

Analysis of Population Structure Changes' Impact on Consumption Patterns Using Extended LA/AIDS and SUR Models: Evidence from China

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Abstract

In recent years, China's population structure has shown significant changes such as accelerated aging, sex ratio adjustment, shrinking family size, rising education levels and increasing urbanization. The study uses data regarding Henan Province from 2002 to 2022 as an example. It combines analyses using the extended LA/AIDS model and the SUR model to explore the impact of demographic changes on the consumption structure of the population and finds that demographic changes, in general, pay dividends to optimizing of the consumption structure, but the impact is multidimensional and complex. In urban areas, the increase in the elderly population inhibits from optimizing the consumption structure, while the growth of the highly educated population and the acceleration of urbanization have a positive effect; in rural regions, the increase of the elderly population and the highly educated population is unfavorable, but the optimization of the sex ratio, the reduction in household size and the increase in urbanization all facilitate the upgrading of the consumption structure.

Keywords: Demographic structure, consumption structure, structural dividend, LA/AIDS model

1. Introduction

Since 2016, China has entered the critical period of speeding up the construction of “a new development pattern with the domestic macro-cycle as the main body and the domestic and international double-cycle promoting each other”. The Chinese government clearly pointed out that “efforts should be made to expand domestic demand and enhance the fundamental role of consumption in economic development”[1]. It is not just the strategic choice of the government, but also the consensus of the academic community to expand residents' consumption demand, promote the transformation and upgrading of residents' consumption, and recognize the role of consumption as the backbone of the domestic cycle and the high-quality development of the economy[2]. The consumption structure is the core issue of consumption theory. Since 1978, China's residents have continued to optimize the consumption structure, which is specifically manifested in a reduction in the share of food, clothing and other survival-type consumption expenditures and an increase in the share of health care, education and entertainment and other development and enjoyment-type consumption expenditures. Optimizing residents' consumption structure requires the industrial structure to make adaptive adjustments to meet the people's increasing needs for a better life. However, the reality is that the adjustment of China's industrial structure in response to changes in the consumption structure of the population is still lagging. The reason for this is that the factors influencing the consumption structure of the population in the new period are not accurately grasped, resulting in a structural imbalance in supply and demand. Among the many factors affecting the consumption structure of the population, population is an important factor that cannot be ignored. In recent years, China's demographic development has

seen some significant changes, facing both the pressure of a large population and the challenges posed by the demographic transition. The population is the main body of consumption activities, and a demographic transition is bound to impact the consumption structure of residents. Therefore, clarifying the impact of demographic shifts on the consumption structure of the population is conducive to accurately grasping the direction of change in the consumption structure of the population, and laying out the relevant economic policies and industrial structure in advance, thus realizing the balance between supply and demand in the consumption of the population.

As the first province in the central region in terms of both population and economic output, the characteristics of the population structure and consumption of Henan Province reflect the overall demographic development of China and the realization of the strategy of expanding domestic demand. According to *the Communiqué of the "Seventh Universal Population Survey"*, compared with 2010, the natural, social and spatial structure of the population in Henan Province has undergone obvious changes, with the main features including aging of the population, a decline in the sex ratio of the population, miniaturization of the size of households, an improvement in the education level of residents, and an increase in the level of urbanization. Since the population is the main body of consumption activities, are changes in the demographic structure of Henan Province to optimize the consumption structure of residents a dividend or obstacle? How should the mechanism behind it be explained? The discussion of the above questions have great theoretical and practical significance for fully exploiting the consumption potential behind the demographic transition, unclogging the domestic circulation, and promoting the high-quality economic development of Henan Province and the entire central region.

This study selects time series data on urban and rural population structure and consumption structure in Henan Province from 2002 to 2022. By incorporating population structure variables into the traditional LA/AIDS model, we extend the model and, based on this, use the SUR method to empirically analyze the impact of population structure changes on residents' consumption structure.

2. Literature Review

The interplay between the population and consumption has been a hot issue in the academic world. The population structure is a systematic concept that mainly includes three dimensions of population: the natural (e.g., the population age structure and gender structure), social (e.g., the population's education structure and household structure), and spatial structures (e.g., the population's urban-rural distribution). Many scholars at home and abroad have explored the relationship between the population structure and residents' consumption from different dimensions, using qualitative or quantitative methods.

The impact of the natural structure of the population on consumption is centered on the age structure and gender structure, and Modigliani was the first to explore the relationship between the age structure of the population and consumption in 1954, he proposed the life cycle theory, which argues that individual consumption changes with age that people's willingness to save decreases when they enter the old age stage when the elderly population of a region increases, the overall saving propensity of the region decreases, and thus the overall saving propensity of the region decreases. Since the propensity to save will decrease, total consumption will increase[3]. However, there are significant differences in the views of subsequent scholars on the relationship between the population age structure and consumption demand. For example, some scholars believe that there is a significant negative relationship between the percentage of the elderly population and the overall consumption demand of residents[4,5]. In contrast, some scholars believe that an increase in the elderly population can promote residents' consumption[6,7]. Meanwhile, the gender structure also affects consumption. Zhao Shouguo and Sun Zhongpeng (2023) found that the level of consumption of residents is significantly negatively correlated with the gender ratio after regressing Chinese provincial panel data from the perspective of precautionary savings[8]. In addition, Jean Baudrillard (1998) argued that men and women have different consumption patterns, with women focusing on self-pleasing consumption and men advocating demanding and selective consumption[9].

