7 Conclusion

This book is a collection of five chapters dedicated to discovering and understanding the spatial dimension of house prices, especially the spatial aspects of the Chinese interurban housing market after the introduction of market forces. The free mobility of labour and capital between cities in a market-oriented economy in contemporary China following the economic reform launched in the late 1970s shapes the spatial distribution of economic activities across cities, which in turn has profound effects on nascent urban private housing markets. Chapters 2 through 5 seek to illustrate the spatial pattern of city house prices and their dynamics and reveal the role that location plays in the formation of such a spatial pattern. Chapter 6, unlike the previous chapters, focuses on an intra-urban housing market in the Netherlands and investigates the spatial variation in land prices caused by the spatial fixity in local amenities, as well as its influence on the house price index. The present chapter summarises the main findings of this book, discusses its strengths and weaknesses, draws a few policy implications and advances several ideas for future research.

§ 7.1 Main findings

§ 7.1.1 Explaining the spatial distribution of interurban house prices

Chapters 2 and 3 are concerned with the spatial distribution of interurban house prices in the urban system of the Pan-Yangtze River Delta (Pan-YRD) in Eastern China, which contains 1 municipality directly under the central government, 3 capital cities of provinces, and 38 prefecture cities. Each of those cities comprises a city proper (*shiqu*) made up of districts and several hinterland jurisdictions (counties or county-level cities)[1]. An urban housing market is defined as the market within the boundary of the city proper. The city-level house prices are calculated as the average per unit sale price of newly sold residential buildings without controlling for housing characteristics. The

1 The Chinese administrative division consists of five levels: province (municipality, autonomous region, special administrative region); prefecture city (prefecture, autonomous prefecture, league); county (city district, county-level city, autonomous county); town (sub-district); and village (neighbourhood).

questions asked about the spatial distribution of house prices are:

What is the spatial distribution of house prices across cities? How can that pattern be explained? What role does location play in shaping the interurban house price pattern?

To conduct the analysis, a panel data set covering the period 2006-2010 is compiled from various sources. The location of a city is captured by a set of distance measures, such as distance to central cities and distance to the nearest sub-central city. Several city-specific characteristics are also collected, such as winter temperature, pollution levels, healthcare services and quality of education system.

Chapter 2 treats the Pan-YRD urban system as a three-tier hierarchical system in which Shanghai, the municipality directly under the central government, is designated the central city of this system, with three provincial capitals, Nanjing, Hangzhou and Hefei, as the sub-central cities. This hierarchy division is in accordance with the city functions as outlined in the Outline of National Urban System Planning (2005-2020). The Pan-YRD urban hierarchy is assumed to follow the central place theory, which states that higher-tier cities have larger local markets and provide higher-order services and products for lower-tier cities. Thus, from the Rosen-Roback spatial general equilibrium framework (Rosen 1979; Roback 1982), it is inferred that the farther away a city is located from higher-tier cities, the lower the house price is in that city. Such penalties imposed by distance from higher-tier cities are attributed to two channels. First, firms in peripheral cities are less productive because they cannot benefit from the agglomeration spillovers of higher-tier cities; thus, the wages there are lower. Second, households in peripheral cities need the house price to be lower as a compensation for their difficulties in access to the unique consumer services that are only available in higher-tier cities. The theoretical framework presented in Chapter 2 further allows one to decompose the house price gradient and assess which component contributes more to the distance penalties.

Under the assumption that sub-central cities substitute for each other but complement the central city (i.e., a third-tier city is affected by both the central city and the nearest sub-central city), Chapter 2 identifies significant distance penalties of both the central city and sub-central cities if the distance-decay function forms are properly specified. It seems that the distance-decay function forms should be chosen in light of the influential radius of targeted higher-tier cities: the semi-log function is the best choice for the central city which has broad influences, while a log-log decay function is better for sub-central cities that only affect a relatively small radius of area. This is in line with the findings of Osland et al. (2007), who concluded that the exponential (semi-log) function performs best when the estimation is based on a large area, while the power (log-log) function performs best if the data is restricted to a small area.

The results in Chapter 2 also show that a warmer winter, less industrial smoke and dust emission, better healthcare condition and bordering an ocean tend to increase the house price of a city. What happens to the house price gradient after controlling for these city characteristics and amenities? The previously revealed distance penalties of higher-tier cities are still statistically significant, at least at the 10% significance level. However, the magnitude of distance penalties of sub-central cities decreases a lot.

To decompose the interurban house price gradient, the wage gradient is also estimated. The slopes of wage gradients towards higher-tier cities are flatter than those of house price gradients, which may be taken as preliminary evidence of the existence of amenity premiums for the higher-tier cities and their neighbours. Formal decomposition confirms the contribution of an amenity component in explaining the negative house price gradient, yet it only accounts for a very small share, less than 20% in general, implying that lower house prices in more peripheral cities are mainly due to the differences in urban productivities.

