

Application of Support Vector Machine Model to Forecast Nigerian Stock Exchange Market for Zenith Bank

Alhaji Ismaila Sulaiman, Nweze Nwaze Obini and Sulyman Muhammad Bello

Department of Statistics, Nasarawa State University, Keffi, Nasarawa State.

Corresponding author: alhajiismail1985@gmail.com

Abstract

Support Vector Machine (SVM) model is applied virtually in every sphere in life. The Nigerian stock exchange (NSE) is not an exception and therefore this study is aimed at applying the model to the NSE in the study. The challenge of stock forecasting is attractive since a small forecasting can enhance the profit significantly. However, the volatile nature of the stock market makes it difficult to apply linear models such as simple time-series or regression techniques. Consequently, support vector machine (SVM) has become a good alternative. It is a popular tool in time series forecasting for the capital investment industry. This machine learning technique which is based on a discriminative classifier algorithm, forecasts more accurately the financial data. The paper discussed the functions and problems of the NSE market. The study of the application of SVM model revealed that it is a good model to forecast the Nigerian stock exchange market effectively.

Keywords: SVM, NSE, Forecasting, Time Series, Models.

Introduction

The Nigerian Stock Exchange (NSE) came into existence in 1960. Currently, NSE is the second largest financial Centre in sub-Saharan Africa. The Exchange is regulated by the Securities and Exchange Commission (SEC), and is licensed under the Investments and Securities Act (ISA). The NSE is a full member and executive committee member of the African Securities Exchanges Association (ASEA), and an affiliate member of the World Federation of Exchanges (NSE, 1961). The NSE is an automated exchange that provides listing and trading services, as well as electronic clearing, settlement and delivery (CSD) services – through Central Securities Clearing System (CSCS) Ltd., a subsidiary of the NSE, which also offers custodian services. Alongside securities listing and trading services, the NSE offers market data dissemination services, market indices, and much more (NSE, 2012).

For over 50 years, the exchange has been an indispensable vehicle that has contributed to the nation's development, and to the development of the Nigerian financial and capital markets. The Nigerian capital market was deregulated in 1993, and in 1995, certain laws were repealed in favor of unrestricted foreign participation by investors. Since then, foreign flows into the Nigerian capital market have continued to rise, in the form of foreign portfolio investment. The NSE is governed by a National Council (Board of Directors). The Council has oversight of all the dealings of the Exchange. According to NSE (2012), NSE continues to evolve to meet the needs of its valued customers, and to achieve the highest level of

competitiveness. It operates fair, orderly and transparent markets that bring together the best of African enterprises, and the local and global investor communities. The Exchange is poised to champion the acceleration of Africa's economic development, and to become "the Gateway to African Markets".

The Nigerian stock exchange which is the main focus of this paper is the key participant in the capital market. Stock exchange is a market place where those who wish to buy or sell shares, stocks, government bonds, debentures and other approved securities can do so although only through members of the stock exchange (Anyanwu, 1993). Thus, it is a market where large and small investors alike buy and sell through stock brokers. In this sense, the stock exchange provides the essential facilities for companies and government to raise money for business expansion and development projects through investors who own shares in companies for ultimate economic benefits of all members of the society.

The Origin of Nigerian Stock Exchange dates back to pre-independence. Before the independence, the Nigerian government at several levels recognized the need for a stock exchange. In the view of Afolabi (1991), the need for establishment of a stock exchange in Nigeria arose partly from the deteriorating government earnings coupled with the mounting recurrent expenditure which left gap for capital budgeting, in such instance, budget deficit was inevitable if capital investments were to be intensified. Also, the development plans of that time expected a sizeable proportion of planned investments to be financed through borrowing. Thus, in 1958 a commission under the leadership of R. E. Barbark was set up by the government of Nigeria to give advice on ways and means of fostering a share's market in Nigeria (Okoro, 1994). Following the recommendations of the Barbark commission, the Lagos stock exchange was then registered and presented with the certificate of registration of business name on 1st March 1959 while on 5th September 1960 it became incorporated and thus began operations on the 5th June, 1961 (Nwankwo, 1988). Again, following the recommendation for Dr. Pius Okigbo's led financial review committee of 1975/76, the then Lagos stock exchange was changed into the Nigerian stock exchange on the 2nd December, 1977 by the federal government. From the date of transformation of the Lagos stock exchange, more branches were opened in Kaduna, Kano, Port Harcourt, Onitsha, Yola and Abuja with its headquarters in Lagos. It is important to note that the activities of Nigerian stock exchange are regulated by the Securities and Exchange Commission (SEC) which was set up by decree No. 71 of 1979.

