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HOUSING TYPES, POPULATION ATTRIBUTES AND THE DEVELOPMENT PATH OF HOUSING IN LARGE CITIES – A CASE STUDY OF ZHENGZHOU, CHINA

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Abstract. Large-city housing costs are commonly attributed to excessive investment or financialization of the property market. The primary cause of housing issues is the imbalance between housing supply and demand. In the context of the urban housing market, the dynamic matching of housing supply and population type plays a crucial role in promoting equilibrium, maximizing the effectiveness of the market's long-term mechanism, and preserving the coordination and stability of the market. To illustrate this point, the paper analyzes the impact of different attributes of population on housing demand from the perspective of dynamic matching between population attributes and housing types. Taking Zhengzhou City in Henan Province as an example, we consider the relationship between population attributes and housing types in the past, construct a theoretical model of population and housing type and anticipate the future supply scale of various housing kinds. Ultimately, our findings provide a theoretical justification for curbing excessive financialization and housing bubbles in large cities. Furthermore, we propose a practical method for urban housing to return to the essence of life from the perspective of matching housing supply and demand.

Keywords: urban housing, housing types, population attributes, population increment, development path, housing matching.

Introduction

Urban housing has long been a prominent concern for those residing in metropolitan areas. Nonetheless, following the implementation of housing market reform, housing prices in China have experienced a significant surge, ultimately leading to the emergence of the wealth effect pertaining to housing. Consequently, housing has gradually transformed from a mere consumer good to an investment product, with financialization further exacerbating the issue of housing inequality. This, in turn, has come to represent a crucial symbol of social differentiation between those of affluent and impoverished backgrounds, ultimately serving as a pivotal mechanism that contributes to social inequality and differentiation (Li & Fan, 2020). In light of the issue of exorbitant residential costs, the Chinese government has put forward the notion that abodes should serve as dwellings rather than as commodities subject to speculation. Additionally, authorities have advocated for the formation of a rental-purchase housing framework. The expansion of metropolitan areas has been paralleled by the movement of people. This migration has engendered a surge in the populace, thereby intensifying the need for habitation in urban locales. As a result, this has perpetually stimulated the escalation of housing costs in Chinese cities. However, the housing supply in big cities is inelastic (Howard & Liebersohn, 2021) and does not match the growth of housing demand, which tends to cause housing market failure. The inadequacies of the housing market not only pose a threat to the economic development at the local level, but also result in prolonged commuting periods, diminished standards of living, and impede social mobility for specific segments of the population. In numerous countries, metropolitan areas have witnessed a surge in the escalation of these apprehensions in recent times (Rodriguez-Pose & Storper, 2020). Contemporary research has successfully identified a plethora of factors responsible for the escalation in residential property prices. The factors in question are those that induce a hike in housing demand and those that are responsible for the amplification in housing supply. These factors entail but are not limited to, construction costs,

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geographic limitations, land policies, income levels, population expansion, housing preferences, tax implications, and speculative demand, among others (Glaeser et al., 2017; Hanink et al., 2012; Huang, 2004; Liang et al., 2016; Yu, 2011; Yu & Huang, 2016).

Some scholars have discovered a correlation between demographic shifts and housing costs. Previous studies in this area mainly point out population size (Ding, 2019), population density (Miles, 2012), population structure (Gevorgyan, 2019; Green & Lee, 2016; Levin et al., 2009; Myers, 1990), labor mobility (Akbari & Aydede, 2012; Wang et al., 2018), household demographic characteristics (Eichholtz & Lindenthal, 2014; Lauster, 2008) and other factors related to housing prices. Mulder (2006) posits the existence of a symbiotic relationship between the population and housing sectors. A burgeoning populace has a significant impact on the demand for housing, which in turn influences the spatial distribution of people, either encouraging or impeding mobility. Concurrently, the escalation of housing costs has resulted in a geographic mismatch between residential areas and places of work, culminating in the gradual suburbanization of the labor force. Most urban inhabitants tend to reside in suburban areas while working in the central business district, resulting in an increased commuting time between their abodes and workplaces. Additionally, there exists a causal connection between population migration and the volatility of house prices. In the short term, the availability of urban housing is constrained. The inflow of migrants will exacerbate the already high urban housing prices, which will, in turn, lead to higher living expenses, ultimately impeding population mobility. There is an inverted U relationship between the proportion of the population in large cities and urbanization (Liu et al., 2022). Among demographic factors, both qualitatively and quantitatively, housing demand varies with age of the population. This change determines future demand for housing. Over the past few decades, many countries have experienced severe population aging. In large cities facing the challenge of aging, there is a contradictory relationship between population dynamics and housing stock, with a surplus of housing stock that is unable to meet the housing needs of the population. The mismatch between the existing housing stock and the needs of the population stems from changes in demographic and household structures in an aging society, as well as changes in the urban housing stock and rental system (Garha & Azevedo, 2021). The aforementioned occurrences are also prevalent within urban areas of China.