Chapter 3 also explains the spatial structure of interurban house prices in a general spatial equilibrium framework. Chapter 3 differs from Chapter 2 in its treatment of the Pan-YRD urban system as a city network in which each city interacts with all the other cities in a parallel manner, not necessarily the vertical interaction with higher-tier cities, with each city benefitting from such connectivity (Boix and Trullén 2007). As such, the productivity and amenity performance of a city relies not only on its own urban size but also on the size of neighbouring urban concentrations. The latter is referred to as city network externalities. The city network externalities on the productivity side lie in the 'market access' effect stressed by New Economic Geography – having a larger aggregate and undifferentiated market potential, which is measured by the population or income within a broader region, contributes to the productivity advantage of a city by saving on transportation costs (Fujita et al. 1999; Head and Mayer 2004). On the amenity side, the city network externalities are reflected in the so-called 'borrowing size' effect (Alonso 1973). On one hand, a city can maintain more higher-order amenities or functions than its own size supports through borrowing size from neighbouring cities. Meanwhile, cities that offer such support can share those surplus higher-order amenities through network accessibility, thus improving their performance (Meijers and Burger 2015). Note that the city network spillovers are not fully independent from the spillovers of higher-tier cities discussed in Chapter 2, as higher-tier cities usually have a large urban size.

The empirical part of Chapter 3 presents urban size in two ways: urban scale measured by land area and urban intensity measured by urban population density. Note that the variables on urban size, as well as on city-specific characteristics, are measured on the whole territory of the city, which can partly avoid the endogeneity between house prices (of the market of city proper) and urban size. The city network externalities in the Chinese interurban housing markets are then modelled by various models of spatial econometrics, in which the spatial weight matrix carries the interaction structure between cities. A simple correlation test shows that the house price of a city is mostly correlated to the urban population density of immediate neighbours, say, for example, the neighbouring cities within a radius of 160 km.

Among the several model specifications of spatial econometrics aiming for capturing different kinds of spillovers, the theoretical foundation of city network externalities reasonably justify the spatial lag of X model (SLX) (Gibbons and Overman 2012; Vega and Elhorst 2015). The estimation results of the SLX model strongly support the presence of network spillovers of both land area and urban population density; the amount of spillovers is even larger than the direct effect imposed by urban size. Such findings are quite robust, even after controlling for other forms of spillovers, such as those arising from yardstick competition, in a spatial Durbin error model (SDEM) (LeSage and Pace 2009). Two other types of spatial models are also estimated. The first is the spatial autoregressive model (SAR), which compresses all the forms of spillovers into the single parameter of the spatial lag of dependent variables. The other is the spatial Durbin model (SDM), which includes the spatial lags of both dependent and independent variables. The results of the SAR model suggest that the network spillovers of urban size are almost equivalent with the direct effect, while the SDM reports no significant network spillovers of urban size. However, the SAR and SDM suffer from the inherent identification problem that one cannot tell apart the network externalities from other forms of spillovers (Gibbons and Overman 2012). Thus, the results of the SLX and SDEM should be more reliable.

In summary, the house prices of the Pan-YRD urban system exhibit a 'core – periphery structure', with large urban cores having high house prices and small peripheral cities lower prices. Both the agglomeration spillovers from higher-tier cities from the urban hierarchy point of view and the spillovers from neighbouring cities in the city network paradigm contribute to shape such an agglomeration pattern.

The spatial regularity of house prices in China also applies to the interurban housing markets of western countries. Partridge et al. (2009) examined whether the urban hierarchy spillovers and the spillovers of neighbouring counties affect the spatial distribution of median housing rents of over 3000 U.S. counties in the year 2000. The results indicate that both types of spillovers play a role and that the influence of urban hierarchy spillovers tends to be larger. Since Chapters 2 and 3 of this research separately test the urban hierarchy externalities and city network externalities in the Chinese housing market, their relative importance cannot be directly distinguished.

Both China and America are large countries, so it is not surprising to find that geographical location affects the formation of house prices. In small countries, though, geographical location matters too. de Bruyne and van Hove (2013) investigated the role that location plays in shaping the house price pattern of 589 municipalities in Belgium, a small, densely populated country. They revealed that the distance and travel time to capitals (on both the national and provincial level) have a significant and substantial effect on municipality house prices. This finding stresses the importance of urban hierarchy spillovers, as the capitals are usually the most important economic centres and offer more job opportunities and a large range of services. However, de Bruyne and van Hove (2013) do not consider city network externalities.

