

Coal Price Forecast Based on ARIMA-BP Combination Model

Jiale Xu¹, Zhen Wang², Dongxiao Li³

¹School of Economics, Qingdao University, Qingdao, Shandong, 266000

²School of Mathematics and Statistics, Qingdao University, Qingdao, Shandong, 266000

³School of Automation, Qingdao University, Qingdao, Shandong, 266000

Keywords: time series analysis, BP neural network model, multiple regression analysis, cubic spline interpolation

Abstract: This paper mainly studies the comprehensive prediction of coal price, based on the time series of influencing factors. On the basis of ARIMA prediction, the coal price prediction model based on BP neural network is established. Through quantitative analysis, the order of main factors affecting coal price and Qinhuangdao Port steam coal is given. It is required to establish a prediction model based on the annex of Qinhuangdao Port steam coal price and the main influencing factors. Firstly, the stationarity test is carried out on the data of each influencing factor, and then the stable series is constructed by the difference of the unstable data. Then, the time series model based on the influencing factors is established, and the prediction of the data of each influencing factor is obtained. Then we establish BP. The neural network takes the influencing factors as the input layer, tests the trained network with fresh data, and analyzes the residual error of the prediction data. Finally, the prediction data of each influencing factor is replaced into the BP neural network model which has been trained and has a high degree of fitting. The prediction model is established by comprehensively considering the changes of influencing factors caused by various situations in the future, and the multiple regression model is established by introducing dummy variables and determining the multiplier of cross terms. This paper studies the trend of coal price under the economic crisis, supply side reform, snow disaster, debt crisis, imported low-cost coal and so on, and puts forward targeted suggestions to the government for various emergencies.

1. Introduction

As the most important primary energy in China, coal is of great significance to the development of China's national economy. Coal price is not only regulated by the relevant departments of the state, but also affected by the domestic coal market. In addition, climate change, travel mode, energy consumption mode, international coal market and other factors will also affect coal prices.

2. Coal price forecast

In order to observe and predict the data more intuitively, the prediction data of the next 31 days and the next 35 weeks are firstly represented in the image

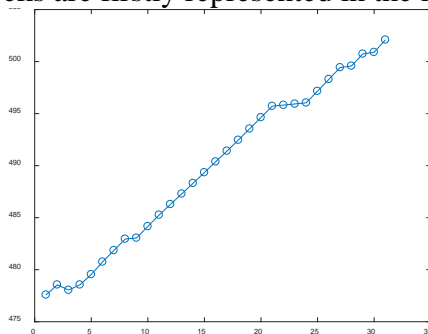


Figure 1 Coal price in the next 31 days

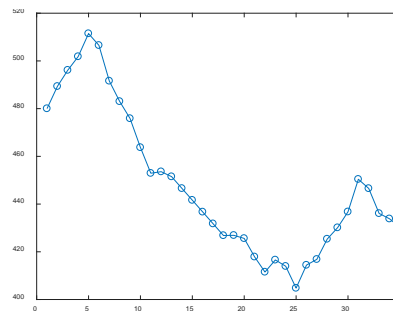


Figure 2 Coal price in the next 35 weeks

It can be seen that in the next 31 days (that is, in a short period of time), the price of coal will be on the rise in the next 35 weeks (that is, for a long time), and the price of coal will fluctuate in the next 36 months, which is obviously in line with the real life.

In order to better illustrate that the forecast data is in line with the change trend of the real data, we draw a picture of the past data

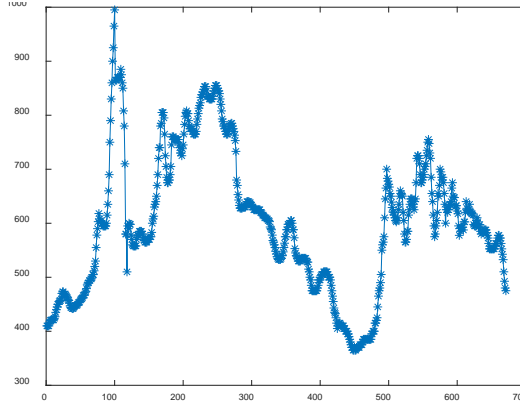


Figure 3 Actual data coal price changes

It can be found that the change trend of the past data is similar to that of our long-term forecast data, which further illustrates the accuracy of our prediction model.