The model to use for its application is the Support Vector Machine (SVM) which is mostly applied to a non-linear model. This technique was recently developed by Vapnik (1995) for learning classification rules. The technique has been widely applied to problems in pattern recognition (Schmidt, 1996), and regression estimation (Vapnik, 1998; Mukherjee, 1997) due to its remarkable theoretical and practical characteristics. These characteristics include good generalization performance, the absence of local minima, and sparse representation of solutions. When the SVM technique is applied to regression problems it is called Support Vector Regression (SVR). The performance of SVR depends on three training parameters.

In the view of Howard and Samuel (1994) who stated that stochastic model predicts a set of possible outcomes weighted by their likelihoods, or probabilities, for instance, a flipping of a coin. While deterministic model predicts a single outcome from a given set of circumstances, stochastic model deal with randomness of a given circumstances. The NSE market is a key determinant of the Nigerian financial system. It provides the essential facilities for companies and government to raise fund for business expansion and development projects through investors (Sabina et. al., 2015). Stock price forecasting is cherished for investors. It tells out the investment opportunities. Unlike other methods which are concerned with company fundamental analysis, in our approach, the independent variables are derived from the stock itself.

The efforts of Researchers such as Bessler and Brandt (1981), Harris and Leuthold (1985) and Dorfman and McIntosh (1990) have been made to find greater forecasting methods, so as to improve existing ones. Several studies have established that univariate time series models are accurate forecasting models. The support vector machine Vapnik (1998) used in this paper is a neural network technique that has been widely used in stock price predictions. It is a popular tool in time series forecasting.

Tay and Cao (2001) revealed that the general acceptance of SVM is due to its good generalization performance. In the work of Nahil and Lyhyaoui (2017) on stock price prediction based on SVM, the outcome of the model provides a better fitting for the stock prices, particularly for those with an important market capitalization.

In the work of Tripathy (2019) on the stock price prediction using SVM approach, the study suggests that SVM model has better prediction performance in short and medium term compared to long term. The study indicates that an investor can make profit by investing in the stock market.

Objective and significant of the paper

To determine the application of forecasting performance of SVM on the Nigerian Stock Exchange (NSE) market. This will enable the managers and investors to manage stock pricing. The paper will also provide the necessary theoretical support for trading SVM models in NSE.

The work is also expected to provide research-based theoretical evidence that will support the policy thrust of the NSE towards the development of suitable model.

Functions of the Nigerian Stock Exchange

The Nigerian stock exchange was set up to implement a number of functions. These functions have been identified as stated by Anyanwu (1993) are as follows:

- (a) To promote appropriate machinery top facilitate further contributions of stock and shares to the general public,
- (b) To uphold increasing participation by the public in the private sector of the economy,
- (c) To encourage the investments of savings as soon as it is clear that the stocks and shares are readily accessible,

- (d) To provide a central meeting place for members to buy and sell existing stocks and shares and for allowing quotations to new ones,
- (e) To provide the machinery for mobilizing private and public savings and making these available for productive investments through stocks and shares,
- (f) To provide opportunities for raising new capital,
- (g) To facilitate dealings in government activities and hence enhance foreign investment in Nigerian manufacturing since government goes into joint venture with foreign investors,
- (h) To reduce the risk of liquidity by facilitating the purchase and sale of securities,
- (i) To protect the public from shady deals and practices in quoted securities so as to ensure fair trading through its rules, regulations and operational codes,
- (j) To provide opportunities for continued operation and attraction of foreign capital for the nation's developments.

