

# Responses of Housing Price under Different Directions of Population Change: Evidence from China's Rust Belt

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**Abstract:** Population growth has been widely regarded as an important driver of surging housing prices of urban China, while it is unclear as yet whether population shrinkage has an impact on housing prices that is symmetrical with that of population growth. This study, taking 35 sample cities in Northeast China, the typical rust belt with intensifying population shrinkage, as examples, provides an empirical assessment of the roles of population growth and shrinkage in changing housing prices by analyzing panel data, as well as a variety of other factors in related to housing price, during the period of 1999–2018. Findings indicate that although gap in housing prices was widening between population growing cities and population shrinking cities, the past two decades witnessed an obvious rise in housing prices of those sample cities to varying degree. Changes in population size did not have a statistically significant impact on housing prices volatility of sample cities, because population reduction did not lead to a decline in housing demand correspondingly and an increasing housing demand aroused by population growth was usually followed by a quicker and larger housing supply. The rising housing prices in sample cities was mainly driven by factors like changes in land cost, investment in real estate, GDP per capita and household number. However, this does not mean that the impact of population shrinkage on housing prices could be ignored. As population shrinkage intensifies, avoiding the rapid decline of house prices should be the focus of real estate regulation in some population shrinking cities of Northeast China. Our findings contribute a new form of asymmetric responses of housing price to population growth and shrinkage, and offer policy implications for real estate regulation of population shrinking cities in China's rust belt.

**Keywords:** asymmetrical impacts; population change; housing price; rust belt; Northeast China

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## 1 Introduction

While the global urban population still keeps growing, population shrinkage has become a new normality of many cities in some developed countries (Turok and Mykhnenko, 2007; Beauregard, 2009; Richardson and Nam, 2014). The parallel patterns of population growth and shrinkage are a consequence of changing urban con-

ditions and have important influences on many aspects of urban development. Similar to the asymmetrical character of many relationship in social sciences (Lieberson, 1985), extensive studies on the impacts of population shrinkage indicate that many aspects of population shrinking cities do not 'scale down' in the same way that they 'scale up' (Galster, 2019). One typical example is the asymmetric impact of population gains and

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losses on housing prices examined by Glaeser and Gyourko (2005). They found that housing price decline in US cities associated with population losses is estimated to be larger than the rise in price associated with population increases. Subsequently, the asymmetrical impact of population change on housing price was reconfirmed by other empirical studies conducted in US (Feng et al., 2018; McDonald, 2020) and other developed countries like Japan (Hashimoto et al., 2020). These studies indicate that there is something distinctive about population shrinkage, and that it is not a simple reverse of population growth (Glaeser and Gyourko, 2005; Galster, 2019).

Rapid urbanization in China since 1990s has gone hand in hand with surging housing price in China's cities, especially after the establishment of market-oriented urban housing system in 1998. According to official data from the National Bureau of Statistics of China (NBSC), the average selling prices of commodity housing rose from 2063 yuan 9 (RMB)/m<sup>2</sup> in 1998 to 9310 yuan/m<sup>2</sup> in 2019 (National Bureau of Statistics, 2000–2020), despite many regulations and control policies, such as purchase restrictions, limit loans and price limits, have been adopted to curb the soaring housing prices (Li and Xu, 2016). Urban population growth as a factor directly influencing housing demand, has also been widely considered as a major factor driving up housing price in China (Bian and Gete, 2015). Thus, controlling or even reducing the population scale was reasonably adopted by China's large cities, such as Beijing, Shanghai and Guangzhou, to cool the housing market and stabilize housing prices. However, the effect of this policy is very limited, especially the contribution of population shocks to housing price is nearly negligible (Ding, 2019). It seems like that the asymmetric response of housing price to population change might not exist in China or take different forms. However, up to date, it is still a hypothesis that needs to be validated with empirical studies.

With the increasing population competition among Chinese cities, population growth of some cities inevitably leads to population shrinkage of others, which forms a divergence in the population trajectory of China's cities (Yang and Dunford, 2018; Long and Gao, 2019; Li et al., 2020). However, as China is still in the process of rapid urbanization, the incidence and severity of population shrinkage in China's cities are gener-

ally lower than those western counterparts like America (Beauregard, 2009) and Europe (Turok and Mykhnenko, 2007). Across China's four planning macroregions, population shrinkage is most prevalent in cities of Northeast China, the typical rust belt of China (Li and Mykhnenko, 2018). Different from the planned population reduction in China's metropolises mentioned above, the population shrinkage of cities in Northeast China is led by the industrial recession and transition, low fertility rate, agglomeration effects of central cities, *etc.* (Ma et al., 2020, 2021; Yan et al., 2021), and has had some Western-like negative consequences, including brain drain, population aging and weakened economic competitiveness (You et al., 2021). Meanwhile, unlike the widespread depression of the real estate market in Western cities with shrinking population, the Northeast cities with population shrinkage since 1990s coincides with the booming development of China's real estate market. The characteristics and particular context of population change in Northeast China provide an ideal sample to test our hypothesis. Through empirical analysis of cities in Northeast China, the study explores the responses of housing prices to population change under a very different housing market situation. The following questions are addressed: 1) How does housing price respond under different directions of population change in cities of Northeast China? 2) Is there an asymmetrical impact of population change on house prices in cities of Northeast China? and 3) why?