3. Test of prediction model

In order to test the accuracy of the model prediction, we forecast the past data, and then compare the predicted data with the actual data to calculate the relative error, so as to test the model.

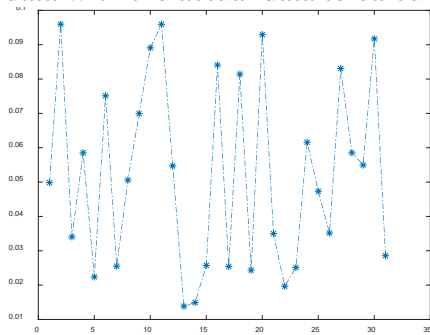


Figure 4 31 day error chart

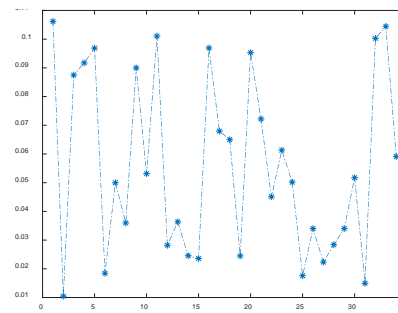


Figure 5 35 week error chart

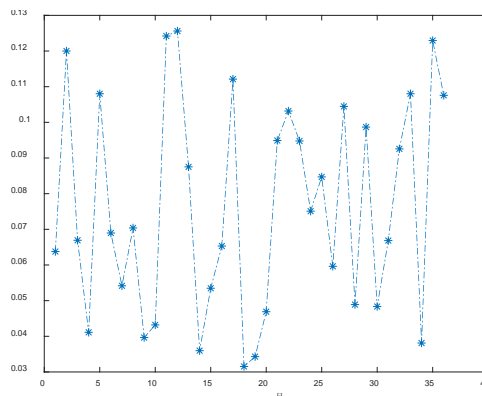


Figure 6 36 month error variation chart

The results show that the prediction error is between 1% and 10% for the next 31 days, 1% to 11% for 35 weeks, 3% to 13% for 36 months, and most of the errors are within 10%. Therefore, it can be proved that our model has certain accuracy.

4. Model establishment and solution

① Model checking

Goodness of fit test: goodness of fit test is used to judge the goodness of fit between the multiple regression model of coal price and the actual data. It mainly judges the fitting degree of the model by constructing the determinable coefficient. Is defined as

$$R^2 = \frac{ESS}{TSS} = \frac{\sum(\hat{y}_i - \bar{y})^2}{\sum(y_i - \bar{y})^2}$$

And because of the internal relationship among the factors collected about coal price, the change has the same trend. The explanatory variables have strong linear correlation and multicollinearity, which can not truly reflect the individual impact of each explanatory variable on coal price. Therefore, the model is tested by multicollinearity. In fitting the regression equation of multivariate time series, the expected values of random error terms have correlation, which will greatly affect the multiple linear regression model and reduce its prediction accuracy. DW test is carried out

$$DW = \frac{\sum_2^x (e_t - e_{t-1})^2}{\sum_1^x e_t^2} \sim 2(1 - \hat{\rho})$$

② Model solving

By stepwise regression, the analysis results shown in table 1 below can be obtained.

