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Population Aging and the Dynamics of Housing Demand: An Empirical Analysis Based on Population Age Structure

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Abstract: The Dynamics of Population Aging and Housing Demand: An Empirical Analysis Based on Age Structure. Globally, population aging has emerged as an inescapable social phenomenon, particularly evident in China where this trend is even more pronounced. As the demographic structure continues to evolve, profound changes are taking place in the dynamics of housing market supply and demand, presenting both new challenges and opportunities for the development of the real estate market. By constructing theoretical models, this study explores the mechanisms through which changes in the age structure affect housing demand. Empirical analysis, supported by statistical data, reveals the specific transformations within the housing market under the backdrop of population aging. The findings indicate that not only does population aging directly reduce housing demand, but it also exerts far-reaching influences on the housing market indirectly through its impact on economic activities and policy orientations. This study aims to provide a scientific foundation for the formulation of relevant policies, thereby promoting the healthy development of the real estate market.

Keywords: Population Aging; Housing Demand; Age Structure; Empirical Analysis

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1.Introduction

In China, the issue of population aging is becoming increasingly severe, posing signifi cant challenges to economic and social development. Real estate, as a pivotal pillar of the national economy, is profoundly infl uenced by shifts in supply and demand due to demographic changes. Notably, the transformation of the age structure not only directly alters housing demand patterns but also exerts far-reaching impacts on the real estate market through indirect eff ects such as changes in the labor market, shifts in family structures, and adjustments in saving and consumption behaviors. Therefore, a thorough exploration of the relationship between changes in the age structure and housing demand is not only instrumental in understanding the dynamics of the current real estate market but also furnishes a scientific foundation for future policy formulation. This thesis, by summarizing relevant theoretical models and analyzing trends in demographic shifts and their specifi c impacts on the housing market, ultimately substantiates these theories through empirical research, thereby offering strategic recommendations to address the challenges posed by population aging [1].

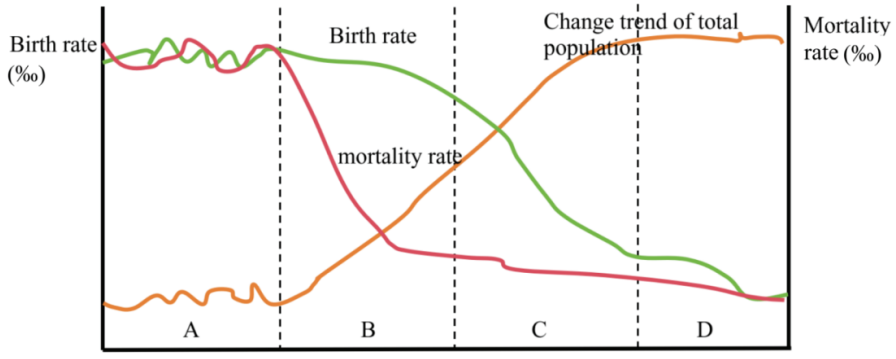
2.Theoretical model of the relationship between population age structure and residential housing demand

2.1 Theoretical model of demographic transition

The demographic transition theory delves into the impact of changes in population age structure on economic growth, based on indicators such as birth rates, death rates, and population growth rates. Originating in the early 20th century, this theory was primarily synthesized through statistical data by Western European nations, illustrating the interplay between economic development and demographic shifts. Demographic transition refers to the gradual transformation of a society's population structure from an initial phase of high mortality, high fertility, and low natural growth rates to a state of low mortality, low fertility, and low natural growth rates. This transition not only affects the overall population size but also profoundly reshapes the age structure of the population [2]. Frank Wallace Notestein, as a pioneering architect of demographic transition theory, systematically articulated the causes and theoretical foundations of this transition, emphasizing the pivotal role of economic development in driving demographic changes.