Problems affecting Nigerian stock exchange

The effect of the Nigerian stock exchange as economic development tool could have been more tremendous if the exchange were not hindered by certain hitches. These problems, according to Okaro (2002) are as follows:

- (a) Poor partnership spirit of Nigerians that has inhibited the development of public limited liability companies.
- (b) Convincing poverty that has obstructed adversely on the saving culture of Nigerians.
- (c) An underdeveloped savings/investment system.
- (d) Aggressive and unreliable macro-economic policy and regulatory environments and lack of transparency in economic management.
- (e) Insufficient market infrastructural facilities.
- (f) Low public awareness of the benefits of an investment in the stock market.
- (g) High rate of withholding tax on dividends.
- (h) Paucity of specialized financial market instrument.
- (i) Buy and hold-tight attitudes of the average Nigerians.
- (j) Absence of a fully, developed, efficiency resale market for corporate securities.
- (k) Inadequate technological knowledge and lack of trained manpower.
- (l) Poor perception of the Nigerian stock market by off shore investors in terms of keeping to international financial reporting standards hence constraining foreign portfolio flow.
- (m) High transaction costs in the stock market.
- (n) Long time period between offering shares for public subscription and allocation of the shares.
- (o) Lack of transparency in corporate performance.
- (p) Insufficient investment advisers.
- (q) Absence of venture capitalist.

Methodology

Support vector machine (SVM) model is a new method of data mining. SVM has efficiently solved complicated problems of classification and forecast which is widely used in many disciplines. Certain applications by SVM to predict the stock market have been given, but the degree of accuracy rate and the adequacy of certain prediction are measured by the predictors' deviation from their own experiences or due to the ineffective data (Huang, 2005). In the field of prediction for stock market, the most vital thing is to enhance the prediction accuracy rate (Huang et al, 2006. Chen et al, 2006). However, little study has justified the suitability of stock market prediction by SVM.

The Theory of SVM model

Different methods can be used to forecast NSE market, however, SVM model will be our focus in this paper. The SVM can be divided into two forms namely: Dual form of SVM and Primal form of SVM. Suppose the training nonlinear time series sample is given as

$\{(x_1, y_1), (x_2, y_2), \dots, (x_k, y_k)\}$ ($x_i \in R^n, y_i \in R, i = 1, 2, \dots, k$) is the number of training sample data. The basic idea of Support Vector Machine for time series prediction is non-linear mapping ϕ that transfer time series to the high dimension feature space, F and then construct the optimized linear regression function in the high feature space, and the expression of the linear regression function as follows:

$$f(x) = w\phi(x) + b. \quad (1)$$

In the aforesaid expression, w and $\phi(x)$ is both m -dimension vector, and b is the offset value. Support Vector Machine adopts the structural risk minimization principle to determine the values of w and b . This is given by

$$\min R_{str} = \frac{1}{2} \|w\|^2 + CR_{emp} \quad (2)$$

In equation (2), $\|w\|^2$ is the complexity of control and c is the weight which is used to control the punishment degree that exceeds the error sample.

$R_{emp} = \frac{1}{k} \sum_{i=1}^k L_t[x_i, y_i - f(x_i)]$ is the error control function, which is usually measured by the ϵ insensitive loss function, and the insensitive loss function is defined as follows:

$$L_e = \begin{cases} |y - f(x)| - \epsilon & |y - f(x)| \geq \epsilon \\ 0 & |y - f(x)| < \epsilon \end{cases} \quad (3)$$

According to the structural risk minimization principle considering the complexity of the regression model obtained from the training set, regression based on the Support Vector Machine essentially is a solution of an optimized question, and the optimized question is in the following.

$$\min \frac{1}{2} \|w\|^2 + c \sum_{i=1}^k (\xi_i + \zeta_i^*)$$

In the question ξ_i and ζ_i^* are slack variables and the question is described as the original question of the support vector machine. For the value of dimension w is huge, in order to conveniently solve the question, introduces the Lagrange multiplier α_i and α_i^* according to the duality theorem, and establish a Lagrange function, then the optimized question is converted to the dual space, and acquires the dual question of the original question, the formula is shown as the (2) expression.