The results of research on the interplay between the social structure of population and consumption are mainly focused on the level of education of residents and the household size. Michael (1975) was the first to study the interplay between the level of education of residents and consumption, and he believed that the improvement in education would increase the income of residents and change their concepts, which will affect the purchasing

power of the residents and their consumption behavior[10]. Feng Dan (2008) conducted a correlation analysis of the consumption behavior of people with undergraduate education and above, and found that in the highly educated group, consumption in the category of personal ability enhancement is negatively correlated with the level of education[11]. Regarding the impact of household size on residents' consumption, Gong Xu et al. (2012) argued that a reduction in the rural household size would lead to a decline in the consumption rate of farmers[12], while Fu Chonghui (2021) and others argued that an increase in one-person and two-person households would promote the growth of residents' consumption[13].

The proportion of the urban population to the total population, i.e., the urbanization rate, is the most typical indicator reflecting the spatial structure of the population. The dual urban-rural structure has prompted China's rural population to continuously migrate from the countryside to the cities. Lei Xiaoyu et al. (2014) argued that the agglomeration effect generated by the migration process would expand the consumption demand of residents[14]. However, Wen Guanzhong et al. (2010) argued that due to the incomplete nature of urbanization, there is a large difference between the urban non-household population and the household population in terms of welfare benefits and other aspects, which reduces the consumption expenditure of the urban non-household population[15]. In addition, Zhou et al. (2009) argued that the existence of the demonstration effect would cause the urban population to increase high-level consumption and reduce basic living consumption[16].

It is easy to surmise from the above research results that changes in population structure have a certain impact on the level or structure of residents' consumption, but due to differences in research samples and methodologies, scholars have reached inconsistent conclusions. The current studies provide a theoretical basis for this study. However, there are still some limitations: first, the existing research on population structure and residents' consumption mostly explores the relationship between the two at the level of total consumption, and there is a relative lack of research on the impact of consumption structure; second, in the research on the interplay between demographic factors and consumer behavior, the influencing factors of residents' consumption are limited to the single level of the population's age structure, gender structure, and so on, and there is a lack of comprehensive and systematic analysis of the population structure. Third, the impact of demographic factors on urban and rural residents' consumption is mostly judged from the overall demographic indicators at the national level. There is a lack of targeted research on a certain province and the impact of the demographic structure on the consumption structure of Henan Province. Based on this, the incremental contributions of this research are outlined below: first, in terms of research perspective, the time-series data on the population structure and consumption structure of urban and rural residents in Henan Province from 2002 to 2022 are selected. The demographic structure is divided into three dimensions, namely, the natural, social, and spatial structures, so as to systematically analyze the effects of the demographic changes on the consumption structure of the residents and the mechanism, and make up for the lack of the relevant empirical research in the past. Secondly, in terms of research methodology, through the introduction of representative indicators of the population structure, such as the proportion of the elderly population and the proportion of the population with tertiary education and above, the traditional LA/AIDS model is expanded. Regression is conducted using the SUR model to empirically analyze the impact of demographic changes on the consumption structure of the population in Henan Province, so as to provide a methodological reference for the subsequent research.

3. Mechanism of the Impact of the Demographic Transition on the Consumption Structure of the Population

3.1 Mechanisms of the natural population structure's influence on consumption structure

Henan Province has had an aging society since 2000. The seventh national population census bulletin shows that by the end of 2020, the number of people aged 65 and above in Henan Province reached 13.49% of the total population of Henan Province, totaling 13.4 million people. According to the United Nations aging standards, Henan Province will enter a moderately aging society during the 14th Five-Year Plan period, and aging will become an important trend in the change of the natural structure of the population in Henan Province.

According to the life cycle theory, the marginal propensity to consume for people of different ages is different due to the differences in their income, preference, and demand[17]. On the one hand, from the traditional point of

view, Chinese elderly do not have a strong desire to consume, the consumption vitality is low, and the consumption psychology is characterized by conservatism; in addition, the precautionary savings hypothesis points out that consumers make precautionary savings to cope with the uncertainty in the future, which will in turn, constrain their own consumption expenditures. Under the trend of aging, the increase in the proportion of the elderly population will inevitably increase the burden of the entire society and family pension; residents, in order to provide for their own or their elders' old age, have to carry out precautionary savings, and thus less enjoyment-type consumption expenditures, which impedes optimizing the residents' consumption structure. Especially in rural areas where disposable incomes are relatively low, aging is a more obvious obstacle to optimizing the consumption structure. On the other hand, thanks to the ongoing promotion in the social security system and the prosperous development of the "silver hair market", the consumption concepts of some of the elderly population have changed. Based on the pursuit of a better life, the elderly population's potential demand for enjoyment-type consumption, such as health and longevity, leisure and entertainment, and tourism, has been rising. Therefore, from another point of view, the aging demographic characteristics of the population provide an opportunity to optimize the consumption structure of the population, but this requires the concerted efforts of both supply and demand sides.

The gender structure is another important aspect of the natural structure of the population. The Henan Statistical Yearbook shows that in 2022, the sex ratio of the urban resident population in Henan Province was 95.68, and the sex ratio of the rural resident population was 100.6, a decrease of 9.38 and 5.69, respectively, compared with 2002. The decline in the sex ratio of the population means a relative increase in the female population and a relative decrease in the male population. The impact of the gender structure on the consumption structure of the population is primarily achieved through two paths: gender consumption differences and the marriage market.

