PREDICTING THE OPENING OF INDIAN STOCK MARKET

A Jiran Meitei*

Rajkishan Nair**

Abstract:

Price volatility at the opening of any market is driven by forces outside the regular trading session and predicting the exact opening price of any market is very difficult. In this paper an attempt has been made to predict the percentage change in the opening price of the Indian Market, represented by BSE, by using the multiple linear regression, taking the other major Asian markets as the independent variables.

Key words: *correlation co-efficient, ADF, t-test, regression, ANOVA*

* Maharaja Agrasen College, Delhi University, Delhi, India

** IILM Graduate School of Management, Greater Noida, India

1. Introduction

One of the most important economic policy decisions across the world, in the post cold war era (since the late 1980s) - especially in the developing world, has been the liberalization and opening up and the subsequent integration of stock markets across the world. In the past two decades, this move towards a synchronized stock market setting has led to a tighter and stronger, economical and financial inter-linkage among developed countries. The colossal cascading nature of the impact of the subprime crisis in the US, on markets across the world, is the best case in example proving this deepening inter-linkages. However, the rise of many important emerging markets, which have been a major driver of global growth the past decades, have opened up additional channels for cross-border relations (Mobarek, 2012).

Equity market liberalization has given investors a hitherto unprecedented opportunity to invest in securities on both sides of their political borders. This has resulted in massive cross border capital flows across the world. Effective liberalization strategies also lead to market integration which is capable of bringing about fundamental effects on both the financial and real sectors. It has also been proved that financial integration helps in increasing financial stability by a more efficient allocation of capital (as a result of intense competition), a higher degree of risk diversification, a reduced probability of asymmetric shocks and enhanced influence on the establishment of a harmonized framework (*Pauer*, *Franz* (2005)). Moreover, financial integration may also promote financial development and hence enhance economic growth in the region. However, the increasing degree of dependence between global stock (financial) markets also leads to the increasing risk of financial instability in one region being transmitted to neighbouring countries more rapidly as demonstrated by the series of financial crises across the world in the last 10 years. Hence explaining and predicting stock market movements becomes an imperative for not only facilitating informed investment decision making but also minimizing the volatile nature of growth cycles.

2. Literature Review

In the post liberalization era, market linkages, stock market integration and prediction have remained a topic of interest **(**Ghosh, A. et al. (1999), Chou et al.(1999), Huang et al. (2000), Tan, K. B., and Y.K. Tse. (2002), Golaka and C. Nath, (2003)**,** Yang, J. et al. (2003), Gurcharan Singh and Pritam Singh (2010)). Most of these studies explain the presence of stock market integration, sharing the notion that markets have been exhibiting tighter co-movements with one and other, and that they are more integrated than ever, which is attributed to the closer financial and economical linkages between them. Though, it is found that the determinants of stock market co-movement and economic integration is still largely less explored and explained (Cheng, Lin, 2008).

There is also a plethora of studies which suggest that countries identified with a higher degree of economic integration should also exhibit greater co-movement in their respective capital markets, Bracker & Koch (1999), Bracker *et al*., (1999), Johnson & Soenen, (2002, 2003). These studies have tried to determine how integrated markets are by examining the degree of the co-movements that stock markets exhibit. There is also a range of studies which deals with emerging stock markets, supposed to have lower exposure to world factors, thus having lower levels of integration (Solnik, 1995). The positioning of this study is in this context, where we propose that determining the opening price of a stock market in an emerging market (purportedly with a lower degree of integration) could be helpful in explaining and predicting stock price movements.

Despite several attempts to predict the correct price of a stock market, a single method which predicts the price correctly is still at large. Some of the commonly used scientific methods for stock market prediction are genetic algorithm, Artificial Neural Network (ANN) and other Meta heuristic algorithms. Cheng (1996) and Van and Robert (1997) has successfully modeled financial time series using Artificial Neural Network (ANN). In light of the absence of rigorous studies in predicting the opening price of a stock market, our attempt here is to estimate the opening price of the Indian stock market, so as to enable a discussion and further studies in the area.

