Analysis of Proportion of Possession of Tourism Income in Tertiary Industry in Hainan Province based on DDD

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Abstract. A fuzzy time series forecasting model-DDD was proposed based on difference and deifference in difference in paper. Prportion of tourism revenue in tertiary industry during 2005-2015 in Hainan province. Results of DDD would provide useful help for the development and planning of tourism in some departments in Hainan province. In addition, a new model proposed was a beneficial supplement for the solving of time series forecasting.

Introduction

Fuzzy set theory was proposed by Zahde in 1965 and it has been a powerful tool for resolving the problem of uncertainty [1]. Song et al[2][3][4] proposed firstly fuzzy time series forecasting model in 1993 and analyzed the prediction of enrollment in University of Alabama during the 1971-1992 period. Other authors also proposed some modified prediction models. Saxena et al[5] proposed a new fuzzy time series prediction model based on inverse fuzzy numbers and they found that the prediction accuracy of average prediction error rate was very high. For example, they found that the value of average value of forecasting error rate (AFER) and mean square error (MSE) was 0.3406% and 9169 respectively when they analyzed the prediction of enrollment in University of Alabama. Wang et al [6][7][8][9][10] modified prediction model of inverse fuzzy number, which simplified calculation process and advanced the prediction accuracy in some cases. For example, Wang found that the value of AFER and MSE was 0.1705% and 1121 respectively based their modified prediction model. In our paper, we further modified the prediction model in [6] and called it fuzzy time series forecasting models based on difference and difference of difference (DDD). We defined the ratio of tourism income in the tertiary industry in the same period of 2005-2015 in Hainan province as proportion of possession of tertiary industry. In this paper, we analyzed prediction of proportion of possession in the period of 2005-2015 in Hainan province based on DDD. Fuzzy prediction accuracy of historical data was very high and value of AFER and MSE was 0.0842% and 0.00188 respectively. In addition, DDD can also predict unknown data of proportion, which indicated that DDD was better time series forecasting model.

Prediction Model of DDD

Establishment of Prediction Formula of DDD.
Prediction of DDD:

$$C_h = K_{h-1} + A_{h-1} + \frac{0.002+1}{\dfrac{0.002}{A_{h-1}} + \dfrac{1}{B_h}} \tag{1}$$

C_h represents forecasting value of proportion of possession in "h" year; K_{h-1} represents proportion of h-1 year, A_{h-1} difference of proportion of possession in h-1 year; B_h represents difference in difference of proportion of possession in h year; 0.002 represents membership of difference of A_{h-1} of difference of proportion of possession in h-1 year.

Application of DDD.

First step: inputting of historical datas; second step: establishing universe of discourse of propprtion; third step: establishing predictiong formulas-(1) of DDD;forth step: prediting the proportion of possession of historical datas using DDD; fifth step: prediting the proportion of possession of unknown datas using DDD.

Proportion of Possession in Tertiary Industry.

Calculation formula of proportion of possession about tertiary industry was discribed in following:

$$K_h=(H_h/D_h)*100\%.$$

H_h represents tourism income of h year; D_h represents tertiary industry of h year.

Normally, rising of proportion of possession in tertiary industry indiactes that real estate develops rapidly; decling of proportion of possession in tertiary industry indicates that toruism develops rapidly. Development of real estate would be in a relatively period when it develops at certain stage, but develpment of tourism has larger space for growth. In presents, tourism is in a period of rapid growth in Hainan province.

Precdiction of Proportion of Possession in 2005-2015 in Hainan Province

Data of tourism income and tertiary industry in the perion of 2005-2015 in Hainan province was shown in Table-1.

Table 1 Proportion of possession of tourism income in sevince industry in the periond of 2005-2015 in Hainan province.

Year	Tourism income (Billion Yuan)/H_h	Income of tertiary industry(Billion Yuan)/D_h	Proportion of possession/ K_h (%)
2005	125.05	377.17	33.1548
2006	141.43	433.57	32.6199
2007	171.37	528.84	32.4049
2008	192.33	643.47	29.8895
2009	211.72	748.59	28.2825
2010	257.63	953.67	27.0146
2011	324.04	1148.93	28.2036
2012	379.12	1339.53	28.3025
2013	428.56	1644.14	26.0659
2014	484.98	1815.23	26.7173
2015	572.49	1971.81	29.0337

Establishing Universe of Discoursed of Historical Datas.

Universe of discoursed of proportion of possession was set up based on the data of table-1:

K = { K_{2005}= 33.1548，K_{2006}= 32.6199，…，K_{2014}=26.7173，K_{2015}= 29.0337}.

