Research on Food security Model of Rural Revitalization Based on Computer Artificial Intelligence Model

Xiuli Lin

College of Marxism, Sichuan University, Chengdu, Sichuan, 610011, China.

1262381492@qq.com

Abstract. In this paper, grain demand and supply models were established based on data collected from the China Statistical Yearbook and the website of the National Bureau of Statistics of China. This paper uses stepwise regression method to establish linear regression, residual autoregressive model and C-D production function, residual autoregressive model to analyze various factors that may affect grain yield. Then, R software was used to conduct collinearity test and residual analysis on the results, and cluster analysis method was used to conduct in-depth analysis on the causes of grain yield fluctuation. Finally, the regression equation of grain yield was obtained. Through MATLAB simulation curve, the values of the four main influencing factors are predicted respectively to get the future grain yield of China.

Keywords: artificial intelligence; rural revitalization; food security model; matlab simulation.

1. Introduction

Today, more than 200 years after the Industrial Revolution, society has failed to keep food security away from the "technological" backdrop, in which the rate of increase in agricultural productivity has greatly outpaced population growth. In recent years, the international food crisis events, such as the soaring international food prices in 2007-2008, led to riots in several countries. "Biofuel" was regarded as the main culprit in most countries dependent on food imports. Domestic scholars and people have heated debates on the necessity of the "1.8 billion mu red line". In 2010, Russia's ban on grain exports caused panic in the Middle East, Europe and other regions, indicating that the existing food security policy system has defects in principle [1]. To establish an effective food security policy system, it is necessary to evaluate and improve the existing policy system on the basis of new practice and theory. To analyze food security issues from the perspective of economics and establish a corresponding theoretical framework is an important premise for food security policy design and evaluation. This paper first establishes a cobweb model of food security based on the analysis of food supply and consumption behavior. Then, it constructs the framework of food security policy under the condition of modern market economy with the conclusion of the model, and explains and evaluates some hot issues with the theoretical conclusion. Finally, the conclusion is given.

2. Mathematical models of food security

The mathematical model of food security is a stochastic dynamic optimization problem. Suppose an individual maximizes each period effect by the expected value discounted to the initial moment, where utility is χ^1 function of the various goods and services it consumes (represented by vector A, the vector in this model and the column vector, plus "" for transpose, i.e., the row vector) and the physical health of the individual w. χ, asset increase (represented by vector S), and individual labor intensity (represented by vector l) are all directly selected, that is, they are control variables in stochastic dynamic optimization problems [2]. Health status w is a state variable, which is affected by control variables and random dynamic exogenous variables Z. Utility is a strictly increasing function of R and w, $\nabla U(x,w)>0$. Without loss of generality, suppose $U\geq 0, w\geq 0$ and $U(x,w|_{w=0})=0$, that is, the minimum value of w always corresponds to the minimum value regardless of the amount of other consumption χ square. In this way, the problem of individual choice can be understood as the solution of formulas (1) to (9) below.

$$Max\, E_0 \sum_{t=0}^{\infty} \beta^t U(w_t, x_t) \tag{1}$$

$$S.t. \quad w_{t+1} = \Theta(w_t, n_t, l_t, x_t^{nf}, z_t, \varphi_t^h) \tag{2}$$

$$n_t = \gamma(x_t^{f'} N, \varphi_t^h, I_t) \tag{3}$$

$$\alpha_{t+1} = \delta a_t + s_t + \varphi_t^a \tag{4}$$

$$p_t^{x'}(x_t + s_t) = p_t^{q'} q_t + b_t + g_t, \forall x, s, q \in T \tag{5}$$

$$x_t + s_t = q_t + k_t, \forall x, s, q \in NT \tag{6}$$

$$\Lambda(q_t, l_t, a_t, w_t \mid \varphi_t^q) = 0 \tag{7}$$

$$b_t \le \Omega(a_t) \tag{8}$$

$$e' l_t \le l_0 \tag{9}$$

$$a_t, l_t, x_t \ge 0 \tag{10}$$

In Formula (1), $\beta \in [0,1]$ is the time discount factor, which is used to describe the intertemporal selection preference of individuals, so that the future utility can be discounted to the initial period 0 to calculate the net present value of the total utility in all periods. Thus, Equation (1), the objective function, represents the expectation of maximizing the net present value of each phase effect discounted to the initial period. To maximize the objective function, the restriction conditions (2) to (10) must be satisfied. Formula (2) describes the changing law of physical health status. The physical health status of t+1 stage is jointly affected by a variety of factors, including the physical health status of t stage, the nutritional intake of t stage (represented by vector n), the labor intensity of t stage l, and the consumption of non-food commodities of t stage (such as medical care, housing, clothing, etc.). Represented by vector x^{nf}), other exogenous variables (including other people's activity patterns, health conditions and infrastructure, represented by vector z) and random disturbances to body health during phase t (represented by ϕ^h). The minimum value of the function $\Theta(g)$ is 0(and the value of the function is always 0 within a certain range of values of the independent variable); Within a certain range, the function is strictly additive of n, x^{nf} and z ; When the function reaches the maximum value w^* , the increase of food consumption will lead to the deterioration of health conditions, for example, excessive food consumption will lead to obesity and a series of health damaging symptoms, that is, the function becomes a minus function of explanatory variable.