3. **Objective of the Study**

Price volatility at the opening of any market is driven by forces outside the regular trading session and knowing how to trade stocks and futures during this period is an opportunity for investors looking for a high rate of return. The often volatile pre-market trading session is widely followed to gauge the market outlook ahead of the regular open. Economic indicators are a main driver of price action in the pre-market trading session. To reduce this volatility in the opening of the market, SEBI in October, 2010 started -the pre-opening session in both the indices (BSE and NSE) which normally lasts for

15minutes. This session consists of order collection period and order matching period. The pre-opening session is a new innovation to arrive at the ideal opening price of scrips for the current trading session and in the process also reduce the volatility in the beginning of the day. The main objective of this paper is to give some direction to the investor/trader on the opening of Indian market on the basis of the opening of the other major Asian markets. To do this analysis we have identified a total of 8 major markets including the Bombay Stock Exchange (BSE). The daily data on the percentage change in the opening of these markets were collected from *yahoo finance* (***http://finance.yahoo.com/***) starting with 1st January 2012 to 31st December 2013. A detail investigation of these data will also be done. The correlation of these markets with the BSE will also be computed. Finally a multiple linear regression method will be used to predict the percentage change in the opening price of BSE.

4. **Data Analysis and Findings**

As mentioned above the data used in this study are from the eight major stock market indices, from India represented by BSE, the Hong Kong market by Heng Seng Index (HIS), the Japanese Market by Nikkei-225, the Indonesian market by Jakarta Composite Index (*JKSE*), the Korean market by Korea Composite Stock Price Index (KOSPI), the Malaysian by *FTSE* 100 Index and the Chinese by Shanghai Stock Exchange Composite Index (SSE). The daily opening (in terms of % change) of these markets has been recorded over a period of two years (from 1st January 2012 to 31st December 2013). The following table shows the total number of trading days for the various markets during this period.

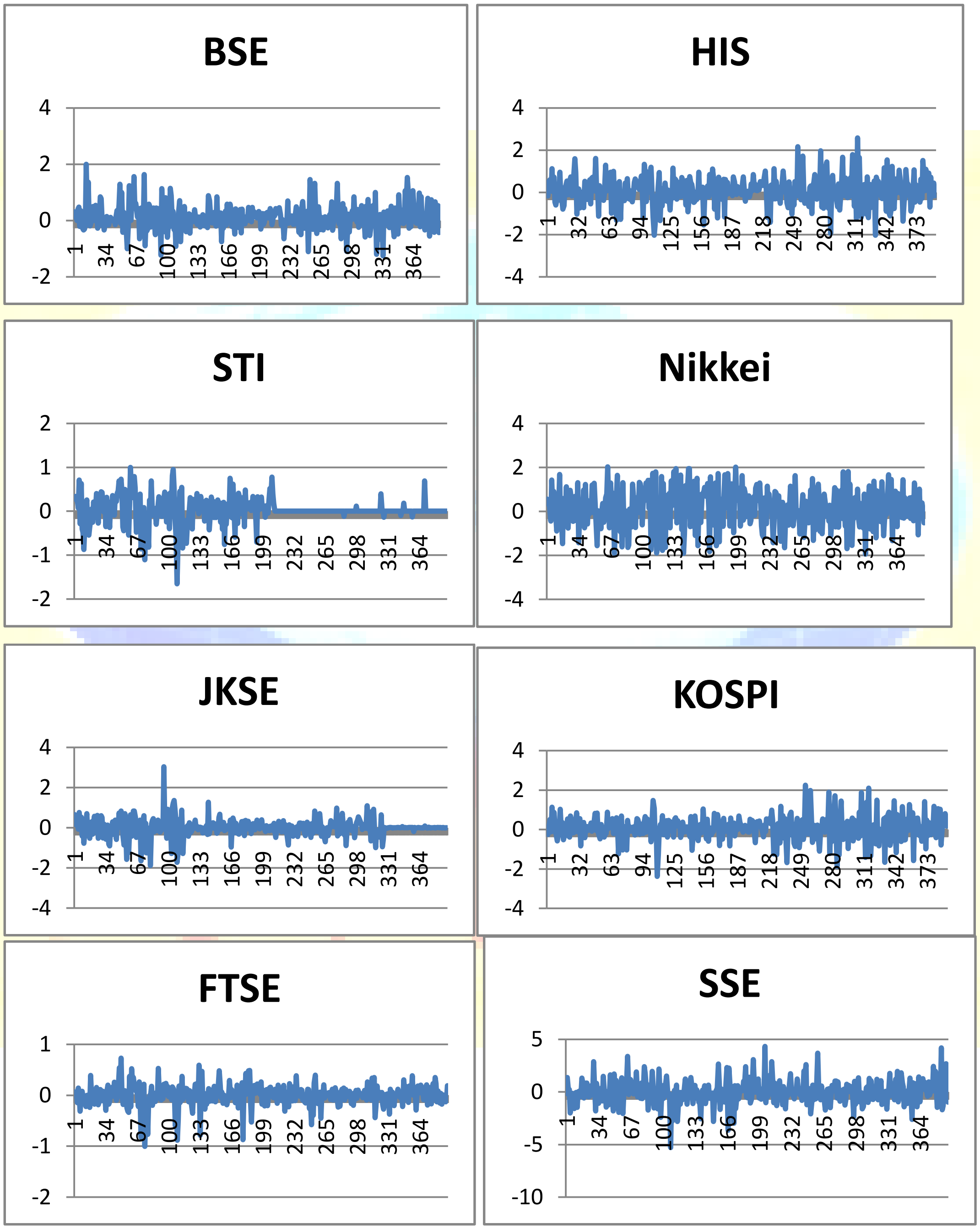
Exchange	BSE	HIS	STI	Nikkei	JKSE	KOSPI	FTSE	SSE
Number of Trading Days	494	504	510	496	484	495	493	482

