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Prediction of Tepix in Security and Exchange Organization (SEO) Using Box-Jenkins Model

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Abstract: Today, risk concept has penetrated in financial communities to the extent that it is not hidden for anyone the necessity for discussion about this subject in investment analyses. Researchers assume unpredictable and random variance in investment efficiency as risk and they use variable of standard deviation of efficiency (return) as risk in investment analysis. Market risk is not an exception to this rule and standard deviation of market efficiency index is calculated for computations in efficient markets. However, whereas conducted studies indicate inefficiency of Tehran Security and Exchange Organization (TSEO) thus no one can claim all of changes in market efficiency index are random. Therefore, standard deviation may not be easily utilized in this variable as risk. With respect to this point, Box-Jenkins time-series model has been adapted in this study to predict variance of market efficiency index. Given the results of testing research hypothesis through rejection of opposite claim, there is no significant difference among variance of efficiency index variable and variance of resulting residual from estimation of a Box-Jenkins Model for variable of efficiency index and variance of errors in this model. As a result, standard deviation of efficiency variable may be used for calculation of diversification risk by verification of research hypothesis.

Key words: Prediction, total index, TSEO, Box-Jenkins Model

INTRODUCTION

Security and exchange organization is deemed as full-height mirror against economic status of a country. On the one hand, SEO organization is a center for collection of savings and liquidity of private sector to finance for long-term investment projects and on the other hand, it is a formal and reliable place for owners of stagnant savings that can employ their surplus funds for investment in enterprises and acquire their own return proportional to the incurred risk. Capital and manpower are some of major cornerstones for production and providing these factors and optimal allocation of them is requisite for economic growth. Such allocation requires presence of market and favorable performance of market forces. Regarding capital, financial market may be responsible for this task. Absorption of dispersive capitals and leading them toward investment activities through optimal allocation process is the foremost task for financial market. Investors enter in the field of investment by motive for receiving profits from two channels of resulting interest from the activity of enterprise of which they have purchased stocks and also resale of stocks. Fluctuation of stock price is natural and normal in all bourse markets but in any case one can select favorable composition of stocks by prediction of stock price and thereby reduce fluctuations and increase the rate of available information to persons. It seems that rise of information in market will lead to better performance. Anticipation of important indices in financial market may be assumed as a step taken toward increase and transparency of information in capital market (Kiani, 2004). Total stock price index in bourse market is one of economic parameters that indicate trend of activity and direction of national capital market and potential of capital market in attraction of liquidity in community it is a criterion for determination and completion of investors' behavior in market and guidance to determine time of buying and sale of securities for them. Term 'Index' denotes lexically as a tool for recognition and or distinguishing between two phenomena from each other. However, it is used statistically as a quantity for comparing magnitude of various sizes of one or more variables. If we like comparing various economic and social phenomena with each other and examining the created changes we utilize indices (Marcellino *et al*., 2006). Total stock price index in TSEO organization is composed a parameter of arithmetic mean with some

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weights equal to stock market value in enterprises and it is well-known internationally as TEPIX that includes all of listed enterprises in bourse market. Rise of this index denotes enhance and improvement in economic conditions and circumstances and reduction of this index signifies crisis and recession (Ariyo *et al*., 2014). The present study tries to measure total index in TSEO organization and predict it with respect to the given time-series in the past based on methodology of Box-Jenkins Model.

Research the oretical bases and hypotheses: After Iran-Iraq war and synchronously with execution of first economic development plan of IRI government in 1990, Tehran Security and Exchange Organization (TEO) restart activity. Coincided with resuming activity of bourse market following to first economic development in which privatization was one of main axes, this trend was led to improvement of TSEO short time after starting activity again and volume of transactions number of listed enterprises in this organization enjoyed noticeable improvement after passing about fourteen years and many natural and legal shareholders involved in this bourse market and gradually it could acquire remarkable position in national economic system so that stock index that was not too important in the past today it is remarkably crucial along with its status, changing factors and results of related changes. In addition to domestic problems of country, political and economic vicissitudes during last decade of 20th century that led to enormous economic changes throughout the world have naturally impacted on Iranian economy as well. The number of influence from various factors either directly or indirectly has not been too small due to economic and social developments and it has led to some changes and cycles in trend of stock price in EO organization (Nia, 2013).

