Grey Correlation Analysis and Forecast of Residents' Income and Consumption Structure

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ABSTRACT. At present, China's economy is facing the problem of declining investment and export growth. To ensure the sound development of China's economy, it is necessary to maintain the effective pull of consumption on economic development. Correctly evaluating the basic situation and changing trend of Chinese residents' consumption structure is helpful to provide theoretical basis for relevant macro-economic policies to improve consumption structure, thus comprehensively improving the consumption level and quality of life of Chinese urban residents. This paper selects 8 indicators related to the consumption structure of rural residents, and based on statistical data, uses grey correlation analysis method to quantitatively analyze the relationship between the consumption structure and income level of rural residents from 2020 to 2023. On this basis, the grey prediction method is applied to establish a prediction model of residents' income level and various consumption expenditures, to predict the income level and various consumption expenditures, and to analyze the future change trend of the relationship between leisure consumption and income level under the background of changes in consumption structure.

1. Introduction

With the rapid growth of the national economy, the income level of residents is also increasing significantly, and consumption has become the core force driving economic growth. It can be seen that consumption plays an important role in economic development. Due to the restriction of the dual economic structure between urban and rural areas in our country, the income of rural residents is low and the consumption demand in the rural market is insufficient, which not only affects the production and life of rural residents, but also affects the virtuous circle of the national economy [1]. With the gradual deepening of the integration of urban and

rural areas, the issue of rural consumption in China has increasingly become a research hotspot. As we all know, consumption and production are interdependent, interdependent and interactive economic behaviors. The purpose of production is to consume, not only to meet people's growing material needs, but also to meet people's cultural needs. As far as rural households in China are concerned, the main factor affecting their consumption structure is income level [2]. A careful study of the current consumption structure of rural residents in China and a timely grasp of the changes in the basic consumption needs of rural residents in China are of great practical significance for guiding farmers to make reasonable consumption, optimizing the consumption structure of farmers, formulating corresponding consumption policies and ensuring the living standards of the people.

Based on the grey correlation theory, this paper intends to analyze the grey correlation degree and its difference between different types of income and the consumption structure of rural residents from the perspective of different income sources, and puts forward relevant countermeasures and suggestions to optimize the consumption structure of rural residents.

2. Grey Relational Analysis on the Influence of Income on Consumption Structure of Rural Residents

2.1 Grey relational analysis model

The grey correlation analysis method can be used to more closely quantify the impact of rural residents' income level on eight items of consumer spending, including food, clothing, housing, household equipment and services, medical care, transportation and communication, cultural and educational entertainment supplies and services, and other goods and services. Income and different kinds of consumption can be regarded as a complete system. In the process of system development, if the trends of changes in the two subsystems are consistent, the two subsystems are highly correlated. On the contrary, it is lower [3]. Therefore, gray correlation analysis provides a quantitative measure for the development and change of a system, which is very suitable for dynamic process analysis. This method, through quantitative analysis of the development trend of dynamic process, completes the comparison of geometric relationships of relevant statistical data under the time series in the system, and obtains the gray correlation degree between the main factor sequence and each behavior factor sequence. It is equally applicable to both the amount of samples and the regularity of samples, and the calculation amount is small and very convenient, and there will be no discrepancy between quantitative results and qualitative analysis results. Moreover, the calculation method is simple and feasible, and the possibility of discrepancy between quantitative results and qualitative results is extremely small. Therefore, it is very suitable for dynamic trend analysis [4].