Jean Baudrillard proposed two consumption paradigms for men and women in his book *Consumption Society*, combining the different physiological and social attributes of men and women: the male paradigm is characterized by rationality and selectivity, while the female paradigm is characterized by self-pleasure and impulsiveness. Compared with men, women pay more attention to the symbolic value of commodities and pursue showy, branded consumption; from this perspective, the increase in the proportion of the female population can increase residents' high-level consumption expenditure and optimize the residents' consumption structure[18]. Another path through which the gender structure affects consumption structure is the marriage market. The increase in the sex ratio will exacerbate men's pressure to marry, while housing, cars, and wealth are important reflections of men's competitiveness in the marriage market. In order to increase the likelihood of finding a spouse, male residents and their families spend a large portion of their income on "status symbols" such as housing and automobiles; in addition, the custom of a "high bride price" in some regions also causes residents to increase their "savings for choosing a spouse" as a precaution, squeezing out other consumption expenditures. The rise in the percent of women in the population eases the pressure on men to choose a spouse, prompting men to spend more of their income on other types of consumption. Therefore, the decline in the sex ratio can, to a certain extent, have an optimizing effect on the consumption structure of the population.

3.2 Mechanisms of influence of the population and social structure on the consumption structure

According to the data of the "*Seventh National Population Census of China*", the average household size in urban areas of Henan in 2020 was 2.78 persons, down 0.27 persons compared with 3.05 persons in 2010; the average household size in rural areas was 2.84 persons, down 0.74 persons compared with 3.58 persons in 2010, and the miniaturization of household size has become an important trend in the shift of the social structure of the population in Henan Province. The miniaturization of the household size has become an important trend in the social structure of the population in Henan Province.

On the one hand, household size is closely related to the fertility rate, and the miniaturization of household size is largely due to the decline in the fertility rate. Paul A. Samuelson put forward the theory of the household savings demand model. He believes that newborns and savings are substitutes for each other, and when the decline in fertility rate leads to a reduction in the size of the household, the household will reduce consumption and increase savings in order to cope with their own retirement expenses in the future[19]. It is also undeniable that small one-person and two-person households often face poverty due to having a single source of income, especially when

the household size is downsized due to family changes such as divorce or the death of a family member, which causes family members to reduce their own developmental and enjoyment consumption expenditures in light of the uncertainty of household income and expenditures. From these two perspectives, the miniaturization of household size may hinder from optimizing the consumption structure of the population. On the other hand, smaller households make family members more independent in their consumption decisions, promoting diversification and the personalization of consumption. Younger membership will also lead to a more open consumption mindset, with a greater inclination towards culture, education, and recreation, among other things. At the same time, the reduced dependency burden will also increase the purchasing power of family members, thus increasing the purchase of symbolic goods such as luxury goods and stimulating residents' consumption potential. Overall, therefore, the miniaturization of household size can contribute to optimizing the consumption structure of the population.

The educational structure of the population is also an important dimension of the social structure of the population. According to *the China Population and Employment Statistical Yearbook*, the proportion of the population with tertiary education or above in urban areas of Henan Province rose from 16.01% in 2002 to 28.88% in 2022, and the proportion of the population with tertiary education or above in rural areas rose from 1.13% in 2002 to 4.62% in 2022. Although there is a certain gap between these figures and those of developed regions, they still reflect the trend of optimizing the educational structure of the population in Henan Province.

People are the primary body of production and consumption, and the impact of the the educational level of the population on the consumption structure of the population can be explained from both the supply and demand sides. From the perspective of the supply side, Schultz pointed out in his proposed human capital theory that human capital plays a decisive role in the economic development of the whole society, and education is an important way to invest in human capital[20]. Highly educated people often have high professional skills and management capabilities; the increase in the proportion of this group is more conducive to driving the productivity of the whole society, promoting the optimization and improving of the industrial structure, making the industrial layout match the residents' continuously optimized consumption demand, and stimulating residents' consumption. From the perspective of the demand side, existing theories and practical experience have proved that the level of education is directly proportional to personal income, and the highly educated population is able to obtain more income, thus stimulating more consumption, not only limited to the consumption of survival materials, but also in the development of enjoyment-type material consumption. In addition, the consumption concepts of the highly educated population are more open and avant-garde, and this population is more capable of accepting some new types of consumer goods, which promotes the diversification of the consumption structure. In addition, the popularization of the Internet and the development of the digital economy have not only enriched the variety and quality of consumer goods but also changed the consumption mode from traditional offline consumption to a combination of online and offline consumption, and the mode of payment has also changed from traditional cash-based payment to electronic payment. The improvement in education can not only change the residents' consumption concepts, but also improve their consumption ability, so that they can adapt to the new consumption mode in the Internet era and optimize their consumption structure under the new consumption mode. Therefore, optimizing the education structure can drive the optimization of residents' consumption structure. However, what should be noted is that the increase in the level of education means that the cost of education is rising; based on the uncertainty of future investment in education, residents may restrain their current consumption desire and reduce their consumption expenditure other than the necessities of life with a future high income and consumption brought by the investment in education. Therefore, in the short run, there is often a relationship between an investment in education and current consumption.

3.3 Mechanisms by which the spatial distribution structure of the population affects the structure of consumption

The spatial structure of the population is concentrated in the urban-rural distribution of the population, which is often expressed by the urbanization rate. According to the data of the Henan Statistical Yearbook, in the 21 years from 2002 to 2022, the urbanization rate of Henan Province rose from 25.8% to 57.07%, and the level of urbanization increased significantly.