Table1: Total number of Trading Days

From **Table 1** it can be seen that **STI** with a total of **510 days** had the maximum number of trading days whereas **SSE** had the least with 482 **days** and BSE has a total of 494 trading days**.** For our analysis we have identified a total of **393** trading days common to all the markets.

4.1. **Testing of stationarity of the time series data using ADF**

Since these data are collected over a period of time, a check for the stationarity of the same will be done. The following charts show the percentage change in the various markets during this period;



Figures 1: Time series plots of the % change in the opening of eight markets

When we carefully observe the above figures we can see that none of the graphs exhibit any trend line and oscillates around zero (no intercept). For testing of stationarity of all the time series data of the different markets we will use ADF test by **D. A. Dickey and W. A. Fuller (1979)** which includes estimation of a unit root for the different time series data. Since the data are free from intercept and trend, the following equation will be used to find the unit root:

$$Y_t = \rho Y_{t-1} + \varepsilon_t \quad (1)$$

Where, Y_t is the relevant time series, and ε_t is the residual term. This test was carried out on levels and first differences. The null hypothesis is that the variable has a unit root i.e. ρ= 1 against the alternative hypothesis having no unit root. If null hypothesis is accepted, then Y_t series is non- stationary time series. The null and alternative hypotheses were stated as: H_0: ρ=1 and H_1:$\rho \neq 1$. The null hypothesis will be rejected if $|ADF|>|t|$ (i.e. if the modulus of ADF test statistic value is greater than modulus of Test critical values).

Name of the Market	ADF test statistic value	Test critical values at	Durbin-Watson stat. value
BSE	-12.105681		1.994516
HIS	-18.953460	1% -2.5709	2.003575
STI	-5.458473		2.011195
Nikkei	-5.257108	5% -1.9416	1.989054
JKSE	-12.288151		1.987724
KOSPI	-12.690976	10% -1.6162	1.992395
FTSE	-19.318612		2.000462
SSE	-19.769067		1.993423

Table 2: ADF calculation

Table 3 gives the values of the ADF test for the different markets along with their critical values at different levels of significance. Since the absolute values of the entire ADF test statistic are greater than absolute value of the critical values at different levels, we reject the null hypothesis and conclude that the different time series data do not processes unit root or in other words the time series data are stationary. The last column of **table 2** gives the Durbin-Watson statistic value for all the markets which hovers around **2**, from this we can conclude that the data do not exhibit any autocorrelation.

4.2. **Test for the linear relationship data using t-statistic:**

To test the linear relationship of the percentage opening of Indian Market represented by BSE with the percentage opening of the other major Asian markets, first we calculate the correlation coefficient of these markets with BSE.

The following is the correlation matrix of the different markets computed form data collected.