We think that the alignment of population and residential accommodations can effectively diminish the demand for housing investments. While previous studies have considered the relationship between population and housing, they have not revealed a match between population attributes and housing type. In particular, there is a lack of focus on those who rely on housing security, who are generally economically weaker and find it difficult to survive living in the city. The novelty of our study is that we fully consider the matching relationship between different attributes of population and housing types, and propose corresponding suggestions based on the existing mismatch between population attributes and housing. For example, we take into account the emerging youth groups in the city – college students and graduates. Because they are the target of competition for talent in each city, cities will provide housing subsidy policies to attract and retain these talents. The provision of reasonably priced housing, economical dwellings, metropolitan villages, extended-stay rental units, and additional forms of subsidized housing can decrease both procurement demand and investment impetus. This not only resolves the housing predicament of low- and moderate-income individuals but concurrently curtails their anticipations of future escalation in housing costs. In this study, we investigate the correlation between population and housing dynamics in major urban areas. Our aim is to mitigate the escalation of housing prices by aligning different housing types with specific population attributes and to address the housing challenges faced by low- and middle-income individuals. To achieve this, we have gathered and meticulously organized population and housing data from Zhengzhou, China. Using the SPSS data analysis software, we have established a linear regression equation to model the relationship between population and housing. Based on this model, we have made projections for various population types from 2021 to 2035. Subsequently, we employed the same linear regression equation to predict the data for different housing types. Our findings present a match between different population attributes and housing types. We can able to find the minimum housing needs as well as the future preferences of different population attributes from a demand perspective, which can enable us to make supply-side efforts to deliver housing options that cater to the specific needs and attributes of the population. We believe that an effective match between population types and housing types will provide a basis for decision-making for government and relevant enterprises.

1. Theoretical background

1.1. The impact of demographics on housing demand

In the late 1960s, scholars analyzed the relationship between demographic fluctuations and the housing construction cycle and demonstrated the impact of demographic changes on total housing demand (Campbell, 1963). Among demographic factors, age structure is considered to be the most important factor in determining the interaction between population and housing demand (Myers & Pitkin, 2009). The effect of population growth on housing demand is contingent upon age. The younger demographic exhibits a greater degree of mobility among new households, which subsequently leads to an amplification in the demand for fresh housing units. On the

other hand, an aging populace within society has a markedly deleterious effect on housing demand (Malmberg, 2010). The advent of population groups into adulthood engenders a surge in the exigency for housing. As these individuals mature, they eventually succumb to mortality or relocate to nursing homes, consequently bequeathing a substantial number of unoccupied dwellings. This, in turn, engenders a commensurate rise in the provision of housing within the housing market. The aging process might bring down house prices in the future. On the contrary, considering the accelerated urban population movement, the process of urbanization will generate more housing demand, thereby promoting housing prices (Chen et al., 2011). Several academics have conducted research into the effects of urbanization on the real estate industry, as well as the surge in inflexible demand for housing that has resulted from the growth of urban populations. Urban areas possess a greater potential for attracting skilled individuals due to their developmental benefits. Due to the widening income gap between rural and urban residents, many farmers left their hometowns and ventured to the major cities to seek employment opportunities. Moreover, the enhancement of educational attainment has the capacity to augment the populace of young homeowners (Myers et al., 2019). Studies show that human capital agglomeration has a long-term positive effect on housing prices and economic development (Yang & Pan, 2020). China's housing reform is characterized by a distinctive housing supply system that engenders significant differentiation in urban social space. The underlying factors responsible for this social-spatial differentiation include the household registration system (Zhao & Howden-Chapman, 2010), work unit characteristics (Li & Wu, 2006), and the dual land system (Zhao, 2013). Hence, residents possessing local urban household registration exhibit a greater degree of contentment with their living conditions relative to the floating population.

Moreover, the housing category plays a significant role in producing the social-spatial segregation of urban inhabitants. There exists a social segregation between household residents and mobile populations within the housing area, where different housing categories typically occupy distinct regions of the city, catering to diverse social and economic groups. With regards to urban population mobility, few scholars have discovered that the rise in the floating population impacts the demand in the real estate market. The immigration process comprises of stages, and the process of settling immigrant populations in cities is a dynamic process that involves three stages: arrival, settlement, and stabilization (Llopis Alvarez & Muller-Eie, 2022). Newly arrived immigrants may be uncertain as to whether they will establish permanent residence in the city, and thus tend to prefer rental accommodations of smaller size, as compared to long-term residents. Young people, who have lived and worked in the city for an extended period, face the prospect of marriage and often seek to purchase a house suitable for family life. Skovgaard Nielsen (2017) has discovered that immigrants face constraints emanating from economic and social status, as well as exclusionary systems, which make it difficult for them to acquire housing in inflow areas. Therefore, immigrants frequently opt for public rental housing as a viable alternative to meet their housing needs. The inflow of migrant populations contributes to urban development, resulting in rapid escalation of urban housing prices, but only a small percentage of migrants have been able to purchase homes in the receiving city. Even if the migrant population has a high income, it remains challenging to obtain urban housing due to the high construction costs and the long-life cycle of urban housing, resulting in a less flexible housing stock that cannot accommodate the needs of highly active populations and households. As a result, the housing market responds less effectively to demographic changes, leading to a mismatch between population and housing. Addressing the mutual matching of housing and population in cities is essential for the promotion of social integration, as well as the achievement of new urbanization strategies.

1.2. Land market and housing supply

Housing and land are institutionally inseparable. In the early days, the government viewed land as an asset. The commoditization of land became a means of generating revenue and paved the way for the massive development of commercial housing in China. However, the assetization of land stimulated an increase in housing assetization, making housing affordability an increasingly acute problem in China's cities, especially for those new entrants to the housing market (Chen & Wu, 2022). Since 2008, the importance of urban land has been increasing and the supply of urban construction land has attracted great attention and regulation by the government. Government intervention in the land market generally takes two forms: land use regulation and direct government control of land supply. When government obtain direct control over residential land supply, it usually determines the quantity of land supply based on the projected demand for housing (Chiu, 2007). At a certain building density, the quantity of land supply should be positively related to the quantity of new housing supply. When there is an adequate supply of land, developers are able to respond quickly to an increase in housing price by building more housing units. By contrast, the responsiveness of new housing supply to change in housing price will be constrained when land supply is inadequate (Yan et al., 2014).