2.2 Calculation results and explanation

Since the consumption of rural residents is closely related to their per capita net income, the article attempts to explore the consumption characteristics of rural residents by analyzing the degree of correlation between various consumption indicators and per capita net income. The relative decrease in the expenditure of rural residents on new housing, housing maintenance and other aspects has also led to a downward trend in the proportion of rural residents' residential consumption expenditure. The defects of asymmetric transformation are effectively avoided, and modeling by using the transformation can well reflect the characteristics of each component, and the model is highly explanatory. A large degree of correlation indicates that this factor has a greater influence on the main factor, while a small degree of correlation indicates that the main factor is not or is less affected by this factor [5]. The closer its development direction and rate are to the main factor sequence, the closer it is to the main factor sequence. What is most relevant to net income is the food consumption of rural residents. At present, the focus of farmers' consumption is still on food. At the same time, other aspects such as culture, education, entertainment and residential consumption have also improved. Due to the different meanings of various factors in the system, it is not easy to compare, or it is difficult to get a correct conclusion when comparing. Therefore, in the gray correlation analysis, dimensionless data processing is generally required.

The per capita net income of rural residents is selected as the mother sequence, and the consumption expenditure of rural residents is selected as the sub-sequence. The specific steps are as follows:

The absolute difference between each subsequence and the parent sequence at the same time is calculated and recorded as: Δ_x

$$\Delta_x = |\, y_0(t) - y_x(t)\,| \quad y = 1,2,3,\cdots,n \tag{1}$$

Then choose the maximum and minimum values. Ask for grey relation again:

$$h_y(t) = \frac{\Delta\min + \rho\Delta_{\max}}{\Delta_y(o) + \rho\Delta_{\max}} \tag{2}$$

ρ is the resolution coefficient, under normal circumstances $0 \le \rho \le 1$, this text let: $\rho = 0.3$.

Finally, correlation degree is calculated

$$h_{0y} = \frac{1}{n}\sum_{o=1}^{n} h_{0y}(o) \quad y = 1,2,3,\cdots,n \tag{3}$$

According to the calculation method and steps of grey correlation degree, the correlation degree between the per capita annual net income and food expenditure, clothing expenditure, residential expenditure, household equipment and services expenditure, medical care expenditure, transportation and communication expenditure, cultural, educational and entertainment supplies and services expenditure and other goods and services expenditure in the consumption structure of rural residents is obtained (see Table 1).

In the consumption expenditure of rural residents, the expenditure on cultural, educational and entertainment goods and services is most affected by income, followed by food, residence and clothing, followed by household equipment goods and services, medical care, other goods and services and transportation and communication. The service consumption of rural residents, such as medical care, culture, education, entertainment, transportation and communication, is at a lower level both in quantity and in relation. Household equipment consumption ranked third, indicating that with the continuous improvement of rural residents' income and living standards, rural residents' demand for bedding, the consumption of mechanical and electrical equipment began to heat up and upgrade, while culture, education and entertainment ranked fourth. The decline in the proportion of clothing consumption shows that the clothing consumption of Shanxi urban residents is continuously improving. After the basic clothing consumption needs of residents are met, attention has been paid to the quality and style of clothing consumption. Examining the dynamic changes of the correlation degree between rural residents' income and consumption structure in different periods can better eliminate the interference caused by exogenous variables such as policies and environment and make the research more specific.

3. Grey Forecast of the Influence of Income on Consumption Structure of Rural Residents

With the acceleration of urbanization and the improvement of people's living standards, people's pursuit of living environment is getting higher and higher, the number of families living in large and high-quality houses is increasing, residents' decoration expenditure is increasing substantially, and living conditions are further improving. The consumption structure of rural residents, which is dominated by subsistence consumption materials, has begun to change and is gradually changing into a consumption structure dominated by enjoyment and development consumption materials. The fitting deviation of regression model is small, but the prediction deviation is large, while the fitting deviation of grey model in training set is large, but the prediction effect is better than regression prediction. The two models have their own advantages and the single model has its own advantages and disadvantages. It shows that the rural residents are still paying attention to physical consumption, and the overall living consumption has not completely got rid of the consumption mode of survival. The grey correlation value and ranking of clothing expenditure items have increased significantly. This shows that the clothing consumption of rural residents

has gradually expanded from the pursuit of clothing quantity to the pursuit of clothing style, quality and color. However, these increases have not changed the consumption structure of rural residents. The characteristics of heavy physical consumption and basic living goods are still obvious.