There are direct and indirect ways for food consumption to enter the utility function. The direct means that when people consume food, they get utility from non-nutritional properties such as taste, texture and color. The indirect way is that the food provides the nutrients to produce the "body healthy" product. Equation (3) gives the function of nutrient intake. Nutrient intake in period $\gamma(g), t$ is the product of the consumption of food in period t (represented by vector x^f) and the nutrient composition contained in these foods (represented by non-negative matrix N), the random disturbance of body health in period t (ϕ^h), and the knowledge of consumers in period t about nutrition (such as how to obtain sufficient nutrients from a given food). The variable is represented as a function of the information set matrix I. Equation (3) shows that nutrient intake is not only a function of food intake. Moreover, good physical health does not necessarily lead to good nutritional status, because if the medical and hygiene conditions are poor, even with a high food intake, it is likely to lead to nutritional insufficiency. Formula (4) describes the variation rule of asset reserves (represented by vector a), $\delta \in [0,1]$ is the asset depreciation factor, and ϕ^a is the random disturbance of assets (that is, the additional gains and losses of assets caused by various uncertain factors). Equation (4) shows that the asset reserves in period t+1 are equal to the net depreciated asset reserves in period t plus the newly added assets in period t plus the random disturbance in period t. Equation (5) is the budget constraint of tradable goods and services. The left-hand side of the equation is the total value of tradable goods and services and newly added assets at period t; The right-hand side shows total revenue, which is equal to the sum of total value of output, net borrowing and net gratuitous transfer payments. Where, p^x is the price vector of tradable goods and services, q is the net output vector, p^q is the price vector of output, b is the net loan amount, g is the accepted net unpaid transfer amount $g = p^{x'} k$, represents the monetary value of tradable unpaid transfer payments, wherein, vector k is the real quantity of unpaid transfer payments, if any element of this vector is not zero, If it is zero, it means it is not tradable), T is a _______ set of tradable goods, including tradable consumer goods, new assets, and output. Formula (6) describes the budget constraints of non-tradable goods; This formula shows that the sum of non-tradable consumer goods and new assets is equal to the sum of non-tradable output and free transfer payments. NT A collection of non-tradable goods. Equation (7) describes the stochastic production technology, which is an implicit function. It can be seen from the equation that the net output is a function of labor intensity, asset reserve and health condition in the case of J of the random disturbance term of the given output. Output here is not just food, but also other goods and services and labor wages (i.e., vector ϕ^q includes the risk that labor loses its job). Equation (8) describes the budget constraint of borrowing, that is, the amount of borrowing must not exceed the value of a function that takes the assets owned by an individual as a variable, and the function $\Omega(a)$ is non-decreasing for the amount of assets. Equation (9) describes the constraints on the distribution of individual labor time, wherein, e is a unit vector and l0 is the total labor time. This equation indicates that the total time used by an individual for all labor cannot exceed the total labor time that can be distributed. Equation (10) shows that asset reserves, labor intensity and the quantity of goods and services consumed in each period are non-negative.

3. Food security policy framework

3.1. Basic framework of food security policy

The theoretical model concludes that the essence of food security policy is to limit food price fluctuations, which reflect market supply and demand, to the extent that they can be recovered [3]. The two methods correspond to the short-term and long-term policy types: to control the price within the established safe range in the short term, and to expand the safe zone of price fluctuation by changing the relative elasticity of food supply and demand in the long term. In reality, the policy system commonly used in various countries is shown in Figure 1. Including short-term price control policies and long-term risk reduction policies.