$$\begin{aligned} \min & \frac{1}{2} \sum_{i,j=1}^k (\alpha_i^* - \alpha_i)(\alpha_j^* - \alpha_j) k(x_i, x_j) + \varepsilon \sum_{i=1}^k (\alpha_i^* + \alpha_i) - \sum_{i=1}^k y_i (\alpha_i^* - \alpha_i) \\ \text{s.t.} & \begin{cases} \sum (\alpha_i^* - \alpha_i) = 0 \\ 0 \leq \alpha_i^*, \alpha_i \leq c (I = 1, 2 \Lambda k). \end{cases} \end{aligned}$$

In the expression $k(x_i, x_j) = [\phi(x_i) \bullet \phi(x_j)]$ is the kernel function, and the most Commonly used optimized kernel function is the Gauss function and the concrete formula

$$k(x_i, x_j) = \exp\left(-\frac{\|x_i - x_j\|^2}{\delta^2}\right). \quad (4)$$

Supposed the solution to the dual question of the original question is, consequently the regression function is expressed as follows.

$$f(x) = \sum_{i=1}^k (\alpha_i - \alpha_i^*) k(x_i, x) + b \quad (5)$$

As for the kernel function for Support Vector Machine the following four basic kernels are used:

$$\text{Linear} : K(x_i, x_j) = x_i^T x_j.$$

$$\text{Polynomial} : (\gamma x_i^T X_j + r)^d, \gamma > 0$$

$$\text{Radial basis function (RBF)} : \exp\left(-\gamma \|x_i - x_j\|^2\right), \gamma > 0$$

Sigmoid : $K(x_i, x_j) = \tanh(\gamma x_i^T x_j + \gamma)$. where, γ, r , and d are kernel parameters
(Dunham, M.H, 2006)

The objective of SVM is different since it does not seek to reduce the empirical risk of making just a few mistakes, but pretends to build reliable models called Structural Risk Minimization Rosillo et al., (2013) and also the SVM searches a structural model that has little risk of making mistakes with future data. A basic theory of the SVM classifier model is presented. SVMs are specific learning algorithms characterized by the capacity control of the decision function and the use of kernel functions (Vapnik, 1999; Cristianini and Taylor, 2000).

Results and Discussions

Table showing the descriptive Statistics of the SVM model results

Role	Name	N	Type	Statistics	Range	Missing
Regular	Price	4027	numeric	avg = 19.570 +/- 4.501	[9.000; 33.510]	0
regular	Open	4027	numeric	avg = 19.573 +/- 4.570	[0.000; 34.200]	0
regular	High	4027	numeric	avg = 19.807 +/- 4.549	[9.440; 34.200]	0
regular	Low	4027	numeric	avg = 19.351 +/- 4.465	[8.830; 32.550]	0
regular	Change	4027	numeric	avg = 0.001 +/- 0.023	[-0.130; 0.102]	0

