Gray Correlation Degree Analysis of Factors Affecting the Consumption of Farmers

YE Cai-xia*, WU Song-qiang, QIN Zheng-qiang

College of Economic Management, Nanjing University of Technology, Nanjing 210009, China

Abstract Consumption status of rural China is briefly described. Basic ideas and analysis steps of Gray Correlation Degree Analysis are introduced. Based on the gray correlation degree between farmers' consumption and 8 items of basic living consumption expenditures, both macroscopic and microscopic factors affecting the consumption of rural residents are obtained. According to relevant statistical data, Gray Correlation Degree Analysis is used to study on the gray correlation degree between the farmers' consumption and the macroscopic and microscopic factors in eastern, central and western regions and the whole China from the angle of time and cross-section sequences. Result shows that farmers' consumption has gradually changed from basic needs to the needs of improving living conditions and life quality. Agricultural information development, rural infrastructure construction, social security, and other macroeconomic factors are the main reasons affecting the consumption level of peasants. And health care, household equipment, and cultural and educational entertainment products are the major consumption for farmers in future. Based on these, relevant countermeasures are put forward, such as increasing personal disposable income of rural residents, improving the infrastructure construction in rural areas, and establishing a perfect social security system and an unimpeded information system.

Key words Farmers' consumption; Macroscope; Microscope; Gray correlation degree; China

Keynes argues that the slow development of economy is caused by the insufficient consumption, so that government should stimulate consumption through active fiscal policy and monetary policy in order to achieve economic growth. Consumer demand includes foreign and domestic consumer consumption. And the main source of economic growth is enlarging the residents' consumption[1-2].

According to the data of National Bureau of Statistics, by the end of 2007, urban population and population have reached 594 million and 728 million in China, accounting for 45% and 55%, respectively. Retail sales of consumer goods in both urban and rural areas are 6 940 350 and 2 391 370 million yuan, accounting for 74.4% and 25.6% of the total consumption, respectively. Almost 60% (more than 700 million) of the people live in rural areas of China, but the rural household consumption accounts for less than 30% of the total consumption[3]. Therefore, it can be concluded that stimulating the consumption demand of rural residents is the main focus of the economic growth. Scholars have suggested o stimulate rural consumption through accelerating the process of rural urbanization. Although the income of rural residents has huge cardinal number, it is lower than that of urban residents. Meanwhile, the income of rural population shows a steady growth, according to the estimates. At present, consumption level of an urban resident is equal to the consumption of three farmers. Every one percentage point increase of urbanization rate will lead to 1 million to 1.2 million labor forces transfer from rural to urban areas. Consumption of urban population is 2.7 -3 times of that of rural population, which results in 1.6 percentage point growth of final consumption[4-5]. China's economy has been developed rapidly in recent years and income level of farmers has greatly improved. Thus, the consumption demand of farmers is also changing. Farmers' consumption has already changed from meeting the basic demand to the enjoyment type demand. But farmers' consumption is still in the doldrums; while the saving rate of farmers is increasing[6].

Factors affecting farmers' consumption should be firstly obtained in order to enlarge the farmers' consumption. We analyze the effects of these factors on farmers' consumption through the gray correlation degree between the farmers' consumption and the macro and micro factors.

1 Research method

According to the theory of gray relational grade, total consumption expenditure of farmers is taken as the reference series and factors affecting farmers' consumption are taken as comparison sequence. Based on the gray relational grades of reference series and comparison series in different areas at different time points, effects of macroeconomic factors on farmers' consumption are compared and analyzed. The basic idea of Gray Relational Analysis is to judge the close correlation according to the similarity of geometry of serial curves. The closer the serial curves are, the greater correlation degree the series becomes. Gray Relational Analysis can make up for the insufficiency of traditional methods of mathematical statistics used for system analysis, which also can be applied in the number and the rule of sample. Therefore, we select this method as the research tool.

(1) Constitution of behavior sequence[7]. Assuming that

Received: November 14, 2009 Accepted: November 25, 2009
Supported by the Philosophy and Social Sciences Fund of Jiangsu Province (09sjb790021) and the Scientific Research Foundation for the Young Scholar of Nanjing University of Technology.
* Corresponding author. E-mail: yeskey22@163.com

X_i is system factor, its observation data in serial number k is $x_i(k)$, $k=1, 2, \cdots, n$. Hence, $X_i=[x_i(1), x_i(2), \cdots, x_i(n)]$ is called the behavior transverse sequence.

