Empirical Research on the Forecast of the Regional Logistics Demand Based on BP Neural Network Nonlinear Nombinatorial Model

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Keywords: BP neural network; nonlinear; logistics demand; forecast

Abstract: With the rapid development of economic globalization and informatization, rapid growth of logistics causes the imbalance between logistics supply and demand. Hence, it is critical to make the accurate logistics demand forecast for the sustainable and sound development of logistics. To achieve that, a nonlinear combinatorial model is constructed for the forecast of the regional logistics based on BP neural network. And the results show that this model with the relatively strong nonlinear mapping ability and comparatively accurate predictive effect provides decisions for logistics planning.

1. Introduction

With the speedy growth of economy and information technique, modern logistics industry develops rapidly all over the world. It is of vital necessity for the sustainable development of regional logistics to make quantitative predictions for the logistics demand scale and development trend, and to keep the relative balance between supply and demand of logistics service [1]. At present, there have existed certain researches on the forecast of regional logistics, but most of them are using single forecasting model or linear combination forecasting model, which have some limitations [2-7]. However, BP neural network prediction method has various advantages such as self learning, training and correction, multidimensional processing, etc, and is able to adopt nonlinear system analysis, which is convenient to determine combination weight of each prediction model from the quantitative aspect so that it enhances the accuracy of the forecast. Meanwhile, it has a high degree of fitting for influencing the forecast of nonlinear complex system. Accordingly, this paper is doing a prediction research on the regional logistics demand by constructing a nonlinear combinatorial model based on BP neural network.

2. Establishing the Index System of Regional Logistics Demand Forecast

Combining the principles of selecting the index of logistics demand forecasting system, in this paper, we establish the index set of logistics demand forecasting system from two aspects - logistics demand index and regional economic index - in the following Table 1.

Table 1 Index set of logistics demand forecasting system

Index Set	Types of Index	Standard of Classification	Index Setting
Index of Logistics Demand	Index of Logistics Demand Scale	From freight scale	Integrated freight volume,rotation volume of freight transport
		From logistics costs	Total social logistics costs,the proportion of logistics costs in GDP
		From fixed assets investment	Aggregate investment in logistics fixed assets
		From industry employees	The proportion of employees in total employment or in total population
	Index of Logistics Demand Structure	From modes of transport	Highway freight volume,railway freight volume,waterway freight volume,airway freight volume,pipeline freight volume
		From logistics demand objects	Industrial products,articles for daily use
		From logistics service functions	Freight volume,storage volume,delivery volume,distribution processing volume,loading,unloading and delivery volume
		From logistics service forms	Total volume of self-running logistics,total volume of outsourcing logistics
		From logistics flow direction	Total volume of internal logistics,Total volume of external logistics
Economic Index of Logistics Demand Forecast	Index of Economic Scale		Gross domestic product,per capita gross domestic product
	Index of Industry Structure		Gross product of primary industry,gross product of the second industry,gross product of the third industry
	Index of Domestic and Foreign Trade		Gross retail sales,total foreign trade value
	Index of Household Consumption Level		Per capita income,per capita consumption level

Combining the analysis of the relative index selection above and considering the availability of statistical data and correlation between each two indexes,in this paper,we choose freight volume (Y ten thousand tons) as the measurement index for the regional logistics demand scale,and choose regional gross domestic product(GDP) X1 (one hundred million yuan),output value of primary industry X2 (one hundred million yuan), output value of the second industry X3 (one hundred million yuan),output value of the third industry X4 (one hundred million yuan),gross retail sales X5 (one hundred million yuan),total regional foreign trade value X6 (ten thousand yuan),per capita consumption level X7 (yuan),etc,as the economic indexes for forecasting the regional logistics demand scale.The specific index system is established in Table 2.

Table 2 Index system for forecasting the regional logistics demand

Index	
Freight Volume	Y
Regional Gross Domestic Product	X1
Output Value of Primary Industry	X2
Output Value of the Second Industry	X3
Output Value of the Third Industry	X4
Gross Retail Sales	X5
Total Regional Foreign Trade Value	X6
Per Capita Consumption Level	X7

3. Empirical Research

The established forecasting index system will be applied to BP neural network, GM (1,1) model, exponential smoothing model, regression analysis method and the paper's model by selecting Fujian province's freight volume from 2006 to 2014 and relative economic influencing factors.