## 2 Literature Review

The notion about the asymmetric impact of population gains and losses on housing prices was originally based on an empirical study of US cities. By using the decadal data of 321 US cities from the 1970s until the 1990s, Glaeser and Gyourko (2005) regressed the percentage growth in housing prices on a transformation of its population growth and found that the sensitivity of house prices changes to population change is asymmetric. Among cities that lost population, the elasticity of housing price change with respect to population change was 1.8. But among cities that are gaining population, the elasticity of house price change with respect to population change was only 0.23. They attributed it to the kinked supply of houses, namely, houses can be constructed rather quickly in cities with a growing popula-

tion, but disappear slowly in cities with a shrinking population. However, this study focused on the dynamics between just the population changes and housing price, other factors impacting housing price were not taken into consideration in their model. In fact, the dynamics of housing price is a result of multiple determinants, the effects of population change on housing price might be offset by other factors under real market conditions. Just like the case of Leipzig, the increasing number of single households leads to a growing total housing demand in the central parts of the city despite population decline (Lauf et al., 2012).

The study of Glaeser and Gyourko (2005) stimulates many scholars to test the robustness of the relationship between population changes and their asymmetrical impact on housing prices. Most of these studies support that housing price respond asymmetrically to positive and negative population change, but are different in magnitude from Glaeser and Gyourko (2005). For example, by adding other control variables like the GDP per capita, housing supply, mortgage rates, *etc.*, scholars investigated population changes and their asymmetrical impact on housing prices of US cities during a different market situation, and found a 0.896 and 1.515 elasticity of price change with respect to population gains and to population losses (Feng et al., 2018). Based on the similar method, empirical studies in Japan also indicate that housing prices fall faster with a declining population than it rises with an increasing population from 1975 to 2015—1% increase in population growth is associated with a 3.4 percentage points increase in house prices, but house price falls 5.1 percentage points with respect to 1% population decline (Hashimoto et al., 2020). However, a few studies stand on an opposite position. A study on single-family house prices in 98 German metropolitan areas showed that growth in population numbers had no significant effect on price, whereas declining population significantly lowered prices (Wolfgang and Lisa, 2008). Another example is the study on the house price change and its determinants of Amsterdam during the last 200 years, they found that population change was not a constant determinant of house price dynamics. It started to affect house prices of Amsterdam after the Second World War (Droes and van de Minne, 2016). These studies imply that the impacts of population gains and losses on housing prices are more diversified than predicated by Glaeser and Gyourko (2005).

ourko (2005).

The commercialization of China's urban housing started relatively late, but the booming development of the real estate market and the rapid growth of housing prices have attracted considerable attention from the nation's policy makers and scholars. An increasing number of studies have been undertaken to probe the dynamics of housing price in China. From the perspectives of supply and demand, diverse factors impacting urban housing price have been identified, including population, income, construction costs, land price, economic development, real estate investment, household number, *etc.* (Bian and Gete, 2015; Wang et al., 2017a; Sun, 2020). In regard to the effects of population change, most studies demonstrate that population growth plays an important role in housing price dynamics of urban China. On the national scale, Wang et al. (2017b) found that for every 1% increase in urbanization, house prices would rise by 0.343% from 2005 to 2010 based on an empirical study on 287 prefecture-level cities in China. Similar results were arrived at by other studies based on different samples. Taking 35 large Chinese cities as example, Ding (2019) showed that the high population growth rate contributes to approximately 1/10 of the upward trend in real housing prices from 1999 to 2012. Empirical study on the impact of the migrant population on housing prices of Beijing found that the average housing prices increased by 9158 yuan/m<sup>2</sup> with a migrant population growth of 1% from 2000 to 2016 (Wang and Xu, 2017). Meanwhile, studies on provincial level showed that the impact of population growth on housing prices was not homogeneous—eastern provinces have a stronger impact, while other provinces have a weaker or no obvious impact (Lin et al., 2018; Wang and Chen, 2018). To date, however, little attention has been paid to house price changes in China's depopulated cities, although much effort has been devoted to the identification, explanation, consequences and coping strategies of population shrinkage in China's cities (Wu et al., 2015; Long and Wu, 2016; Yang and Dunford, 2018; Liu et al., 2020).

Previous studies have enriched our understanding of housing price responses under different directions of population change, whereas few analyses were based on cities in developing countries. In addition, the time-varying characteristics of this non-linear relationship have not been sufficiently discussed despite studies that

have found that the effects of population change on house price dynamics are not constant. Considering the differences between developing countries and developed countries in terms of housing markets and urbanization stages, it would be interesting to see a similar analysis for cases in developing countries. Taking cities in Northeast China as example, the study diversifies the existing literature by examining the extent to which the asymmetrical response discussed in previous studies are generalizable in a booming housing market and how it changes across temporal periods.

