ISSN : 0974 - 7435 Volume 10 Issue 9

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(9), 2014 [3069-3077]

Foreign rural cooperatives correlation growth data comparative research

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ABSTRACT

The paper utilizes trend extrapolation prediction approach to predict foreign rural cooperatives correlation growth data in four years after 2013. Firstly it adopts modified exponential curve method to make quantitative analysis of Australia, America, New Zealand one region rural cooperatives correlation growth data during 2005-2013, gets prediction mathematical model, on this basis, considering three countries rural cooperatives correlation growth data each period changing rates are different, and utilizes growth curve to make further prediction on number of people, lets prediction value to be more accurate, so that studies three countries rural cooperatives correlation growth data development trend in four years after 2013. Finally it gets American one region rural cooperatives amount is relative more, but its changing trend is smaller, Australian and New Zealand one region rural cooperatives amount changes ranges are relative bigger but amount is relative little, the model provides theoretical support for future studying foreign rural cooperatives growth.

KEYWORDS

Rural cooperatives; Growth curve model; Time sequence model; Growth data; Mathematical model.

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INTRODUCTION

From foreign rural cooperatives being founded to now, it has already above 160 years history, driven by market economy, foreign rural cooperatives have become important economic systems of its economic development, and they vigorously drive each country economic development.

As early as 19th century, someone put forward cooperative organizations relative theories, used combination between rural regions and peasants to common develop agriculture, such method played important roles in its subsequent rural cooperatives development; emergence of first rural cooperative of modernity in the world was set up in 1844, which had irreplaceable effects on subsequent establishing rural cooperatives economic entity. Emily Yanof had ever put forward institution of attorneyship that used commune members as clients in around 1940, after that under the perfection of descendants, the social economy theory was proposed and the conclusion built foundation for modern cooperatives development.

The paper just on the basis of previous studies, carries on studying recent years' foreign rural cooperatives correlation growth data by time sequence model's modified index curve and growth curve, and meanwhile it gets future years' development trend, the model will promote the field development.

MODEL ESTABLISHMENTS

World earliest rural cooperative was Rochdale Society of Equitable Pioneers that constructed by industrial workers, the cooperative represented contemporary people aspiration and expectation of cooperatives to a certain extent. So the paper takes foreign rural cooperatives correlation growth data as research objects, due to each country status is different, its data changing extent will also have differences.

Foreign rural cooperatives correlation growth data study and time sequence application

Trend extrapolation predication method is one of methods in time sequence, its main thought is finding out things development general rules according to their development history and reality information, and further predicating development trend in some time in future based on this. Its predication method steps are mainly following Figure 1:

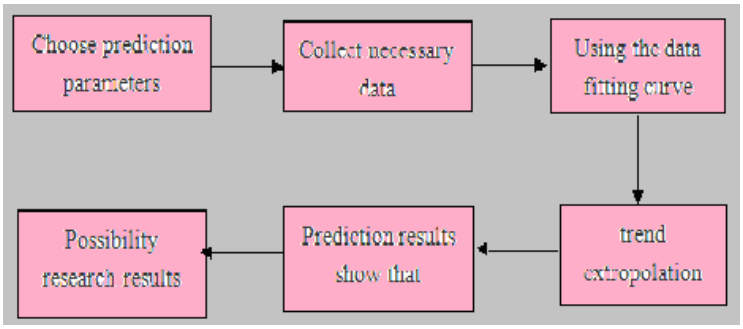

Figure 1 : Trend extrapolation prediction steps

For foreign rural cooperatives correlation growth data changes prediction, it belongs to trend extrapolation prediction method studying ranges, here apply growth curve and modified exponential curve methods to predict foreign rural cooperatives correlation growth data.

Modified exponential curve method application

All things development has certain limitations, modified exponential curve overcomes exponential curve method drawback of predicted value being infinitely increased with time passing when predict, its prediction gets closer to actual things change rules. Modified exponential curve method mathematical model is:

$$\hat{\mathbf{Y}}_{\mathbf{t}} = \mathbf{N} + \mathbf{ab}^{\mathbf{t}} \quad \textbf{(1)}$$

Among them, N, a, b should be defined with historical data.

(1) Modified exponential curve method model

Features of modified exponential curve description:

In the preliminary stage, growth is rapid, and subsequently growth rate gradually reduces ;

When $N > 0, a < 0, 0 < b < 1, t \to \infty, ab^t \to 0,$ that $\hat{Y}_t \to N$

When K value can be implemented and defined, adopt least square method to define parameters in model, and when N value cannot be defined in advance, adopt three sums method.