Modern iterations of the demographic transition theory have further refined this perspective, positing that population growth is an endogenous variable of economic growth, while economic growth, in turn, relies on population growth to supply labor, thereby fostering economic development. Consequently, a bidirectional interaction exists between demographic transition and economic growth. Building upon the foundations of demographic transition theory, Kindleberger and Herrick proposed a four-stage model (see Figure 1) delineating the phases of demographic transition: the high mortality and high fertility stage, the stage characterized by rapidly declining mortality with relatively stable fertility, the phase where fertility begins to decline while mortality remains at low levels, and the stage of low mortality and low fertility. These stages not only depict the evolution of population structure but also elucidate the varying impacts on housing demand across different phases [3].

Figure 1.The four stages of demographic transition proposed by Kindleberger and Herrick



Note: A is for countries and areas with high birth and death rates; B is for countries and areas where birth rates have remained high and death rates have begun to decline; C is for countries and areas where birth rates have begun to decline and death rates are low; and D is for countries and areas with low birth and death rates.

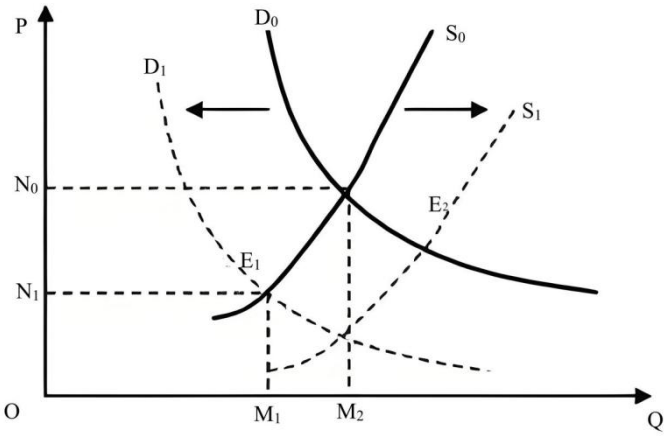
2.2 Theoretical Model of Real Estate Supply and Demand

The theory of real estate supply and demand occupies an important place in economics, and its core lies in analyzing the effects of changes in demand and supply on market equilibrium. According to the general principles of economics, changes in demand and supply refer to changes in the quantity demanded and supplied caused by changes in other factors while the price of the commodity itself remains unchanged, which is manifested as a shift in the entire curve. As shown in Figure 2, when demand decreases, the demand curve shifts from D_0 to D_1, and if the supply curve S_0 remains unchanged, the market equilibrium point will move to E_1, which results in a lower equilibrium price and a lower equilibrium quantity [4]. On the contrary, if demand remains constant and supply increases, the supply curve shifts right to S_1 and the equilibrium point moves to E_2, where the equilibrium price decreases and the equilibrium quantity increases.

In the real estate market, changes in the age structure of the population constitute a significant non-price factor, exerting a substantial influence on both the demand and supply of housing. An increase in the proportion of young people typically boosts housing demand, particularly in the categories of first-time homebuyers and those seeking improved accommodation, which can shift the demand curve to the right and drive up property prices. Conversely, a rise in the proportion of the elderly population may dampen housing demand, especially for larger and higher-story residences, causing the demand curve to shift to the left and potentially leading to a decline in property prices. Additionally, population aging can also impact the behavior

of the supply side, as the elderly may opt to sell or rent out their properties upon retirement, thereby increasing the supply of available housing, shifting the supply curve to the right, and further influencing market equilibrium [5].

