MUTUAL INTERDEPENDENCE OF STOCK MARKETS BASED ON SUPPORT VECTOR MACHINE

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Keywords: Stock index, Mutual prediction, Nonlinear dependence, Support Vector Machine.

Abstract: China's market economy continues to advance, which makes the transparency of information of stock market increasing, the information between the stock market flows faster, a variety of interactions between the stocks increasingly significant. In this paper, support vector machine method is used to study the stock market in the nonlinear discontinuous time series, through the establishment of different support vector machine model, respectively to predict for the Shanghai A shares index, the Shenzhen A share index, the Shanghai B share index and Shenzhen B share index, analyze their absolute error and relative error, it was found there is a strong nonlinear interdependence in the same stock market and a strong dependence of different securities markets, the Shanghai index has a larger effect compare to the Shenzhen index slightly.

1 INTRODUCTION

By studying the interaction between the predictive ability of stock to analyze the interdependence of the stock market, stock prediction is the use of mutual support vector machines for the training data using different indexes to predict changes in other stock indices open space and trends, through analysis the error between models to study the predicted relationship between stock index, which can analyze the dependence between the stock market, mainly to describe the mutual coordination of the stock index between the various elements of the situation is good or bad, to measure the phase transition characteristics and laws between the two indexes. According to the basic principles of coordination theory, the coordination degree determines which sequence and structure the system will reach when it comes to a critical region or the trend from disorderly to orderly.

The main methods of researches between stocks are stock co-integration (Daimin, 2002; Yu et al., 2004; Guang and Yang, 2010; Xiyu and Yufang, 2004) and prediction (Pi-e and Yanhua, 2000; Ping et al., 2003; Xing et al., 2001; Yuchuan and Zuoquan, 2007). Co-integration analysis is used to study relationship and co-integration of the stock index, futures, options, mutual stock fluctuations and so on, by the methods of ADF, Johansen, Granger Test, but all of these methods cannot describe the nonlinear characteristics. There is a lot of studying on a short-term or long-term prediction of a stock index, but less about mutual prediction. Support Vector Machine (SVM) theory is based on statistical learning theory, and the approximately realize of the minimization structural risk, the effective prediction of stock index by the method of SVM regression prediction gives powerful message about the overall change in the stock market, which makes sense for index prediction. The mutual authentication and prediction of different stock index as the training data gives us a new method to understand the relevance and synergy of securities market change.

China's stock market is still in "weak efficient market", which is not a simple linear and orderly market; it is the financial market with complex nonlinear characteristics. Not only investors is irrationality with overreaction occurs or lack of reflect, but also the market is often unstable. With the internal features of nonlinear, discontinuous, the time-series of the stock market and SVM methods have similar characteristics. The paper establishes SVM neural network model, with the Shanghai A Share Index and Shenzhen A Share Index as the training data, then it analyzes other indexes (including the Shanghai A Shares Index and Shenzhen A Shares Index) for regression predict. By analyzing the predicted results and the forecast error, we study the correlation and collaboration between

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different indexes.

2 MANUSCRIPT PREPARATION

2.1 Basic Principles

Support Vector Machine (Cortes and Vapnik, 1995) which is proposed by Vapnik firstly, establishes a separating hyper plane as a decision surface to maximize interval edge between the positive cases and the counter cases, , its learning strategy is a structural risk minimization principle (minimize the expected risk, and also minimize the empirical risk and confidence interval). Practical issues will be converted by a nonlinear transformation to high-dimensional feature space; in the high-dimensional space it constructs linear decision function to realize the nonlinear decision function of the original spaces. The key of SVM learning algorithm is the concept of inner product kernel between the support vector x (i) and the input control vector x. SVM is composed with small subset which is extracted from the training data by the algorithm. SVM neural network system is shown in Figure 1.

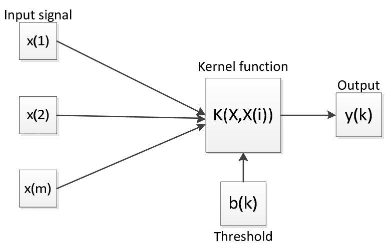


Figure1: SVM neural network system.

The method of Kernel Function avoids the specific form of nonlinear mapping, so that the field of linear learning achievements can be naturally extended to non-linear learning areas, with the kernel function instead of the linear term of linear equations, it can make the original linear algorithm "nonlinear", which can do linear regression. The class of Kernel Function mainly includes linear kernel, polynomial kernel function, radial basis function and the two-sensor kernel function.

2.2 First Section

(1) Data selection: Select the opening index, the closing index, total volume, total turnover, the highest index, the lowest index of a stock index trading day (as the penultimate trading day) as independent variables, and the opening index of the corresponding trading day (from the second date) as the dependent variable.

(2) Data normalization: Using the mapminmax function of Matlab, it normalizes, of the independent variables and dependent variable respectively.

(3) Parameters selection: it optimizes the penalty parameters c and kernel function parameters g of SVM by genetic algorithm.