When the government intensified its intervention in the land market, the supply of residential land was severely restricted. When the supply of residential land decreases, developers race to buy government land, making land prices high, which in turn promotes higher costs for the housing built. Despite rapidly rising home prices, more than half of all households are still interested in buying a new home. The central policy has introduced purchase restriction policies in the hope of controlling housing demand, yet it has not cooled the city's real estate market,

which stems from the fact that the localized policies might be, to a certain extent, different from the central government's original guidelines. When local municipal government formally issued its localized measures for implementing the central government's policies, the market uncertainty induced by the State Council's notice disappeared, confidence about the future growth of housing prices was rebuilt up. Some potential homebuyers who are not excluded from the market by the limits seized the opportunity to purchase homes, therefore driving up housing prices. This was far from the expectations of policy makers (Jia et al., 2018).

1.3. Analysis of urban housing types and problems

China's urban housing reform has resulted in a housing system that is increasingly market-oriented. This shift has given rise to the coexistence of numerous distinct housing types. China has implemented the dual housing supply system consisting of commercial housing provided by the private sector and social housing provided by the public sector. The current housing supply mainly consists of private sector housing (regular commercial housing), subsidized housing (e.g., affordable housing), and public rental housing (e.g., talent apartments). Commercial housing is built by private developers and sold at market-determined prices. Therefore, the supply of commercial housing is excessive and the prices are rising too fast. Affordable housing is planned and directed by the state. It has the characteristics of economy, security, and practicability, and can be suitable for the affordability of low- and middle-income families. The talent apartment serves as a rental living facility that supports talent employment and provides temporary living arrangements for entrepreneurs in a specific location. The apartment follows the principle of renting rather than selling, with a household size ranging from 10 to 200 m^2 and a limited rental period. Its accommodation is primarily provided to professionals, doctors, and both international and local university students who have not purchased their own houses and are not entitled to other subsidized housing. At present, China's urban housing system faces some unresolved internal contradictions, such as rapidly increasing prices for regular commercial housing, insufficient coverage of subsidized housing and public rental housing, and a mismatch of housing supply and demand levels, calling into question the effectiveness of existing land supply policies. Although land allocations for residential development have increased, they have not matched the growth in housing demand. Policies to regulate access to housing for urban migrants further add to the complexity and can be socially destabilizing.

1.3.1. Excessive price increase of regular commercial housing

In previous years, data from China's statistical yearbook reveals that the average cost of commercial housing has increased from 1854 yuan/m^2 to 9980 yuan/m^2 (National Bureau of Statistics of China, 2020). In some mega-cities, this price is even higher than 30,000 yuan, which outstrips the rise in the material index, such as Beijing and Shanghai. The burgeoning real estate investment sector is evident, as evidenced by the data released by the Zhengzhou Bureau of Statistics indicating that the total sales area of commercial housing was 209.99 million m^2 before 2010, which had risen to approximately 439.28 million m^2 by the end of 2020 (Henan Province Bureau of Statistics [HAPBS], 2021). The proportion of investment has gradually increased from 22% in 2007 to 43% in 2017, with the proportion of real estate investment remaining above 30% since 2011. Housing prices have continued to increase annually. The real estate market began to rise steadily in 2010, and by 2016 Zhengzhou house prices began to soar, and since then the rise has eased. After nearly ten years of development, the average price of commercial housing in Zhengzhou has reached 10,215 yuan/m^2 in 2020 from 3,994 yuan/m^2 in 2007. The high price of housing has brought great pressure on the life of ordinary urban residents.

1.3.2. Insufficient coverage of affordable housing

The proliferation of commercial housing is advancing expeditiously, while the subsidized housing construction that is spearheaded by the government is consistently underprovided. Consequently, this has not only resulted in a swift escalation of housing costs, but also in a disparity within the housing system. The supply of affordable housing is relatively limited, and local governments tend to restrict the resources for affordable housing to the local household population. In other words, the threshold for obtaining affordable housing is so high that it fails to cover the large numbers of rural migrants and urban workers in the process of urbanization (He et al., 2022). In addition, cities with more dependence on land finance and higher fiscal autonomy were less likely to devote land to affordable housing construction unless local governments' reliance on urban land-based interests is weakened. Although the central government has issued a series of guaranteed housing support policies to help ease the housing difficulties of new citizens, young people, etc., local government revenues are mainly dependent on land grant revenues, and high land prices allow local governments to achieve rapid short-term economic growth (Zou, 2014). In cities with a high level of economic development, housing and land prices are high, leading to high costs for sheltered housing. It can be seen that resources for affordable housing are not well concentrated in areas with high rates of population urbanization, and there is a certain degree of spatial mismatch (He et al., 2022).

1.3.3. A mismatch between supply and demand levels

Another significant factor contributing to elevated housing prices is the incongruity that exists between supply and demand. A spatial partition between the demand for housing and the supply of land exacerbates the predicament of the dislocation between the demand and supply

of housing. This predicament is gradually escalating. The equilibrium between the housing supply and demand varies considerably across different regions in China. Some regions experience a scarcity of housing supply, while others have an oversupply of housing in the market (Weng & Pan, 2019). Furthermore, the present occupancy of the subsidized housing primarily comprises of resettled households, which strays from the initial aim of safeguarding the housing rights and interests of the low- and middle-income urban groups. Additionally, the design of the housing does not align with their living necessities. This incongruity between supply and demand will inevitably result in a significant accumulation of commercial housing. On one hand, certain individuals are incapable of affording housing, while on the other, some high-income individuals possess multiple residences. In order to curb excessively high housing prices, China's Central Government has announced a policy of restricting home purchases. While the purchase restriction policy reduced house prices and transaction amounts, it did not affect the housing investment or construction market. Heterogeneity exists across cities, with first- and second-tier cities, as well as highly urbanized cities, experiencing significant reductions in house prices following the implementation of the policy, but the housing policy is less effective in curbing speculative demand (Wu & Li, 2018).