The impact of urbanization on residents' consumption can be explained at three levels: the income, demonstration, and agglomeration effects[21]. In the process of urbanization, rural laborers are transferred from primary industry to secondary and tertiary industries in towns and cities, and their income level is improved to a certain extent, indirectly stimulating their consumption demand. At the same time, consumption behavior is exemplary, and the consumption behavior of the transferred population is often influenced by the consumption concepts and behaviors of urban residents, stimulating their own consumption of cultural, educational, entertainment and other developmental and enjoyable materials, and promoting the transformation of the consumption structure to a higher level. The essence of urbanization is the process of population agglomeration in cities and towns, which makes human capital and material capital concentrate in cities and produces an agglomeration effect on the economic development of cities. This agglomeration effect can be reflected not only in the income of residents but also in the consumption environment: large shopping malls, e-commerce platforms, and other new business models make residents' consumption choices expand, which leads to the development of the consumption structure. New business models, such as large shopping malls and e-commerce platforms, expand residents' consumption choices, thus contributing to the diversification of their consumption structure. Therefore, urbanization can optimize residents' consumption structure through the income, demonstration, and agglomeration effects. However, the household registration system, which divides urban and rural areas, makes the "incompleteness" of China's urbanization very prominent, and the lower cultural quality and lack of social security create uncertainty about the future income and expenditure of the migrant population, thus restricting the optimization of its consumption structure. However, in the long term, urbanization can still result in the optimization of the consumption structure of the population.

In summary, this study puts forward the following hypotheses:

Hypothesis 1. Overall, demographic changes have a dividend effect on optimizing residents' consumption structure;

Hypothesis 2. The influence of demographic shifts on residents' consumption structure shows differences depending on the population's urban rural distribution, age structure, sex ratio, urbanization rate, education level, etc.

4. Empirical Analysis

4.1 Introduction of the LA/AIDS model and its extension

Deaton and Muellbauer first proposed the AIDS model (Almost Ideal Demand System) in 1980, which is essentially an econometric model obtained by expanding the price variable part of the theoretical model of Engel's coefficient, and the core idea is to minimize the expenditures for a given level of utility. The basic form of the AIDS model is as follows:

$$\omega_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \frac{X}{P} \quad (1)$$

The w_i is the share of i-th type of commodity in the total per capital consumption expenditure. p_j is the price of the j-th type of commodity. X is total per capital consumption expenditure. P represents the price index. And α_i , γ_{ij} , β_i are the parameters to be estimated.

P is calculated by the following formula:

$$\ln P = \alpha_0 + \sum_k \alpha_k \ln P_k + \frac{1}{2} \sum_k \sum_j \gamma_{k,j} \ln P_k \ln P_j \quad (2)$$

The individual coefficients in the AIDS model satisfy the following properties:

$$\text{additivity: } \sum_{i=1}^n \alpha_i = 1, \sum_{i=1}^n \gamma_{ij} = 0, \sum_{i=1}^n \beta_i = 0$$

$$\text{Chirality: } \sum_j \gamma_{ij} = 0; \text{ symmetry: } \gamma_{ij} = \gamma_{ji}.$$

In the practical application of the model, the Stone price index is commonly used as an alternative because the price index P is nonlinear and too difficult to measure. Therefore, the academic community often uses the Stone price index as a substitute for P . The Stone price index is calculated as follows $\ln P = \sum_i \omega_i \ln P_i$, where ω_i is the proportion of the i -th commodity in the total per capital consumption expenditure, and P_i is the price of the i -th commodity. The AIDS model that introduces the Stone price index is called the LA/AIDS model (Linear Approximated/Almost Ideal Demand System).

The LA/AIDS model has a solid theoretical foundation, is easy to use, and has been widely used by scholars at home and abroad to study various consumption structure issues. In recent years, many scholars have not been satisfied with the basic form of the model and extended the model by introducing one or more influencing factors of the consumption structure, such as Hu Ridong (2014) who extended the LA/AIDS model by introducing the disparity in income levels between urban and rural residents, and Gu Yuchen et al. (2022) who extended the LA/AIDS model by introducing the Internet penetration rate[22,23]. In this study, based on the traditional LA/AIDS model, the model is extended by introducing demographic factors, and this is used as the basis for subsequent econometric empirical analysis. The specific steps are as follows:

First, the variables of the natural structure of the population (the percentage of the population aged sixty-five and above and the sex ratio of the population), the social structure (the percentage of population with tertiary education and above and the average household size), and the spatial structure (the urbanization rate) are introduced into the base LA/AIDS model in the following form:

$$\omega_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \frac{X}{P} + \lambda_i \text{old} + \eta_i \text{sex} + \delta_i \text{edu} + \varepsilon_i \text{hou} + \chi_i \text{urb} \quad (3)$$

where ω_i is the share of i -th commodity in the total per capital consumption expenditure, p_j is the price of j -th commodity, X is the total per capital consumption expenditure, P is the Stone price index, old is the share of the elderly population, sex is the gender ratio of the population, edu is the share of the population with tertiary education and above, hou is the average household size, and urb is the urbanization rate.

Following Hu, Ridong et al. (2014), the effect of serial auto-correlation can be eliminated by performing first-order differencing on the model. The form after first-order differencing of the extended model is as follows:

$$\Delta \omega_i = \alpha_i + \sum_j \gamma_{ij} \Delta \ln p_j + \beta_i \Delta \ln \frac{X}{P} + \lambda_i \Delta \text{old} + \eta_i \Delta \text{sex} + \delta_i \Delta \text{edu} + \varepsilon_i \Delta \text{hou} + \chi_i \Delta \text{urb} \quad (4)$$

$$\Delta \ln p_j = \ln p_{j,t} - \ln p_{j,t-1} = \ln \frac{p_{j,t}}{p_{j,t-1}} = \ln k_{j,t} \quad (5)$$

where $k_{j,t}$ is the price index of the j -th commodity at moment t .