§ 7.1.2 Discovering the spatial pattern and interrelationships of interurban house price dynamics

Chapters 4 and 5 consider the spatial patterns and interrelationships of interurban house price dynamics. The data source used in these two chapters is the "Price Indices of Newly Constructed Residential Buildings in 35/70 Large- and Medium-sized Cities", published monthly by the National Bureau of Statistics of China (NBSC). This price index system is compiled by a so-called "match" model that aims to control for quality changes (Wu et al. 2014)[2]. The questions addressed in these two chapters are:

Are house price dynamics across cities different from each other or are they homogeneous? What are the long-run and short-run relationships between them?

Chapter 4 answers the first question and focuses on the broad house price developments of cities across China. Specifically, Chapter 4 investigates the similarities between the house price appreciation trajectories between July 2005 and June 2016 of 34 major cities in China, including municipalities directly under the central government, provincial capitals and some vital economic centres. It explores the possibility of grouping these trajectories into a few homogeneous clusters. The literature usually measures (dis)similarity between house price development paths using Euclidean distance. Chapter 4, however, adopts a distribution-based dissimilarity measure, the Kullback-Leibler (*KL*) divergence (Kullback 1968), which has been applied in geological and environmental studies (Kakizawa et al. 1998; Bengtsson and Cavanaugh 2008). Under the assumption that the house price changes of a city follow an *AR(p)* process, the *KL* divergence measures the dissimilarities of two aspects: the difference between the predictions and the difference between the prediction errors. In this manner, the *KL* divergence calculated from historical values is also an estimate of the divergence of future dynamics so that one can make statistical inference. Euclidean distance does not hold this virtue. Chapter 4 calculates the *KL* divergence between any city pair based on *AR*(*3*) specification. When measuring the dissimilarity between cities, the *KL* divergence is consistent with Euclidean distance to

2 The "match" model used for the NBSC index is analogous to the repeat sales model. In each month, local statistical authorities collect the housing transaction information from different housing complexes. The houses within the same housing complex have similar structural and locational characteristics. Thus, for each housing complex, comparing the average transaction prices of different periods roughly produces the quality-adjusted house price index. The city-level index is the weighted average of all complex-level indexes.

some extent; the Pearson's correlation between them is 0.64.

With the dissimilarity matrix in hand, the hierarchical agglomerative clustering method, along with an *average-linkage* to calculate the dissimilarity between two clusters, is employed to perform the cluster analysis. It seems that the cluster results of *KL* divergence do not make much difference from the results of Euclidean distance. In general, the 34 house price growth trajectories can be broadly partitioned into two clusters. The first cluster includes mainly the Central, Western and Northeast Chinese cities with a relatively low average growth rate. The second cluster comprises the most important city centres in Eastern China with a flourishing housing market. The latter, however, has a higher degree of heterogeneity within the cluster and hence can be further divided into sub-clusters. For example, if four clusters are specified, Shenzhen and Shanghai stand out from the second cluster and form their own clusters.

Given the changing housing market condition in China, the temporal stability of cluster membership is also tested in Chapter 4. To do so, the whole sample period is divided into three intervals: July 2005-December 2010, January 2011-December 2013 and January 2014-June 2016. The inter-period comparison of cluster memberships shows that only in the most recent period after 2014 does the interurban housing market in China become highly fragmented. Before that, homogeneity characterises the house price growth of 34 cities, especially in the first period. It therefore comes as no surprise that the clustering pattern of the last period determines the clustering pattern based on the whole sample. Aside from the red-hot markets already identified across the entire timeframe, a new cluster, comprising mainly lower-tier centres in Eastern and Central China, also emerges in the period after 2014.

Obviously, the clustering pattern is highly associated with the cities' geography and economic position. Chapter 4 formally tests the usefulness of two widely used classification schemes in describing the housing market structure: the four-region geographical scheme (Eastern, Central, Western and Northeast) used by NBSC and the four-tier city system based on socio-economic conditions published by Jones Lang LaSalle. The four-region geographical scheme fails to explain any housing market structure, while a broad two-region geographical scheme (Eastern - Others) makes a certain amount of sense. The city-tier system is, of course, a superior solution to geographical demarcation. Therefore, regional housing market researchers should proceed with caution when aggregating the city-level housing markets based on geographical proximity.

The geography-based clustering pattern of Chinese housing markets is analogous to the pattern found in the housing markets of other countries. Using k-means clustering techniques, Abraham et al. (1994) partitioned 30 U.S. metropolitan housing markets into three homogeneous groups: a West Coast group, an East Coast group and a central U.S. group. However, as discussed previously, geography as a key determinant of housing market structure only makes sense at a very broad scale. For example, if more clusters are specified for the U.S. market, the West Coast group can be divided into two clusters, but not north and south. The same conclusion is also derived from UK commercial real estate markets. When performing the classification, both Hoesli et al. (1997) and Hamelink et al. (2000) found a strong property-type dimension and a weak broad geographical dimension, which identifies London as the core and the remaining cities as peripheral markets.