### 3 Materials and Methods

#### 3.1 Study area

Northeast China including Liaoning, Jilin and Heilongjiang provinces, is an important geographical region in China (Fig. 1). Administratively, the region is further divided into 30 prefecture-level cities, 4 sub-provincial cities and 2 Prefectures. It covers an area of 787 300 km<sup>2</sup> and is home to 108.7 million people in 2019. Northeast China is often referred to as the Rust Belt of China due to the recession of its once-powerful industrial sector (Wang et al., 2014). Over the last two decades, urbanization of the region has slowed down significantly, with the urbanization rate higher than the national average by 19.2 percentage in 1999 and only 2.6 percent higher in 2019. Moreover, just like many Rust Belts in the world, population shrinkage is emerging and

intensifying in cities of Northeast China, affecting 52 county-level cities in the 1990s and 94 county-level cities in the 2000s (Li and Mykhnenko, 2018). Nevertheless, the housing market of the region does not seem to have been severely affected as a whole. Since the ending of the allocation of welfare housing in 1998, the average price of commodity house in the region has increased from 1641.7 yuan/m<sup>2</sup> to 7861.7 yuan/m<sup>2</sup> in 2019.

#### 3.2 Data and methods

The study investigates the housing price responses under different directions of population change in Northeast China from 1999 to 2018. The 35 cities at the prefecture-level and above are used as analysis units, as it is the smallest unit for which long time-series data can be obtained. To be consistent with previous studies (Glaeser and Gyourko, 2005), the research period is split into decade-long intervals to reflect population change and housing price responses. We calculate the house price and the population size for each unit over the sample period as follows:

$$HP_{i,t} = SH_{i,t} / FH_{i,t} \quad (1)$$

$$Pop_{i,t} = TPop_{i,t} - RPop_{i,t} \quad (2)$$

where  $HP_{i,t}$  is the housing price of city  $i$  in year  $t$ ,  $SH_{i,t}$  is the sales of commercial house of city  $i$  in year  $t$ , the data are deflated by using Consumer Price Index (CPI),  $FH_{i,t}$  is the floor space of sold commercial house of city

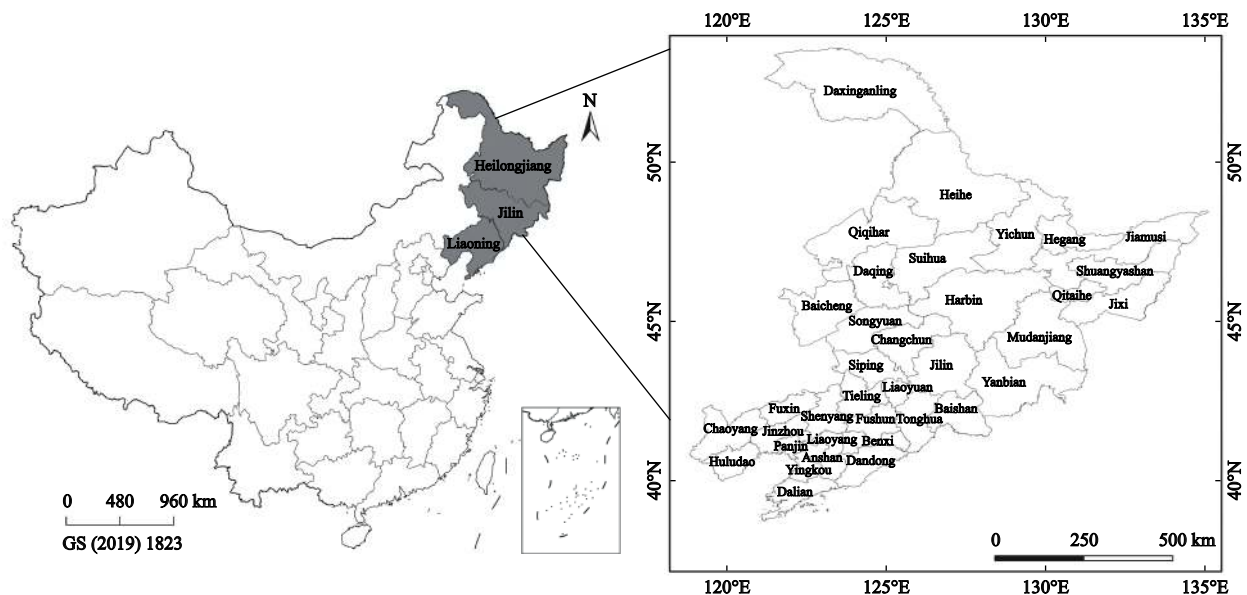


Fig. 1 Location of study area

$i$  in year  $t$ .  $Pop_{i,t}$  is the population of city  $i$  in year  $t$ ,  $TPop_{i,t}$  is the total population of city  $i$  in year  $t$ ,  $RPop_{i,t}$  is the rural population of city  $i$  in year  $t$ .

We use the modeling approach advocated by York (2012) and McGee and York (2018) to analyze whether the effects of population loss and population gain on housing prices are symmetrical or not. Empirical evidence of previous studies reminds us that the relevant factors should be included in the model as well, so we also add the following additional factors affecting the supply and demand of commercial housing. From the perspective of housing supply, the following factors were selected: land price (*Landcost*), investment in real estate (*Investment*), completed area of commercial housing (*Completed*) and new added area of construction land (*Construction*). From the perspective of housing demand, GDP per capita (*GDPper*), disposable income per capita (*Income*) and the number of urban households (*Household*) were selected as additional exploratory factors. In addition, we add time dummy variables for each year to account for general period effects.