2. Model construction and analysis

Based on the aforementioned housing development issues prevalent in major urban centers, the present study aims to establish a model for the progression of housing advantages in said areas, which aligns housing categories with corresponding population demographics and fosters the healthy growth of urban housing. To this end, regression analysis was conducted on the factors influencing the supply and population distribution of housing in Zhengzhou, utilizing data procured from "Henan Statistical Yearbook" (HAPBS, 2021), "Zhengzhou Housing Security and Real Estate Bureau 2021 Annual Report on Government Information Disclosure" (Zhengzhou Housing Security and Real Estate Bureau, 2021).

2.1. Variables selection and regression model

In recent years, Zhengzhou has been developing continuously, becoming a national central city and an international comprehensive transportation hub, with a strong population absorption force in the Central Plains. As a result, population density has increased significantly and housing has become an important issue. In previous studies on the relationship between population and housing, some scholars have divided the population by household size (Day, 2018), population structure (Choi et al., 2019), and mobility status (Li et al., 2022). In this paper, from the perspective of population attributes, we mainly select the resident population, registered population, migrant workers, university graduates, and the group of college students, and there are differences in the housing demand among these different population attributes.

The permanent residents who have already integrated into the city, formed their families and lived in the city for a long time. They have a certain economic base and can afford the price of general commercial housing. The registered population is divided according to the place of registration of the household, and they have the housing benefits of that city. The restriction on housing registration makes it easier for the registered population to qualify for housing. Moreover, cities are now reforming their household registration systems to attract talent, and have enacted a number of subsidized settlement policies. Therefore, the demand for housing by the registered population can well reflect the development of the city. Migrant workers have an even more profound impact on urban housing. They are constantly flowing into cities and choosing urban life for the sake of their children's education and improved quality of life, which has led to a growing urban population and rapidly rising housing prices (Wang et al., 2017). However, the majority of them are primarily occupied in occupations that offer lower wages, and their absence of official residency status poses a challenge in accessing affordable urban housing, thereby exacerbating the severity and complexity of the housing issue. The annual increase in the count of individuals with university degrees results in a new cohort of youthful migrants emerging from educational institutions. As they leave the educational system for the first time, they find themselves in a transitional phase characterized by economic vulnerability and the need to further refine their skills across diverse domains. Consequently, this has prompted municipal authorities across different cities to direct their attention towards the housing predicament faced by these graduates, in an endeavor to exert their utmost efforts in aiding the aspiring citizens and young individuals, among others, in mitigating the challenges encountered in securing housing. Urban housing prices affect the job location choice of college graduates (Lin et al., 2022). Although most cities have provided housing subsidy policies for graduates for talent introduction, the current housing prices are still beyond the graduates' financial ability (Li et al., 2017), and most of them have to choose the form of talent apartments with rented rooms, becoming a new generation of housing difficulty body. The number of college students in Zhengzhou has even exceeded one million. Although many schools provide cheap accommodation for college students, growth in the number of college students has increased demand for accommodation beyond that which universities themselves can provide, provoking private investor supply-side responses. The large number of students seeking off-campus rental housing has created pressure on the city's rental housing market (Sood & Vicino, 2023; Wilkinson & Greenhalgh, 2022). Although college students become graduates or permanent residents of the city after a few years, new groups of

college students are also increasing every year, and they still have an important impact on urban housing.

Therefore, we choose these five groups of population as the independent variable, and the amount of new area of general commercial housing, talent apartments and affordable housing as the dependent variable for the different housing needs of these groups. We establish the regression equation model of population attributes and housing. The symbols are described in Table 1.

Table 1. Representation of regression model variables

Symbol	Implication	Unit
X_1	Permanent resident population	10,000
X_2	Registered population	10,000
X_3	Migrant workers	10,000
X_4	University graduates	10,000
X_5	College students	10,000
Y_1	New commercial housing	10,000 m^2
Y_2	New talent apartments	10,000 m^2
Y_3	New affordable housing	10,000 m^2

$$Y_1 = A + aX_1 + bX_2 + cX_3 + dX_4 + eX_5;$$

$$Y_2 = B + fX_1 + gX_2 + hX_3 + iX_4 + jX_5;$$

$$Y_3 = C + kX_1 + lX_2 + mX_3 + nX_4 + oX_5,$$

where A, B, C, a, b..., o are unknown parameters.

2.2. Data collection and organization

The data pertaining to population and real estate utilized in this study has been sourced from the appropriate official government websites and platforms, namely, "Henan Statistical Yearbook" (HAPBS, 2021), "Zhengzhou Housing Security and Real Estate Bureau 2021 Annual Report on Government Information Disclosure" (Zhengzhou Housing Security and Real Estate Bureau, 2021). According to the statistical data, the data on the population types and housing types in Zhengzhou in the past ten years are obtained. The specific data are shown in Table 2, and Table 3.

