Research on Coal Price Forecast based on ARIMA and SVM combination Model

*Yin Zheng[1,a], Kun Yuan[2,b], Lei Dai[3,c]

[1] School of Finance, Anhui University of Finance and Economics, Bengbu Anhui, China;
[2] School of Finance, Anhui University of Finance and Economics, Bengbu Anhui, China.
[3]School of Finance, Anhui University of Finance and Economics, Bengbu Anhui, China;

Abstract-China is the largest producer and consumer of coal in the world. Qinhuangdao Port is not only the largest coal export port in the world, but also an important coal transportation hub in China. The study of the change of coal price in Qinhuangdao Port is of great significance to the study of the change of coal price in the whole country. In this paper, in order to avoid the large prediction error of a single prediction model, an ARIMA-SVM parallel combination model is constructed, and the appropriate weight ratio of ARIMA and SVM model is obtained by calculation, so as to obtain more reliable prediction results. The results show that the international competitiveness of the domestic coal market is insufficient, the coal trading system is incomplete and depends too much on coal resources. For this reason, the government should promote the adjustment of energy structure, improve the mode of transportation, actively improve the coal futures trading system, and realize the upgrading of coal industry.

1 Introduction

As the most widely distributed and most stored energy in the world, coal has been widely used in various fields. China is the largest producer and consumer of coal in the world, and Qinhuangdao Port is not only the largest coal export port in the world, but also an important coal transportation hub in China. The study of the change of coal price in Qinhuangdao Port is of great significance to the study of the change of coal price in the whole country. Coal is also a commodity, and its price is not only regulated by relevant departments, but also affected by domestic and foreign coal markets. At the same time, climatic conditions and energy consumption patterns will also have a certain impact. Studying the trend of coal price can not only provide decision-making basis for coal-related enterprises, but also ensure the normal life of residents. Hao Jialong and Ning Yuncai (2007)[1] the highest weekly coal price in Qinhuangdao from 2005 to August 30, 2006 is selected as the research object, and the Box-Jenkins method is used to establish the prediction model of ARIMA (1prime2), which achieves a good short-term prediction effect. Zou Shaohui, Zhang Jinsuo (2010)[2] by selecting the highest Monday price data of Datong blended coal in Qinhuangdao from January 1994 to December 2008, this paper makes an empirical study on coal price by using unit root test and Monte-Carlo test. The research shows that under normal circumstances, geometric Brownian motion can better fit the changes of coal prices in China; in some sudden cases, the risk-neutral jump-diffusion model can better fit the changes of coal prices in China. Wang Weixian, Chen Lijun (2012) [3] by establishing the BP neural network model to predict and analyze the stock price, and using genetic algorithm to optimize the model, the prediction progress of the model is improved. By constructing the ARIMA-SVM combination model to forecast the coal price, this paper solves the limitation of the single model prediction, effectively improves the prediction accuracy of the model, and puts forward the relevant policy suggestions according to the forecast results.

2 Data Sources and Basic Theories

2.1 Data Sources

The data of this paper comes from the China Coal Market Network. In order to deal with the problem, the following hypotheses are put forward: (1) the coal price is Qinhuangdao thermal coal price, and the type of coal price is the closing price of coal; (2) the coal price is a non-stationary time series, which is stabilized by the first-order difference.

2.2 Basic Theory

ARIMA model is a time series prediction method proposed by Box and Jenkins in the 1970s. ARIMA(p,d,q) is the differential autoregressive moving average model, where p is the autoregressive term, Q is the number of transferred average terms, d is the difference number, AR is autoregressive and MA is the moving average. [1] The

[a*]e-mail: 750449633@qq.com
[b]e-mail: 1499738626@qq.com, [c]e-mail: 1934209768@qq.com

autoregressive model describes the relationship between the current value and the historical value. The moving average model is the accumulation of error terms in the autoregressive model. The ARIMA model is obtained by combining the autoregressive model, the moving average model and the difference method.