(2) Annihilated image of starting point. It is assumed hat D is the sequence operator, and $X_iD=[x_i(1)d, x_i(2)d, \cdots, x_i(n)d]$.

Where $x_i(k)d=x_i(k)-x_i(1), k=1,2,\cdots,n$. Hence, D is the annihilated operator of starting point; X_iD is the bigger annihilated image of X_i, denoted by $X_iD=X_i^0=[x_i^0(1), x_i^0(2), \cdots, x_i^0(n)]$.

(3) Defining $|S_0|$, $|S_i|$ and $|S_i-S_0|$. Assuming the lengths of X_0 and X_i are the same and are all 1 interval sequence. $X_0^0=[x_0^0(1), x_0^0(2), \cdots, x_0^0(n)]$, $X_i^0=[x_i^0(1), x_i^0(2), \cdots, x_i^0(n)]$ are the annihilated images of starting points X_0^0 and X_i^0. Hence, we have

$$|S_i|=\left|\sum_{k=2}^{n-1}x_i^0(k)+\frac{1}{2}x_i^0(n)\right|(i=0,1,\cdots,n-1),\ |s_i-s_0|=$$

$$\left|\sum_{k=2}^{n-1}[x_i^0(k)-x_0^0(k)]+\frac{1}{2}[x_i^0(n)-x_0^0(n)]\right|(i=0,1,\cdots,n-1).$$

(4) Absolute correlation degree.

$$\varepsilon_{0i}=\frac{1+|s_0|+|s_i|}{1+|s_0|+|s_i|+|s_i-s_0|}(i=0,1,\cdots,n-1).$$

(5) Relative correlation degree. Initial value of X_i is

$$X_i'=[x_i'(1), x_i'(2), x_i'(3), \cdots, x_i'(n)]=\left[\frac{x_i(1)}{x_i(1)}, \frac{x_i(2)}{x_i(1)}, \frac{x_i(3)}{x_i(1)}, \frac{x_i(n)}{x_i(1)}\right](i=0,1,\cdots,n-1).$$

Then, the calculation step is the same with the absolute correlation degree, that is

$$|S_i'|=\left|\sum_{k=2}^{n-1}x_i'^0(k)-\frac{1}{2}x_i'^0(n)\right|(i=0,1,\cdots,n)$$

$$|s_i'-s_0'|=\left|\sum_{k=2}^{n-1}[x_i'^0(k)-x_0'^0(k)]-\frac{1}{2}[x_i'^0(n)-x_0'^0(n)]\right|$$

$$(i=1,2,\cdots,n)$$

Hence, relative correlation degree is

$$r_{0i}=\frac{1+|s_0'|+|s_i'|}{1+|s_0'|+|s_i'|+|s_i'-s_0'|}(i=1,2,\cdots,n).$$

(6) Comprehensive correlation degree. Assuming $\theta\in(0,1)$, we select $\theta=0.5$, since relationship of absolute quantity is as important as the relationship of relative quantity. Based on $\rho_{0i}=\theta\varepsilon_{0i}+(1-\theta)r_{0i}, i=1,2,\cdots,n$, comprehensive correlation degree is usually adopted during comparison.

2 Factors affecting farmers' consumption

Per capita total consumption expenditure in rural areas in the years 1991 –1995, 1996 –2000 and 2001 –2005 is taken as the reference sequence. All total of eight living consumption expenditures are used as comparative sequence to establish the information space of gray correlation differences. Gray correlation degree is calculated according to the spatial parameters (Table 1)[8-9].

Table 1 Gray correlation degree between farmers' consumption and their living consumption during the eighth, ninth and tenth – five year plans

Period	Food	Cloth	Residence	Household facility	Medical care	Transportation and communication	Cultural entertainment	Others
The eighth-five year plan	0.945 2	0.864 7	0.547 8	0.514 7	0.815 7	0.625 7	0.497 6	0.787 3
The ninth-five year plan	0.913 7	0.813 8	0.657 9	0.820 9	0.860 9	0.612 9	0.835 7	0.881 2
The tenth-five year plan	0.861 8	0.782 9	0.738 2	0.690 0	0.853 4	0.523 0	0.823 0	0.613 9

Note: Eighth five-year plan is the years 1991 –1995; ninth five-year plan is the years 1996 –2000; tenth five-year plan is the years 2001 –2005.