Figure 2. Supply and demand for real estate



2.3 Transmission effects of changes in the age structure of the population on residential housing demand

2.3.1 Direct effect

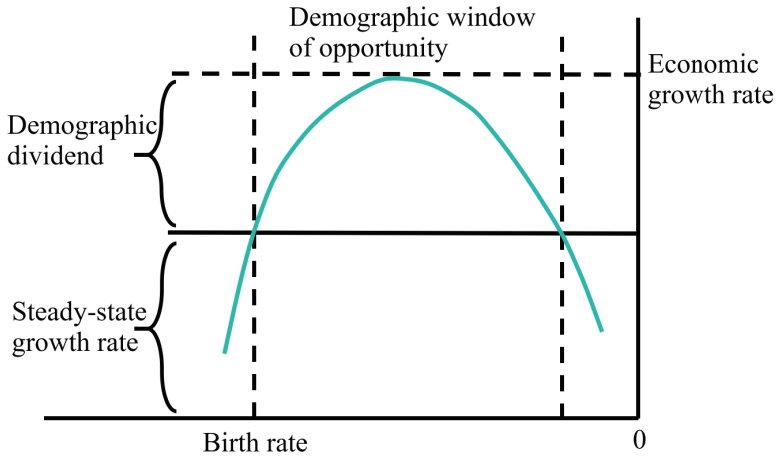
The shift in the population's age structure exerts a profound direct influence on residential housing demand, primarily manifested in the realm of labor supply. The working population constitutes the primary force in housing consumption, exhibiting significantly different housing demand patterns across various age groups. Notably, the cohort entering the workforce or preparing for marriage, typically around the age of 30, demonstrates the most fervent housing demand. This surge in demand during this phase is often characterized by an upward trajectory, driven by the need for independent living spaces to support both the initial stages of their careers and the establishment of family life. Nevertheless, as individuals age, particularly upon entering their senior years, the likelihood of purchasing homes diminishes substantially. The housing needs of the elderly are predominantly focused on enhancing living conditions and adapting to health requirements, rather than acquiring new properties [6].

However, the intensification of the aging population trend has ushered in a new dynamic. With the improvement of pension and retirement benefits for the elderly, those with favorable economic conditions are increasingly likely to opt for the purchase of retirement apartments post-retirement. This emerging demand pattern subtly alters the conventional perception of low elderly housing purchase intentions. The escalation in elderly housing demand primarily centers around aspects such as safety, convenience, and medical facilities, necessitating a more diversified and specialized housing market. Concurrently, while the juvenile population does have housing needs, their inability to afford purchases primarily results in their demands being met through their parents' housing acquisitions. Young couples, upon having children, tend to opt for larger residences, especially as the number of children increases or when they grow older, requiring separate bedrooms. This enhancement in demand serves as a crucial impetus driving the development of the housing market.

2.3.2 Indirect effect

The direct effect of changes in the population's age structure on housing demand primarily manifests in the differences in housing needs across different age groups. The analytical framework provided by Cai Fang (2010) clearly elucidates the relationship between demographic transition and economic growth, which is equally applicable to the impact of age structure on housing demand. Assuming the absence of demographic transition and technological advancement, when the total birth rate is high, a larger proportion of the population is young, concentrating housing demand on first-time home purchases and housing for improvement. During this phase, housing demand typically exhibits an upward trend, as young people enter the labor market and require independent living spaces to support their career advancement and the establishment of family life [7]. As society progresses, a decline in the birth rate enriches the working-age population structure, leading to rapid economic growth and the formation of a demographic dividend, known as the "demographic opportunity window," as illustrated in Figure 3.

Figure 3. Demographic dividend and economic growth



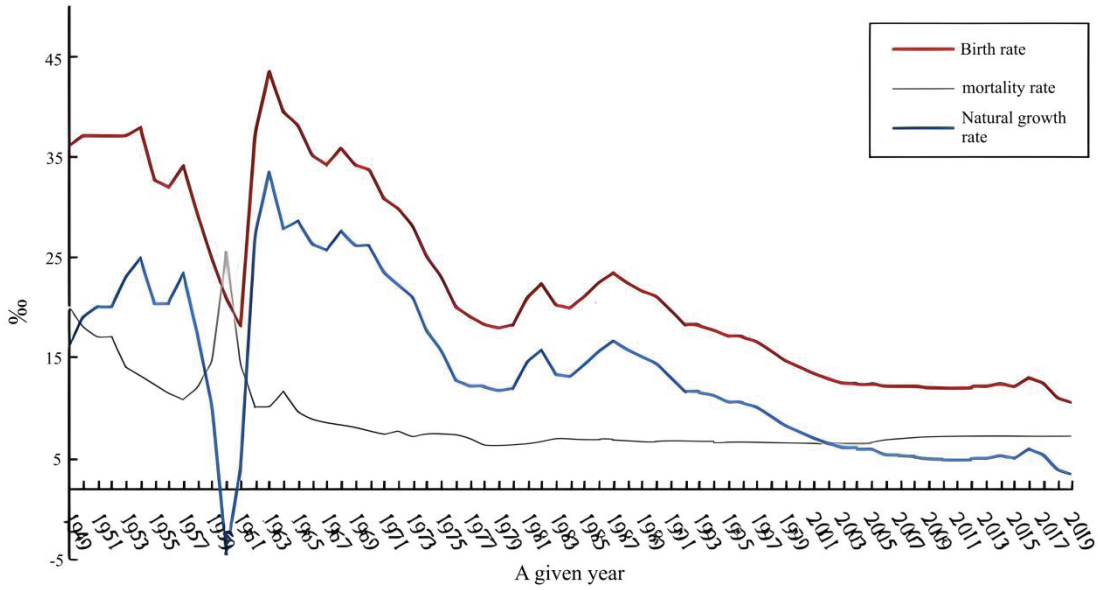
3.Study on the Dynamic Changes of Population Aging and Housing Demand