Table 1 regression analysis results

Selection factors	Standard regression coefficient	Partial regression coefficient	Standard error	T	P
Qinhuangdao production	1.1195	27.5164	11.6680	2.3583	0.0078
enterprise cost	8.6995E-06	6.2371	0.0004	1.6599	0.0179
Coal demand	-0.0065	-2.3746	0.7844	-3.0275	0.0383
Coal stock	0.0539	5.6961	2.7143	2.0985	0.0324
International price	-0.3753	-16.3410	6.5867	-2.4809	0.0481
Price of substitutes	11.6199	59.4045	56.0959	1.0590	0.03493
Supervision times	0.3578	12.9873	0.0357	1.9871	0.0290

This table can only reflect part of the data. In order to observe the daily data more intuitively, we will compare the real value of coal price at the time point of past emergencies with the predicted value of this model, as shown in the following figure:

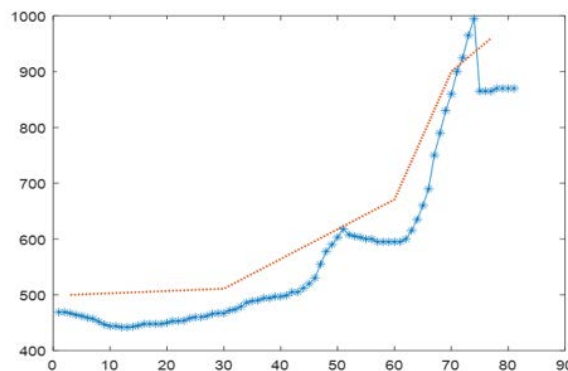


Figure 7 Economic crisis forecast and actual comparison

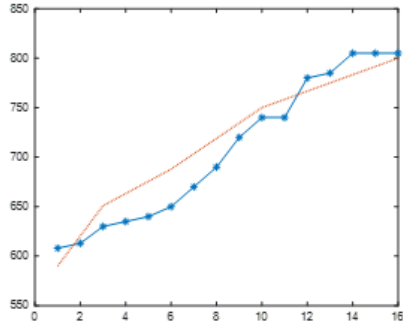


Figure 8 Snow disaster prediction and actual comparison chart

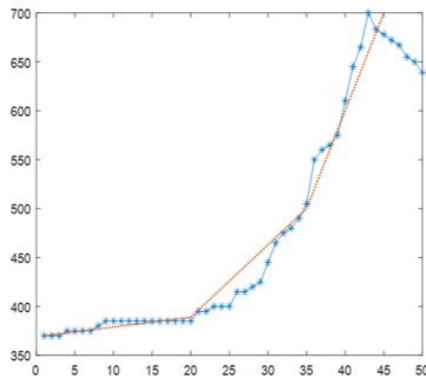


Figure 9 Actual comparison chart of supply side reform forecast

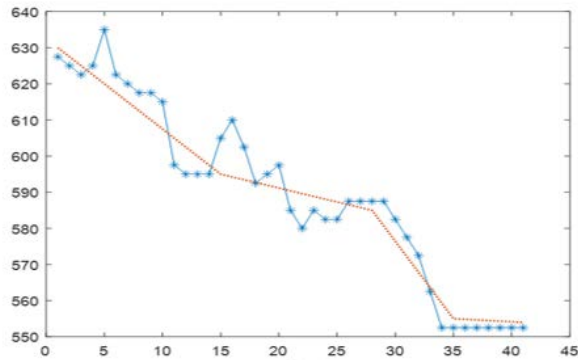


Figure 10 Comparison chart of environmental protection problem prediction and actual situation