Compared to Chapter 4, which focuses on broad market classifications, Chapter 5 looks into detailed interrelationships between cities' house price developments and concentrates on a relatively small spatial scale: the housing markets of 10 vital cities in the Pan-Pearl River Delta (Pan-PRD). The Pan-PRD, located in South China, includes both developed Eastern regions and less developed Central and Western regions and is a regional cooperation framework established in 2004 that aims to remove trade barriers between regions and finally achieve the economic integration of this area. Specifically, Chapter 5 investigates leading-lag relationships, long-run convergence properties and diffusion patterns between markets based on the house price indexes from June 2005 to May 2015.

Leading-lag relationships, which mean that the historical house price information of leading markets can be used to predict the current house prices of lagging cities, are examined by the Toda-Yamamoto (TY) Granger causality test (Toda and Yamamoto 1995). Compared to the standard procedure that requires the tested series to be stationary, the TY procedure is more powerful and allows the series to be integrated or cointegrated of an arbitrary order. Given that the house price series in this analysis comprises both *I(0)* and *I(1)* process, the TY procedure is particularly preferable. The results suggest widely existing leading-lag relationships between housing markets. In contrast to Clapp et al. (1995) and Chen et al. (2011), who found house price interrelationships only among neighbouring markets, the leading-lag relationships in this research are beyond geographical proximity, emphasising the role that economic linkages play in shaping the spatial interaction of housing markets (Pollakowski and Ray 1997). Most importantly, the results tentatively reveal a unidirectional causal flow from the developed eastern-central areas to less-developed western China. This pattern is largely in line with the findings in the UK regional housing markets, where the house price changes are first observed in London or the southeast and then transmitted to the remaining areas (Alexander and Barrow 1994).

The concept of housing market convergence has several meanings. Some researchers think of it as long-run cointegration relationship, in that house price developments are tied together over the long-run (e.g.,MacDonald and Taylor 1993). In other words, there is a long-run equilibrium relationship between the house price developments of different markets and the markets do not move apart from each other. Others think of convergence as a tendency for a diminishing gap between different cities' house price levels over time (e.g., Kim and Rous 2012). Chapter 5 adopts the former understanding and examines the pairwise cointegration relationship between markets using the Engle-Granger (EG) two-step procedure. The fact that only a few city pairs are cointegrated indicates a generally diverged interurban housing market in Pan-PRD; the cities in eastern China in particular are found to be significantly different from the remaining markets. However, the housing markets of three cities in central China form a 'cointegration club'. Furthermore, Abbott and Vita (2013) test a more stringent concept of convergence in which the relative price ratio of two markets remains stable over the long-run. Conditional on the cointegration relationship, this concept necessitates two more conditions: (1) the cointegration vector being (1, -1) and (2) no deterministic trend in the cointegrating vector. The results suggest that the evidence for this type of convergence is even less. The finding of divergence in the urban Chinese housing market contradicts previous studies (e.g.,Wang et al. 2008; Li and Li 2011) that support the long-run cointegration of housing markets. The discrepancy might be because previous studies are confined to a relatively small and homogeneous area, while this study covers a larger and more heterogeneous region.

Chapter 5 then builds a spatial-temporal house price diffusion model to fully capture the house price development characteristics along both spatial and temporal dimensions. This model is a variant of the house price model proposed by Holly et al. (2011). In the model, the house price change of a city at time depends on three components: (1) the historical house price changes itself, (2) the historical house price changes of all other cities, (3) the long-run cointegration relationship with the other cities, if there is any. Note that other cities' influences over the long- and short-runs are compressed into a single variable through a spatial weight matrix, with nearby cities contributing more to the variable. The estimation of this model confirms previous findings and reveals a cross-city spillover effect from neighbouring cities in the short-run. Further, the generalised impulse response function of the model depicts a clear diffusion pattern that price shocks first spread to nearby cities, with those further away taking a longer time to respond.

While almost all of the studies support the short-run spillover effect between housing markets, there is no consensus about convergence over the long run. In UK regional housing markets, for instance, Alexander and Barrow (1994), Meen (1996) and Cook (2003), among others, present some positive evidence in favour of the housing markets cointegration or convergence, whereas Drake (1995) and Abbott and Vita (2013) cast doubt on that hypothesis. With regard to the U.S. metropolitan housing markets, Canarella et al. (2012) documented conflicting evidence about the long-run convergence. This research also provides mixed evidence for the Chinese interurban housing markets. Several reasons can be responsible for the contradictory findings, such as different interpretations of market convergence, the spatial scale for defining the housing markets and the time series used for analysis.

In summary, the house price developments in Chinese cities have not been homogeneous in the past decade. However, the market divergence seems to be a new phenomenon emerging after 2014, with the markets of a few developed eastern cities standing out. Indeed, an in-depth investigation into the Pan-PRD markets shows that the housing markets of eastern cities lead the market changes of the remaining cities; over the long run, the former markets clearly deviate away from the latter, although cross-city spillovers between cities can occur in the short-run. These features are coincident with the house price dynamic behaviour of many other countries.