If two component vectors $a = (a_1, a_2, \cdots, a_Q), b = (b_1, b_2, \cdots, b_Q)$ are set, their Aitchison [6] distance is

$$q_s(i, j) = \left(\sum_{i=1}^{Q} (\ln \frac{a_i}{g(a)} - \ln \frac{b_i}{g(b)})^2 \right)^{1/2} \tag{4}$$

Among them, $g(a) = (a_1 a_2 \cdots a_Q)^{1/Q}, g(b) = (b_1 b_2 \cdots b_Q)^{1/Q}$.

Assuming that both the prediction matrix M and the original matrix J are $N \times Q \times Q$ dimensions, M_i and J_i represent the i-th row of M and J, and q_s represents the Aitchison distance, then the average Aitchison distance error (MSD) [7] is calculated as) As shown.

$$MSD = \frac{\sum_{i=1}^{N} q_s(M_i, J_i)}{N} \tag{5}$$

Where $q_s(M_i, J_i)$ represents the Aitchison distance between the real component and the predicted component. In this paper, MSD is taken as an evaluation index. The smaller the average Aitchison distance error is, the closer the prediction matrix M is to the original data matrix J, the better the prediction effect is.

Applying the above prediction model, we can get the per capita net income of rural residents and the predicted values of consumption indicators from 2020 to 2023 (see Table 2).

The author forecasts the consumption data through grey GM(1,1) and establishes a grey forecasting model for the per capita net income of rural residents and various consumption sequences. The good fitting performance of the regression model and the good prediction effect of the grey prediction are combined, and the data after the transformation of the consumption structure of rural residents from 2020 to 2023 are first subjected to regression prediction, and the fitting value is obtained as the original input value of the grey prediction for prediction. Furthermore, the average correlation degree between rural residents' net income and consumption structure is calculated, which is 0. 822 in the first stage. The average correlation degree in the second stage was 0. 805. The average correlation degree in the third stage is 0. 871. This is related

to the relative decline in expenditures for new or renovated housing caused by more and more farmers working in cities in the new urbanization construction. The correlation order of other consumption indicators has not changed. This shows that, although with the continuous introduction of the national policy of benefiting and supporting farmers, farmers' income is increasing. On the other hand, the expenditure on household equipment, medical care and transportation and communication, which reflect the demand for enjoyable consumption, is less affected by income, which indicates that the rural areas are still at a relatively low level of well-off or well-off with adequate food and clothing, and the overall consumption level in the rural areas is not high.

4. Analysis on Transformation and Upgrading Strategies of Farmers' Consumption Structure

4.1 Promote the real increase of farmers' family income

The most fundamental factor that determines the consumption structure is the income level. If the income level does not reach the practical standard, then even if there is the concept of upgrading and transforming the consumption structure, there is no way to implement this concept. While continuously satisfying the material consumption demand of "food, clothing, use, housing and transportation", the spiritual consumption demand for entertainment, education and cultural services is continuously increasing. Only by increasing the net income of rural residents can they improve their lives, effectively adjust the consumption structure of rural residents, guide rural residents to pay attention to service and spiritual consumption consciousness, and lead a high-quality life [8]. On the one hand, due to the relatively low proportion and steady growth of these two expenditures, namely, the slow development of entertainment and education industry in the region is not conducive to the upgrading of the consumption structure of rural residents; On the other hand, rural residents have always attached great importance to education, so education spending tends to be large. Developing the economy and raising the income of rural residents will lay a solid material foundation for raising the consumption level of rural residents. Raising the income level of rural residents is the core issue to solve the consumption structure problem.