3.1 Basic data

Table 3 Freight and other economic influencing factors in Fujian province from 2006 to 2014

Years	Freight Volume Y	Provincial GDP X1	Output Value of Primary Industry	Output Value of the Second Industry	Output Value of the Third Industry	Gross Retail Sales	Total Regional Foreign Trade Value	Per Capita Consumption Level
2006	44304	7583.85	865.98	3695.04	3022.83	2717.62	49375457	7971
2007	50500	9248.53	1002.11	4476.42	3770	3212.34	56612396	8943
2008	57254	10823.01	1158.17	5318.44	4346.4	3866.69	58908991	10645
2009	58231	12236.53	1182.74	6005.3	5048.49	4480.99	54408483	11336
2010	66159	14737.12	1363.67	7522.83	5850.62	5310.03	73638807	13187
2011	75272	17560.18	1612.24	9069.2	6878.74	6276.19	92698273	14958
2012	84417	19701.78	1776.71	10187.94	7737.13	7256.53	98435836	16144
2013	96718	21868.49	1936.31	11315.3	8508.03	8275.34	104864338	17115
2014	111757	24055.76	2076.99	12501.06	9368.86	9346.7	17749.9171	18532

3.2 Comparative analysis

In order to contrast the predictive effect of this nonlinear combinatorial model with the four single predictive methods, this paper uses the fitting value of each method and the absolute error and relative error between the actual values as the comparative standard. The fitting value error of five prediction methods is revealed in the Table 4. And the absolute and relative error of five prediction methods are as the following Table 5.

Table 4 Analysis of freight volume fitting value in Fujian province

Years	Actual Value	Fitting Value				
		GM(1,1)	BP Neural Network	Exponential Smoothing	Regression	Nonlinear Combination
2006	44304	-	44252.68	-	39634.69	45371.13
2007	50500	47777.85	50410.30	51739.20	47631.91	50492.82
2008	57254	53731.74	57216.83	60587.52	55629.12	57287.22
2009	58231	60427.58	58513.27	61975.58	63626.34	58464.33
2010	66159	67957.82	65795.49	70363.22	71623.56	65630.73
2011	75272	76426.46	75515.88	81127.33	79620.77	75223.89
2012	84417	85950.43	84891.97	91715.66	87617.99	84801.67
2013	96718	96661.23	96061.63	105543.48	95615.21	97110.53
2014	111757	108706.77	106077.57	122625.56	103612.42	111173.70

It is shown in the Table 4 and Table 5, the relative error of nonlinear combinatorial model, BP neural network, GM(1,1),exponential smoothing model, regression analysis model is 0.07%,0.58%,1.0150%,1.52% and 1.98% respectively, and the forecasting performance is from good to bad. Among those methods, BP neural network nonlinear combinatorial model established in this paper is able to guarantee the fine fitting value of the predictive model and actual data and the high accuracy, enabling to show more advantages of BP neural network in the actual use. In conclusion, comparing with other 4 single predictive models, the model proposed in this paper is more reasonable.

Hence, the whole province's freight volume in the five years is predicted,according to nonlinear combinatorial model: x' (2015)=122755.67,x' (2016)=135392.87,x' (2017)=148561.14,x' (2018)=162044.11,x' (2019)=175598.56.

Table 5 Three Scheme comparing

	Absolute Error					Relative Error				
	GM(1,1)	BP	Exponential Smoothing	Regression	Combination	GM(1,1)	BP	Exponential Smoothing	Regression	Combination
2006	-	-51.3	-	-4669.31	-	-	-0.12%	-	-10.54%	-
2007	-2722.2	-89.7	1239.20	-2868.09	-7.18	-5.39%	-0.18%	2.46%	-5.68%	-0.01%
2008	-3522.3	-37.2	3333.52	-1624.88	33.22	-6.15%	-0.07%	5.82%	-2.84%	0.06%
2009	2196.6	282.3	3744.58	5395.34	233.33	3.77%	0.48%	6.43%	9.27%	0.40%
2010	1798.8	-363.5	4204.22	5464.56	-528.27	2.72%	-0.55%	6.35%	8.26%	-0.80%
2011	1154.5	243.9	5855.33	4348.77	-48.11	1.53%	0.32%	7.78%	5.78%	-0.06%
2012	1533.4	474.9	7298.66	3200.99	384.67	1.81%	0.56%	8.65%	3.79%	0.46%
2013	-56.8	-656.4	8825.48	-1102.79	392.53	-0.06%	-0.68%	9.12%	-1.14%	0.41%
2014	-3050.2	-5679.4	10868.56	-8144.58	-583.30	-2.73%	-5.08%	9.73%	-7.29%	-0.52%
mean	721.55	636.8	1513.47	1423.77	73.81	1.02%	0.58%	1.52%	1.98%	0.07%

4. Conclusion

By using five prediction methods like BP neural network, GM (1,1) model, exponential smoothing model, regression analysis method, nonlinear combinatorial model based on BP neural network to do a prediction research on the regional logistics demand scale and structure in Fujian province, the conclusion is obtained that, firstly, it is a available and accurate research method to

predict the regional logistics demand by using the indexes of logistics demand and regional economy; secondly, establishing nonlinear combinatorial model which is applied to predict the regional logistics demand not only gets over the disadvantage of traditional single forecast methods, but it has the high accuracy.

Acknowledgments

This work is partially supported by the Natural Science Foundation of Fujian Province for Youths, China (grant No. 2017J05116), the Natural Science Foundation of Fujian Province, China (grant No. 2015J01286), the JK class project in Fujian Province Department of Education (grant No. JK2014037), the Education Research Project of Fujian Province for Young and Middle-aged Teacher (grant No. JAS150448). We deeply appreciate the organizations mentioned above.

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