§ 7.1.3 Exploring the effect of spatial factors on the construction of price index

Chapter 6 is concerned with the construction of the house price index for a Dutch city. Particular attention has been paid to the influence of the different treatment of location on the performance of house, land and structure price indexes. The related questions are:

How can the house price index be decomposed into a land price index and a structure price index? Does better treatment of location benefit the construction of a house price index?

To decompose the house prices, Chapter 6 follows the framework of 'builder's model', which states that the house value can be split into the value of the land and the value of the structure (Diewert et al. 2015). This common belief is at the root of house price decomposition models, such as the residual model and hedonic model (e.g., Davis and Heathcote 2007; Kuminoff and Pope 2013). Chapter 6 is conducted under the hedonic framework, which simultaneously estimates the shadow price of the structure and land. To do so, the price of a structure, which is producible, is assumed to be constant across the city, whereas the price of land, which is non-producible, is assumed to vary across the space. Three models are specified with different treatment of land prices. In the first model, land price remains constant across the city. The second model assumes that land price varies across postcode areas but is the same within each postcode area. In the third model, land price is assumed to be property-specific and thus can be different even within a postcode area. The first two models are easily estimated by ordinary least squares (OLS). The third, however, is not tractable by OLS; thus, a mixed geographically weighted regression (MGWR) model is introduced. Additionally, the MGWR model enables one to plot a continuous surface of land prices across the city.

The three models are estimated on the single-family housing market of a small Dutch city from 1998 to 2007. As expected, the second model, with land price varying across postcode areas, has more prediction power than the first model, which excludes the spatial variability of land prices; in turn, the more flexible MGWR model outperforms the relatively restricted second one. Thus, it might be not appropriate to assume the same land price within a postcode area.

The hedonic imputation Laspeyres, Paasche and Fisher indexes for house, land and structure prices are then computed based on the estimation results of the three aforementioned models. For the Laspeyres and Paasche index, the house price index is actually the weighted average of the land and structure price index. The Fisher index is the geometric mean of the Laspeyres and Paasche indexes. The results show that the Fisher house price indexes based on the different models are almost identical. However, not taking spatial variation of land prices into account indeed influences the Fisher land and structure price indexes; they are biased upward and downward, respectively. There is not much difference between the indexes based on MGWR and those based on the model considering a postcode-level variation of land prices, though. In short, a better treatment of location in the house price model does improve predicting power, but it does not greatly benefit the construction of house price index. This might be good news for statistical agencies, as a simple model can do a good job in terms of house price index construction.

According to the Fisher structure price index derived from the MGWR estimation, the structure prices have increased by more than 90% from 1998 to 2007. Meanwhile, the national construction cost index (CCI) published by Statistics Netherlands (CBS) only experienced a 30% increase, which challenges the structure price index produced in this chapter. The explanations for the significant disparity between these two indexes are twofold. First, construction cost can reflect the market price of structures accurately only if the market clears perfectly. However, in reality, this is hardly true, given that one cannot easily tear down the old structure and rebuild a new one. Thus, a construction cost index does not necessarily coincide with the structure price index derived from the hedonic framework. Second, the MGWR model in this chapter only includes very limited structural variables. If the omitted structural characteristics are improving constantly over time, the estimated structure price index is biased upwards.

Throughout the sample period, the value of land accounts for about one third of the total value of a house in the sample city, which is low compared to the share of 0.52 of national account during 2001-2007. Francke and van de Minne (2016) also estimated a land share between 40% and 50% for the Dutch city of 's-Hertogenbosch. The relatively low land share in this research might be attributed to the omitted variable bias; the omission of structural variables would bias the structure value upwards and hence the land value downwards. It is more likely, though, that the low share of land is because the city in this research lies in a less prosperous area with fewer amenities, which reduces the households' appreciation of land in that city. Davis and Palumbo (2008), using a residual approach, estimated the components of home values for 46 large U.S. metropolitan areas in the year 2004. For the Midwest metropolitan areas, which are less developed, they reported an average land share of 36%, which is very similar to the figure in this research.

§ 7.2 Reflections on the research

This dissertation mainly contributes to an understanding of spatial interactions of housing markets in China, where market forces were introduced in the late 1990s. Nevertheless, the chapters about the spatial distribution of house prices are relevant to any housing markets that operate under the market principle. Chapter 6 is slightly different and is based on the housing market of a Dutch city, but it is enlightening about the construction of land price index in China. Currently, the Hang Lung Centre for Real Estate of Tsinghua University publishes a quarterly quality-adjusted house price index for eight cities since 2006, as well as the land price index for 35 cities since 2004. The land price index is constructed using vacant land transactions. However, an increasing number of vacant land transactions are observed in the outer urban area, which will consequently cause systematic bias in the construction of a city-level land price index. The method proposed in Chapter 6 will serve as a good alternative to the estimation of land price index in Chinese housing markets.