Average absolute percentage error: $\mathrm{MAPE} = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{y_i-\widehat{y_i}}{y_i}\right| \times 100$

Average absolute percentage error: $\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i-\widehat{y_i})^2}$

The SVM method maps the sample space to a high-dimensional or even infinite-dimensional feature space through a non-linear mapping, so that the nonlinear separable problem in the original sample space is transformed into a linearly separable problem in the feature space. The basic steps of parallel model to predict time series:

Set the original sequence as $\{x_t\}$, among them, t=1,2,3,…,n and n denote the number of predicted samples.

The predicted value of the I prediction method at t time is x_{it}, The absolute prediction error of the I test method at t time is $E_{it} = |x_i - x_{it}|$, among them, i=1,2,t=1,2,…,n

Let l_1 and l_2 be the weighted coefficients of prediction model I and II respectively, and $l_1 + l_2 = 1$. Then $\widehat{x_{it}} = l_1 x_{1t} + l_2 x_{2t}$ is x_{it} Combined forecast value of it, $E_{it} = x_i - \widehat{x_{it}} = l_1 E_{1t} + l_2 E_{2t}$ represents the prediction error of the combined prediction model at time t, J= $\sum_{t=1}^{n} E_t^2$ is the sum of the square error of the combined prediction.

3 Prediction of Coal Price Based on ARIMA-SVM Combination Model

3.1 Research Ideas

A single model is often unable to fully reflect the impact of various factors on the future coal price trend, so the parallel combination model of ARIMA-SVM is used to comprehensively consider the impact of various situations on coal price in the future. Based on the prediction results of ARIMA model, combined with the prediction of SVM model, the weights of the two models are calculated, the appropriate weight ratio of ARIMA model and SVM model is obtained, and the simulation results are given.

3.2 Research Process

3.2.1 Establish SVM Model

Because the sample set formed by all kinds of influence factors is a nonlinear sample set, the processing steps are as follows: first, select the appropriate kernel function and penalty parameters, construct and solve the convex quadratic programming problem, and calculate the optimal solution. Again, carry on the calculation. Finally, the classification decision function is obtained.

The commonly used kernel function is Gaussian kernel function:

$$K(x,z) = \exp\left(-\frac{\|x-z\|^2}{2\sigma^2}\right)$$

Because the corresponding SVM is a Gaussian radial basis function classifier, the classification decision function in this case is:

$$f(x) = sign\left(\sum_{i=1}^{N} \alpha_i^* y_i \exp\left(-\frac{\|x-z\|^2}{2\sigma^2}\right) + b^*\right)$$

3.2.2 The Result of Simulation Experiment

The simulation experiment is carried out according to the data calculation of standardized residual diagram, histogram + estimated density diagram, Q-Q diagram and related graph, and the simulation results are shown in figure 1.