The logic of the modeling approach is to control for other factors that are known to influence housing prices volatility and assess the effect of population loss and population gain separately in one model. To accomplish this, we created separate independent variables for population loss (*Poploss*) and population gain (*Popgain*), where the increase variable is coded as 0 if there are decreases and the decrease variable is coded as 0 if there are increases (York, 2012; McGee and York, 2018). Specifically, the model we estimate is as follows:

$$HR_{i,t} = \beta_0 + \beta_1 PopgainR_{i,t} + \beta_2 PoplossR_{i,t} + \beta_3 LandcostR_{i,t} + \beta_4 InvestmentR_{i,t} + \beta_5 CompletedR_{i,t} + \beta_6 ConstructionR_{i,t} + \beta_7 GDPperR_{i,t} + \beta_8 HouseholdR_{i,t} + \beta_9 IncomeR_{i,t} + \lambda_t + u_i + \varepsilon_{i,t} \quad (3)$$

where  $HR_{i,t}$  is the housing price change rate of city  $i$  in year  $t$ ,  $\beta_0$  is the constant,  $\beta_1$ – $\beta_9$  are the coefficients of the independent variables,  $R_{i,t}$  is the change rate of independent variable of city  $i$  in year  $t$ ,  $\lambda_t$  is the period effect in the year  $t$ ,  $u_i$  is the unknown fixed effect for each city and the  $\varepsilon_{i,t}$  is the error term.

Other variables included in the model are the annual change rate of the variables under consideration (Table 1), to make it an elasticity model. The raw data of the study was derived from the national, provincial and municipal statistical yearbooks, and the statistical bulletin of sample cities (Table 2). Due to the lack of data in Daxinganling Region, the study conducted an empirical analysis of 35 sample cities with complete data.

## 4 Results

### 4.1 Population change and housing price responses

During the study period, the demographic trend of 35 cities in Northeast China has undergone significant changes. It can be seen that the distribution curve of population change shifted leftward over time (Fig. 2), which suggests that a large number of cities that exhibited population growth from 1999 to 2008 experienced population decline from 2009 to 2018. During the period from 1999 to 2008, 28 cities experienced population growth with an average population growth of around 12

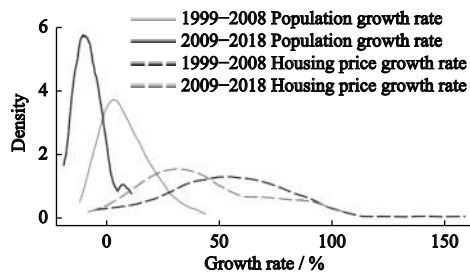
**Table 1** Variables and their abbreviations

Abbreviations	Variables
$PoplossR_{i,t}$	Population loss rate of city $i$ in year $t$
$PopgainR_{i,t}$	Population gain rate of city $i$ in year $t$
$*LandcostR_{i,t}$	Landcost change rate of city $i$ in year $t$
$*InvestmentR_{i,t}$	Change rate of real estate investment of city $i$ in year $t$
$CompletedR_{i,t}$	Change rate of completed area of commercial housing of city $i$ in year $t$
$ConstructionR_{i,t}$	Change rate of new added construction land area of city $i$ in year $t$
$*GDPperR_{i,t}$	Change rate of GDP per capita of city $i$ in year $t$
$HouseholdR_{i,t}$	Change rate of urban households of city $i$ in year $t$
$*IncomeR_{i,t}$	Change rate of disposable income per capita of city $i$ in year $t$

Notes: Variables with "\*" are calculated at comparable price.  $PoplossR_{i,t}$  is equal to population change rate when it is negative, otherwise is 0;  $PopgainR_{i,t}$  is equal to population change rate when it is positive, otherwise is 0

**Table 2** Data source and description

Data	Source	Applications	Details
Sales of commercial house, the floor space of sold commercial house	Bureau of Statistics of Heilongjiang, 1999–2019; Bureau of Statistics of Jilin, 1999–2019; Bureau of Statistics of Liaoning, 1999–2019; National Bureau of Statistics of China, 1999–2019, 2000–2015; Leading Group Office of National Economic Census of Heilongjiang Provincial People’s Government, 2006, 2010, 2016, 2021	Calculation of commercial housing price change	Statistical data of 35 sample cities from 1998 to 2018, all data are collected and calculated based on the same administrative boundaries
Total population, rural population, land transfer amount, land transfer area, real estate investment, completed area of commercial housing, new added area of construction land, GDP, total households, rural households, disposable income per capita	Bureau of Statistics of Heilongjiang, 1999–2019; Bureau of Statistics of Jilin, 1999–2019; Bureau of Statistics of Liaoning, 1999–2019; Editorial Department of China Land and Resources Yearbook, 2000–2013; Ministry of Land and Resources of China, 2005–2018; National Bureau of Statistics of China, 2000–2020, 2000–2015; China Society of Urban Development, 1999–2019; Ministry of Housing and Urban-Rural Development, PRC, 2007–2020.	Identification of drivers for housing price change	
Consumer price index	Bureau of Statistics of Heilongjiang, 1999–2019; Bureau of Statistics of Jilin, 1999–2019; Bureau of Statistics of Liaoning, 1999–2019	Calculation of comparable price	