3.1 Transformation of the age structure of China's population

3.1.1 Trend of Population Structure Transformation

The trend of transformation in the age structure of China's population has been particularly significant since the 1970s. As shown in figure 4, the data show that the birth rate in China was 2.793 per cent in 1973, and with the implementation of the family planning policy, this figure dropped to 1.782 per cent in 1979. Although there was a wave of "baby boom" in the 1980s, which led to a brief rebound in the fertility rate, the birth rate has continued to decline since then, and by 2000 it had fallen to 1.403%. Unlike the developed countries of Western Europe, which took hundreds of years to gradually realize the transition to a low birth rate, China completed the process in only 30 years, which scholars consider to be the result of the "lag" and "compression" of the fertility transition.

Figure 4. Stages of demographic transition in the country, 1949-2015



3.1.2 Trends in population ageing

The trend of population aging in my country began in 2001, when the proportion of the population aged 65 and over reached 7.1%. With the persistence of low birth and death rates, the proportion of the elderly population has risen annually, reaching 137 million, or 10.1% of the total population, by 2015. This trend not only reflects changes in population structure but also exerts significant impacts on social and economic development. Population aging presents the country with the challenge of aging before achieving prosperity, as overall income levels still remain in the upper-middle-income bracket. The pressure

of an aging population imposes higher demands on the nation's capital accumulation and the pension security system. In terms of housing needs, the increase in the elderly population has led to a marked rise in demand for elderly-oriented and low-rise residences. These dwellings must be equipped with comprehensive living facilities and medical care services to cater to the special needs of the elderly. Moreover, the middle-aged, under the dual pressures of supporting the elderly and raising children, place greater emphasis on the comfort and convenience of their living environment, which has unveiled new characteristics in the demand for improved housing. Furthermore, population aging may influence the process of urbanization, with the housing demand in some cities potentially declining due to a reduction in the young population. This scenario poses new challenges for urban planning and housing policy formulation [8].

3.2 Changes in Housing Market Demand under the Demographic Age Structure Shift

3.2.1 Changes in housing sales in the context of demographic transition

The shift in the demographic age structure has exerted a significant impact on the housing market's sales. With the decline in birth rates and the increasing proportion of the elderly population, the number of young homebuyers has gradually decreased, directly leading to a reduction in the demand for first-time home purchases. Data from the National Bureau of Statistics indicates that the proportion of first-time homebuyers has been decreasing year by year in recent years, particularly in first-tier cities, where the decline in young population has caused structural changes in market demand. Simultaneously, the middle-aged demographic, facing the pressures of career stability and family care, has seen a growing demand for improved homes. This segment places greater emphasis on the comfort, safety, and surrounding amenities of their residences, such as high-quality educational, medical, and transportation resources. Consequently, the market for improved housing has flourished. The rise in the elderly population has also spurred the development of retirement-oriented housing markets, with such residences typically situated in scenic suburban areas or near ecological parks, equipped with comprehensive medical facilities and living services. Real estate developers are increasingly focusing their attention on this niche market, launching more products tailored for senior living. Additionally, changes in the demographic age structure have influenced the payment capabilities and preferences of homebuyers. Research reveals that middle to high-income elderly individuals are more inclined to purchase high-quality, low-density residences, while low-income elderly individuals are more reliant on government-provided affordable housing or retirement communities.