According to the statistics, rural residents' expenditure on food and cloth basically shows the declining trend in China; while that on residence, medical care and cultural entertainment is increasing. Table 1 shows that it is basically consistent with the results of gray correlation analysis.

Farmers' consumption has close correlation with food and cloth consumption, indicating that food and cloth are the major factors affecting the total expenditure of farmers. Gray correlation degree between farmers' consumption and the food, cloth and transportation and communication has shown a decline trend, reflecting that the basic livelihood of the farmers is fulfilled.

Gray correlation degree between farmers' consumption and residence, medical care and cultural entertainment shows an increasing trend, indicating that both farmers' living level and living environment are improved and the health and spiritual life of farmer are paid high attention to. During the ninth-five year period, farmers' consumption has high correlation with the household facility, indicating that increase of farmers' income has improved the production and living conditions of farmers.

Table 1 indicates that during each period, farmers' consumption has great gray correlation degree with the medical care, showing that medical care has great impact on farmers' consumption. Relatively high medical fee in reality, as well as the lack of medical insurance of farmers, has discouraged the enthusiasm of consumer. Gray correlation degree between farmers' consumption and household facility have decreased from 0.820 9 in the ninth-five year period to 0.690 0 in the tenth-five year period. Household facility in rural household does not fully play its role due to the poor water and power supply, and the problems in road and TV signal, which have restricted their consumption of agricultural machinery and household appliances.

With the development of social economy, income level of farmers has been greatly improved. In the year 1990, per capita net income of farmers is only 686.31 yuan, and it grows to 4 140.36 yuan in the year 2007, up by more than 5 times.

Expansion of domestic demand is the source of China's economic growth, and improving the farmers' consumption demand is particularly important. Table 1 reports that farmers have turned from the basic living consumption to enjoying type consumption, which needs relatively perfect infrastructure, expeditious information, reasonable social security system and other supporting macro-factors. We select farmers' basic living

consumption as the micro-factors. And macro-factors conduct quantitative analysis mainly based on the fixed assets investment of governments. Farmers' consumption level is directly affected by the rural water, electricity and gas and investment in supply industry, rural transport, storage and postal investment. Thus, they are taken as the macro-factors.

Table 2 Gray correlation degree between farmers' consumption and the macro and micro factors from the year 2005 to 2007

Year	Per capita net income	Household facilities and services	Cultural and educational entertainment products and services	Health care	Food, cloth, lodging and transportation	Water, electricity and gas investment and supply industry	Transportation, storage and postal	Information development and computer software	Health and social security and social welfare
2005	0.925 0	0.673 3	0.754 4	0.895 9	0.954 0	0.671 9	0.655 1	0.759 6	0.664 2
2006	0.922 5	0.666 9	0.730 0	0.893 8	0.950 5	0.703 4	0.676 4	0.737 6	0.658 2
2007	0.875 0	0.672 3	0.671 9	0.896 9	0.920 4	0.718 1	0.679 0	0.703 3	0.649 5

3 Gray correlation degree between farmers' consumption and its influencing factors

3.1 Gray correlation change between farmers' consumption and macro and micro factors from 2005 to 2007 Annual total consumption of rural residents in the eastern, central, western and northeastern regions in the years 2005 – 2007 is taken as the reference sequence, while the macro and micro factors affecting farmers' consumption are taken as the comparative sequence, in order to establish the information space of gray correlation difference. According to the spatial parameter, Table 3 reports the calculation result of gray correlation.

According to the macro-factors, farmers' consumption has relatively great correlation degree with the farmers' income, food, cloth, lodging, transportation and health care. And the correlation degree between the farmers' income and the food, cloth, lodging and transportation is declining, indicating that farmers' income, food, cloth, lodging, transportation and health care are the major factors affecting farmers' consumption. However, if the basic living of farmer is guaranteed, income level will not be the only reason affecting farmers' consumption. It is common that farmers go back into poverty because of diseases. They can hardly bear the cost of diseases, and want more savings to deal with the problems of pension, health care and other issues in future. Household equipment and cultural entertainment have little correlation, which is consistent with reality. The imperfect rural infrastructure can not stimulate the effective demand for agricultural machinery and household appliances.