Source: Rapid Miners 5.0

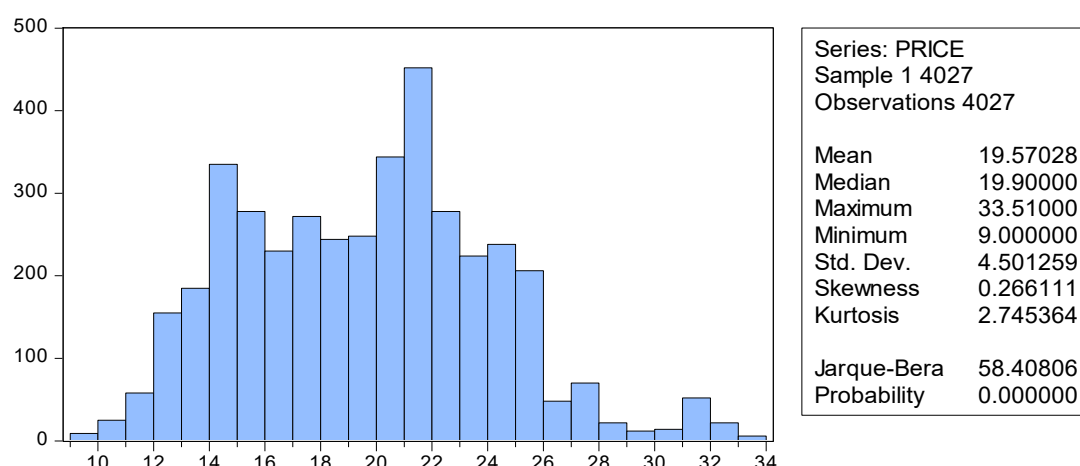


Figure1 showing the histogram of the Zenith bank Stock Prices

The histogram indicates that stock prices from the range 21.00 – 22.00 has the highest frequency of 4027 stock periods (from 2nd January, 2004 to 11th February, 2020) so also stock prices from 31.00 – 34.00 has the lowest frequencies. The plot indicates the descriptive statistics where the Zenith Bank Stock prices has a mean of 19.57 and the median value of 19.9 while the maximum value is 33.51 and the minimum value is 9.00 so also its standard deviation of 4.50, skewness of 0.266 and its kurtosis of 2.7454, Jarque-bera 58.41 and probability of 0.000.

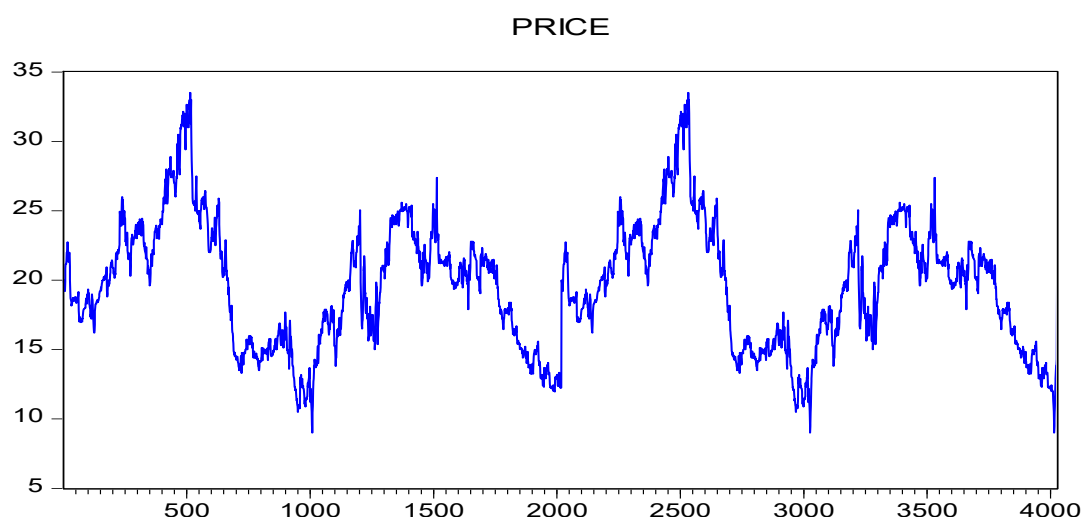


Figure showing the time series plot of the stock prices of the Zenith bank

The descriptive statistics indicate that 4027 sample of Zenith Bank daily stock price from 2nd January 2004 to 2nd January 2020 with a period of 16 years. Where the Zenith Bank stock price has an average of 19.57 as stock price index and the price ranges from minimum value 9.00 to the maximum value of 33.510. The open price index, High price index, Low price index and percentage change price index has an average of (19.573, 19.807, 19.351, 0.001) whereas the minimum and maximum value for open price index (0.000; 34.20) while high

price index (9.44; 34.200) while Low price index (8.830; 32.550) and the minimum and maximum value for percentage change in price index (-0.130; 0.102).

Conclusion

The application of SVM model in forecasting Nigerian stock exchange market price for zenith bank is very effective. The study discussed the functions and problems of the NSE market. The study of the application of SVM model revealed that it is a good model to forecast the Nigerian stock exchange market effectively. It also dwelled into the functions and the problems affecting the NSE as a whole.

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