A regression equation was established based on the relationship between the dates from 2010 to 2020 and each population type, and then the independent variable date was substituted into the equation to obtain the population type prediction data for each year. The forecast data

Table 2. 2010–2019 population data

Date	Permanent resident population	Registered population	Migrant workers	University graduates	College students
2010	866	734	115	56	102
2011	886	744	120	60	103
2012	903	758	119	67	116
2013	919	762	125	72	125
2014	938	785	130	80	137
2015	957	810	134	85	146
2016	972	827	141	91	157
2017	988	842	144	104	180
2018	1014	863	149	106	184
2019	1035	878	146	116	200

Table 3. 2010–2019 housing data

Date	New commercial housing	New talent apartments	New affordable housing
2010	1200	0	120
2011	1306	0	150
2012	1226	0	136
2013	1313	0.4	132
2014	1293	0.6	140
2015	1695	1	167
2016	2571	1.3	230
2017	2735	2.5	284
2018	3330	2.8	360
2019	3242	3	340

Table 4. Predicted data of Zhengzhou population type from 2021 to 2035

Date	Permanent resident population	Registered population	Migrant workers	University graduates	College students
2021	1296	1054	183	135	215
2022	1340	1093	191	141	223
2023	1389	1132	198	149	235
2024	1434	1161	205	156	243
2025	1469	1182	212	164	252
2026	1506	1210	219	169	259
2027	1548	1249	226	175	266
2028	1580	1288	233	181	271
2029	1610	1327	240	186	278
2030	1640	1366	247	192	288
2031	1675	1405	254	198	297
2032	1706	1444	261	203	307
2033	1752	1474	270	209	317
2034	1789	1503	278	216	326
2035	1826	1536	288	225	336

Table 5. Forecast data for each housing type based on natural development trends

Date	New commercial housing	New talent apartments	New affordable housing
2021	3835.23	3.636	367.681
2022	4110.86	3.952	393.142
2023	4386.49	4.268	418.603
2024	4662.12	4.584	444.064
2025	4937.75	4.9	469.525
2026	5213.38	5.216	494.986
2027	5489.01	5.532	520.447
2028	5764.64	5.848	545.908
2029	6040.27	6.164	571.369
2030	6315.9	6.48	596.83
2031	6591.53	6.796	622.291
2032	6867.16	7.112	647.752
2033	7142.79	7.428	673.213
2034	7418.42	7.744	698.674
2035	7694.05	8.06	724.135

of population types for Zhengzhou from 2021–2035 are shown in Table 4.

We forecast housing types from 2021 to 2035 based on real estate trends. With the new commercial housing, new talent apartments, and new affordable housing as the dependent variables and the date as the independent variable, we obtained the regression equations between the three housing types and the date through linear regression analysis by SPSS, and then calculated the forecast data of housing types from 2021–2035, as shown in Table 5.

2.3. Regression analysis of population type and housing type in Zhengzhou from 2010 to 2019

Considering that there may be multicollinearity problems between variables, multivariate analysis is used to analyze the multivariate linear relationship between all independent variables and dependent variables, as shown in Table 6.

It can be seen that the registered population of Zhengzhou has the greatest impact on the total area of new commercial housing, and the demand for commercial housing from non-local residents in Zhengzhou is also increasing.

Table 6. Relationship between the independent variables and the area of new commercial housing

Model	Unstandardized coefficient		Standardized coefficient	*t*	Sig.
	B	Std. Error	Beta		
(Constant)	–5856.357	6823.789		–0.858	0.439
College students	–5.603	15.765	0.219	–0.355	0.740
Registered population	17.144	7.629	1.013	2.247	0.088
Migrant workers	33.221	30.833	0.546	1.077	0.342
Permanent resident population	–11.265	5.949	0.730	–1.893	0.131
University graduates	14.888	26.385	0.367	0.564	0.603

Table 7. Relationship between the independent variables and the area of new talent apartments

Model	Unstandardized coefficient		Standardized coefficient	*t*	Sig.
	B	Std. Error	Beta		
(Constant)	6.382	12.424		0.514	0.635
College students	0.019	0.029	0.666	0.672	0.538
Permanent resident population	–0.014	0.011	0.815	–1.316	0.259
Registered population	–0.009	0.014	0.477	–0.659	0.546
Migrant workers	0.082	0.056	1.197	1.470	0.216
University graduates	0.018	0.048	0.402	0.385	0.720

Table 8. Relationship between the independent variables and the area of new affordable housing

Model	Unstandardized coefficient		Standardized coefficient	*t*	Sig.
	B	Std. Error	Beta		
(Constant)	–1081.066	1356.987		–0.797	0.470
College students	–2.593	3.135	1.068	–0.827	0.455
Permanent resident population	–0.756	1.183	0.516	–0.639	0.558
Registered population	1.858	1.517	1.156	1.225	0.288
Migrant workers	5.707	6.131	0.988	0.931	0.405
University graduates	1.526	5.247	0.395	0.291	0.786

College students are unlikely to buy commercial housing in the short term, and may not necessarily stay in Zhengzhou in the future, so the correlation with the total area of new commercial housing is low. Then we continue to analyze the relationship between the independent variables and the area of new talent apartments, as shown in Table 7.

From Table 7, it can be seen that the population of migrant workers and the resident population of Zhengzhou have the most obvious influence on the area of new talent apartments. With many universities purchasing talent apartments for their students or teachers, it leads to an increased correlation between the number of college students and the area of new talent apartments. Finally, we analyzed the relationship between the respective variables and the area of new affordable housing, as shown in Table 8.

It can be seen that the registered population and college students in Zhengzhou are strongly correlated with the new affordable housing. Affordable housing is mainly for middle- and low-income groups to live in peace, and the college group is also a major part of affordable housing.

From the above tables, it can be seen that the sig values between the independent variables and the dependent variable are all much greater than 0.05. Since there is an inclusion relationship between the individual samples and the phenomenon of multicollinearity between the variables, we adopt the ridge regression analysis method to determine the coefficients of the regression equation.