Financial markets throughout the world have been put as focus of attention by researchers because of two separate reasons, i.e., personal financial motives and public economic aspects. Since the middle of 1970s and especially 1980, wide efforts were started about predictability of stock prices by means of new mathematical techniques, long time-series and artificial intelligence and many test were conducted on information about stock price and index in countries such as UK, US, Canada, Germany and Japan to indicate presence or absence of a certain structure in stock price information and there by to disprove theory of random paces (Abarbanell and Bushee, 1998).

Stock price index: Index is an indicator that shows variance of price or return of one or a group of securities during certain period of time. In other words, it requires a measurement and comparison tool for distinguishing and recognition between various effects. More simply, bourse index denotes variance of a portfolio composed of all stocks from financial market that measures financial market status. Trend of bourse index is influenced by economic, social, political and international factors of a community at macro level (Al-Shiab, 2006).

Index is a statistical criterion that shows change in movement and direction of an economy or stock market in this fraction numerator is sum of market value for listed companies in bourse market and the index base number is placed as denominator. Accordingly, bourse indices, particularly total index of bourse market are one the foremost criteria for evaluation of investment performance in bourse market and even non-financial investments.

Bourse index calculation techniques: It is a quantity represents numerous homogenous quantities. Index numbers are tools for measurement, comparison, and evaluation of phenomena with certain nature and at least with one distinctive property. As usual, time changes are measured and they are presented as (%). The advantages of using index are as follows (Gonzalo and Taamouti, 2012).

- The probable changes in prices may be looked for in future by analysis on index numbers
- Index is a tool for comparing variance of a phenomenon at two different times
- Index numbers express general and total information about market structure and they indicate general status of market
- Index is a tool for comparing group changes in some phenomena with each other. Prices in different industries may be compared with each other by this index

Bourse Index (TEPIX) can be measured using technique of simple and weighted means but based on more partial perspective, index calculation methods are follows:

- Simple price index
- Combined price index
- Unweighted prices index
- Unweighted relative prices index
- Weighted prices index
- Harmonic indices of prices
- Laspeyres index
- Paasche index
- Edgeworth index
- Fisher's ideal priced index

TEPIX of Tehran bourse market has been known in the world while Laspeyres index technique is the basis for

bourse index in our country and in this technique index is harmonically computed according to current value of the published stock.

Tehran bourse price index (TEPIX): Today subject of stock price index in TESO and range of the related variance is one of the most serious and pivotal issues in capital market and due to inadequate information about way of use, it may unreasonably lead to disappointment and/or empathy for a group of potential investors, national economic directors and practitioners in capital market. Principally, it is impossible to measure comprehensively market by an index and it is necessary to design and use different parameters for various goals. In order to assess their own stocks, share holders of industrial companies should be better to use industrial index or index of the respective industry instead of total price index and holder of investment companies to use financial index. Certainly under this condition, variance of exclusive indices will show more perfect image of market. One of foremost criteria for evaluation of investment performance in bourse market and even non-financial investments are bourse indices and particularly TEPIX. At present, most of institutional and individual investors in TSEO measure movement and direction of market with this criterion periodically. Total Price Index in TSEO that is called TEPIX includes an assumed portfolio of total accepted stocks in bourse. This index only denotes variance of stock price during a specific time period similar to financial and industrial indices (Yeganeh, 2014). Given that measurement of potential of TEPIX in TSEO is predicted with respect to the given time-series in the past based on methodology of Box-Jenkins as the main goal in this study, research hypothesis is expressed as follows: There is no significant difference among variance of Box-Jenkins prediction errors and variance of index changes.