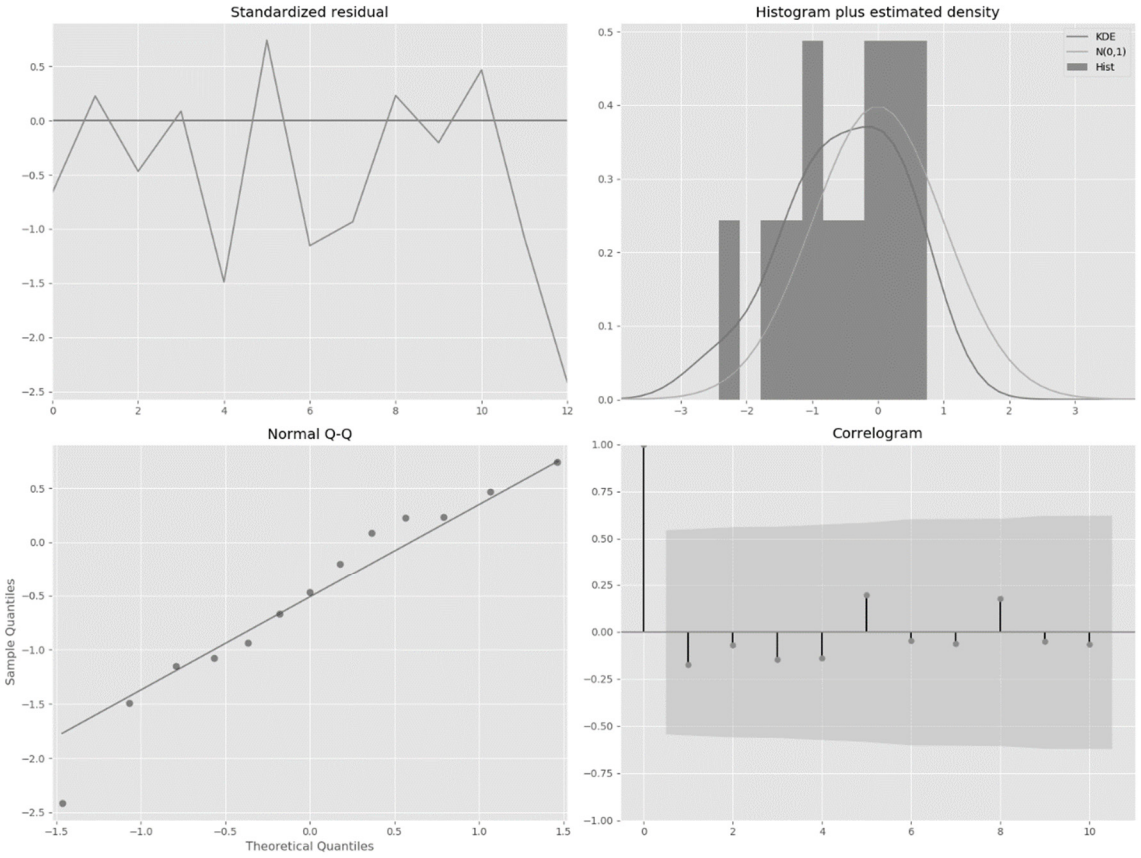

Figure 1 Simulation experiment result diagram

3.2.3 Weight Calculation of ARIMA-SVM Model

The forecasting method adopted is parallel combination forecasting. Through the calculation of weights, the appropriate weight ratio of ARIMA and SVM models is obtained as follows:

$l_1 = 0.234,\ l_2 = 0.736$

The upper value is substituted into the combination model of ARIMA and SVM, and a new combination forecast result of coal price is obtained, as shown in Table 1.

Table1. Comparison of prediction results

Time	Actual coal price	ARIMA predicted value	SVM predicted value	Mixed model predicted value
January-19	590	589.7914074	589.9002496	589.8715211
February-19	595.125	590.1315466	595.0253472	593.733649
March-19	627	598.2740666	607.9222222	605.3756318
April-19	625.625	645.1156947	607.9222222	617.7392842
May-19	613.5	613.3334072	607.9222222	609.3504819
June-19	597.5	613.6050599	597.399566	601.6769385
July-19	600	587.3435207	599.8996636	596.585522
August-19	586	607.9816698	585.9003472	591.7286203
September-19	586.25	572.1375011	586.1502496	582.451643
October-19	580.125	595.1498926	580.2253472	584.1646188
November-19	554.5	570.6497163	557.9222222	561.2815912
December-19	552.5	544.3153586	557.9222222	554.3307473
January-20	561.6	557.6615543	561.6996636	560.6338215
February-20	575	564.0837376	575.099566	572.191984
March-20	557.5	581.8842211	557.9222222	564.2468919
April-20	498	542.1223585	557.9222222	553.7519141

3.3 Result Analysis

The MAPE value of coal price forecast based on ARIMA-SVM combination model is 1.49%, which is lower than that of single ARIMA model and single SVM model, and the fitting effect is better, which avoids the limitation of single model. At the same time, from the simulation experiment, it is further confirmed that the combination model of ARIMA-SVM has a good and reliable prediction effect on coal price.

4 Relevant policy recommendations based on the above research

4.1 Deepen the Supply-side Reform and Promote the Adjustment of China's Energy Structure

China is a big country of coal production and consumption. As an important strategic resource of our country, coal plays an important role in the economic development of our country. As early as November 2015, President Xi Jinping proposed "supply-side reform", which aims to remove excess capacity and speed up the use of clean energy. According to national data, from 2012 to 2017, state investment in the coal mining and dressing industry has dropped significantly from 537.024 billion yuan to 264.838 billion yuan, and has decreased significantly every year, while domestic coal consumption has not decreased, or even increased slightly. This shows that the supply-side reform of the energy industry has achieved remarkable results, improving the coal industry that was once an extensive development.

