Analysis and Forecast of Shaanxi GDP Based on the ARIMA Model

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Abstract Based on the 2008 Shaanxi Statistical Yearbook and the relevant data of Shaanxi GDP in the years 1952 -2007, SPSS statistical software and time series analysis are used to establish ARIMA(1,2,1) time series model, according to the four steps, recognition rules and stationary test of time series under AIC criterion. ACF graph and PACF graph are used to conduct the applicability test on model. Then, the actual value and predicted value in the years 2002 -2007 are compared in order to forecast the GDP of Shaanxi Province in the next six years based on this model. Result shows that the relative error of actual value and predicted value is within the range of 5%, and the forecasting effect of this model is relatively good. It is forecasted that the GDP of Shaanxi Province is 647.750, 765.662, 905.866, 1 073.510, 1 274.469 and 1 515.820 billion Yuan in the year from 2008 to 2013, respectively. According to the result, GDP of Shaanxi Province shows a higher growth trend in the years 2008 -2013. The forecasting result of this model is only a predicted value. But the national economy is a complex and dynamic system. We should pay attention to the risk of the adjustment in economic operation and adjust the corresponding target value according to the actual situation.

Key words GDP, ARIMA model, ACF graph, PACF graph, Time series analysis, China

Gross Domestic Product is the ultimate product produced by all the units in a country or an area within a certain period of time. GDP can not only weigh the national products and income size as a whole, but also weigh the economic fluctuation and the periodic status of the economy in general. Thus the data of GDP has become the most concerned economic statistics in macro economy and is regarded as an important index for assessing the national economic development and for judging the operating status of macro economy. Besides, it is also the vital basis for government to set down economic developmental strategies and economic policies. Therefore, accurate GDP analysis and prediction are of great theoretical and realistic value for improving the economic growth of Shaanxi Province.

In recent years, many scholars both at home and abroad have studied the developmental patterns of GDP and the methods of predicting it. By application of SPSS statistical software, Liang Xin and other scholars established the ARIMA(1,2,1) model under AIC criterion . After the applicability test on the model by non-parametric statistical methods, they empirically analyzed and forecasted the data of Guangxi GDP in the years 1950 - 2006[1]. Based on Chinese GDP data records in the years 1954 - 2004, Zhao Ying established ARIMA(1,1,1) model by Box-Jenkins' method . The model revealed the changes in the laws of Chinese GDP growth and empirically analyzed the regressive results[2]. What's more, based on the data of Mongolian GDP from 1952 to 2005, LI Zhan-jiang and other scholars established ARIMA(0,2,1) model by using SAS software. And then, the GDP of Mongol in the year of 2006 was forecasted by using this model[3]. In addition, JIN Shan analyzed the data of GuiZhou GDP in the years 1950 - 2006 and by using EVIEWS software ARIMA(1,1,1) model was established, which revealed the variation of GuiZhou GDP growth[4]. However, the statistical research on Shaanxi GDP is still relatively small. Upon this, by using SPSS statistical software, the appropriate model was obtained based on the ACF graph and PACF graph and repeatedly fitting under AIC criterion. And then the applicability test on the model was conducted according to the residual sequence of the ACF graph and the PACF graph, thus the GDP data of Shaanxi Province in the years 1952 - 2007 is analyzed and the GDP of Shaanxi Province in the next six years is predicted. The results have reference value.

1 Date sources and research method

1.1 Data Sources Based on the 2008 Shaanxi Statistical Yearbook and the relevant data of Shaanxi GDP in the years 1952 -2007.

1.2 Research method Time series analysis is the method for studying the laws of stochastic data series by the use of stochastic process theory and mathematical statistical method, so as to make forecast on the real issues. There are a lot of time series data in social economic system whose laws need to be found out by establishing appropriate model through time series analysis so as to forecast the future of the phenomenon.

2 The establishment of ARIMA(p, d, q) model

ARIMA(p, d, q) model was first raised by U. S. statisticians G. E. P. Box and G. M. Jenkins in 1970. The model is an analysis method widely used in various types of time series data analysis and a short-term forecasting method with high predictive accuracy. Its essence is a combination of difference operation and ARIMA model[5].