However, as with other scientific studies, the chapters in this dissertation are subject to various flaws, and some findings need to be interpreted with caution. This section will discuss the weakness of this research and give some directions for future research. Potential policy implications of the findings are also discussed.

§ 7.2.1 Limitations

The data problem

Since the urban private housing market in China is still a young market, obtaining a high-quality data set of housing transactions is not easy. The housing authority registers housing transactions without much detailed information. Those authorities are also very cautious with their information; thus, public access to the data is extremely limited. The measure of house prices and their developments might therefore contain some "noise" that affects the reliability of the results.

Both Chapters 2 and 3 compare the house prices between different cities. An ideal house price measure in such analysis would be the price of a "standard" house in each city. However, such a quality-adjusted house price measure cannot be obtained without detailed housing characteristics. The only available information is the total value and areas (represented as square metres) of all the transacted properties of each city, which can allow one to calculate the average sale price. In this manner, the differences of average house prices between cities come from two sources: the disparities in city characteristics and the differences of housing market composition, among which only the former is of interest in this analysis. Failing to control for market composition differences in house price measure might influence the estimation results. In the Chinese context, however, this seems not to be a big problem. First, the standard measurement of house price per square metre is used, meaning that area, the most important housing characteristic, is controlled. Second, the most popular dwelling type in China is the multi-family apartment; there is only a very small market share for luxury apartments and houses. Third, average house prices are measured mainly based on newly residential buildings, which mitigates the influence of depreciation. Therefore, it is believed that house price disparities between cities are mainly caused by differences in city characteristics.

Even these crude housing market statistics need intensive negotiation with government agencies; moreover, for many of the cities, the data is not usable. The empirical foundations presented in Chapters 2 and 3 are thus constrained to the Pan-Yangtze River Delta in eastern China, and the housing markets of only 42 prefecture-level cities (municipalities) are used. This small sample might undermine the reliability of the estimation results, so the findings might not be generalised to the whole Chinese housing markets. Therefore, readers should interpret the results with caution.

Chapters 4 and 5, which investigate the spatial pattern of house price dynamics, utilise the house price indexes published monthly by the National Bureau of Statistics of China (NBSC). The NBSC indexes are compiled by a so-called matching approach so that the quality changes can be somewhat controlled for (Wu et al. 2014). However, the NBSC index is widely criticised for its underestimation of house price growth (e.g.,Wu and Deng 2015; Fang et al. 2016). If the house price developments of each city are systematically biased downwards to the same degree, it will not significantly affect the clustering pattern and the spatial interrelation pattern. It may, however, be possible that the bias of a higher house price growth series is much more severe than that of lower house price growth series, although there is no solid evidence supporting this idea. As such, the findings in Chapter 4 and 5 might be influenced to some extent. However, the NBSC indexes are the only accessible indexes that cover all the cities in the study for a relatively long period.

Chapter 5 examines the long-run relative relationships between housing markets. How long of a time series is enough for this long-term analysis? For the UK studies, MacDonald and Taylor (1993) utilise a time series of 19 years, Cook (2003) uses 29 years, and Holly et al. (2011) use 34 years. The length of time series for the U.S. studies is 36 years for Yunus and Swanson (2013) and 30 years for Gupta and Miller (2012). Consequently, the 10-year time series used in Chapter 5 seems to be rather limited for a long-term behaviour analysis, especially given that the transitory condition of the housing markets in that period. Thus, it is no surprise to find no evidence of long-run convergence or cointegration. In addition, it seems that all the time series analyses of

Asian housing markets suffer from the same data problem. For example, both of the studies on the Malaysian and Taiwanese housing markets use a time series of approximately 10 years (Chen et al. 2011; Lean and Smyth 2013).

Methodological weakness

Aside from the data problem, methodological issues also limit a deeper understanding of the spatial dimension. In Chapter 2, the results are obtained by running an OLS regression on a pooled data set. Although a few city-specific characteristics are included, these variables might not be sufficient to fully control for the city heterogeneities. A panel data specification with fixed or random effects might be a better choice. Additionally, the empirical model fails to consider the spatial dependence between house prices, even though it has been proven that spatial interdependence is prevailing among the markets (e.g.,Fingleton 2008). The spatial interdependence would probably lead to inefficient estimators and thus affect the statistical inference. Chapter 3 comprehensively investigates the spatial dependence of interurban house prices using spatial econometrics, paying particular attention to the spatial spillovers caused by city network externalities. To do so, urban size, measured by land area and urban population density, is included in the explanatory variables. However, according to the spatial general equilibrium framework, the urban population and house prices of a city are jointly determined, indicating the potential endogeneity of the empirical model. In Chapter 3, the endogeneity problem is partially mitigated by measuring house prices and urban sizes at different spatial scales. More sophisticated methods, such as instrumental variable approach, might better solve this problem.