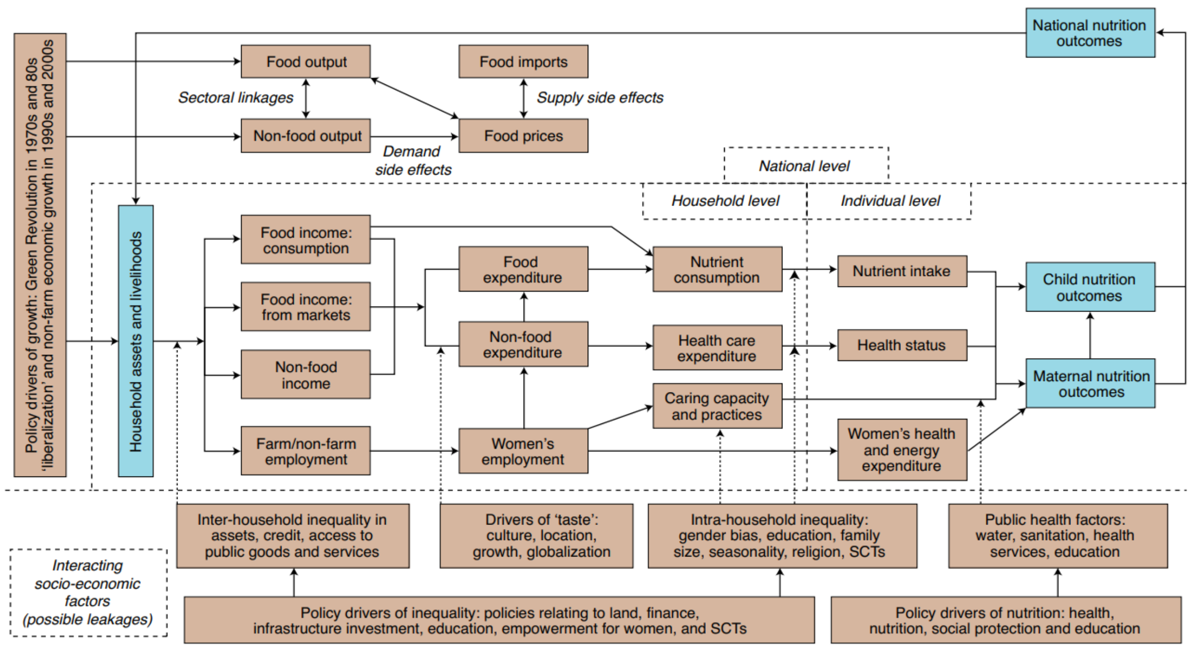

Figure 1. Institutional framework of food security policy

3.2. Short-term grain reserve and price control

In the short term, the government's food security policy aims to control the fluctuation of food price within the production cycle within a safe level, which usually adopts two ways: food reserve and price policy. The government, as the main body of the policy, maintains a certain amount of grain reserve. When there is a temporary demand gap in food production and other supply links, selling in the market can calm the excessive rise of prices [4]. When grain supply exceeds demand, the purchase policy can prevent the price from falling excessively. Developed market economies, including the United States, France, Japan and Australia, as well as developing countries, including China, Brazil and India, all implement the grain reserve system. At the same time, the government directly controls the price increases of non-shortage food caused by inefficient markets. Since agricultural production is basically completed by farmers and is very dispersed, and food suppliers are relatively concentrated and have certain market power compared with farmers, there may be certain economic profits in the grain selling price. The government must control this phenomenon of market failure. In addition, rising food prices caused by irrational expectations, sudden increases in food production costs and the influence of international market prices need to be controlled.

4. Cluster analysis of causes affecting food security

Like economic cycles, food production has cycles. Since the reform and opening up, the development of Chinese grain production is not steady, the total production fluctuation is very obvious. The cycle of food production is roughly once every four or five years, with alternating periods of harvest and failure. Instead of a good harvest and a bad harvest, there are good harvest years, bad harvest years and peaceful years within a cycle [5]. Two consecutive good years or two bad years or two normal years are normal, and the development of grain production in general presents an upward spiral. The reasons for cyclical fluctuations cannot be well explained by the objective factors defined above, considering that they may be related to external factors, such as changes in domestic food production policies and fluctuations in the international market environment. However, these factors are often abstract, and it is obvious that conventional numerical analysis will not work. In this regard, the data from 1990 to 2021 are divided into four categories according to the K-means Cluster process by clustering analysis in time order based on the selected comprehensive index. According to the SPSS analysis data, the following classification results can be obtained by considering the actual situation of grain development in China in recent years and relevant policies and measures (Table 1 to Table 3).