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2.1 The stationary test of time series According to the scatter diagram, ACF graph and PACF graph of the time series and its variance, trends, laws of seasonal variation tested by the unit root of ADF, the smooth of the time series could be recognized. If the data is unstable and there is a certain degree of growth or decline, the data's difference treatment is needed to make it stable. If the data contains heteroskedasticity, the technical processing of the data is needed until the autocorrelation function value and the partial autocorrelation function value of the processed data is without significant difference from zero[6].

2.2 According to the recognition rules of the time series model to establish the relevant model Estimating the number of order p and q of the ARMA model through ACF graph and PACF graph and choosing the parameters as little as possible at the initial estimate. Through estimating the value of the autocorrelation order p and the moving average order q through ACF and PACF to select the appropriate model to fit. The selection criteria of model order is shown on Table 1. The model order p, q should be determined by the best criterion function method. Generally, the smallest AIC and BIC criteria are chosen as guidelines for order determination criteria.

Table 1 Selection criteria of model order

Model equations	AR(p)	MA(q)	ARMA(p,q)
ACF	Tailing	q step lag truncation	($q-p$) step lag truncation
Partial ACF	p step lag truncation	Tailing	($p-q$) step lag truncation

2.3 Model checking Testing the model is to see whether the parameters is significant and to diagnose whether the residual sequence is the white noise sequence. If so, the model can be used for practical forecast.

2.4 Model forecasting By the use of the tested-model to forecast. After testing the model we know that the residual sequence is the white noise sequence, which can be used for practical prediction, so the GDP of Shaanxi Province can be forecasted.

3 Results and analysis

3.1 The analysis of Shaanxi GDP After analyzing the data of Shaanxi GDP in the years 1952 –2007[7] by using SPSS13.0, the time series of the data was obtained (Fig.1). From Fig.1 we know that with the reform and opening up policy and the increase of people's living standards, the overall GDP of Shaanxi Province in the past fifty-six years has shown the trend of exponential growth, especially since the reform and opening up. Therefore, we often regarded it as non-stationary time series. This kind of non-stationary time series which contains exponential trend can often be carried out by logarithmic transformation. The result is that the exponential trend will be transformed into linear trend. And then, through difference of the linear trend, the linear trend can be eliminated. Therefore, the time series of Shaanxi GDP data was obtained by taking the logarithm of the data and making a second-order difference (Fig.2). From the Fig.2, we can see that the time series has achieved smooth after taking logarithm and making a second-order difference. In this end, the model was recognized and ordered by the logarithmic transformed and second-order difference data.

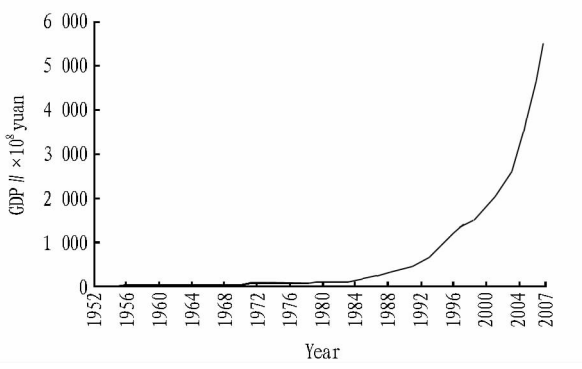

Fig.1 GDP time series of Shaanxi Province from 1952 to 2007

3.2 The recognition and order of the model In order to find the best order , the way of combining the ACF graph, the PACF graph, AIC and BIC together were applied to determine the best order of the model. The value of AIC and BIC under each model was calculated by selecting different parameters for re-fitting. By comparison with their values, we know that in the case of the convergence criteria comes to a maximum of 10, the parameter changes of 0.001% and squares changes of 0.001%, when the (p,d,q) equals (1,2,1), the value of AIC and BIC come to the minimum of −74.141 and −68.174 respectively.

3.3 Parameter estimation When the (p,d,q) equals (1,2,1), the parameter's estimation of the model are: AR1 =0.209, MA1 = 0.974, constant = 0.002. Upon examination, the estimated values of the parameters are all significant.