Among them, divide time sequence corresponding n pieces of observation value into three parts,and three parts are equal as well as every part totally has m periods, that is also $n = 3m$.

Part one: $Y_1, Y_2, Y_3, \cdots, Y_m$;

Part two: $Y_{m+1}, Y_{m+2}, Y_{m+3}, \cdots, Y_{2m}$;

Part three: $Y_{2m+1}, Y_{2m+2}, Y_{2m+3}, \cdots, Y_{3m}$

In above, observation value sum is every part trend sum,and corresponding three sums method steps are as following:

Record observation value,it gets each part sum is :

$$S_1 = \sum_{t=1}^{m} Y_t, \ \mathbf{S_2 = \sum_{t=m+1}^{2m} Y_t}, \ \mathbf{S_3 = \sum_{t=2m+1}^{3m} Y_t}, \quad \textbf{(2)}$$

And it has:

$$\begin{cases} \mathbf{S_1 = \sum_{t=1}^{m} \hat{Y}_t = \sum_{t=1}^{m} (N + ab^t) = mN + ab(1 + b + b^2 + \cdots + b^{m-1})} \\ \mathbf{S_2 = \sum_{t=m+1}^{2m} \hat{Y}_t = \sum_{t=m+1}^{2m} (K + ab^t) = mN + ab^{m+1}(1 + b + b^2 + \cdots + b^{m-1})} \\ \mathbf{S_3 = \sum_{t=2m+1}^{3m} \hat{Y}_t = \sum_{t=2m+1}^{3m} (K + ab^t) = mN + ab^{2m+1}(1 + b + b^2 + \cdots + b^{m-1})} \end{cases} \quad \textbf{(3)}$$

Among them: $(1 + b + b^2 + \cdots + b^{m-1})(b - 1) = b^m - 1$

It further can get:

$$\begin{cases} \mathbf{S_1 = mN + ab\frac{b^{m-1}}{b-1}} \\ \mathbf{S_2 = mN + ab^{m+1}\frac{b^{m-1}}{b-1}} \\ \mathbf{S_3 = mN + ab^{2m+1}\frac{b^{m-1}}{b-1}} \end{cases} \quad \textbf{(4)}$$

Thereupon, it can get:

$$\begin{cases} b = \left(\dfrac{S_3 - S_2}{S_2 - S_1}\right)^{\frac{1}{m}} \\ a = (S_2 - S_1)\dfrac{b-1}{b(b^m-1)^2} \\ N = \dfrac{1}{m}\left[S_1 - \dfrac{ab(b^m-1)}{(b-1)}\right] \end{cases} \quad (5)$$

Besides, when predict data, it should test data, test method is:

$$\frac{Y_{t+1} - Y_t}{Y_t - Y_{t-1}} \approx b \quad (6)$$

(2) Modified exponential curve method application

According to foreign rural cooperatives correlation growth data, by China's statistics yearbook and national rural cooperatives statistics database investigation report, it gets following data TABLE 1:

TABLE 1 : 2005~2013 foreign rural cooperatives correlation growth amount status

Year	Australian one region rural cooperatives amount	American one region rural cooperatives amount	New Zealand one region rural cooperatives amount
2005	158974	648821	129876
2006	168851	683796	130134
2007	179824	698079	132691
2008	189393	706301	149693
2009	198024	715329	159925
2010	207716	783067	172374
2011	199948	799245	185771
2012	205236	810844	201114
2013	206521	811855	203981

1. For foreign rural cooperatives correlation growth amount status

Predict Australian one region rural cooperatives amount

Now divide above nine data into three parts, every part with three data that $n = 9, m = 3$,and take year 2005 as initial year that $t = 1$.

At first, it is easily known by calculating: $\dfrac{Y_{t+1} - Y_t}{Y_t - Y_{t-1}} \in [0.55, 1.25]$

According to formula (2-2) it gets: $S_1 = 1872, S_2 = 1952, S_3 = 1993$

Then by formula (2-5) it gets: $b = 0.8003, a = -84.022, N = 678.708$

So obtained Australian one region rural cooperatives amount modified exponential curve mathematical model is :

$$Y = N + ab^t = 678.708 - 84.022 \times 0.8003^t$$

When predict Australian one region rural cooperatives amount development change in future four years after 2013, only need to input t value into above formula, as predicting Y_{2014}, then it has $t = 2014 - 2005 + 1 = 10$. It further gets following TABLE 2 prediction result:

TABLE 2 : Australian one region rural cooperatives amount prediction

Year	2014	2015	2016	2017
Australian one region rural cooperatives amount prediction value	207985	210257	211682	219851