	BSE	HIS	STI	Nikkei 225	JKSE	KOSPI	FTSE	SSE
BSE	1							
HIS	**0.620686**	1						
STI	**0.342381**	0.484222	1					
Nikkei	**0.410724**	0.589857	0.379743	1				
JKSE	**0.499744**	0.586092	0.530092	0.4750125	1			
KOSPI	**0.594284**	0.797048	0.400205	0.6214297	0.542749	1		
FTSE	**0.350142**	0.397693	0.375204	0.3379709	0.410705	0.401302	1	
SSE	**0.306146**	0.336002	0.213944	0.185927	0.152114	0.253708	0.124758	1

Table 3: Correlation Matrix

It can be seen from the above table that there is a positive correlation between BSE and all the other markets, the highest being 0.620686 (with HSI) and lowest as 0.306146 (with SSE).

A test for the linear relationship is done by using the ***t*-test for testing the population correlation coefficient**. We follow standard hypothesis test procedures in conducting this hypothesis test for the population correlation coefficient ρ.

First, we specify the null and alternative hypotheses:

Null hypothesis $H_0: \rho = 0$

Alternative hypothesis $H_A: \rho \neq 0$

Second, we calculate the value of the test statistic using the following formula:

Test statistic: $t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$, which follows t-distribution with (n-2) *d.f.* (2)

Third, we use the resulting test statistic to calculate the *p*-value. The *p*-value is determined by referring to a *t*-distribution with *n*-2 degrees of freedom. The following table gives the different t-values along with their p-values.

	Correlation co-efficient	**t value**	**p-value**

	value with BSE		
HIS	0.620686	15.6535	3.17E-43
STI	0.342381	7.205647	3E-12
Nikkei	0.410724	8.907546	2E-17
JKSE	0.499744	11.40857	3.21E-26
KOSPI	0.594284	14.61129	6.9E-39
FTSE	0.350142	7.391518	8.89E-13
SSE	0.306146	6.358974	5.67E-10

Table 4: Test for the linear relationship of the different markets with BSE

Since all the p-values in **Table 4** are very small we reject the entire null hypothesis and conclude that there is linear relationship between the BSE and the different Asian markets.

4.3. **Predicting BSE opening using Multiple Regression Analysis:**

Conceptually multiple linear regression is used to predict the value of the dependent variable when the value of many independent variables and constant are known. We can also use multiple regression to examine the relationship of the independent variables with the dependent variable

The general form of a multiple regression model is

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_{p-1} X_{p-1} + \varepsilon \qquad (3)$$

where,

β_0 is the intercept parameter.

$\beta_1, \beta_2, \cdots, \beta_{p-1}$ are the parameters associated with p-1 predictor variables $X_1, X_2, \ldots, X_{p-1}$ are also known as regression coefficients, and represents change in Y for a unit increase in the corresponding predictor variable when all the other variables are held constant. ε is the random error which follows normal distribution.

In our case we have a total of seven independent variables with BSE as the dependent variable. The following are the hypothesis we have setup for our test;

Null hypothesis $H_0: \beta_i = 0 \ \forall \ i = 0,1,2,\cdots,6,7$

Alternative hypothesis H_A: at least $\beta_i \neq 0 \ \forall \ i = 0,1,2,\cdots,6,7$

The following is the outputs of MS excel multiple linear regression analysis with seven (different markets) independent variables.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.671640953
R Square	0.451101569
Adjusted R Square	**0.441121598**
Standard Error	0.331724717
Observations	393

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	34.81759296	4.973942	45.20069	1.56E-46
Residual	385	42.36589595	0.110041		
Total	392	77.1834889			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.101023869	0.0170729	5.917206	7.24E-09	0.067456	0.134592
HIS	0.191812919	0.046561903	4.119525	4.65E-05	0.100265	0.28336
STI	-0.049579651	0.073225063	-0.67709	0.498758	-0.19355	0.094391
Nikkei 225	-0.014080842	0.025577292	-0.55052	0.582281	-0.06437	0.036208
JKSE	0.183897445	0.05066408	3.62974	0.000322	0.084285	0.28351
KOSPI	0.172520506	0.048796569	3.535505	0.000457	0.076579	0.268462
FTSE	0.153888404	0.093440189	1.646919	0.100391	-0.02983	0.337605
SSE	0.049428154	0.015899447	3.108797	0.002018	0.018168	0.080689

Interpretation: Since the p-value in the ANOVA table is very small, there is sufficient evidence to reject the null hypothesis in favor of the alternative hypothesis. So we conclude that at least one of the β_i's is not equal to zero. Thus, at least one independent variable is linearly related to Y, which implies the multiple linear regression model is valid.