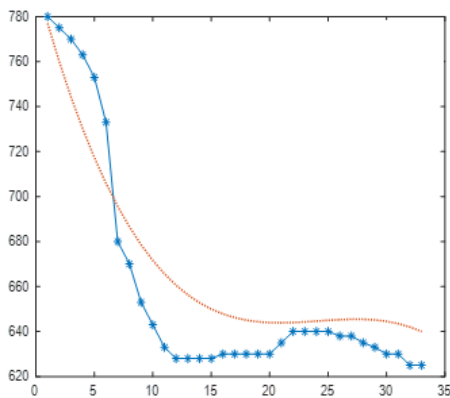


Figure 11 Debt crisis forecast and actual comparison

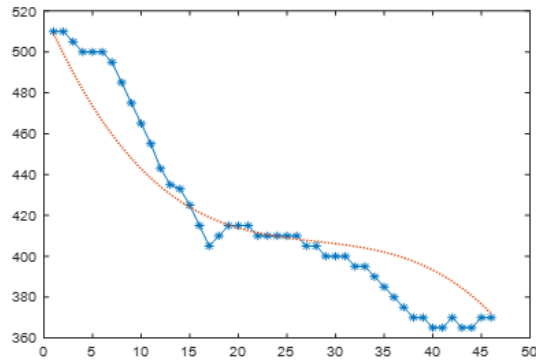


Figure 12 Actual comparison chart of imported low price coal

From the table data, we can see that from the economic crisis in 2008, the snow disaster in 2009, the European debt crisis in 12 years, the impact of low-cost coal imports in 15 years, the structural supply side reform in 16 years, and the environmental protection problems in 19 years. The average absolute residual value of the real value and the predicted value of the coal price is 10.81, which shows that the fitting degree of the model in this paper is good even in extreme cases.

5. Forecast results

Through the above analysis, the influence of various future situations will be quantified and acted on the influencing factors. Through the time series model based on ARIMA for each influencing factor in question 2, we will bring the prediction data of each influencing factor into the model of question 3, and we can get the following coal price forecast chart:

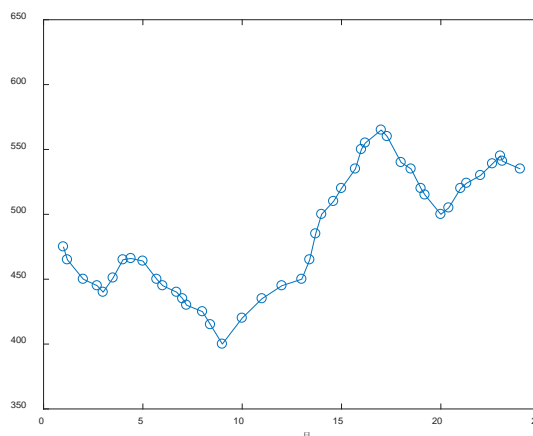


Figure 13 Prediction chart

6. Policy suggestion

(1) We should accurately predict the market demand, establish and improve the social responsibility reserve system with minimum and maximum inventory as the main content, improve the overall inventory level of social coal, promote the balance of supply and demand, and ensure the stable supply of the market.

(2) According to the market demand, it is necessary to limit production and price, balance market demand, and maintain the order of coal market trading. The coal industry and coal consumption industry in many places should work together to cope with the sharp decline in the market situation, balance the total amount of coal, and prevent financial crisis through the sales strategy of documents, The marketing department should strictly implement the basic principles of marketing according to law and production according to sales, so as to ensure that the enterprise fund chain is not broken in the economic crisis.

(3) Further promote the reorganization and integration of coal enterprises, through reasonable adjustment, merger and combination, and by combining government regulation and market operation, improve the coal industry concentration, and further enhance the overall anti risk ability and competitive strength of the coal industry.

(4) Actively follow the pace of national development strategy adjustment, combine with the local actual situation and local advantages to carry out enterprise development and operation transformation. Take modern coal chemical industry as the transformation day standard, strive to extend the industrial chain, take coal as the basis, transform in multiple ways, and take the path of resource transformation, value-added and enterprise circular development. We should establish the business concept of " market" and strive to produce new products with diversified varieties, Adopt advanced production technology and management means, speed up equipment renewal speed, improve coal mining efficiency and reduce production cost.

(5) We should enhance the innovation ability of the coal industry, accelerate the formation of new competitive advantages based on scientific and technological progress, institutional innovation and management innovation, promote the development of the coal industry to the high end of the industrial chain, and enhance the international competitiveness of coal market.

References

- [1] Wang Lei. Study on emergency reserve of coal resources in Central China to cope with sudden natural disasters [D]. China University of mining and technology, 2016
- [2] Xu Yue. Empirical analysis of influencing factors of coal price in China [J]. Times finance. 2017 (14)
- [3] Liu Haiyue, Bai Yanping. Analysis of time series model and neural network model in stock forecasting [J]. Practice and understanding of mathematics. 2011 (04)