4.2 Optimize the Reform of Transportation System and Reduce the Cost of Coal Price

At present, the transportation of coal has become a major obstacle to the supply of coal. The transportation cost of coal accounts for 50% of the total price of coal. Most of the transportation of coal at home and abroad is carried by sea, rail and so on. Railway transport is the main mode of coal transport in China, and more than 60% of China's coal resources are transported by railway. Speed up the railway construction, separate the government from the enterprises, break the monopoly, encourage non-state-owned capital to enter the railway construction, optimize the railway transport distribution mode, realize the marketization of the railway transport distribution, and increase the distribution rate. it can greatly reduce the transportation cost and rationalize the coal transportation cost. At the same time, buyers and sellers should be allowed to restrict and choose each other and give full play to the role of the competition mechanism.

4.3 Promote the Reform of Power Generation and Reduce Our Dependence On Coal

The electric power industry is a mature industry, in essence, there is no problem caused by technology, and the current problem is cost. China is very rich in coal resources, and has quite a lot of good coal quality, so we will choose coal-fired power generation for the sake of economy. The price of thermal power in most provinces is between 0.25 and 0.45 yuan per kilowatt-hour, second only to large-scale hydropower. The approved price of nuclear power is 0.43 yuan per kilowatt-hour, which is obviously higher than that of thermal power in most provinces. Therefore, even today, with the continuous development and application of new energy, thermal power is still the main mode of power supply. only by constantly developing and upgrading new energy and solving the cost problem can we improve the way of power generation that requires the use of coal resources. and then optimize the coal industry. And then reduce the environmental problems caused by coal combustion.

4.4 Improve the Coal Futures Trading System and Establish Coal Price Index

In recent years, China's coal export volume is showing a substantial upward trend, but as a big coal country, China does not have an open and complete coal price system, so that other countries can not timely understand the changes of coal prices in China. The establishment of a sound coal futures trading system can promote the relationship between the domestic coal market and the international coal market. At present, China's influence on coal pricing in the international market is not enough. Only by actively connecting with the international market and participating in the international competition, can we improve our influence in the international coal market and make the domestic coal market develop better. In 2013, the China Securities Regulatory Commission approved the application for the listing of thermal coal futures. It is believed that through the listing of more coal futures products, the domestic coal futures trading system can be improved as soon as possible, so that China's coal market can be in line with international standards and improve international competitiveness.

5 Conclusion

Through the analysis of the above model, at present, the cost of coal transportation in China is high, so it is necessary to optimize the reform of transportation system. China still relies too much on coal power generation, and it is the key point of the current work to continuously develop and upgrade new energy sources and reduce the dependence on coal. At present, the international competitiveness of the coal market is still insufficient, sound and reasonable coal futures trading system and coal price index, make the domestic coal market in line with international standards, constantly enhance the international influence of the coal market, and achieve the upgrading of the coal industry.

References

1. J.L. Hao, Y.C. Ning. Research on Coal Price Forecast based on Box-Jenkins method [J]. Prices in China,

2007,1:10-11,26.

2. S.H. Zou, J.S. Zhang. Empirical study on Coal Price change Model in China [J]. Journal of Coal Industry, 2010, 35(3): 525-528.
3. W.X. Wang, L.J.Chen. Modeling and Simulation of Stock Price Forecast [J]. Computer simulation, 2012, 29(1): 344-347.
4. J.M. Zhu. Analysis and Forecast of influencing factors of Coal Price in China [J]. Chinese coal, 2017,43(11):20-24.
5. W. Zhao. Influencing factors and Forecast Analysis of Power Coal Price [J]. Power generation and air conditioning, 2017,38(2):1-6.
6. K.H. Song, H. Qiao. Post-capacity era Shaanxi thermal coal market analysis and price forecast [J]. Low carbon world, 2016(34):234-235.
7. J.Y. Lv, J.N. Du. Carbon emissions trading price prediction using ARIMA-SVM model [J]. Journal of Xi'an University of Science and Technology, 2020,40(3):542-548.
8. L.D. Chang, Z.J. Liang. Research on Coal cost Forecast based on BP Neural Network [J]. Coal technology, 2019,38(4):180-182.