiangsu province, 9 cities in northern of Zhejiang province and 2 cities of Anhui province which belongs to central China(see fig.3 in appendix). Now, Shanghai, Jiangsu, Zhejiang and Anhui are considered as the Pan-Yangtze River Delta due to the mutual economic development. The traditional Pearl River Delta consists of 9 cities in Guangdong province, and Pan-Pearl River Delta presented in recent years refers to 11 regions(9+2), including Guangdong, Fujian and Hainan(Eastern China), Jiangxi and Hunan(Central China), Guanxi, Sichuan, Guizhou and Yunnan(Western China), Hong Kong and Macao(Special Administrative Region)(see fig.4 in appendix). The Circum-Bohai Sea Region is the hinterland surrounding Beijing and Tianjin, and other areas in Hebei, Liaoning and Shandong which surround the Bohai Sea (see fig.5 in appendix).

In this project, the study area is mainly confined by the Greater Yangtze River Delta (Shanghai, Jiangsu, Zhejiang and Anhui), Pan-pearl River Delta (Guangdong, Fujian, Hainan, Jiangxi and Hunan) and Circum-Bohai Sea Region (Beijing, Tianjin, Hebei, Shandong and Liaoning)\(^8\) (see fig.6 in appendix). Usually, we will take one of the three economic zones as our case study. It is also possible, of course, that we choose all these three regions and make a comparison between each other.

**Data Source**

**Statistical Yearbook**

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\(^7\) The demarcation of these four regions is determined by National Bureau of Statistics of China on 13/6/2011.

\(^8\) Considering that it is really difficult to collect data in Western China, the 4 western provinces in Pan-pearl River Delta are dropped out.
The statistical yearbook which is published by statistical bureau every year can provide comprehensive and systematic data covering the economic, technological and social development. There are two important indicators related to the housing market: “total sales of commercial housing” and “total sold floor space”. The average house prices can be derived by dividing the latter one from the former one. The common socio-economic indicators can also be acquired from the yearbook, such as population, income and mortgage.

Besides, National Bureau of Statistics of China monthly publishes the house price index “Sales Price Indices of Residential Building in 70 Large and Medium-sized Cities”. This can also provide us with some house prices information.

Real Estate Agencies

In terms of important cities, the big real estate agencies (such as E-house China, Centaline Property Agency and World-Union Property) usually publish the “Annual Report of Real Estate” every year, from which you can explore some useful data. There is another house price index—“House Price Indices of 100 Cities” produced by China Index Academy from June of 2010, which will be an important data source for our study.

Map Source

With regard to the map data, they can be downloaded from National Geomatic Center of China and some other open map resources, such as NASA socioeconomic data and application center (SEDAC).

Reference:


Appendix

Figure 2. Four Regions Demarcation of China

Figure 3. Yangtze River Delta

Figure 4. Pearl River Delta
Figure 5. Circum-Bohai Sea Region

Figure 6. Study Area