2.4. Determination of regression equation coefficients by ridge regression analysis

Ridge regression analysis is carried out on the relationship between the respective variables and the new commercial housing area, the new talent apartments area, and the new affordable housing area, among which:

PRP – Permanent resident population; RP – Registered population; MW – Migrant workers; UG – University

graduates; CS – College students; CH – New commercial housing area; TA – New talent apartments area; AH – New affordable housing area.

Ridge regression analysis on the relationship between each variable and the new commercial housing area. The analysis results are shown in Tables 9 and 10.

The regression equation between the independent variables with the new commercial housing area is derived from the SPSS ridge regression operation:

$$Y_1 = -7450 - 11 \cdot \mathrm{PRP} + 17 \cdot \mathrm{RP} + 33 \cdot \mathrm{MW} + 15 \cdot \mathrm{UG} - 5 \cdot \mathrm{CS}. \quad (1)$$

The ridge regression analysis is carried out on the relationship between the respective variables and the new talent apartments area. The analysis results are shown in Tables 11 and 12.

It can be concluded that the regression equation between the independent variables and the new talent apartments area is as follows:

$$Y_2 = -180 - 0.014 \cdot \mathrm{PRP} - 0.009 \cdot \mathrm{RP} + 0.825 \cdot \mathrm{MW} + 0.185 \cdot \mathrm{UG} + 0.193 \cdot \mathrm{CS}. \quad (2)$$

The ridge regression analysis is carried out on the relationship between the independent variables and the new affordable housing area. The analysis results are shown in Tables 13 and 14.

It can be concluded that the regression equation between the independent variables and the new affordable housing area is as follows:

$$Y_3 = -1281 - 7.6 \cdot \mathrm{PRP} + 1.9 \cdot \mathrm{RP} + 5.7 \cdot \mathrm{MW} + 1.5 \cdot \mathrm{UG} - 2.6 \cdot \mathrm{CS}. \quad (3)$$

It is discernible from the expressions of the aforementioned three equations that the analysis of these three scenarios is more intricate. This is unequivocally linked to the fact that certain independent variables exhibit a decline or negative growth rate; nonetheless, in general, we can observe the degree of correlation between the independent variables and the dependent variable. There exists an inverse correlation between diverse housing types and the permanent resident population in Zhengzhou, which may be attributed to the exorbitant housing prices and the exclusionary effect. Housing strays from residential attributes and gravitates towards attracting investment capital and a

Table 9. Model summary

R	R^2	Adj. R^2	SE	F	Sig. F
0.995154	0.990332	0.978247	130.704443	81.948674	0.000405

Table 10. Model paraments

Variable	B	SE(B)	Beta	B/SE(B)
PRP	–11.265154	5.949482	–0.730059	–1.893468
RP	17.144285	7.628710	1.013218	2.247337
MW	33.221186	30.833001	0.546448	1.077455
UG	14.888051	26.384950	0.366617	0.564263
CS	–5.603453	15.765017	–0.219237	–0.355436
Constant	–7450.357209	6823.788737	0.000000	–0.858227

Table 11. Model summary

R	R^2	Adj. R^2	SE	F	Sig. F
0.987448	0.975054	0.943872	0.237977	31.269497	0.002655

Table 12. Model paraments

Variable	B	SE(B)	Beta	B/SE(B)
PRP	–0.014252	0.010832	–0.814873	–1.315696
RP	–0.009157	0.013890	–0.477463	–0.659281
MW	0.082498	0.056139	1.197196	1.469540
UG	0.0184881	0.048040	0.401663	0.384854
CS	0.019298	0.028704	0.666138	0.672322
Constant	–180.382275	12.424274	0.000000	0.513694

Table 13. Model summary

R	R^2	Adj. R^2	SE	F	Sig. F
0.978592	0.957641	0.904693	25.992046	18.086376	0.007520

Table 14. Model paraments

Variable	B	SE(B)	Beta	B/SE(B)
PRP	–0.756008	1.183121	–0.515707	–0.638994
RP	1.857748	1.517055	1.155650	1.224575
MW	5.706606	6.131489	0.988024	0.930705
UG	1.525563	5.246944	0.395423	0.290753
CS	–2.593451	3.135051	–1.068051	–0.827244
Constant	–1281.065901	1356.987123	0.000000	–0.796666

mobile population. The association between commercial housing and the population is more pronounced. Among these, the migrant population evinces a stronger correlation with commercial housing. The process of urbanization has led to an upsurge in the number of migrants in major cities, which signifies people's yearning for superior housing and resources, consequently contributing to the escalation in commercial housing prices. The degree of positive correlation between the population of college graduates and the area of commercial housing is greater than that of talent apartments. Talent apartments are primarily associated with attracting college graduates to promote urban innovation and development. Most college talents still place their aspirations on commercial housing. This could be due to the fact that talent apartments are not suitable for family populations, and new talents require more extensive commercial housing to settle in the city. In the forthcoming times, it is imperative to provide appropriate apartments in accordance with the talent structure. For instance, certain smaller-sized apartments are suitable for students. It may be feasible to moderately augment the investment in apartments, enhance the quality of apartments, and provide housing security for high-level talents. The groups inhabiting affordable housing mainly comprise of middle- and low-income groups who migrate to Zhengzhou for work and household registration. Hence, it can be deduced that when the price of commercial housing ascends excessively, it is essential to construct high-quality affordable housing to cater to people's living security.

3. Advantage path prediction analysis

Previous research indicates a strong correlation between population attributes and housing type. Therefore, it is imperative that future studies focus on the alignment of these two factors to alleviate housing difficulties. Such an approach would not only facilitate a more precise and appropriate housing supply for the market but also provide a foundation for decision-making by the government and private companies, ultimately leading to the development of housing types that cater to market demands and meet the needs of the populace. The future housing supply type can be predicted by analyzing the previous regression analysis of population and housing as well as the population forecast data from 2021 to 2035, after which the future population type and housing type can be further examined.