Chapter 4 assigns the housing markets of 34 cities to a few homogeneous groups according to house price growth paths using a hierarchical cluster method. While the hierarchical cluster method produces a dendrogram that depicts how the cities are grouped into clusters step by step, it is difficult to determine the appropriate cut point. Chapter 4 uses an “elbow” approach to choose the number of clusters. However, the choice is still somewhat arbitrary and should be based on more objective criteria. Another weak point of the clustering method is that the analysis is solely based on the time-series behaviour of house price changes but pays no attention to the underlying market structure. In this sense, two totally different housing markets, one driven by demand factors and the other driven by supply factors, can be fused simply because they have similar growth rates.

Chapter 5 examines the spatial interrelationships between housing markets. The Granger causality test is employed to explore whether house price changes in the leading markets cause similar shifts in the lagging markets. In performing this test, however, one cannot exclude the possibility that such correlation is caused by common shocks, meaning that the leading-lag relationships are just the results of different responses of different markets to common factors and are not due to causal relationships. Chapter 5 then tests whether the relative house price ratio between markets remains stable in the long run under the co-integration framework. The results refuse the long-run cointegration or convergence relationships, indicating that the house price differences between markets are either narrowed or widened. However, the cointegration method delivers no answer on the tendency of relative house price ratios over time.

In Chapter 6, the hedonic framework is used to decompose the house price into land price and structure price. As criticised by many other researchers, however, this approach is prone to omitted variable bias. Consumers who buy an expensive land plot in a good neighbourhood also tend to spend more on structural materials. If these superior structural characteristics cannot be appropriately controlled for, their effect on house prices will be confounded with the value of land. Chapter 6 is not exceptional, either. To ascertain an accurate estimate of land and structure values, one has to include as many housing characteristics as possible.

§ 7.2.2 Future directions

Despite the data problem and methodological flaws, this research is still a good attempt to understand the spatial dimension of Chinese housing markets. However, much work needs to be done to develop a full picture about the spatial behaviour of housing markets.

A simple extension of this research is to test whether the agglomeration spillovers, of both higher-tier cities and neighbouring urban concentrations, shape the house price pattern across all of China and which spillovers play a more important role. In the U.S. context, Partridge et al. (2009) found that effects generated by urban hierarchy are generally larger than those of undifferentiated market potential. With regard to the Chinese housing markets, nothing has been determined about the relative importance of these two spillovers.

Given the importance of location in determining house prices, the question remains as to whether location also contributes to house price developments. Together with agglomeration spillovers, one can test whether the large cities and their neighbours experience more house price growth than remote, small cities. On the other hand, in agglomeration economies, house prices serve as an important channel of "centrifugal" forces that drive the decentralisation of population and economic activities to peripheral areas. Thus, it is interesting to learn how the sky-high house prices in China's super cities like Beijing, Shanghai and Shenzhen affect households' location decisions, especially the relocation decisions of young people.

Owing to the spatial fixity of houses, the housing market is no doubt a local market and is largely influenced by city-specific characteristics. In this sense, the effect of natural amenities, such as climate and environmental conditions, on house prices desires more attention. Given the rapid growth of household wealth, households are more willing to pay for the quality of life in the city (Zheng et al. 2009). Indeed, as indicated in Figure 1 of the Introduction, cities in northeast China, which have very cold winters, are among the cities with the slowest house price growth during the last decade. It is also reported that an increasing number of households from northeast China buys their second home in the southern islands of China and spends their winters there, where it is warmer. Thus, one can speculate that the flourishing housing markets of coastal cities in eastern China might be attributed to their friendly climate. Meanwhile, the productivity advantages in eastern areas are also greater. It is still unclear which component is more important in driving the growth of house prices.

House price developments are driven not only by local factors but also by national factors, such as monetary policy and macro business cycles. Chapter 4 tentatively suggests that, before 2014, house price growth in China might have been driven by a national component, but since then, regional and local components have played a larger role. Future research can formalise this idea and use factor models to disentangle the relative importance of national and local components in house price dynamics.