Table 3 Gray correlation degree between farmers' consumption and the macro and micro factors in different areas during the years 2004 – 2007

Area	Per capita net income	Household facilities and services	Cultural and educational entertainment products and services	Health care	Food, cloth, lodging and transportation	Water, electricity and gas investment and supply industry	Transportation, storage and postal	Information development and computer software	Health and social security and social welfare
Eastern area	0.848 7	0.763 2	0.674 2	0.678 2	0.832 7	0.802 1	0.758 0	0.825 0	0.731 6
Central area	0.921 9	0.672 3	0.539 1	0.782 6	0.914 5	0.654 3	0.643 1	0.725 5	0.637 3
Western area	0.953 8	0.542 3	0.432 9	0.892 3	0.932 1	0.542 8	0.625 0	0.621 0	0.652 9

According to the macroscopic correlation, correlation degree of water, electricity, gas and transportation in fixed investment is increasing. In fact, local governments have accelerated the improvement of rural infrastructure over the past few years. And improvement of infrastructure can promote the farmers' consumption. Fig. 1 illustrates that average possessive quantity of durable consumer goods per 100 rural households has been increased from the 1990s. However, since the transportation, water and power supply still have many problems, power usage in family stays idle, resulting in the usage decrease of durable consumer goods in rural areas. Since the year 2000, possessive quantity of durable consumer goods has been increased with the improvement of rural infrastructure.

Among the macro factors, farmers' consumption has great gray correlation degree with information development and social security investment. Farmers want to grasp the information of production and living during consumption. However, they do not know the market and can not produce the suitable products. At the same time, there are few choices for the consumption of farmers and they can hardly buy the products they want. Thus, consumption desire of farmers is failed to be stimulated. Among all the influencing factors, gray correlation degree between the health and social security and the social welfare is relatively small. But the gray correlation degree of medical health care is relatively great, indicating that the social security system is extremely imperfect. Although farmers' income is improved, they still can not bear the medical expenses.

3.2 Gray correlation degree between the farmers' consumption and the macro and micro factors in different areas Taking the total consumption of eastern, central and western areas as the reference sequences, and the macro and micro factors affecting rural residents' consumption as the comparative sequence, we establish the information space of gray difference and calculate the gray correlation degree according to the spatial parameter (Table 3).

Table 3 indicates that farmers' income has relatively great

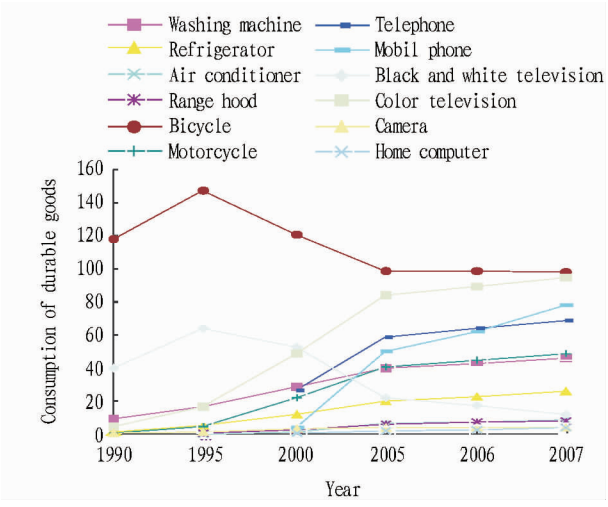

Fig.1 Average possessive quantity of durable consumer goods per 100 rural households

correlation degree with the food, cloth, lodging and transportation, showing that income is an important factor influencing the farmers' consumption, and total consumption expenditure of farmers is mainly the food, cloth, lodging and transportation. Gay correlation degrees of the per capita net income, the health care and the food, cloth, lodging and transportation are smaller in eastern area than those in central and western areas. But the gray correlation degrees of the household facilities and the cultural and educational entertainment are the maximum among all the consumption of farmers, indicating that the economy is relatively developed in eastern area and farmers' income is relatively high. Consumption of farmers has changed from the basic needs of food and cloth to the needs of improving living conditions and life quality. Both the perfect infrastructure and the unimpeded information system in eastern area have laid the foundation for the consumption of farmers. Gray correlation degrees of the water, electricity and gas investment and supply industry, the transportation, storage and postal, the information development and computer software and the health and social security and social welfare are 0.802 1, 0.758 0, 0.825 0 and 0.731 6 in eastern area, respectively, which are the biggest gray correlation of macro factors among eastern, central and western areas. In fact, eastern area has efficient distribution network of stores and perfect after-sales service system, offering more opportunities for farmers to earn non-agricultural income. In eastern area, expectation of social economy is far higher than that in other areas. Social security system in rural areas is relatively perfect, and farmers have the capacity to buy products. However, in the central and western areas, with the inconvenient transportation, enclosed information, and backward local economy, income of socio-economic expectation of farmers is relatively low. Based on the consumer psychology, farmers need more economic security. Consumption level of farmers is restricted by the backward local economy, imperfect infrastructure, and defective social security system. Result of gray correlation degree in these areas is contrast with that of eastern area. Gray correlation degree of basic living is relatively high, but the degree of household facility, entertainment and macro factors is relatively low.