The Stone price index P satisfies $\ln P = \sum_i \omega_i \ln P_i$, so it can be obtained as follows:

$$\begin{aligned}
\ln \frac{P_t}{P_{t-1}} &= \ln P_t - \ln P_{t-1} \\
&= \sum_i \omega_{i,t} \ln P_{i,t} - \sum_i \omega_{i,t-1} \ln P_{i,t-1} \\
&= \sum_i \omega_{i,t} (\ln P_{i,t} - \ln P_{i,t-1}) + \sum_i \ln P_{i,t-1} (\omega_{i,t} - \omega_{i,t-1})
\end{aligned} \tag{6}$$

The existence of consumption inertia makes $\omega_{i,t} \approx \omega_{i,t-1}$, so equation (6) can be simplified to:

$$\ln \frac{P_t}{P_{t-1}} \approx \sum_i \omega_{i,t} (\ln P_{i,t} - \ln P_{i,t-1}) = \sum_i \omega_{i,t} \ln \frac{P_{i,t}}{P_{i,t-1}} = \sum_i \omega_{i,t} \ln k_{i,t} \tag{7}$$

In the same way, equation (4) can be transformed into:

$$\begin{aligned}
\Delta \omega_i &= \alpha_i + \sum_j \gamma_{ij} \Delta \ln k_j + \beta_i (\Delta \ln X - \sum_i \omega_i \ln k_i) + \lambda_i \Delta old + \eta_i \Delta sex + \delta_i \Delta edu \\
&+ \varepsilon_i \Delta hou + \chi_i \Delta urb
\end{aligned} \tag{8}$$

An estimation of equation (8) can be derived from the impact of each demographic factor indicator on the share of expenditure on various types of goods, and then determine whether demographic changes have promoted the optimization and promotion of the consumption structure of residents.

4.2 Data source and indicator selection

Considering China's unique urban rural dichotomy, this study constructs an LA/AIDS model with eight consumer goods categories, expands it with demographic factors, and conducts econometric analyses for urban and rural residents separately. In light of the *National Bureau of Statistics (NBS)*, the eight categories of consumer goods are food, clothing, housing, household equipment, health care, transportation and communication, education and entertainment, and other goods and services. Lv Zhike et al. (2020) classified the above eight categories of consumer goods into subsistence consumer goods and development and enjoyment consumer goods, of which food, clothing, and housing are subsistence consumer goods, and household goods and services, transportation and communication, health care, education, culture, and entertainment are development and enjoyment consumer goods[24]. With reference to this classification, this study regards the decline in the proportion of residents' expenditures on survival-type consumer goods of total consumption expenditures and the increase in the share of expenditures on development- and enjoyment-type consumer goods of total consumption expenditures as the optimization of residents' consumption structure. This study selects the time series data of the population structure and consumption structure of urban and rural residents in Henan Province from 2002 to 2022, in which ω_i -the proportion of urban and rural residents' expenditures on various types of consumer goods, p_i -the price indexes of various types of consumer goods in rural and urban regions, and X -the total consumption expenditures per capital of urban and rural residents are all obtained from the *Henan Provincial Statistical Yearbook (2003-2023)*. The price indices of various types of consumer goods are all converted to the data for the base period in 2002. The price indexes of various consumer goods are converted to the base period of 2002. The natural structure, social structure and spatial structure of urban and rural populations are introduced, with the proportion of the population aged 65 and above, the sex ratio of the population, the proportion of the population with tertiary education and above, the average household size, and the urbanization rate as proxies, respectively. The selected population structure variables are all derived from the *China Demographic Statistics Yearbook (2003-2006)* and the *China Population and Employment Statistics Yearbook (2007-2023)*.

4.3 Parameter estimation

Since there are multiple consumption expenditure equations in the model, some random factors may cause contemporaneous correlation between the perturbation terms of the equations, and the model after first-order

differencing does not contain an intercept term; the effectiveness of parameter estimation can be improved by using the SUR model for system estimation.

Because the consumption of “other goods and services” accounts for a small proportion of the total consumption expenditure of residents, and the statistical caliber of such consumer goods varies from year to year, we consider deleting the item of “other goods and services” in the subsequent econometric analysis. In order to avoid the influence of a singular matrix on the validity of the parameter estimation results, the system of equations is estimated two times: The first time, we first exclude the equation for “food” and estimate the coefficient value and significance of the remaining six equations. The second time, any equation other than the “food” term is excluded and the remaining equations are fitted to obtain the coefficient value and significance of the “food” term equation. The two estimates of the coefficient values and significance of the remaining terms are the same. The estimation results are shown in the below Tables 1 and 2.

Table 1. The estimated results of the LA/AIDS outreach model for urban residents.