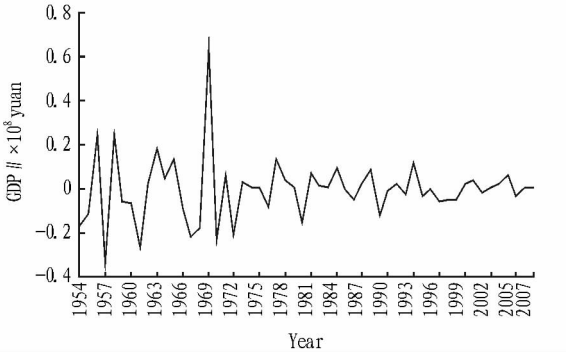

Fig. 2 Time series after logarithmic transformation and second-order difference

3.4 The applicability test of the model The applicability test is to test the original data and the error sequence of the fitting data (residual sequence) to see whether it is consistent with the facts, whether it is a good response to the reality. While the test of time series model is to test whether the residual sequence is the white noise sequence, if so, that means the model can be used for forecasting. If not so, that means the model needs improving. In this paper, the ACF graph and PACF graph of residual sequence are adopted to test whether the residual sequence is the white noise sequence. The ACF

graph and PACF graph of residual sequence are shown on Fig. 3 and Fig. 4. According to the figures we learned that the residual sequence is the white noise sequence, so the ARIMA(1,2,1) fits the time series of Shaanxi GDP well.

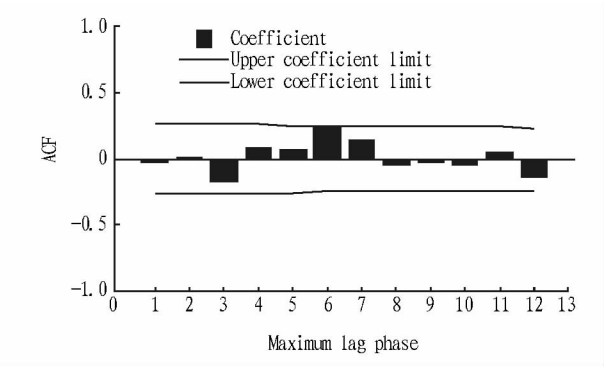

Fig. 3 ACF of residual sequence

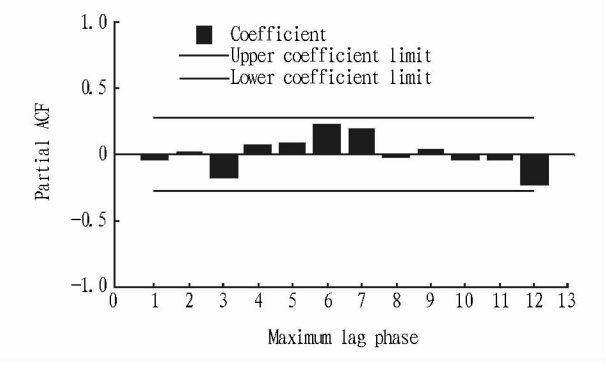

Fig. 4 PACF of residual sequence

3.5 The establishment of ARIMA(1,2,1) model Establishing of the time series model ARIMA(1,2,1) of Shaanxi GDP:

$$(1-0.209B)(1-B)^2 \ln X_t = (1+0.974B)\varepsilon_t + 0.002$$

3.6 The forecast of GDP The time series of the predicted value and actual value of Shaanxi GDP were obtained by the use of ARIMA(1,2,1) (Fig. 5). The figure shows that the fitting effect is relatively good. The results of the comparison with the

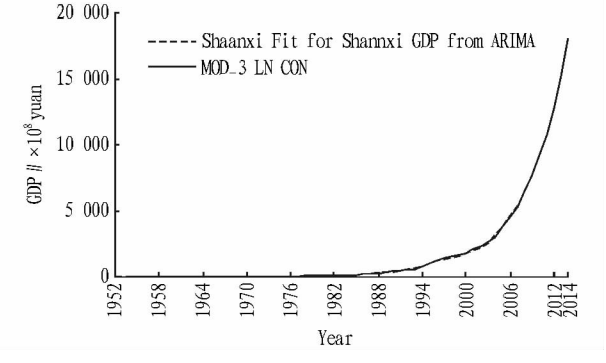

Fig. 5 GDP time series of Shaanxi Province from 1952 to 2007

actual value and predicted value from 2002 to 2007 are shown on the following Table 2. The Table 2 indicates that the relative error of actual value and predicted value is within the range of 5%, so the forecasting effect of this model is relatively good. It is forecasted that the GDP of Shaanxi Province is 647.750, 765.662, 905.866, 1 073.510, 1 274.469, and 1 515.820 billion Yuan in the year from 2008 to 2013, respectively.