4.2 Improve the rural social security system

A perfect rural social security system has a positive impact on the elimination of rural residents' consumption concerns. In particular, the basic old-age medical insurance system for urban residents gradually developed in recent years needs to be further developed. We will increase transfer payments to low-and middle-income groups in society and establish and improve a multi-faceted and multi-level social

security system. It is not easy to increase the economic income of the peasant group. For the disposable income, most peasants choose to deposit it in the bank instead of engaging in consumption activities, which leads to the occurrence of weak social consumption behavior in our country and is not conducive to the improvement of social and economic level. In the next four years, income will still have a great influence on leisure and entertainment expenditure. With the increase of income, the consumption structure of residents will continue to upgrade. The close relationship between "clothing, food, housing and transportation" expenditure and income will gradually decrease, while the consumption demand in the spiritual level will continue to increase. This shows that in the next few years, rural residents will undergo a series of major changes in terms of consumption content, consumption patterns and consumption concepts. The pace of upgrading consumer goods will accelerate and the trend of diversified and diversified consumption will be obvious.

4.3 Actively guide people's consumption concept and promote the upgrading of consumption structure

Vigorously develop consumer products dominated by enjoyment-oriented and development-oriented consumer materials to lead the upgrading of the consumption structure of rural residents. Through improving the rural infrastructure, the consumption level of rural residents is continuously raised, especially the level and level of service consumption, so as to improve the consumption structure of rural residents. Therefore, it is necessary to rationally adjust relevant consumption policies, perfect the socialist market mechanism, and take advantage of the opportunity of upgrading the consumption structure to transform the growth of consumption demand into real economic growth [9]. Based on the advantages of geography and natural resources, encourage the sustainable and healthy development of characteristic agriculture and green ecological agriculture, realize effective supply and improve the operational income of rural residents; To proceed from the actual situation in the local area, formulate specific guiding opinions in a unified way and carry them out well, carry out publicity, education and promotion of typical experiences of changing customs and habits, and guide cultural consumption; Allowing and encouraging the third force to participate in income adjustment will be an important means to reduce the intensity and negative impact of tax policies. In addition, the upgrading and transformation of industrial structure will further drive the income growth of farmers, thus forming a virtuous circle with the upgrading and transformation of consumption structure and ultimately benefiting farmers.

5. Summary

Both historical data and forecast results show that income and leisure consumption are closely related. On the premise of income growth, leisure consumption is very effective as a long-term development strategy to expand

domestic demand. In recent years, the steady increase of rural residents' income and the promotion of new urbanization have accelerated the adjustment of consumption structure, thus driving the development of hedonic consumption expenditure. Only when the income increases can the living standard of farmers be improved accordingly. On this basis, we will guide the rural residents to change their consumption concepts, so that they can get greater material and spiritual satisfaction and continuously improve their consumption structure. Therefore, the government must introduce corresponding measures to improve residents' income, increase consumer confidence, and provide precondition for expanding domestic demand. With the increase of farmers' income and the upgrading of rural consumption structure, positive and targeted measures should be taken to develop the rural consumption market, meet the consumption needs of farmers, improve the overall consumption level in rural areas and promote the development of rural economy.

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Table 1 Correlation between Consumption Structure and Income of Rural Residents in 2020-2023

Consumer items	Food	Dress	Live	Household equipment	Medical care	Traffic communication	Culture, education and entertainment	Other commodities
Degree of correlation	0.921	0.974	0.833	0.890	0.907	0.956	0.875	0.885

Table 2 Per Capita Net Income and Consumption Expenditure Forecast for Rural Households (Unit: Yuan)

Consumer items	Food	Dress	Live	Household equipment	Medical care	Traffic communication	Culture, education and entertainment	Other commodities
2020	8632.68	5876.74	3869.91	3982.07	5543.02	4257.22	4496.63	3371.02
2021	9354.22	6896.32	5528.01	4896.55	6012.81	4994.01	5946.07	482.07
2022	10342.69	8812.90	6882.08	6841.05	7962.36	6899.21	6997.11	5584.83
2023	12819.07	12997.03	8801.71	7996.33	8107.05	8474.52	8669.44	6964.27