3.2.2 Changes in housing prices in the context of demographic transition

The demographic shift has exerted profound influence on housing prices. With a reduction in the young working population, the demand for first-time home purchases has significantly declined, particularly in economically mature first-tier cities, where the outflow of young people has led to a decrease in demand, thereby affecting the upward trend of housing prices. Concurrently, the stable career periods and family support pressures faced by middle-aged individuals have spurred an increase in their demand for upgraded housing. This segment of the population typically possesses higher purchasing power, thus driving up the prices in the mid-to-high-end housing market. The growing proportion of the elderly population has also impacted housing prices. The rising demand for retirement homes has led to an increase in the prices of such properties. These residences are usually located in areas with beautiful environments and well-developed supporting facilities, attracting many affluent elderly individuals. Meanwhile, the increased demand for affordable rental housing and senior living communities among low-income elderly individuals has prompted the government to enhance the supply of such housing, aiming to balance market supply and demand. This transformation has played a regulatory role on the overall housing price structure, resulting in a stratified market phenomenon [9].

4.Empirical analysis of the impact of changes in the age structure of the population on residential housing demand

4.1 Theoretical model of housing demand determination

This issue can be explored by constructing a theoretical model of the determination of housing demand that takes into account key factors such as the age structure of the population, income levels, household size and housing preferences. The model can be elaborated in the following ways:

First, the housing demand function Q_i is defined as the amount of housing demanded by resident i. This can be expressed as a

function of income Y_i, age A_i, household size H_i and other influencing factors Z_i, as in equation (1):

$$Q_i = f(Y_i, A_i, H_i, Z_i) \tag{1}$$

Where Y_i represents the income level of resident i, A_i represents the age of resident i, H_i represents the household size of resident i, and Z_i represents other factors affecting housing demand, such as geographic location and educational resources.

In order to analyze the specific impact of age structure on housing demand, the age grouping variable can be further introduced. Assuming that the age grouping is (A_1,A_2, ... , A_n), the housing demand of each age group can be expressed as equation (2):

$$Q_{ij} = f(Y_i, A_i, H_i, Z_i) \tag{2}$$

where Q_{ij} is the housing demand of resident i in age group j. This formula makes it possible to specifically analyze the differences in housing demand among residents of different age groups.

Family size is also an important factor affecting housing demand. Assuming that the household size is (H_1,H_2, ... , H_m), the housing demand function can be adjusted according to the difference in household size, as in equation (3):

$$Q_i = f(Y_i, A_i, H_i, Z_i) = \beta_0 + \beta_1 Y_i + \beta_2 A_i + \beta_3 H_i + \beta_4 Z_i + \varepsilon_i \tag{3}$$

Here β_0 is the constant term, $\beta_1, \beta_2, \beta_3, \beta_4$ is the coefficient of each variable and ϵi is the random error term. Through regression analysis, the values of the coefficients can be estimated to understand the specific impact of each factor on housing demand.

In addition, the impact of income level on housing demand cannot be ignored. High-income groups are more inclined to buy high-quality and large-area residences, while low-income groups are more inclined to small or low-rent housing. The elasticity η of income on housing demand can be calculated by formula (4):

$$\eta = \frac{\partial Q_i / \partial Y_i}{Q_i / Y_i} = \beta_1 \tag{4}$$

This elasticity analysis allows further understanding of the extent to which changes in income affect housing demand. Changes in the age structure of the population not only affect the total amount of housing demand, but also the structure and type of demand. Therefore, the construction of this theoretical model can provide a scientific basis for policy makers and real estate developers to help them better cope with the changes in housing demand brought about by population aging, thus promoting the healthy and stable development of the real estate market [10].

4.2 Regression results and analysis

4.2.1 Relationship between population age structure and housing demand

Through the empirical analysis of the relationship between population age structure and housing demand, this paper uses multiple linear regression models to explore the changes in housing demand of residents of different age groups. The results of the regression analysis are shown in Table 1, demonstrating the impact of residents of various age groups on housing demand and the significance level.