3.1. Forecast data of new housing supply types from 2021 to 2035

Using SPSS, the regression equation between the new housing types and the population attributes from 2010 to 2019 was obtained, as shown in Table 15.

Table 15. The population attributes of Zhengzhou City are related to the regression relationship between various housing supplies

Regression equation types	Regression equation
The regression equation of commercial housing and population types	$Y_1 = -7450 - 11 \cdot \mathrm{PRP} + 17 \cdot \mathrm{RP} + 33 \cdot \mathrm{MW} + 15 \cdot \mathrm{UG} - 5 \cdot \mathrm{CS}$
Regression equation of talent apartments and each population type	$Y_2 = -180 - 0.014 \cdot \mathrm{PRP} - 0.009 \cdot \mathrm{RP} + 0.825 \cdot \mathrm{MW} + 0.185 \cdot \mathrm{UG} + 0.193 \cdot \mathrm{CS}$
Regression equation of affordable housing and each population type	$Y_3 = -1281 - 7.6 \cdot \mathrm{PRP} + 1.9 \cdot \mathrm{RP} + 5.7 \cdot \mathrm{MW} + 1.5 \cdot \mathrm{UG} - 2.6 \cdot \mathrm{CS}$

Table 16. Forecast data of housing types in Zhengzhou from 2021–2035

Date	Commercial housing	Talent apartments	Affordable housing
2021	3442	13	439
2022	4159	25	436
2023	4574	33	498
2024	4990	40	560
2025	5405	48	622
2026	5821	56	685
2027	6236	64	747
2028	6652	71	809
2029	7067	79	871
2030	7483	87	933
2031	7898	94	995
2032	8314	102	1057
2033	8794	111	1131
2034	9957	100	1486
2035	10690	112	1584

Then use the regression equation between the housing types and various population types to calculate the forecast data of each housing type from 2021 to 2035, as shown in Table 16.

Comparing the forecast data of each house type under the natural development trend in Table 5 with the forecast data under the development trend of the reference population attributes in Table 16, it can be seen that the predicted data for housing type, under the influence of demographic type factors, has a great difference. This also explains the necessity of studying the matching of population attributes and housing type to a certain extent.

3.2. The matching of population attributes and talent apartment

To enhance urban construction and development, municipalities furnish elite apartments to entice high-caliber talents to settle down. In 2017, the Zhengzhou administration promulgated a talent policy to attract talents at all levels to propel development. Given the surging housing prices and rents in numerous cities, particularly first and second-tier cities, lodging has emerged as a crucial consideration for young individuals when selecting a city, especially college graduates (Wang et al., 2021). Consequently, providing talent apartments for college graduates and other cohorts plays a pivotal role in aiding Zhengzhou City's talent acquisition scheme. As a result of the talent apartment's guaranteed and low price, the administration shoulders the primary responsibility for the relevant construction and supply. Thus, the administration ought to consider fully the dynamic demand for talent apartments from college graduates and other groups in the context of talent acquisition, augment investment in the construction and supply of talent apartments, to effectively satisfy the housing needs of diverse talent groups, and align with the size of the new population in Zhengzhou.

3.3. The matching of population attributes and affordable housing

Under the circumstance of demographic change, the domain of affordable housing is anticipated to exhibit an upward trajectory in the forthcoming years. Affordable housing, which is a form of commercial housing that guarantees its nature, is of paramount importance in addressing the housing requirements of the populace, particularly those belonging to the low- and middle-income strata. With an increasing influx of immigrants to Zhengzhou, affordable housing, which is characterized by relatively low prices and guaranteed nature, has emerged as a critical welfare project that supports the process of urban expansion and demographic growth. The construction and provision of affordable housing necessitate not just the leadership of the government but also its implementation at the micro-operational level. The government should augment its endeavors in planning, construction, and investment to ensure an orderly and adequate supply of affordable housing. Furthermore, it should also take into account the equitable distribution of affordable housing and devise a gradient supply model to meet the needs of a wide range of groups. More importantly, it also needs to consider the spatial suitability of affordable housing, so that affordable housing does not only exist in the suburban areas of the city and meets people's basic transportation needs.

3.4. The matching of population attributes and commercial housing

The largest sector of residential areas is currently comprised of commercial housing. Zhengzhou is presently

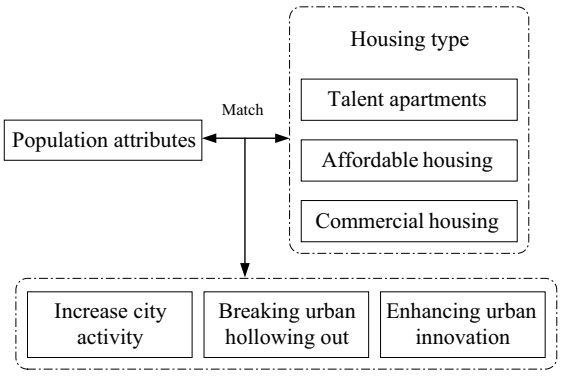

Figure 1. Advantages of housing matching population mechanism

accelerating the development of its metropolitan region. The establishment of high-quality integrated development of the Central Plains urban agglomeration depends on satisfying the housing needs of the population as a fundamental and obligatory requirement. The provision of commercial housing in an orderly manner is of paramount importance. However, the assurance of adequate supply does not entail a laissez-faire approach to the haphazard development of commercial housing. Instead, it necessitates an increase in effective supply and the provision of commercial housing that is relevant to the type of population and the demands of consumers. This will not only mitigate or inhibit the problem of escalating housing prices due to a decrease in supply in the residential market but also safeguard the housing needs of the population. While ensuring the supply of commercial housing, it is also pertinent to consider that continuous investment in the capital of the commercial residential market will create further inflationary pressure. Hence, the government must adopt administrative and legal measures to increase macro-control of the real estate market. It is also crucial to collect data and manage the types of commercial housing developed by companies to effectively regulate the market inflow of commercial housing, especially the supply of different types of housing to correspond to the type of population.