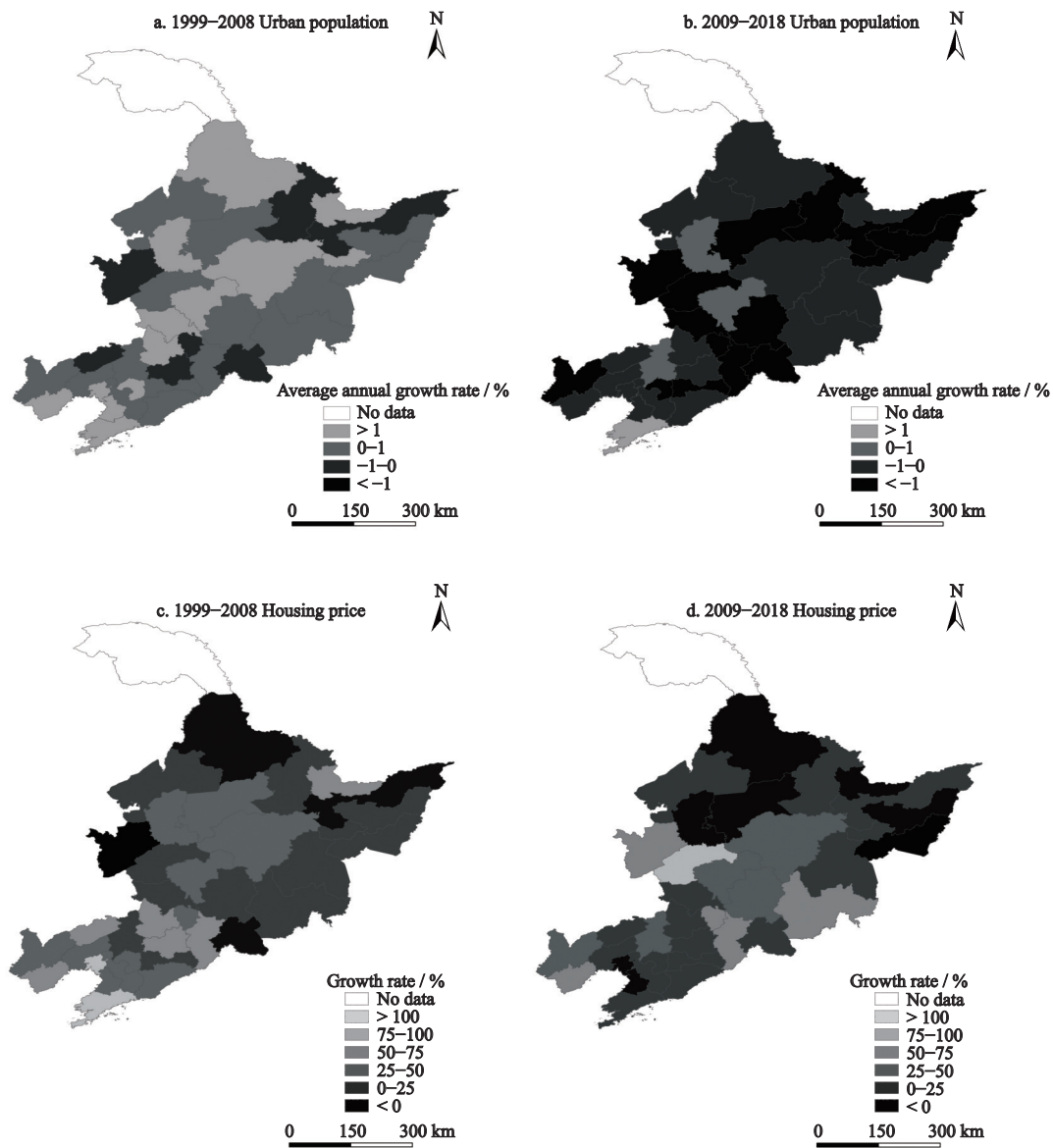
**Fig. 2** Kernel density of population and housing price change of sample cities in Northeast China from 1999 to 2018

percent, and 13 cities of them, mainly distributed along Harbin-Dalian railway (Fig. 3), underwent rapid population growth (average annual growth above 1%). There were seven cities that experienced population shrinkage, most of them are resource-based cities (Fig. 3). In general, population growth was still the mainstream of cities in Northeast China during this period. Population shrinkage is moderate with an annual population loss of less than 1% and only concentrated in a few cities. As a result, the total population of these 35 cities increased by a 4.1million from 1999 to 2008.

Between 2009 and 2018, the number of cities with shrinking populations rose sharply, 31 out of 35 cities experienced population loss. Meanwhile, the severity of population shrinkage also rose significantly, nearly half of these population shrinking cities experienced annual population loss of over 1%, especially for cities located in Heilongjiang Province and Jilin Province (Fig. 3). Only four cities (Shenyang, Dalian, Changchun and

Daqing), either large/capital cities or mining cities with unexhausted resources, showed a positive population growth (Fig. 3). Nevertheless, compared to the previous decade, the population growth rate of these cities has decreased significantly. Obviously, population shrinkage had become widespread and intensified among cities in Northeast China from 2009 to 2018. On the contrary, population growth during this period had been rare for cities in the region. In aggregate, the total population of these 35 cities was reduced by 2.4 million from 2009 to 2018.