MATERIALS AND METHODS

Research method: Box-Jenkins time-series model was utilized in present study. This method includes four phases: first step is called trial identification phase that deals with recognizing the pilot model. This is done using sample autocorrelation function and partial autocorrelation function. As trial model was recognized we enter in second phase and estimate parameters of model. This step is called estimation phase. Third step is known as recognition of accuracy of fitting where in this phase adequacy and goodness of trial and estimated identification is determined for the model. If lack of goodness is proved for the model, the model should be adjusted and corrected. Recognition techniques may contribute us in way of adjustment and improvement of model. When final model is acquired we use it for prediction of subsequent values in time-series. The above step (fourth) is called prediction phased. Box-Jenkins methodology is an iterative technique. As a result, if trial model is considered as unfitted, it should be returned again to trial recognition step and new and better model should be extracted and then we should estimate parameters of new model and fitness of them. This cycle of trial recognition, estimation and identifying accuracy of fitting will be continued as long as final fitted model is found. At the end, the given final model will be employed for prediction of subsequent values of time-series. Box-Jenkins method can predict both for cross-sectional data and continuous and discontinuous data. Therefore, data should be measured within identical time intervals (e.g., hourly, daily, weekly or monthly). Moreover, Box-Jenkins methodology can be utilized for prediction of seasonal and non-seasonal data.

Statistical population and sample: The statistical population of present study comprises of total price index and stock efficiency index in SEO organization where it is recorded daily in SEO organization and SEO reports consist of this index. The studied sample includes recorded total index in Tehran Security and Exchange Organization at the end of last transactional day of any month (from 21st March 2004 through 20th February 2015).

Method of data collection: Data and information was totally collected in current research by means of existing reports in TESO organization.

RESULTS AND DISCUSSION

Research findings: The main data are the problem of series of monthly mean of market index (Rmt) in this study in which Box-Jenkins Model is built for this variable (Table 1). The input data of problem are the same as total price index (TEPIX) in SEO organization. The changes should be random in an efficient market. In order to determine random nature of this variance, initially autocorrelation function and partial autocorrelation functions should be calculated for primary differences of index variable (i.e., variance). To determine needed

Table 1: Descriptive statistics of data

Variables	Values
Mean	25098.53
Standard Error Mean (SEM)	1957.772
Median	13271.96
Mode	81.31
Standard error	22322.039
Variance	4.983E8
Kurtosis	1.524
Kurtosis standard error	0.212
Skewness	0.952
Skewness standard error	0.422

Table 2: Parameters of estimated model

Model	Natural	AR (Log 1)	Estimate	SE	t-value	Sig.
Moving Index-Model_1	Lag	0.541	0.074	7.298	0.000	Differen

Table 3: Inferential statistics on estimated model

Stationary R^2	R^2	Root of mean square error (RMSE)	Mean absolute predicted error (MAPE) (%)	Mean absolute predicted error (MAPE)	MaxAPE	MaxAE	Normalized BIC	Degree of freedom	Statistic	Effect coefficient
0.253	0.994	1760.583	3.568	989.819	12.675	8212.817	14.984	13.950	17	0.671

Box-Jenkins statistic

Table 4: Inferential statistic of estimated model in percentile

				Percentile						
Fit statistic	Mean	Minimum	Maximum	5	10	25	50	75	90	95
Stationary R^2	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253
R^2	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994
RMSE	1760.583	1760.583	1760.583	1760.583	1760.583	1760.583	1760.583	1760.583	1760.583	1760.583
MAPE	3.568	3.568	3.568	3.568	3.568	3.568	3.568	3.568	3.568	3.568
MaxAPE	12.675	12.675	12.675	12.675	12.675	12.675	12.675	12.675	12.675	12.675
MAE	989.819	989.819	989.819	989.819	989.819	989.819	989.819	989.819	989.819	989.819
MaxAE	8212.817	8212.817	8212.817	8212.817	8212.817	8212.817	8212.817	8212.817	8212.817	8212.817
Normalized BIC	14.984	14.984	14.984	14.984	14.984	14.984	14.984	14.984	14.984	14.984

Table 5: Kolmogorov-Smirnov normality test

Variables	Noise residual from INDEX-Model_1
N	131
Normal parameters[a, b]	
Mean	0.0059
SD	0.04499
Most extreme differences	
Absolute	0.078
Positive	0.078
Negative	-0.051
Kolmogorov-Smirnov Z	0.895
Asymp. Sig. (2-tailed)	0.400

Table 6: Analysis of Variance (ANOVA)

Variables	Sum of square	Degree of freedom	Sum of quare	F-values	Sig.
Inter group	6.487E10	129	5.028E8	30109.498	0.004
Intragroup	16700.700	1	16700.700		
Total	6.487E10	130			

differentiation degree, ac.f and pac.f functions were calculated and it was tried for first series. Autocorrelation charts were examined and primary trial model was identified for prediction with respect to peak points in these diagrams and specific forms of their declination. Then, model parameters were estimated and elements of adequacy residuals for model were analyzed by stationary test. The selected final model will be utilized for prediction. Afterwards, parameters of trial model were estimated and parameters were calculated to determine precision of fitting. At next step, significance of parameters was tested and this operation was conducted for several trial models and finally the fittest models were identified.