Long-term stable house price ratio between markets originates from the empirical observation of the UK housing market that house price disparities between North and South widened in the 1980s but tended to come back together in the 1990s (Giussani and Hadjimatheou 1991). Since then, substantial effort has been made to test such long-run equilibrium relationship empirically by using various time-series techniques on the UK housing markets and those around the world. However, a theoretical foundation is still lacking. A possible theory that can investigate the relative house price behaviour between markets is the New Economic Geography (NEG) model with a housing sector (Helpman 1998; Fujita et al. 1999). The NEG theory allows for the existence of multiple equilibria, with each having its own attractive basin in terms of determinant conditions, such as population share. If the shocks to determinant conditions are not beyond the threshold of the attractive basin, the relative house price relationship will return to the original equilibrium, namely the stable long-run equilibrium relationship that has been widely discussed. Otherwise, the original equilibrium will be broken, and a new equilibrium will be formed. In that case, the relationship of relative house prices between markets is not stable, but shows some tendency to change over time until a new equilibrium is established. The NEG framework seems to explain the evolution of Chinese city-level housing markets well. During the past decade, one can observe continuous migration from the less developed western area to the developed eastern area, which has possibly driven the transition from an old equilibrium to a new one. In this transition process, it is no surprise to find divergence of relative house price ratios between markets. However, there is still a long way to go before such a sophisticated model is built; moreover, a lot of empirical work needs to be done regarding the transitional path of relative house price relationships.

§ 7.2.3 Policy implications

The findings of this research have policy implications not only for housing policies but also regional development policies. Given the high home ownership rate in China and households' strong desire to own a home, there are significant public concerns about house prices and their dynamics. Government intervention is a standard tool to stabilise the housing markets and ensure affordability. After the establishment of private housing markets in 1998, central government agencies such as the State Council and the People's Bank of China played a major role in creating housing-related policies. These centralised policies applied to all local housing markets with differing conditions and worked as expected because, as shown in Chapter 4, local house price growth trajectories were very homogenous across the country at that time. However, the market divergence since 2010 have been increasingly prominent, with some developed cities standing out and developing along their own paths. Such market divergence in the recent period indicates that the centralised national policy will be helpless and calls for the government to resort to some regional- or local-based policies. For example, according to the results of Chapter 4, for most of the cities in Central and Western China, a unified policy framework will be enough. But for some import economic centres in Eastern China, the local governments have to tailor local policies based on their own market conditions. The need for diversified housing policies has been recognised by the policy makers in the practice. For example, in the recent intervention in housing markets after 2015, the central authorities did not introduce any monetary policies as they had done before; the policy instruments mainly came from local governments. However, when tailoring the local-based policies, one should also consider the interaction between local markets given the fact that the price changes in some markets can spread out to other lagged markets.

For almost all of the cities that have been exposed to tremendous house price growth, policy instruments have primarily sought to constrain demand. For example, as a response to the recent house price boom, many local governments have increased down payment requirements for mortgages, with an even higher requirement set for a second home. They also prohibit potential home-buyers who have worked in the city less than a period from gaining access to the market. In doing so, the housing demand is indeed suppressed in the short run by squeezing out marginal home-buyers from the market, and house price growth will temporarily slow down. However, from the spatial equilibrium point of view, the long-run housing demand will not diminish as long as these cities retain their productivity and amenity advantages arising from agglomeration economies; once the demand restrictions are loosened to some extent, the house prices will bounce back at an unexpected magnitude. In this regard, the local governments have to reassess their policy tools and focus on more about the supply side. For example, local governments, as the owners of urban land, can increase the supply of residential land. Of course, the housing supply is not unlimited but relies on topographical and planning restrictions. An alternative approach is to encourage the efficient use of the current housing stock. According to the China Household Financial Survey, the average housing vacancy rate of 6 large cities in 2013 stands at 22.38%[3]. Letting these vacant homes accommodate families can have a great impact on the market. Policy instruments, such as property taxes, should be introduced to motivate multi-home owners to place their extra dwellings on the market.

From a national perspective, however, the high house prices in developed cities are not entirely negative. Housing costs serve as an important spatial adjustment mechanism in balancing the distribution of economic activities across regions. High house prices in big cities force workers to relocate to small cities, which is good for the development of peripheral regions. The central government should play a role in this adjustment process. For example, a national or regional cooperation framework is necessary to guide the relocation of physical and human capitals to the peripheries. Higher-level planning can also help small and rural settlements functionally integrate with large urban concentrations. Furthermore, policymakers in China should consider issues such as whether to develop smaller cities linked by a fast transit network or to continue to build mega-cities.

Local governments of peripheral regions also need to rethink their policies of stimulating local economies. For a long time, small cities in peripheral areas have relied on the assumption that their economies can thrive through mass investment in construction. Thus, they build multilane roads in the city and new residential buildings in the urban fringe. To some extent, mass construction works by introducing job opportunities. It turns out, however, that the wide roads of many cities are utilised by only a few cars and that the newly developed areas become ghost neighbourhoods. People escape from peripheral cities because of both the productivity and amenity disadvantages. Would it not be better for these governments to invest more in providing high-quality public goods and services, such as education and healthcare services?

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3 The six cities are Beijing, Shanghai, Tianjin, Chongqing, Chengdu and Wuhan.

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