Table 1. Influence of housing demand by age groups of the population

variable	coefficient	Standard error	T-value	p-value
20-29 years old	0.250	0.048	5.21	0.000
30-39 years old	0.183	0.042	4.36	0.000
40-49 years old	0.119	0.035	3.40	0.001
50-59 years old	-0.078	0.037	-2.11	0.035
Age 60 and above	-0.145	0.041	-3.54	0.000
income	0.502	0.053	9.47	0.000
Family size	0.301	0.049	6.14	0.000
Constant term	1.200	0.195	6.15	0.000

Table 1 illustrates that residents in the age groups of 20-29 and 30-39 have a markedly positive impact on housing demand, with coefficients of 0.250 and 0.183, respectively. This indicates a heightened need for housing among young working populations, particularly concerning first-time home purchases and living arrangements. Although the influence is less pronounced for those aged 40-49, it remains positive (0.119), likely due to their career stability and family expansion phases, which generate a strong demand for improved housing conditions. Conversely, the impact on housing demand for residents aged 50-59 and 60 and above gradually turns negative, with coefficients of -0.078 and -0.145, respectively. This suggests a decline in housing demand among the elderly, especially regarding housing replacement and retirement needs. Furthermore, income and household size significantly affect housing demand, with coefficients of 0.502 and 0.301, respectively, highlighting that higher-income families and larger households place greater emphasis on the quality and size of their dwellings. These regression results provide crucial empirical evidence for understanding how changes in population age structure influence housing demand, aiding policymakers and real estate developers in adjusting housing supply strategies to better meet the diverse needs of residents across different age groups.

4.2.2 Relationship between control variables and housing demand

In the empirical analysis exploring the impact of changes in population age structure on residents' housing demand, the role of control variables cannot be ignored as well. This paper uses a multiple linear regression model and introduces several control variables to examine their specific impact on housing demand. Table 2 demonstrates the regression results and significance levels of each control variable.

Table 2. regression results for each control variable

variable	coefficient	Standard error	T-value	p-value
Income level	0.502	0.053	9.47	0.000
Family size	0.301	0.049	6.14	0.000
Marital status	0.205	0.062	3.31	0.001
Educational level	0.150	0.045	3.33	0.001
Occupational type	0.123	0.038	3.24	0.001
Constant term	1.200	0.195	6.15	0.000

From the regression results in Table 2, the income level has the largest positive effect on housing demand with a coefficient of 0.502 and is highly significant at the 0.000 level of significance. This indicates that high-income residents have a higher demand for housing, especially in terms of high-quality dwellings. The positive effect of family size on housing demand is also more significant, with a coefficient of 0.301, which indicates that the more family members there are, the greater the demand for housing. Marital status has a more significant effect on housing demand, with a coefficient of 0.205, which may be due to the fact that married residents have a greater need for larger homes and family living space compared to single residents. The positive influence of education level on housing demand has a coefficient of 0.150, showing that residents with higher education levels have a higher demand for housing, especially in terms of improving their living conditions and choosing housing in high-quality school districts. The coefficient of influence of occupation type on housing demand is 0.123, reflecting the differences in housing demand among residents of different occupations, such as the higher demand for housing quality among residents of high-skilled occupations and managerial positions. The coefficient of the constant term is 1.200, indicating the baseline level of housing demand when controlling for other variables.

5.Conclusion

In summary, the impact of population aging on housing demand is multifaceted, not only directly changing the supply and demand relationship in the housing market by reducing the number of working people and increasing the proportion of elderly people, but also generating indirect effects at the level of family structure, economic activities, and policy orientation. Through theoretical modeling and empirical analysis, this study clearly demonstrates the multiple transmission mechanisms

of population age structure changes on housing demand. These findings not only provide a strong basis for the government to formulate relevant housing policies, but also point out the direction for real estate companies to adjust their market strategies. In the face of the increasingly severe trend of population aging, how to balance housing supply and demand, optimize housing structure, and improve housing services will be an important topic for future research and practice. It is hoped that this study will provide useful references for in-depth discussions in this field and promote the sustainable development of the real estate market.

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Conflict of Interests

The author(s)declare(s) that there is no conflict of interest regarding the publication of this paper.

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