3.3 Gary correlation between farmers' consumption and the macro and micro factors Difference information space of gray correlation is established by taking per capita consumption of rural residents in the years 2003 – 2007 as the reference sequence and the macro factor affecting farmers' consumption as the comparative sequence. According to the spatial parameter, the gray correlation degree is calculated (Table 4).

Table 4 Gray correlation degree between farmers' consumption and macro and micro factors

Index	Correlation degree	Rank
Per capita net income	0.921 7	2
Household facilities and services	0.656 4	8
Cultural and educational entertainment products and services	0.716 1	7
Health care	0.976 0	1
Food, cloth, lodging and transportation	0.836 0	4
Water, electricity and gas investment and supply industry	0.740 1	6
Transportation, storage and postal	0.845 0	3
Information development and computer software	0.623 4	9
Health and social security and social welfare	0.748 2	5

Nationally, gray correlation degree between farmers' consumption and medical care is the maximum, indicating that medical care is a factor greatly affecting the farmers' consumption. However, gray correlation degree between farmers' consumption and social warfare is only 0.748 2, taking the fifth place. This indicates that the imperfect social security system, as well as the problems in medical care, makes farmers dare not to spend money. Farmers' income has relatively great correlation degree with the transportation, farmers' income and the food, cloth and lodging; and food, cloth, lodging and transportation are still the major expenditure of farmers in their living consumption. Moreover, personal income is the most important constraints during farmers' consumption. Farmers' consumption has relatively low correlation with the household facilities and the cultural and educational entertainment products. Although the water, electricity and other infrastructure in rural areas have been greatly improved, they still can not meet the current needs of the development of rural economy. Correlation degree between farmers' consumption and water, electricity and gas supply is only 0.740 1. Farmers in most areas obtain information mainly from television and radio. Besides, there is almost no network in rural areas and the gray correlation degree of information development only reaches 0.623 4, which ranks the last among all the nine indices.

4 Conclusion

Through analyzing the gray correlation degree between farmers' consumption and basic life consumption, we can find out that the basic life demand of farmers is basically fulfilled. The current demand of farmers as consumers is to improve the living conditions and the quality of life. Health care, household facility, and cultural and educational entertainment products are

the focus of future consumption of farmers. These consumer demands are decided primarily by the improvement of farmers' income level and the support by the infrastructure. The "Eleventh Five-Year Plan" takes the improvement rural infrastructure as a major task, including the rural hydraulic engineering, eco-projects, rural roads, storage facilities, rural power grid, and information channel, in order to improve the capacity of sustainable development in rural areas and to lay a solid foundation to start the rural consumption[10-11].

Improvement of farmers' consumption level is the sign of the improved living standards of farmers. Analysis of its impact factors can help to find out the potential demand of the farmers and to flourish rural economy. Farmers' income is the key factor affecting rural consumption. However, the most important thing to improve farmers' income is to perfect the rural infrastructure. At the same time, we should establish a perfect rural social security system and an unblocked information system. Gray correlation degree between farmers' consumption in different areas and its macro and micro factors has confirmed that the perfect infrastructure and the better external environment in developed areas have allowed a stronger consumer confidence of farmers, so that promoting the balanced regional economic development is a major task at present.

References

[1] CHEN LS. Analysis on main factors of peasants' famliy expenditure [J]. Finance and Economy, 2009(3):8-10. (in Chinese).

[2] SUN WK, BAI ZE. Income fluctuation and influential factors on farmer' consumption[J]. Journal of Tsinghua University:Philosophy and Social Sciences, 2008(6):133-138. (in Chinese).

[3] HU YJ, DONG YY. Econometric analysis on consumption of peasants in China[J]. Journal of Shijiazhuang University of Economics, 2006(1):59-65. (in Chinese).

[4] LIANG D. Paying attention to rural market and con-sumption under new situation[J]. Finance and Economy, 2009(4):8-11. (in Chinese).