	Food	Clothing	Living goods and services	Medical care	Transportation and communications	Education, culture and entertainment	Housing
$\ln p_1$	0.161***	0.026	-0.004	-0.047***	-0.023	0.010	-0.128
	(0.053)	(0.017)	(0.018)	(0.016)	(0.027)	(0.046)	(0.112)
$\ln p_2$	-0.550***	-0.192***	0.054	-0.034	-0.001	0.081	0.750**
	(0.178)	(0.057)	(0.061)	(0.054)	(0.091)	(0.155)	(0.379)
$\ln p_3$	0.253	0.137**	0.052	-0.033	-0.120	-0.041	-0.349
	(0.192)	(0.062)	(0.065)	(0.059)	(0.099)	(0.167)	(0.408)
$\ln p_4$	0.153	-0.022	-0.034	0.015	0.100**	-0.074	-0.141
	(0.094)	(0.030)	(0.032)	(0.029)	(0.049)	(0.082)	(0.201)
$\ln p_5$	-0.044	0.024	0.004	0.090	0.037	0.228	-0.219
	(0.201)	(0.065)	(0.068)	(0.061)	(0.103)	(0.175)	(0.427)
$\ln p_6$	-0.019	-0.126**	-0.122*	-0.084	-0.353***	-0.012	0.801*
	(0.194)	(0.062)	(0.066)	(0.059)	(0.099)	(0.169)	(0.412)
$\ln p_7$	0.023	0.040	-0.002	-0.144***	0.049	0.035	-0.052
	(0.097)	(0.031)	(0.033)	(0.030)	(0.050)	(0.085)	(0.207)
$\ln(X / P)$	-0.002	0.001*	0.001	-0.000	-0.003**	0.004*	0.000
	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.005)
<i>old</i>	0.219	0.029	-0.242*	-0.313**	0.063	0.457	-0.423
	(0.406)	(0.131)	(0.138)	(0.124)	(0.209)	(0.354)	(0.865)
<i>sex</i>	-0.048	-0.080***	0.015	0.020	-0.032	-0.038	0.162
	(0.066)	(0.021)	(0.022)	(0.020)	(0.034)	(0.057)	(0.140)
<i>edu</i>	0.057	0.079***	0.026	-0.084***	0.080**	0.061	-0.277*
	(0.077)	(0.025)	(0.026)	(0.024)	(0.040)	(0.067)	(0.165)
<i>hou</i>	-0.003	-0.004***	0.000	0.007***	-0.003	-0.003	0.008
	(0.004)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.008)
<i>urb</i>	-1.069**	-0.245*	0.165	0.625***	0.301	-0.013	0.391
	(0.446)	(0.144)	(0.152)	(0.137)	(0.229)	(0.389)	(0.951)

Note: standard errors are in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% significance levels, respectively.

Table 2. The estimation results of the LA/AIDS outreach model for rural residents.

	Food	Clothing	Living goods and services	Medical care	Transportation and communications	Education, culture and entertainment	Housing
$\ln p_1$	0.198*** (0.043)	-0.004 (0.024)	0.009 (0.015)	0.060* (0.034)	-0.006 (0.047)	-0.025 (0.023)	-0.222** (0.095)
$\ln p_2$	-0.105 (0.148)	0.132 (0.083)	-0.022 (0.053)	-0.030 (0.117)	0.337** (0.161)	0.315*** (0.078)	-0.579* (0.323)
$\ln p_3$	-0.640*** (0.228)	-0.021 (0.128)	0.164** (0.082)	-0.009 (0.180)	-0.745*** (0.248)	-0.789*** (0.120)	1.767*** (0.498)
$\ln p_4$	0.266** (0.126)	-0.064 (0.071)	0.026 (0.045)	0.311*** (0.100)	-0.012 (0.137)	0.312*** (0.067)	-0.711** (0.276)
$\ln p_5$	-0.004 (0.110)	0.016 (0.062)	-0.086** (0.039)	0.196** (0.087)	0.015 (0.120)	0.248*** (0.058)	-0.315 (0.240)
$\ln p_6$	0.594*** (0.128)	-0.057 (0.072)	-0.014 (0.046)	0.142 (0.101)	-0.221 (0.139)	0.003 (0.067)	-0.523* (0.279)
$\ln p_7$	-0.128* (0.076)	0.112*** (0.043)	0.101*** (0.027)	-0.015 (0.060)	0.004 (0.083)	-0.123*** (0.040)	-0.013 (0.167)
$\ln(X / P)$	-0.045 (0.028)	-0.011 (0.016)	-0.015 (0.010)	-0.027 (0.022)	0.008 (0.030)	0.106*** (0.015)	-0.008 (0.061)
<i>old</i>	0.154 (0.204)	0.204* (0.114)	0.020 (0.073)	-0.394** (0.161)	0.008 (0.221)	-0.329*** (0.108)	0.229 (0.445)
<i>sex</i>	-0.021 (0.115)	-0.006 (0.064)	-0.090** (0.041)	-0.292*** (0.091)	-0.169 (0.125)	-0.023 (0.061)	0.622** (0.250)
<i>edu</i>	1.866*** (0.372)	-0.279 (0.208)	0.023 (0.133)	-0.088 (0.293)	-0.536 (0.404)	-0.236 (0.196)	-0.658 (0.812)
<i>hou</i>	0.003 (0.002)	-0.002 (0.001)	-0.002** (0.001)	-0.004** (0.002)	0.002 (0.002)	0.001 (0.001)	0.002 (0.004)
<i>urb</i>	-1.647*** (0.384)	-0.086 (0.215)	-0.191 (0.137)	-0.367 (0.303)	0.699* (0.418)	-0.270 (0.203)	2.016** (0.839)

Note: standard errors are in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% significance levels, respectively.

4.4 Analysis of results

The output regression results show that the transformation of the population structure has an impact on the consumption structure of urban and rural residents. Still, the degree of impact on the various types of consumption expenditures of residents varies, and there are obvious differences between urban and rural regions.

4.4.1 The impact of the natural structure of the population on the consumption structure of urban and rural residents

From the perspective of the population age structure, for urban residents, an increase in the proportion of people aged 65 and above has a significant negative impact on residents' expenditures on daily necessities and services as well as medical care; for rural residents, an increase in the proportion of people aged 65 and above has a significant positive impact on expenditures on clothing, and a significant negative impact on expenditures on medical care and education, culture and entertainment. The rise in the proportion of elderly people in the age structure of the population will increase the burden of family and social old-age pension. Residents reduce their

own consumption expenditures on health care, education and recreation and other developmental and enjoyable materials, which hinders the optimization of the consumption structure of urban and rural residents.