(4) Training and prediction: it uses the best parameters c and g to train SVM model, and uses different index to do regression prediction for studying the regression results and errors.

3 EMPIRICAL STUDY

In this paper, the research object includes the Shanghai A Share Index from December 19, 1990 to December 31, 2010, the Shenzhen A Share Index from October 4, 1992 to December 31, 2010, the Shanghai B Share Index from February 21, 1992 to December 31, and the Shenzhen B Share Index from October 6, 1992 to December 31, 2010, it remove unreasonable data and select the opening index, the closing index, total volume, total turnover, the highest index, the lowest index as major indicators, it uses different stock index as the training data to study the mutual predictability and interoperability of them.

3.1 Mutual Predictability of the Shanghai A Share Index and Other Share Indexes

The Shanghai A share index is the training data in model 1, it respectively predicts the Shanghai A share index, Shenzhen A share index, Shanghai B share index, Shenzhen B share index, it comes to $c = 67.6781$, $g = 25.5882$ through training.

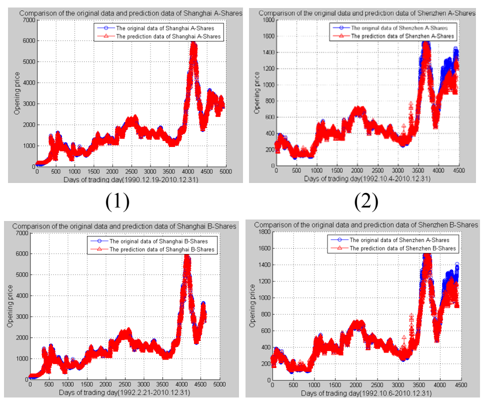
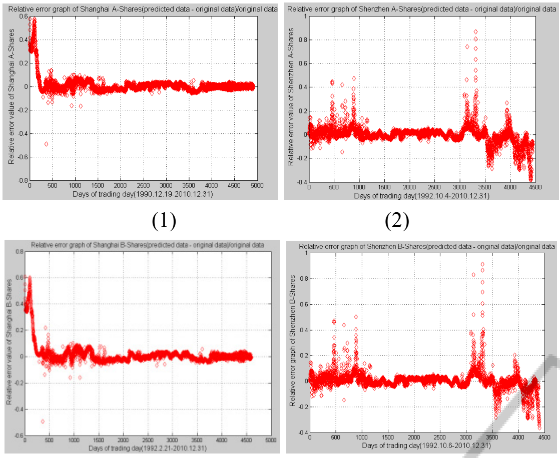


Figure 2: Comparisons of the original data and prediction data in Model 1.



(1) (2)

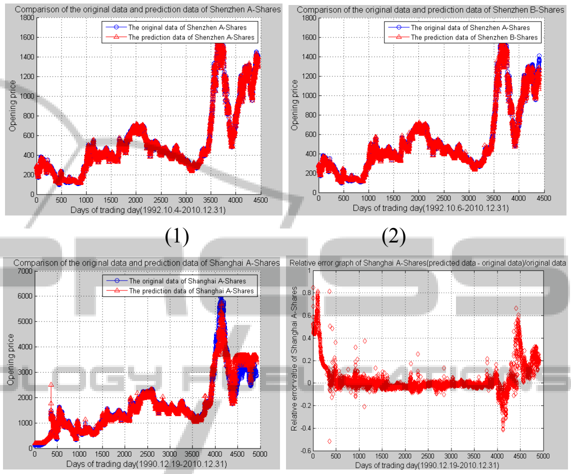
(3) (4)

Figure 3: Relative error in Model 1.

For each share index, it use Shanghai A share index SVM neural network forecasting model to predict. Figure 2 shows the results of the regression prediction and the original data of the Shanghai A share index, Shenzhen A share index, Shanghai B share index, Shenzhen B share index, Figure 3 shows the relative error of each index, it can be seen that Shanghai A share index has the mean square error of 3.0629e-005, the correlation coefficient of 99.898%; Shenzhen A share index has the mean square error of 0.00142668, the correlation coefficient of 97.9941%; Shanghai B share index has the mean square error of 3.13279e-005 correlation coefficient of 99.8898%; Shenzhen B share index has the mean square error of 0.000907803, the correlation coefficient of 98.4753% by calculating. It shows that the predictability between Shanghai A share index and B share index is strong, investors in Shanghai Stock Exchange have the same expectations between A share and B share, they have strong nonlinear interdependence. The Shanghai A share index, Shenzhen A share index and Shenzhen B share index also can mutual predict with a certain degree of interdependence, but week than The Shanghai A share index and The Shanghai B share index. The degree of interdependence between Shenzhen Stock Exchange and Shanghai Stock Exchange is relatively low, investors always focused on a particular stock investment in the same exchange market; it has poor coordination between different markets.