[5] ZHU YS. The six obstacles in farmer' consumption and the countermeasures[J]. Pioneering with Science & Technology Monthly, 2004 (8):82-84. (in Chinese).

[6] LI Y. Analysis on market consumption of farmers in China[J]. Issues in Agricultural Economy, 2009(5):53-55. (in Chinese).

[7] DENG JL. Basic methods of grey system[M]. Wuhan: Huazhong University of Science and Technology Press, 2002. (in Chinese).

[8] XIANG LC, WU XB. Study based on the grey theory on the changes about the revenue and consumption of the rural resident in the developed areas[J]. China Rural Survey, 2008(2):13-18. (in Chinese).

[9] TIAN Q, MA J, GAO TM. Regional difference analysis of influencing factors of Chinese citizens' consumption[J]. Management World, 2008(7):27-33. (in Chinese).

[10] WANG HW. Basic trend of Chinese rural residents' consumption and essential restricting factors of farmer consumption behavior[J]. Management World, 2000(4):59-70. (in Chinese).

[11] MA SC, LIU ZB. Analysis of influencing factors on China's farmer consumption behavior[J]. The Journal of Quantitative & Technical Economics, 2006(5):20-30. (in Chinese).

[12] ZHANG J, XIE JQ, ZHOU WY. Comparative analysis of rural consumption expenditure in China[J]. Asian Agricultural Research, 2009, 1(6):10-12.

[13] XU L K, ZHANG CX. Analysis of the contribution of the tertiary industry development to farmer income-increasing[J]. Journal of Anhui Agricultural Sciences, 2006, 34(21):285-287. (in Chinese).

[14] GE F, HUANG J, MU YY. Comparative analysis on the effects of income structure on consumption level of rural residents in eastern and western China——a case study on Jiangsu and Xinjiang Province[J]. Asian Agriculture Research, 2009, 1(8):1-5.

[15] ZHENG LG, WEI HA, ZHANG CY. Influence of higher education charges on rural economy in China[J]. Journal of Anhui Agricultural Sciences, 2007, 35(13):286, 319. (in Chinese).

[16] HUANG J, GE F, MU YY. On the relations between income structural change and consumption of rural residents in China[J]. Asian Agriculture Research, 2009, 1(8):11-14, 48.

[17] HUANG DP, YOU M, JIN BS. Analysis of the farmer income and consumption in Luan City[J]. Journal of Anhui Agricultural Sciences, 2004, 32(3):191-193. (in Chinese).

[18] LIU M, WANG GR, WANG HJ. Propensity analysis on consumption expenditure of rural residents in Hebei Province, China[J]. Asian Agriculture Research, 2009, 1(8): 20- 23, 43.

[19] LUO ZH. Analysis on factors influencing Chinese farmers' consuming behavior[J]. of Hunan Agricultural University: Social Science, 2008, 9(1):33-35. (in Chinese).

[20] LI QF, KANG GL, LI XF, *et al*. Factors influencing grain production of Henan Province based on gray correlation[J]. Asian Agricultural Research, 2009, 1(5):23-27.

[21] XIU CB. Analysis on characteristics and influence factors of peasants' subsistence consumption in Qingdao area[J]. of Qingdao Agricultural University(Social Science Edition, 2008, 20(4):37-42. (in Chinese).

农民消费影响因素的灰色关联度分析

叶彩霞,吴松强,秦政强 (南京工业大学经济管理学院,江苏南京 210009)

摘要 简述了中国农村的消费现状,介绍了灰色关联度方法的基本思想和分析步骤。通过分析农民消费与8项基本生活消费支出的灰关联度,得出了影响农村居民消费的宏观和微观因素。根据相关统计数据,从时间和截面序列及全国角度出发,运用灰色关联度模型研究了东、中、西部地区及全国范围内农民消费与其宏观、微观影响因素的灰关联度。结果表明,农民消费需求已从满足基本生活需求开始逐步转向改善生活条件、提高生活质量的需求;农业信息开发、农村基础设施建设及社会保障等宏观因素是影响农民消费水平的主要因素;医疗保健、家庭设备及文教娱乐用品是农民今后消费的重点。基于此,提出了相关对策:不断提高农村居民的个人可支配收入、完善农村的基础设施建设、建立健全的社会保障制度和畅通的信息系统等。

关键词 农民消费;宏观;微观;灰关联度