From the perspective of the gender structure of the population, for urban residents, the rise in the sex ratio of the population has a significant negative impact on residents' clothing expenditures; for rural residents, the rise in the sex ratio of the population has a significant negative impact on residents' expenditures on basic living items, services and medical care, and a significant positive impact on residents' housing expenditures. An increase in the sex ratio means a relative decrease in the female population. There are differences in the consumption items of different genders, and women pay more attention to the symbolic value of commodities and more attention to branding and extravagance in clothing, so the increase in the proportion of the female population in urban areas has a certain positive impact on residents' clothing expenditure, but the extent of the impact is relatively small. As for rural residents, the increase in the sex ratio has a greater impact on residential expenditures, even greater than the combined impact on expenditures on health care and living goods and services. From the perspective of the marriage economy, residence expenditure reflects to some extent the cost of marriage for men. In order to save up for a house and thus increase their competitiveness in choosing a spouse, men inevitably spend less on household goods and services, health care, etc. to increase their competitive savings. Therefore, the reduction in the sex ratio of the population does not exert a substantial influence on refining the expenditure patterns of urban dwellers. In contrast, it has an obvious dividend effect for rural residents.

4.4.2 Influence of the social structure of the population on the consumption structure of urban and rural residents

From the perspective of population education structure, for urban residents, the increase in the proportion of the population with tertiary education and above has an important positive impact on residents' clothing, transportation, and communication expenditures, but the degree of impact is small; it has a significant negative impact on residents' health care and housing expenditures, and the degree of impact on residents' housing expenditures is larger; for rural residents, the increase in the proportion of the population with tertiary education and above significantly increases residents' food expenditures, with a greater degree of influence. It is worth noting that the increase in the proportion of the population with tertiary education and above and the optimization of the population's educational structure are conducive overall to promoting the optimization of the consumption structure of urban residents in Henan Province, but hinder the optimization of the consumption structure of rural residents. The possible explanation for this result is that the proportion of the population with tertiary education and above in rural areas of Henan Province is relatively small, the optimization of the rural education structure is relatively slow, and the driving effect on the optimization of the consumption structure has not yet come to the fore; in addition, the increase in the level of education is often accompanied by an increase in the cost of education. The disposable income per capital of the rural residents is relatively low. In order to cope with the uncertainty of future education expenditures, current development and enjoyment-type consumption must be restrained in exchange for higher income and consumption in the future, thus restricting the optimization of the consumption structure.

In terms of the average household size, an increase in the average household size in urban areas results in less spending on clothing and more spending on health care, while a rise in the average household size in rural areas results in a decrease in spending on health care and household goods and services. Smaller household sizes can optimize the spending composition of rural residents, while the optimization of the consumption structure of urban residents is not obvious.

4.4.3 Influence of population spatial structure on the consumption structure of urban and rural residents

For urban residents, the increase in urbanization rate has a significant negative effect on food and clothing expenditures, and a significant positive effect on health care expenditures; for rural residents, the increase in the urbanization rate has a significant negative effect on food expenditures, and a significant positive effect on transportation and communication and housing expenditures. When comparing the size of the regression coefficients, urbanization has a certain degree of optimization effect on the consumption structure of both urban and rural residents. However, the optimization effect on the consumption structure of urban residents is more obvious. The possible explanation for this is that in the process of population mobility between urban and rural

areas, the rural household registration population uses part of their income to buy houses and save up for urban household registration, thus restricting their expenditure on other consumption items and, to a certain extent, offsetting the optimization of the consumption patterns of the rural residents via the demonstration and agglomeration effects of urbanization.

5. Policy Recommendations

Based on the above analysis of results, this study proposes the following suggestions:

5.1 Improving the old-age and medical care system and developing high-quality products and services for the elderly

With the demographic characteristics of further aging, how to fully stimulate the consumption potential of the elderly population has become a topic of the times for Henan Province to cope with the new requirements of the economy and the new demographic situation. Transforming the challenges created by aging into new opportunities for economic growth requires concerted efforts from both the supply and demand sides. From the demand-side perspective, in order to activate the consumption vitality of the elderly group, we should ensure that the elderly have the material and health capabilities to realize their consumption needs. We should improve the pension and medical security system to ensure the aged people's economic security. We should push forward the reform of delaying the retirement age to alleviate the contradiction between the retirement age and China's average life expectancy. We should promote individual and family pensions based on the pilot experience and construct a multi-pillar pension security system that encompasses the individual, the family, and employing organizations, so as to solidify the elderly group's basic purchasing power and reduce the pressure caused by the preventive saving motive on the release of consumption vitality of the elderly population. From the supply side perspective, we should focus on the needs of people's livelihoods, vigorously develop the silver-hair economy, and create high-quality products and services for the elderly. Enterprises must align with market demands, be propelled by advancements in science and technology, and persistently introduce novel products and innovative business models that can meet the special material and spiritual needs of the elderly population, such as "Internet +senior care services", entertainment for the elderly, daily health care, and cultural and tourism for the elderly so as to make the elderly industry become a new focus point for expanding domestic demand. Concurrently, industry growth is contingent upon governmental backing and direction; governments should include the elderly industry in the important agenda of regional industrial development, policy support, and regulatory guidance for the elderly industry; optimize the development of the elderly industry of the financial and tax and the rule of law environment; and guide the elderly industry to achieve benign development.