Values of t-test for estimation indicate that t-statistic = 7.298 as accepted with respect to critical level 1.96. Namely, null hypothesis H_0 is rejected and H_1 is accepted. In Table 2, significance level is zero and <0.05 thus H_0 hypothesis is rejected. In other words, it is higher than expected level in society.

As it seen in Table 3, significance of all parameters was confirmed. Stationary R^2 coefficient was utilized to determine output. This coefficient (0.253) indicates that the given model has been estimated as good (fitted) one. Box-Jenkins statistic was also used to determine random nature of residuals and null hypothesis (H_0) was accepted that indicated lack of autocorrelation among data (Table 4).

In Table 5 given significance value we conclude data are distributed normally. Therefore, it can be implied at 95% confidence level that all hypotheses are distributed normally and this confirms assumption of normality of residuals and no significant difference is shown. At next step, significance of difference in variances is tested using conducted.

Significance of difference in variance is tested by ANOVA. In other words, if significance level (Sig.) is <0.05, difference is not significant. As it seen in Table 6 in ANOVA results, F-statistic is 0.30109 at significance level (Sig. = 0.04). With respect to critical level, estimation difference is not significant and there is no relationship among variance of Box-Jenkins predicted errors and variance of changes in index therefore research hypothesis is accepted.

CONCLUSION

Today, due to enormous number of effective variables, directors, investors and shareholders prefer to employ a mechanism to assist and consult with them in

making decisions in their activities for this reason they try to adapt techniques thereby their estimations is closer to reality and their error is at minimum level. The present research has predicted stock price at the level of monthly data by three estimator models to introduce best model for prediction in terms of accuracy. In fact, as estimation of a model is closer to reality, there is lesser error in prediction. Therefore, R^2 d coefficient is used for determination that is reasonable criterion from researcher's point of view.

It has been tried in this survey to analyze accuracy of prediction using data for removal of noises versus primary data and results signify that removal of noises from data is led to improving accuracy for prediction. Whereas according to conducted researches and studies on efficiency of TSEO organization, they indicate efficiency at very low level and at the same time effect of financial markets is undeniable on economic development of a country thus with respect to the given results from testing of research hypothesis through rejection of opposite assumption, there is no significance difference among variance of efficiency index and variance of the given residual from estimation of Box-Jenkins Model for variable of index efficiency, and variance of errors in this model. As a result, following to verification of research hypothesis, standard deviation of variable can be thereby used in calculation of diversification risk.

SUGGESTIONS

With respect to given results, following suggestions are proposed:

- In the absence of primary structure, researchers in modeling field may use results of this study for fitted structuralizing of their models
- Accordingly, it is suggested to officials and investors in financial markets to notice modeling based on Box-Jenkins technique in addition to the current model for prediction as a powerful tool for predictions as well

The presence of correlation between subsequent prices in financial market indicates the governing psychological climate over bourse market and inefficiency of SEO. It is suggested to put foremost efficiency cornerstone as agenda, i.e., dissemination and disclosure of proper, accurate and extensive information within very short periods of time.

At present, paying attention to changes in previous prices is the best technique for prediction of price in Tehran financial market for investors and those who expected for short-term return.

For future studies: In addition to questions which are answered in any study, it prepares ground for proposing newer questions. In this part some cases are mentioned that can be assumed as basis for other researches: some other techniques such as FARIMA pattern can be used in linear models and many other numerous models such as neural network, fuzzy neural network and genetic algorithm in prediction and comparison of total stock price index. Only total stock price index in the past was used as predictor factor in the future for this study. One can design more accurate networks by entering fundamental indices in building of neural networks and fuzzy neural networks. Weighting has been done by means of random numbers in this investigation and research outputs are also based on them while genetic algorithm can be used in weighting process. Mechanization of total prediction system and presentation of prediction techniques as comprehensive software by expert in computer field can facilitate and make it more perceivable application of these methods for unfamiliar persons with programming environments.

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