Different from the demographic change mentioned above, the housing prices of most cities in Northeast China showed an upward trend from 1999 to 2018. After adjusting for inflation, the average house prices of sample cities increased by 150% during this period. Comparatively, housing price of sample cities experienced a higher average growth rate (56%) as population growth during the period from 1999 to 2008 (Fig. 3), especially for cities located in Liaoning Province, the south of Heilongjiang Province and the central of Jilin Province (Fig. 3). While the housing price growth of most cities has not been reversed during the following decade, the average growth rate of housing price slowed down to 43% with the widespread population shrinkage of cities in the region (Fig. 2), the number of cities with house price growth rate less than 50% increased significantly (Fig. 3). Meanwhile, the housing price gap between population growing cities and population shrinking cities was expanding from 468 yuan/m<sup>2</sup> in



**Fig. 3** Changes in population and housing price of sample cities in Northeast China from 1999 to 2018

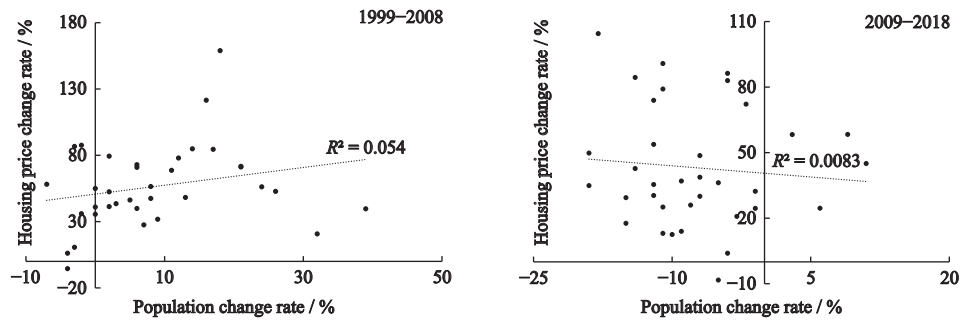
2009 to 2893 yuan/m<sup>2</sup> in 2018.

According to the changes in population and housing price, three categories of coupled relationships between them can be identified (Fig. 4), namely positive growth of population and housing price, negative growth of population and housing price, population shrinkage and housing price rising. From 1999 to 2008, the most common category, including 28 cities, was positive growth of population and housing price. For cities with shrinking population, nearly all of them, except for Baicheng where housing price decreased by 77 yuan/m<sup>2</sup>, experienced rises of housing prices. During the period between 2009 and 2018, 30 out of 35 cities followed the same pattern of population shrinkage and housing price

rising, only Jixi experienced negative growth of population and housing price (decreased by 230 yuan/m<sup>2</sup>). Overall, positive growth of housing price was prevalent among cities in Northeast China regardless of whether they experienced population growth or shrinkage, and there was no significant linear relationship between changes in population and housing price as manifested in the Fig. 4.

#### 4.2 The effects of population changes on housing price volatility

The results of the regression analyses between a housing price change and its determinants are reported in Table 3. It can be seen that the effects of population



**Fig. 4** Coupled relationships between population change and housing price volatility of sample cities in Northeast China from 1999 to 2018

gain and loss on housing price volatility are different in direction and magnitude. The estimated coefficient for *PoplossR* has been higher than that of *PopgainR* over the investigated period, implying that a larger decline in housing price associated with population loss than a housing price increase with the same size of population gain. For example, during the period 1999–2008, one percent increase in population, on average, increases the house price by 0.197% while one percent loss of population, on average, decreases the house price by 0.598%. Nevertheless, it should be noted that the asymmetry effect is not as significant as found in previous studies (Glaeser and Gyourko, 2005; Feng et al., 2018; Hashimoto et al., 2020). Such a result indicates that changes in population size did not have a statistically significant impact on housing prices volatility of sample

cities from 1999 to 2018, which is similar to Drees and van de Minne (2016) where they found that population change is not a constant determinant of house price dynamics. This confirms the overall increase in housing prices across Northeast China since the commercialization of urban housing, regardless of population growth or shrinkage.

#### 4.3 Other factors influencing housing price volatility

According to the regression results of our model (Table 3), most factors influencing housing volatility of sample cities came from the supply side, but their impacts were weakening during the investigated period, which can account for the slowdown of housing price growth rate of sample cities. It can be seen in Table 4 that the supply-side factors influencing housing price were much more variable in the first decade than in the second. Among these factors, the rise of land price and real estate investment played a significant role in promoting housing price in the first decade. Comparatively, the increase of land price, which is an important part of housing price and local fiscal revenue, had a stronger driving effect on the rise of house price. However, in the second decade, with the introduction of the government's measures to deal with the problems of land finance and high inventory of housing, the growth rate of these two indicators decreased significantly (Table 4). As a result, the effect of real estate investment on house price change was insignificant, and the impact of land price growth on the rise of house price decreased significantly.