5.2 Setting up an education fund to improve support for rural groups with high levels of education.

Theories and practices have proved that optimizing the education structure in the long run can drive the transformation and upgrading of the residents' consumption patterns. However, the conclusion of the above study shows that the increase in the number of highly educated people in rural areas of Henan Province has not optimized the consumption structure of the population. Due to the lower family income, students from rural families often face greater pressure of education expenditure in the process of studying, which squeezes the family consumption expenditure. Thus, the immediate effect of the increase in education level on consumption is not obvious. The establishment of an education fund, improvement in the higher education scholarship system, etc., can continue to reduce the cost of education in rural groups of highly educated people, alleviate the uncertainty of future education expenditure on the current consumption of the constraints on the residents, and further give play to the role of education on the improvement in consumer consumption level. This requires the Government to further increase its investment in education, encourage social capital to participate in education investment, and diversify the main bodies of education investment in order to make up for the lack of public investment in education in some regions.

5.3 Implementing the concept of “people's cities” and promoting new urbanization in a scientific and orderly manner.

China's urbanization process is government-led and deeply influenced by the urban-rural dualistic social structure. Many non-household residents in cities cannot enjoy the same medical, educational or other household welfare benefits as household residents, which increases the willingness of the non-household population to save and does not facilitate the enhancement of the residents' consumption pattern. It is necessary to adhere to the “people's city” concept as a guide, promote a new type of people-centered urbanization, continue to improve the policy system for citizenship of the rural migrant population, promote the equalization of public benefits for urban and rural household residents, and improve the policy of linking “people, land, and money”. We should continue to gradually relax the urban settlement threshold for rural migrant laborers; focus on solving the problems of children's education, housing security, social insurance, and other issues of the migrant population; and promote the early realization of citizenship by the foreign population; so as to fully unleash the potential for domestic demand contained in urbanization. We should optimize the layout and spatial form of urbanization, reasonably allocate urban construction land according to the size of the urban population of each place, optimize the construction of the transportation systems and other infrastructures, and create a good working and living environment, so as to attract more high-quality people to work and live there. optimize the layout and spatial form of urbanization, reasonably allocate land for urban construction according to the size of urban population in each place, optimize infrastructure construction such as transportation system, create a good working and living environment, attract an inflow of high-quality human capital into the cities, and gather innovative elements to guide the development of urban industries and thus the upgrading of consumption by upgrading industries.

5.4 Enriching the supply of new types of consumer goods, such as digital collections and emotional consumption, to satisfy the diverse and individualized consumption demands of consumers

Expanding residents' consumption choices is an important aspect of cultivating residents' consumption demand and enhancing social consumption capacity[25]. Systematically considering the complexity of demographic configuration, we should synergize efforts from both supply and demand sides to meet the consumption needs of different types of people. According to the current trend of demographic change, health consumption, emotional consumption, and quality consumption have become the common pursuit of many groups of people. Therefore, enterprises should improve their awareness of innovation and promote the quality of various products and production processes to the middle and high end. Secondly, enterprises should continue to develop new consumption areas such as smart homes, health and wellness, digital collections, and emotional consumption, to cater to the new trend of consumption upgrading, cultivate new consumption growth points, satisfy the personalized consumption needs of different groups of people, expand the consumption choices of the population and optimize the consumption structure.

6. Conclusion

This study constructed the LA/AIDS expansion model including the proportion of elderly people aged 65 and above, the population sex ratio and other demographic variables, and combined the time series data on the consumption patterns of residents in Henan Province during 2002-2022 to systematically examine the impact of demographic shifts on the consumption patterns of Henan's residents and the mechanism behind it.

After theoretical analysis and empirical testing, the following conclusions were drawn: (1) Demographic changes optimize the consumption structure of the population in general, creating a “structural dividend” for the population's consumption, but it needs to be judged from different dimensions. (2) Regarding the age structure of the population, the increase in the proportion of elderly people aged 65 and above decreases the urban residents' budge on daily essential, services, and medical care; and reduces the proportion of rural residents' expenditure on education, culture, and entertainment; and increases the proportion of rural residents' expenditure on clothing, so it is not conducive to optimizing the consumption structure of urban and rural residents. (3) Regarding the gender structure of the population, the rise in the proportion of women increases the proportion of urban residents' expenditure on clothing; increases the share of spending by rural residents on medical care, living goods, and services; and reduces the share of spending by rural residents on housing. Thus, the decline in the gender ratio of

the population has an obvious effect on optimizing the consumption structure of rural residents in Henan Province but not on optimizing the urban residents' consumption patterns. (4) Regarding the education structure of the population, the increase in the proportion of people with a college education or above increases the proportion of urban residents' expenditure on clothing, transportation, and communication, as well as the share of spending by rural residents on food, and decreases the share of urban residents' expenditure on housing. By comparing the magnitude of the regression coefficients, it can be concluded that the growth in the share of people with a college education or above is conducive to optimizing the consumption structure of urban residents overall but impedes the refinement of the consumption structure for rural dwellers.(5) The miniaturization of the average household size increases the proportion of urban residents' clothing and rural residents' health care and living goods and services expenditures, so the miniaturization of household size is conducive to optimizing the spending patterns of rural inhabitants, but it's not obvious for the urban residents. (6) An increase in the urbanization rate increases the share of urban residents' spending on health care and rural residents' spending on transportation, communication, and housing and decreases the share of urban residents' spending on food and clothing. Therefore, a rise in the urbanization rate can enhance the consumption patterns for both urban and rural populations, and it is more obvious for the urban residents.

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