Table 1. Number Of Cases In Each Cluster

Classification number	Number of classifications
1	9.000
2	6.000
3	13.000
4	4.000

Table 2. Final Cluster Centers

	Cluster			
	1	2	3	4
X1	80129	73361	83988	78873
X2	114728	105377	111702	104461
X3	103	108	108	100
X4	108	108	107	101
X5	44571	56585	48552	54110
X6	1474	5014	3141	4288
X7	1727	7520	3404	5652
X8	40685	42202	49271	52089
X9	278	3972	1220	2429
X10	148	4248	535	1506

Table 3. Clustering results

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
X1	1.581E8	3	1964429.586	28	80.458	.000
X2	1.610E8	3	7643279.303	28	21.062	.000
X3	101.911	3	59.817	28	1.704	.189
X4	52.259	3	115.609	28	.452	.718
X5	2.053E8	3	4178993.119	28	49.127	.000
X6	1.710E7	3	296555.959	28	57.663	.000
X7	4.546E7	3	451992.393	28	100.576	.000
X8	2.092E8	3	2.759E7	28	7.584	.001
X9	1.803E7	3	339455.627	28	53.125	.000
X10	2.392E7	3	761713.813	28	31.409	.000
Y	2.915E8	3	1.294E7	28	22.529	.000

It can be seen from the results of cluster analysis that there has been an obvious similarity since 2005. In order to facilitate the modeling, ordinary linear regression and residual autoregressive models are adopted for prediction. X1 rural population (10,000), X2 grain crop planting area, X7 total power of agricultural machinery (gigawatts), X8 disaster area (thousands of hectares) are the final gradual regression retention factors, and the impact factors are also consistent with the actual situation. Check the multicollinearity of the four retention factors, and the verification results are also very impressive. The regression equation obtained without internal collinearity is acceptable [6]. From the comparison diagram between the results of the regression equation and the actual grain yield, we can see that the simulation of the regression equation obtained is impressive (FIG. 2). Especially in recent years, the simulation situation is good; Finally, from the cluster analysis, we can see that the period from 1978 to 2009 can be divided into four cycles due to China's policy factors. When making the forecast, we should focus on the fit degree since 2005. From the comparison chart, it can be seen that the degree of fit since 2005 is at an acceptable level, thus proving the availability of the regression equation obtained (Figure 3).

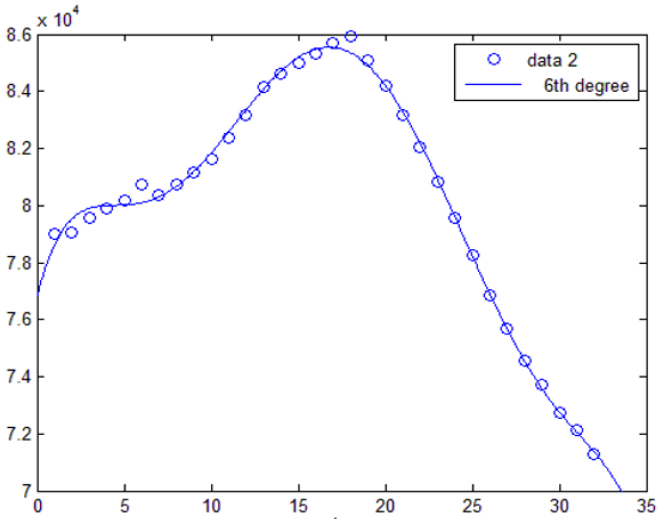

Figure 2. Fit between time and population

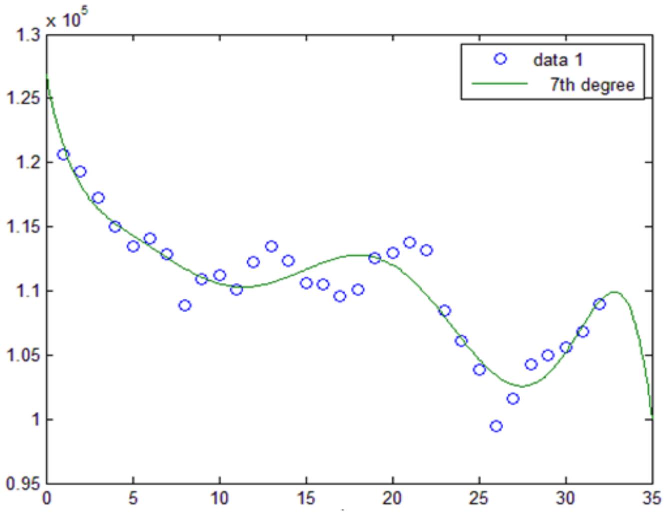

Figure 3. Fitting between planting area of food crops and time

5. Conclusion

The mathematical economic model introduced in this paper emphasizes the characteristics of insufficient food consumption. Key exogenous random variables are interdependent and steady-trend, and may have non-steady-state indirect effects on the sale of productive assets such as land and livestock, reduced nutrient intake, disrupted education, and permanently reduced human capital. In the life cycle model of consumption, consumption is stable and a function of lifetime income. Therefore, independent and equally distributed random perturbations of price or output have no effect on consumption.

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