3.2 Mutual Predictability of the Shenzhen A Share Index and Other Share Indexes

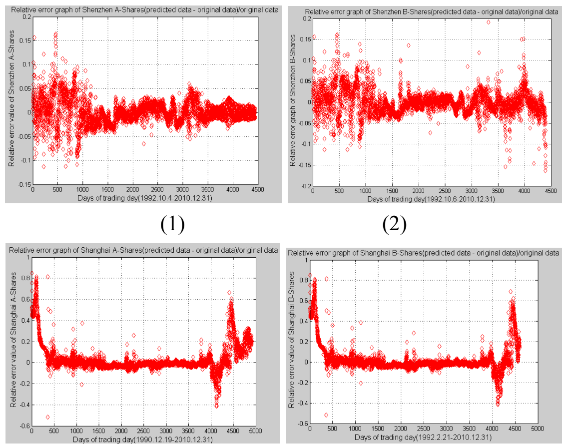
The Shenzhen A share index is the training data in model 2, it respectively predicts the Shenzhen A share index, Shenzhen B share index, Shanghai A share index, Shanghai B share index , it comes to c = 2.48966, g = 75.2551 through training.



(1) (2)

(3) (4)

Figure 4: Comparisons of the original data and prediction data in Model 2.



(1) (2)

(3) (4)

Figure 5: Relative error in Model 2.

For each share index, it use Shenzhen A share index SVM neural network forecasting model to predict. Figure 4 shows the results of the regression prediction and the original data of the Shenzhen A share index, Shenzhen B share index, Shanghai A share index, Shanghai B share index. Figure 5 shows the relative error of each index, it can be seen that

Shenzhen A share index has the mean square error of 2.82236e-005, the correlation coefficient of 99.9429%; Shenzhen B share index has the mean square error of 1.42277 e-004, the correlation coefficient of 99.7345%; Shanghai A share index has the mean square error of 0.00186936, the correlation coefficient of 93.9273%; Shanghai B share index has the mean square error of 0.00173146 correlation coefficient of 93.9391% by calculating. It shows that the Shenzhen A share index and Shenzhen B share index have strong mutual predictability, it has a strong nonlinear interdependence, but less than index in the Shanghai Stock Exchange, the Shenzhen B share index is more affected by Shenzhen A share index. Mutual prediction between the Shanghai A share index Shenzhen A shares and B share index is week than indexes in the same stock market, but they also have some interdependence, the results of the previous model is verified by model 2, consistent with the actual situation.

4 CONCLUSIONS

With the gradual development of socialist market economy, investors gradually obtain a reasonable expectation by historical data and portfolio analysis, so that investment is increasingly rational, and any changes in a stock market information will affect other securities market, cooperatively of stock markets becomes the more and more stronger. In the paper, it establishes two SVM neural network regression prediction model to analyze mutual predictability and cooperatively of Shanghai A shares, Shanghai B shares, Shenzhen A shares and Shenzhen B Share Index, we know that two indices in a same stock exchange have a strong nonlinear interdependence, the index of the various exchanges also have a certain dependence, Shanghai Stock Exchange affect Shenzhen Stock Exchange relatively larger.

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REFERENCES

Shi Daimin. Research of Co-integration for the Stock Index Fluctuation of Shanghai and Shenzhen Stock Markets [J], *Quantitative And Technical Economics*, 2002, 19 (9) _3.

Wei-Bin Yu, Ying Fan, Yi-Ming Wei, etc. The co-integration Analysis of the Brent Futures Market [J]. *Application Of Statistics And Management*, 2004, 23 (5) _7.

Qin Wei Guang, Rei-Cheng Yang. Study on Linkage between Chinas Stock Market Index and Main Index for International Stock Market: Based on Co-integration Analysis [J]. *Technology Economics*, 2010, 29 (11).

Cheng Xiyu, Chen Yufang. Non-linear Co-integration Analysis on Dowjones Index and Nasdaq Index [J]. *Systems Engineering--Theory & Practice*, 2004, 24 (7)_5.

Zheng Pi-e, Ma Yanhua. Rbf Neural Network-Based Stocks Market Modeling And Forecasting [J]. *Journal Of Tianjin University*, 2000, 33 (4) 4.

Chen Ping, Wang Chengzhen, Zhou Jun and so on. Prediction and Analysis for the Index of Shanghai Stock Exchange by SAS System on Monthly Data [J]. *Systems Engineering-Theory & Practice*, 2003, 23 (6)_7.

Chen Xing, Meng Weidong, Yan Taihua and so on. Forecasting Stock Market Quotations via Fuzzy Neural Network Based on TS Model [J]. *Systems Engineering - Theory & Practice*, 2001, 21 (2)_7.

Zhang Yuchuan, Zhang Zuoquan. Application of Support Vector Machines in Stock Price Predicting [J]. *Journal Of Beijing Jiaotong University*, 2007, 31 (6)_4.

Corinna Cortes and V. Vapnik, "Support-Vector Networks, Machine Learning, 20, 1995