FOR AMERICAN ONE REGION RURAL COOPERATIVES CORRELATION GROWTH AMOUNT PREDICTION

According to a. step, it is clear:

At first, it is easily known by calculating: $\frac{Y_{t+1} - Y_t}{Y_t - Y_{t-1}} \in [0.48, 1.02]$

According to formula (2-2)it gets: $S_1 = 1865, S_2 = 1742, S_3 = 1876$

Then by formula (2-5)it gets: $b = 0.7112, a = -75.015, N = 698.797$

So obtained American one region rural cooperatives amount modified exponential curve mathematical model is:

$$Y = N + ab^t = 698.797 - 75.015 \times 0.7112^t$$

When predict American one region rural cooperatives amount development change in future four years after 2013, only need to input t value into above formula, as predicting Y_{2014}, then it has $t = 2014 - 2005 + 1 = 10$. It further gets following TABLE 3 prediction result:

TABLE 3: American one region rural cooperatives amount prediction

Year	2014	2015	2016	2017
American one region rural cooperatives amount prediction value	817528	819977	827460	829919

FOR NEW ZEALAND ONE REGION RURAL COOPERATIVES CORRELATION GROWTH AMOUNT PREDICTION

According to a. step, it is clear:

At first, it is easily known by calculating: $\frac{Y_{t+1} - Y_t}{Y_t - Y_{t-1}} \in [0.42, 1.75]$

According to formula (2-2)it gets: $S_1 = 1792, S_2 = 1758, S_3 = 1921$

Then by formula (2-5)it gets: $b = 0.8011, a = -80.022, N = 667.598$

So obtained New Zealand one region rural cooperatives amount modified exponential curve mathematical model is:

$$Y = N + ab^t = 667.598 - 80.022 \times 0.8011^t$$

When predict New Zealand one region rural cooperatives amount development change in future four years after 2013, only need to input t value into above formula, as predicting Y_{2014}, then it has $t = 2014 - 2005 + 1 = 10$. It further gets following TABLE 4 prediction result:

TABLE 4: New Zealand one region rural cooperatives amount prediction

Year	2014	2015	2016	2017
New Zealand one region rural cooperatives amount prediction value	209978	217585	218797	220928

FOREIGN RURAL COOPERATIVES CORRELATION GROWTH DATA PREDICTION GROWTH CURVE APPLICATION

In above modified exponential curve, it only predicts things development trend in some time in future, but things change rate in each period is different. Foreign rural cooperatives correlation growth data change trend is uncertain with time passing, so prediction accuracy of purely using modified exponential curve method is lower. In order to pursuit better solution on development trend uncertainty problem, the paper introduces growth curve model.

Growth curve general mathematical model:

$$\frac{dY}{dt} = rY(1 - \frac{Y}{M}) \quad \textbf{(7)}$$

Among them, y is predicted value, M is its limit value, r is growth constant,and $r > 0$. Solve the differential equation, finally it gets:

$$Y = \frac{M}{1 + ce^{-rt}} \quad \textbf{(8)}$$

In the following,record Logistic curve general form as:

$$Y_t = \frac{1}{N + ab^t}, N > 0, a > 0, 0 < b \neq 1 \quad \textbf{(9)}$$

Among them,in Logistic curve, parameter estimation makes following changes: $Y_t^{'} = \frac{1}{Y_t}$, that:

$$Y_t^{'} = N + ab^t \quad \textbf{(10)}$$

Follow modified exponential curve method's three sums method to estimate parameters, then it has:

$$S_1 = \sum_{t=1}^{m} Y^{'}{}_t,\ S_2 = \sum_{t=m+1}^{2m} Y^{'}{}_t,\ S_3 = \sum_{t=2m+1}^{3m} Y^{'}{}_t, \quad \textbf{(11)}$$

And it has:

$$\begin{cases} b = \left(\dfrac{S_3 - S_2}{S_2 - S_1} \right)^{\frac{1}{m}} \\ a = (S_2 - S_1) \dfrac{b-1}{b(b^m - 1)^2} \\ N = \dfrac{1}{m} \left[S_1 - \dfrac{ab(b^m - 1)}{(b-1)} \right] \end{cases} \quad \textbf{(12)}$$

By formula $Y_t^{'} = \dfrac{1}{Y_t}$,we can get data during year 2005~2013 after changing as following TABLE 5:

TABLE 5 : Data after logistic curve changing

Year	Australian one region rural cooperatives amount $Y_t^{'} / \times 10^5$	American one region rural cooperatives amount $Y_t^{'} / \times 10^5$	New Zealand one region rural cooperatives amount $Y_t^{'} / \times 10^5$
2005	0.625	0.154	0.769
2006	0.593	0.146	0.768
2007	0.554	0.143	0.754
2008	0.524	0.142	0.669
2009	0.504	0.138	0.625
2010	0.482	0.128	0.589
2011	0.500	0.125	0.539
2012	0.487	0.12	0.497
2013	0.207	0.119	0.622

1 Prediction on Australian one region rural cooperatives amount

According to formula (2-11)it gets: $S_1 = 0.00482, S_2 = 0.004626, S_3 = 0.00453$

Then according to formula (2-12)it gets: $b = 0.829, a = 0.0002057, N = 0.001462$

So obtained Australian one region rural cooperatives amount mathematical model is:

$$Y_t = \frac{1}{0.001462 + 0.0002057 \times 0.829^t}$$

When predict Australian one region rural cooperatives amount development change in future four years after 2013, only need to input t value into above formula, as predicting Y_{2014}, then it has $t = 2014 - 2005 + 1 = 10$. It further gets following TABLE 6 prediction result:

TABLE 6 : Australian one region rural cooperatives amount prediction

Year	2014	2015	2016	2017
Australian one region rural cooperatives amount prediction value	207882	210235	211877	219821

2 Prediction on American one region rural cooperatives amount

According to formula (2-11)it gets: $S_1 = 0.00396, S_2 = 0.004537, S_3 = 0.00441$

Then according to formula (2-12)it gets: $b = 0.821, a = 0.0002049, N = 0.001387$

So obtained American one region rural cooperatives amount mathematical model is:

$$Y_t = \frac{1}{0.001461 + 0.0002056 \times 0.828^t}$$

When predict American one region rural cooperatives amount development change in future four years after 2013, only need to input t value into above formula, as predicting Y_{2014}, then it has $t = 2014 - 2005 + 1 = 10$. It further gets following TABLE 7 prediction result:

TABLE 7 : American one region rural cooperatives amount prediction

Year	2014	2015	2016	2017
American one region rural cooperatives amount prediction value	817528	819872	827464	829928

3 Prediction on New Zealand one region rural cooperatives amount

According to formula (2-11)it gets: $S_1 = 0.00423, S_2 = 0.004621, S_3 = 0.00457$

Then according to formula (2-12)it gets: $b = 0.835, a = 0.0002157, N = 0.001402$

So obtained New Zealand one region rural cooperatives amount mathematical model is:

$$Y_t = \frac{1}{0.001402 + 0.0002157 \times 0.835^t}$$

When predict New Zealand one region rural cooperatives amount development change in future four years after 2013, only need to input t value into above formula, as predicting Y_{2014}, then it has $t = 2014 - 2005 + 1 = 10$. It further gets following TABLE 8 prediction result:

TABLE 8 : New Zealand one region rural cooperatives amount prediction

Year	2014	2015	2016	2017
New Zealand one region rural cooperatives amount prediction value	209964	217553	218788	220909

To sum up, foreign new rural cooperatives amount development future five years prediction is TABLE 9:

TABLE 9 : Foreign new rural cooperatives amount development prediction

	2014	2015	2016	2017
Australian one region rural cooperatives amount prediction value	207880	210236	211876	219828
American one region rural cooperatives amount prediction value	817528	819874	827461	829921
New Zealand one region rural cooperatives amount prediction value	209961	217551	218787	220904

Due to exponential curve method has drawbacks like its predicted values will infinitely increase with time passing when predict, in order to overcome the drawback, the paper introduces modified exponential curve method, the method is a kind of prediction method on the basis of exponential curve method, according to the method, it analyzes year 2005~2013 foreign rural cooperatives correlation growth data, and get modified exponential curve method equations, so that makes reasonable prediction on foreign rural cooperatives correlation growth data in four years after 2013, and gets foreign rural cooperatives correlation growth data development trend tends to stable.

CONCLUSION

Trend extrapolation prediction method predicted objects present rising or diminishing trends with time changing, and it can find out such corresponding functions, apply the model into foreign rural cooperatives correlation growth data development prediction is just proper. By comparing foreign rural cooperatives correlation growth data, it gets previous cooperatives amount changing trend, and makes quantitative research and prediction on its changing trend by China's statistical yearbook's relative data, finally it provides current stage foreign rural cooperatives correlation growth data analysis results: American one region rural cooperatives amount is relative more, but its changing trend is smaller, Australian and New Zealand amounts are relative little, but changes ranges are relative bigger.

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