Universe of discoursed of difference of proportion of possession was set up based on the formula of Bh=Kh -Kh-1:

B = {B_{2006}= -0.5349，B_{2007}= -0.2150，…，B_{2014}=0.6514，B_{2015}= 2.3164}.

Universe of discoursed of difference in difference of proportion of possession was set up based on the formula of Ah=Bh -Bh-1:

A = {A_{2007}= 0.3199，A_{2008}= -2.3004，…，A_{2014}=0.2.8880，A_{2015}= 1.6650}.

All above universes of discoursed were shown in Table-2.

Table 2 Proportion of possession of tourism income in tertiary industry in the perion of 2005-2015 in Hainan province based on DDD.

Year	Proportion of possession/ K_h(%)	Difference/B_h	Difference in difference/ A_h	Prediction value/ C_h	$(C_h - K_h)^2$	$\lvert C_h - K_h \rvert / K_h$
2005	33.1548	-	-	-	-	-
2006	32.6199	-0.5349	-	-	-	-
2007	32.4049	-0.2150	0.3199	32.4059	0.000001	0.000031
2008	29.8895	-2.5154	-2.3004	29.9332	0.001910	0.001462
2009	28.2825	-1.6070	0.9084	28.2850	0.000006	0.000088
2010	27.0146	-1.2679	0.3391	27.0154	0.000001	0.000030
2011	28.2036	1.1890	2.4569	28.2181	0.000210	0.000514
2012	28.3025	0.0989	-1.0901	28.2983	0.000018	0.000148
2013	26.0659	-2.2366	-2.3355	25.9452	0.014568	0.004631
2014	26.7173	0.6514	2.8880	26.7306	0.000177	0.000498
2015	29.0337	2.3164	1.6650	29.0285	0.000027	0.000179
AFER						0.0842%
MSE					0.001880	

Establishment of prediction formula of DDD as formula-(1).

Prediction of Proportion of Possession of Tertiary Industry in 2005-2015 in Hainan Province Based on DDD.

Calculation results of proportion of possession were shown in Table-2 using the formula-(1). We found that value of AFER and MSE was 0.0842% and 0.00188 respectively from Table-1, which indicating high prediction accuracy.

Prediction of Unknown Proportion of Possession of Tertiary Industry in 2016-2018 in Hainan Province Based on DDD.

When we analyzed prediction value of unknown tourism income in 2016, we can not calculate directly the prediction value of proportion of possession in 2016 using the formula-(1) because the value of difference in difference (A_{2016}) of 2016 was unknown. So difference in difference (A_{2016}) was provided additionally and was marked as A^+_{2016}. Parameters of B_{2014} and A_{2015} of prediction value of proportion of possession in 2015 were corrected and value of error rate between forecasting value and real date was less than 1%.

Correction process of B_{2014} and A_{2015} was following:

$A^+_{2016}= A_{2015}+ B_{2014} - B_{2015}=1.6650+0.6514 -2.3146=0.0018$

B_{2014} was modified to B_{2015}=2.1364, we calculated formula-(1) using A^+_{2016}=0.0018 and K_{2014}=26.7173, and got the modified prediction value (29.0355) of proportion of possession in 2015. In addition, the value of forecasting error rate was 0.0062%, which was less than 1%. The above results were shown in Table-3.

Table 3 Prediction of unknown proportion of possession in 2016-2018 in Hainan province based on DDD-(4-3-1).

Year	Real value of proportion of possession/K_h(%)	Prediction value/C_h	Difference /B_{2005}	Difference in difference/ A^+_{2016}	Growing percentage than previous year/%
2015	29.0337	29.0355	2.3164	-	0.0062
2016		31.3519	2.3164	0.0018	7.9845
2017		33.6701	2.3164	0.0018	7.3941
2018		35.9883		0.0018	6.8850

We calculated formula-(1) using $B_{2015}=2.1364$, $A^{+}_{2016}=0.0018$, $K_{2015}=29.0337$, and got the prediction value(29.0355) of proportion of possession in 2016 and the growing percentage(7.9845%) than previous year. Using same calculating method, we found that the prediction value of proportion of possession of 2017 and 2018 was 33.6701 and 35.9883 respectively, and the growing percentage of 2017 and 2018 was 7.3941% and 6.8850% respectively. All above calculation results were shown in Table-3.

Conclusion

Prediction formula of DDD has simple structure and high forecasting accuracy using historical data of time series. For example, the value of AFER and MSE was 0.0842% and 0.00188 respectively when proportion of possession of tourism income in tertiary industry in 2005-2015 in Hainan province based on DDD. Whatsmore, DDD can also predict well unknown data, which was a research hotspots in future.

Acknowledgments

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