Land supply can directly affect housing supply and then influence housing prices (Li, 2010). Over the two periods, the growth of newly added area of construction land had a significant negative effect on house price change, but the effect decreased slightly due to the redu-

**Table 3** Regression results of house price change and its determinants of sample cities in Northeast China from 1999 to 2018

Independent variables	1999–2008	2009–2018
<i>PopgainR</i>	0.197	0.205
<i>PoplossR</i>	−0.598	−0.445
<i>LandcostR</i>	0.498***	0.068***
<i>InvestmentR</i>	0.026**	−0.006
<i>CompletedR</i>	−0.015***	0.010**
<i>ConstructionR</i>	−0.040***	−0.023*
<i>GDPperR</i>	−0.003	0.387***
<i>HouseholdR</i>	0.087**	−0.094
<i>IncomeR</i>	0.005	−0.008
Constant	0.030	0.057***
Observations	315	315
Fixed effects	Y	Y
Time effects	Y	Y
$R^2$ (within)	0.670	0.504

Note: \*\*\*, \*\*, and \* indicate significant at the 0.01, 0.05 and 0.1 levels

**Table 4** Growth rate of the supply-side factors influencing housing price of the sample cities in Northeast China from 1999 to 2018 / %

Factor	1999–2008	2009–2018
Land cost	850	47
Real estate investment	874	37
Completed floor space of commercial houses	333	–32
New added construction land area	125	–33

cing supply of newly added construction land during the 2009–2018 period (Table 4). This shows that the elasticity of land supply in the sample cities remained high during the study period and the reduction of land supply did not have a positive impact on house prices as found in other studies (Wen et al., 2017). The change in completed area of commercial housing was similar to that of new added area of construction land, but the impact of this indicator on housing price volatility changed in the two time periods (Table 4). Over the 1999–2008 period, the rapid supply of a large number of housing actually played a negative role in housing price change. During the period 2009–2018, while the completed area of commercial housing decreased significantly, the oversupply of housing has not changed, as the unsold area of commercial housing in 35 sample cities increased from 32.1 million  $m^2$  to 62.4 million  $m^2$ . Against this backdrop, the decline in completed areas of commercial housing did not drive a rapid rise in house price. Instead, the growth rate of house price slowed down with the reduction in the completed areas of commercial housing during this period.

Among the demand-side factors, the changes of GDP per capita had a periodical positive impact on housing price volatility during the investigated period. In the first decade, especially after the implementation of the revitalization strategy of Northeast China, the GDP per capita of sample cities grew significantly (195% on average) under the policy and financial supports from the central government. However, the economic development of Northeast China during the period was mainly driven by external forces, and the development path of over-reliance on heavy industries was still relatively obvious (Li and Zhang, 2012; Wang et al., 2014). A large number of revitalization policies and funds were put into restructuring state-owned enterprises and industrial chain extension of traditional heavy industries, while improvement in urban infrastructure and urban environ-

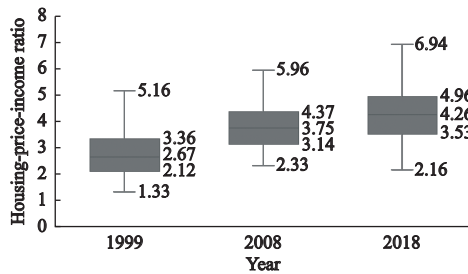
ment progressed slowly, except for the large-scale renovation of shantytowns (Zhang, 2008). Therefore, the development environment of most cities has not been significantly improved with economic growth, which led to the insignificant role of economic growth in driving housing prices in the period. Between 2009 and 2018, more attention was paid to the transformation of economic growth pattern and the cultivation of endogenous development impetus, such as eliminating the backward production capacity of traditional heavy industries and vigorously advancing urban renewal. Although the economic growth rate of sample cities generally slowed down during this period, the quality of economic development has been significantly improved (Zhang, 2013), which had a positive impact on house prices.

As the basic unit of housing consumption, changes in households number have an important impact on housing demand (Lauf et al., 2012). During the investigated period, the household number of sample cities grew significantly as households size became smaller. In particular, the process of household miniaturization was significantly accelerated by the rapid advancement of shantytown renovation during the first decade, as households with multiple generations in shanty towns were largely replaced by small households (Li et al., 2015). The number of urban households increased by 29% (4.661 million households) from 1999 to 2008, which had a significant positive impact on rising house prices. Between 2009 and 2018, with the gradual completion of the shantytown renovation, the growth rate of household numbers in sample cities dropped to 8% on average. Therefore, changes in household numbers did not have a significant impact on house price volatility during this period. In addition, the effect of the increase in disposable income per capita was also insignificant as it did not enhance the housing purchasing power of residents. As shown in Fig. 5, the housing-price-to-income ratio of sample cities still kept rising during the investigated period.

## 5 Discussion

### 5.1 Why is the impact of population change on housing price insignificant in Northeast China?

Previous explanations about the asymmetric impact are mainly based on the kinked supply proposed by Glaeser



**Fig. 5** Changes in housing-price-to-income ratio of sample cities in Northeast China from 1999 to 2018

and Gyorko (2005), one implicit assumption of these explanations is that housing demand will change accordingly with population change. This is suitable for the housing market in that housing demand is largely determined by changes in population size. For example, the floor space per capita of US increased from approximately 37.2 m<sup>2</sup> to 74.3 m<sup>2</sup> over the 1891–2010 period, while population increased five times during the same period, the change of floor space per capita is relatively small compared with population change (Moura et al., 2015). Under this background, population changes usually have a significant impact on housing demand, and then asymmetrically affect housing price volatility as housing supply adjusts elastically when population growth and inelastically when population shrinkage.