Table 2 Comparison of Shaanxi GDP from 2002 to 2007

Year	Actual value	Predicted value	Relative error	Year	Actual value	Predicted value	Relative error
2002	2 253.39	2 317.96	0.028 25	2005	3 772.69	3 753.98	0.004 97
2003	2 587.72	2 602.43	0.005 67	2006	4 523.74	4 436.82	0.019 40
2004	3 175.58	3 007.67	0.054 33	2007	5 465.79	5 341.18	0.023 06

4 Conclusion and discussion

Through time series analysis of Shaanxi GDP in the years 1952 – 2007, the ARIMA (1,2,1) model was established. Transformation of the series by the model parameters turned the residual sequence into white noise sequence. The fitting result of the model is convincing and practical by using SPSS13.0. The GDP of Shaanxi province from 2008 to 2013 is forecasted by the model. The result shows that the relative error is within the range of 5%, which is relatively ideal. According to the result predicted, GDP of Shaanxi province shows a higher growth trend in the next six years from 2008 to 2013. However the forecasting result of this model is only a predicted value, the national economy is a complex and dynamic system. The adjustments of national macro policy and the changes of the development environment will cause the relative change of macroeconomic indicators. Therefore, we should pay attention to the risk of adjustment in economic operation and maintain the stability and continuity of the microeconomic regulation and control so as to prevent the economy from severe fluctuations and adjust the corresponding target value according to the actual situation.

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tudinal comparable but also measure the degree of improvement or deterioriation of energy resources and emission of different industries in different regions.

(4) To those published statistics nowadays about small towns and cities, many kinds of data in the evaluation index system may not be gained directly, most of which should be gained through practical research or sample survey. But the results gained through this kind of research are not comprehensive and systematic enough, or even not representative. Because the industrial development of small towns and cities plays an important role in the national industrial development system, it hints that in the published statistics, some related departments should pay more attention to those statistical data collection on industrial energy, resources consumption and enviromental emission in small cities and towns.

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小城镇产业资源能源消耗评价技术模型与指标体系

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摘要 基于层次性、代表性、可操作性、完备性原则,从小城镇产业发展的资源消耗、能源消耗、环境排放 3 个方面选取了 10 个指标,构建了小城镇产业"节能减排"程度综合评价指标体系,并借鉴模糊数学方式,构建了 2 级层次结构的定量化计算模型。其中,1 级模型着眼于每一个具体的评价指标,在评价指标集合上计算各区域从属于"节能减排"的隶属度,并对计算结果进行排序;2 级模型则根据 1 级模型的排序计算结果,着眼于每个 1 级评价指标集合,在整个评价指标体系上计算各区域从属于"节能减排"的隶属度,最终以此计算结果进行排序。从层次分析法和信息熵方法 2 个角度介绍了各级评价指标权重的确定方法。结果表明,该模型可用于小城镇产业"节能减排"程度的定量化、综合化测度;运用该模型有助于判断不同地区、行业的资源、能源消耗及环境排放的改善或恶化程度。

关键词 小城镇;资源;能源;节能减排

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基于 ARIMA 模型的陕西省 GDP 分析与预测

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摘要 依据 2008 年陕西统计年鉴与 1952 ~ 2007 年陕西省 GDP 相关数据,采用 SPSS 统计软件及时间序列分析法,通过时间序列的平稳性检验、根据时间序列模型的识别规则进行定阶、模型检验、模型预测 4 大步骤在 AIC 准则下建立了 ARIMA(1,2,1)时间序列模型,并根据 ACF 图和 PACF 图对模型做了适应性检验,然后对 2002 ~ 2007 年的实际值与预测值作比较,并利用该模型对陕西省未来 6 年的 GDP 做出预测。结果表明,各年实际值与预测值之间的相对误差均控制在 5% 以内,该模型的预测效果相对较好;根据模型预测的 2008 ~ 2013 年陕西 GDP 数据分别为 6 477.50 亿、7 656.62 亿、9 058.66 亿、10 735.10 亿、12 744.69 亿、15 158.20 亿元,从预测结果看,陕西省的 GDP 在 2008 ~ 2013 年 6 年内仍将呈现出较高的增长趋势;该模型得出的预测结果只是一个预测值,而国民经济是一个复杂多变的动态系统,应随时注意经济运行中蕴藏着调整的风险,适时根据实际情况调整相应的目标值。

关键词 GDP;ARIMA 模型;ACF 图;PACF 图;时间序列分析