After the above analysis, the appropriate matching mechanism between population attributes and housing types is shown in Figure 1.

Conclusions and discussion

The present study's investigation has demonstrated a close correlation between population attributes and housing type. At present, a severe asymmetry exists between the supply and demand of housing. The scarcity of reasonably priced housing, such as talent apartments and affordable housing, has contributed to housing's investment properties, thereby exacerbating the discrepancy between supply and demand. The mismatch between urban populations and housing will lead to the financialization of housing investment and an increase in housing prices. Properly aligning population attributes and housing type can alleviate the housing difficulties faced by large cities and presents an effective solution to returning houses to residential properties. This mechanism is pivotal to resolving the supply and demand contradictions in large cities, as well as the contradictions between residents' income and housing prices. Additionally, it serves as a crucial element in addressing the contradiction between the government's reliance on land finance and the assurance of essential housing needs for residents. The specific research findings are outlined below.

(1) The development of forthcoming housing varieties is influenced by the evolution of population varieties. When the diversity of housing provision is aligned with the housing requirements of individuals, it can diminish the need for housing investments. Individuals depend on affordable housing, low-cost housing, urban villages, and long-term rental apartments to fulfill their basic needs, which can mitigate the housing burden of people with low- and middle-income and resolve their housing predicaments. The government ought to augment the supply of subsidized housing. This subsidized housing can resolve the housing predicament, diminish people's aspirations for future housing price increments, and restore the housing provision to the aspect of housing needs of diverse population types.

(2) There is a strong correlation between different types of housing and urban population inflows and outflows. Over time, urban population inflows will generate different intensities of demand for different types of housing, so the type of housing supply should be a dynamic adjustment process. Planning housing supply according to the different attributes of the population will be effective in reducing housing prices.

(3) Matching housing classifications with the populace and ensuring the fundamental housing needs of individuals are met represents the crux of resolving the aforementioned issues. One should augment the availability of subsidized housing, as well as refine the entrance and exit mechanisms pertaining to such housing, in order to satisfy the housing needs of the majority of individuals with middle to low-income levels. Simultaneously, it is imperative to safeguard the land intended for elementary urban construction. The government should further alleviate restrictions on migration, while simultaneously tailoring housing subsidies to individuals with distinctive talents. This will foster an environment that is conducive to innovation and entrepreneurship, and promote the stability of employment for local and foreign university students in Zhengzhou. Such measures will enhance urban activism and advance urban innovation.

The aforementioned findings hold significant reference value for the formulation of China's housing policy. Firstly, the local government ought to construct a multi-tiered housing supply system based on the population's attributes and quantity to cater to the varied requirements of diverse groups. They must not only rationally plan the number of self-owned, commercial housing, subsidized housing, public rental housing, and dilapidated communities, etc.,

but also provide differentiated housing supply for different groups to mitigate housing prices and address the housing demands of low- and middle-income individuals, including urban migrants and new citizens. Secondly, it is vital to establish sound entry and exit mechanisms for subsidized housing. The government should prohibit middle and high-income individuals from acquiring subsidized housing and extend the coverage scope for low-income individuals. It should oversee the subsequent income of family members who have already obtained guaranteed housing so that those who no longer satisfy the requirements shall withdraw from guaranteed housing. Lastly, it is imperative to foster the high-welfare talent settlement policy and the reform of the household registration system, and to guarantee that highly skilled talents can live and work in Zhengzhou. The government should provide eligible personnel with Provide guaranteed rental housing, and give a certain area subsidy to those who rent market-oriented rental housing, so as to take advantage of low housing prices to retain talents and attract talents.

The research in this paper, undoubtedly, presents certain limitations. The paper employs data concerning the population and housing in Zhengzhou City, Henan Province. Nevertheless, the selection of the city sample is relatively narrow. The focus of the study lies primarily in examining the relationship between housing demand across various demographic attributes and the prevailing housing supply. However, the variable of population income level remains absent. Although it is noteworthy that guaranteed housing is primarily a policy benefiting low-income groups, and we have included demographic variables such as graduates and migrant workers as representatives of this group, we find ourselves still lacking specific data to substantiate this claim. This deficiency arises from the challenge of obtaining income data for different attributes of demographic groups. Consequently, it becomes imperative to further investigate the impact of income level on housing in subsequent studies. Furthermore, taking into account the projected sluggish population growth and the impending aging problem, the rate at which new housing units will be developed is expected to decelerate. In order to offer a broader range of housing security, the government and relevant authorities must contemplate the rejuvenation of old housing structures as well as the provision of long-term rental housing in the future. Additionally, we plan to conduct a comparative analysis by selecting a large dataset from multiple cities.

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Author contributions

Zhifeng Shen and Jing Li conceived the study. Zhifeng Shen, Jing Li, Ahsan Siraj, Shilpa Taneja, and Zhihui Li were responsible for the design and development of the research. Zhihui Li and Jing Li were responsible for data collection and data interpretation. Jing Li, Ahsan Siraj, and Shilpa Taneja wrote the first draft, edited, and revised the article. All authors have read and agreed to the published version of the manuscript.

Disclosure statement

Authors declare that they do not have any competing financial, professional, or personal interests from other parties.

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