However, this is not completely consistent with the actual housing situation in Northeast China. After the ending of the allocation of welfare housing in 1998, housing demand, which has been suppressed for a long time with a greatly releasing. The floor space per capita of 35 sample cities in Northeast China was only 9.6 m<sup>2</sup> in 1999 and the figure grew to 30 m<sup>2</sup> in 2018. Meanwhile, the population of these cities increased by only 4% over the period. Comparatively, the improvement of residential conditions played a greater role in promoting housing demand of Northeast China over the period. Even for cities with shrinking populations, housing demand was kept rising due to the significant improvement of floor space per capita and the moderate population decline (Table 5). Therefore, the negative effect of

population loss on housing price was largely offset by the positive effect of residential conditions improvement.

On the other hand, the rising housing demand associated with population growth was accompanied by a quicker and larger housing supply. Over the 1999–2008 period, the completed floor space of commercial houses of population growing cities increased by 367%, while the population of these cities only rose by 12% (Table 5). During the following decade, the growth rate of the completed floor space of commercial houses slowed down significantly to destock the oversupply of housing of the former decade. Overall, the high housing supply elasticity, especially over the 1999–2008 period, lead to the weak impact of population growth on housing price appreciation.

## 5.2 Can housing prices in population shrinking cities of Northeast China keep rising?

Although the impacts of population change on housing prices were insignificant during the investigated period, the issue still requires ongoing attention, especially for cities with intensifying population shrinkage. In fact, the commodity housing price of Jixi, a typical population-shrinking city, has declined during the period 2009–2018. Moreover, other population-shrinking cities also face the risk of falling commodity housing prices. Firstly, considering that the improvement of residential conditions in population shrinking cities has slowed down dramatically in the past decade (Table 3), the accelerated population shrinkage would in the end lead to a smaller demand for commercial housing, which might have a negative impact on the price of commercial housing. Secondly, along with the population shrinkage, the number of urban households in some cities, like Hegang, Jixi, Benxi, Liaoyang and Chaoyang, begun to decrease during the recent five years which would further reduce the demand for commercial housing. Thirdly, some population shrinking cities, such as Fuxin, Dandong and Siping, are not effective in de-

**Table 5** Growth rate of population and housing supply/demand of sample cities in Northeast China from 1999 to 2018 / %

Factor	Population shrinking cities		Factor	Population growing cities	
	1999–2008	2009–2018		1999–2008	2009–2018
Population	–4	–9	Population	12	7
Floor space per capita	131	21	Completed floor space of commercial houses	367	–52

stocking commercial housing, the unsold area of commercial housing kept growing, which would lead to difficulties in sustaining the growth of commercial housing prices. Overall, given the weakening impacts of factors contributing to house price appreciation, the negative impact of population shrinkage on house prices may become increasingly significant, declining commercial housing prices could be a medium- or a long-term trend for some population shrinking cities. It is necessary to further explore detailed analysis on the risk of housing price decline in population-shrinking cities, which would provide useful implications on real estate regulation of Northeast China, we leave this for future research.

## 6 Conclusions and Implications

This study investigates the responses of housing price under different directions of population change and quantitatively measures the contributions of population growth and shrinkage to the housing price volatility in Northeast China from 1999 to 2018. Based on the results, we can show that the responses of housing price to population growth and shrinkage are asymmetric both in directions and magnitudes. Almost all sample cities, regardless of population growth or shrinkage, experienced varying degrees of housing price appreciation over the investigated period. However, we did not find a statistically significant impact of population size change on housing prices volatility of sample cities. This finding contributes new evidence that the asymmetric impact of population gains and losses on housing prices is context-specific and might vary across different regions and temporal periods. For a region with moderate population change and booming housing market, like Northeast China, housing price volatility might not be sensitive to changes in population size. One reason for this is that changes in population size are relatively small relative to changes in residential conditions and housing supply. A declining population was not necessarily followed by a decline in housing demand as the significant improvement in floor space per capita, and an increasing housing demand was usually followed by a quicker and larger housing supply. Under such conditions, population size change is not an excellent predictor of housing price volatility.

The rising housing price of sample cities was driven

by factors other than population fluctuation, such as growth in land cost, investment in real estate, GDP per capita and household number during the investigated period. However, the commercial housing prices of sample cities, especially for those cities with intensifying population shrinkage can expect very different futures, a medium- or a long-term decline is one of them. Because the factors contributing to housing price appreciation have weakened, while factors such as population shrinkage, declining household number, oversupply of commercial house become more influential. This would be particularly troubling because housing price decline usually pushes further shrinkage of the urban population. Thus, avoiding the rapid decline of house prices, rather than curbing the rapid rise of housing prices, should be the focus of real estate regulation in some population shrinking cities of Northeast China.

The study shown here can help explain why controlling population size does not always have an important impact on housing price volatility. Since a smaller population does not lead to a smaller housing demand immediately, and those other factors which driving housing price would remain growing for quite some time even after population shrinkage has started. The delayed response of housing price provides valuable time for population-shrinking cities to adjust their housing markets to a smaller population. Different from the 'purchase restriction' policy generally adopted in China's metropolises, it would be more appropriate for population shrinking cities to put quantity or time restrictions on housing sales. For example, commodity houses without pre-sale licenses are not allowed to be sold, and commodity houses must be held for a certain number of years before they can be resold. These restrictions on housing sales would help population shrinking cities reducing commercial housing stocks and avoiding over-investment in real estate.

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