But we can also see from the above output that corresponding to the STI, Nikkei 255 and FTSE, the p-values of the co-efficient are greater than 0.05, therefore we do not wish to reject the null hypothesis, H_0: $\beta_i = 0$ for these markets. In other words the changes in the markets do not result to any change in the BSE. We therefore redo the analysis by dropping these variables from the analysis.

Figure 2 represents the residual plot; it can also be seen from the figure that the error points fluctuate around the straight line and thus the normality assumption of the error can be justified.

Now the number of independent variables has been reduced from seven to four (HIS, JKSE, KOSPI and SSE) only. On the basis of this the following is the output.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.6683
R Square	0.446626
Adjusted R Square	**0.440921**
Standard Error	0.331784
Observations	393

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	34.47212	8.618029	78.28817	1.23E-48
Residual	388	42.71137	0.110081		
Total	392	77.18349			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*

Intercept	**0.098836**	0.016938	5.835166	1.13E-08	0.065534	0.132138
HIS	**0.18766**	0.045443	4.12953	4.45E-05	0.098314	0.277006
JKSE	**0.185288**	0.046562	3.979401	8.25E-05	0.093743	0.276833
KOSPI	**0.175052**	0.046405	3.772239	0.000187	0.083814	0.266289
SSE	**0.048622**	0.01584	3.069612	0.002294	0.01748	0.079765

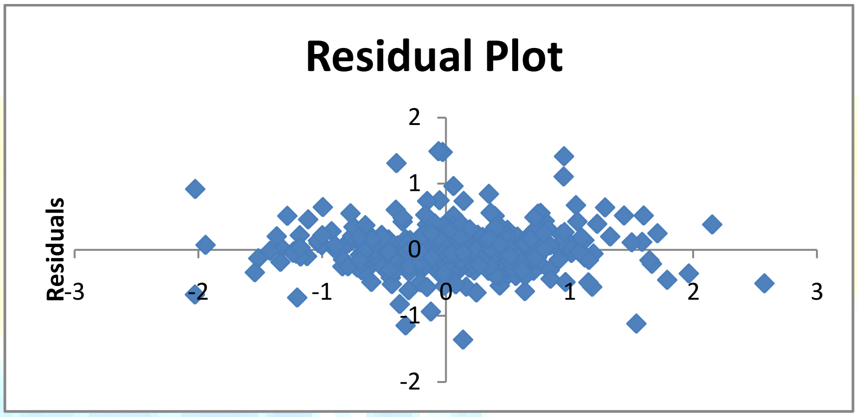


Figure 2: Residual Plot

Interpretation: Again the p-value in the above ANOVA table is very small; there is sufficient evidence to reject the null hypothesis in favor of the alternative hypothesis. At least one of the β_i is not equal to zero. Thus, at least one independent variable is linearly related to Y, which implies the multiple linear regression model is valid.

We can also see that p-values of the all the co-efficients are all very small, therefore we reject the null hypothesis, H_0: $\beta_i = 0$ for these markets. In other words the changes in the markets do result to some change in the BSE.

Figure 3 represents the residual plot for this analysis; it can also be seen from the figure that the error points fluctuate around the straight line and thus the normality assumption of the error can be justified.

Therefore the fitted multiple linear regression for predicting the opening of BSE is,

$$\begin{aligned}\%\ \boldsymbol{change\ in\ BSE} &= \mathbf{0.098836} + \mathbf{0.18766} * (\%\ \textbf{change in HIS}) + \mathbf{0.185288} * (\%\textbf{change in JKSE}) \\ &+ \mathbf{0.175052} * (\%\ \textbf{change in KOSPI}) + \mathbf{0.048622} * (\%\textbf{change in SSE})\end{aligned}$$

5. Conclusion

The study attempted to predict the percentage change in the opening of Indian stock market (represented by BSE) subject to the major emerging Asian markets by fitting a linear regression line. In the process we also found that all (seven) markets are positively correlated to BSE. The highest correlation occurs with the HIS and the lowest with SSE. In the multiple regression analysis it has been found that the percentage change in the opening of STI, Nikkei 255 and FTSE markets does not influence the change in the opening of BSE, whereas HS, JKSE, KOSPI and SSE does influence the opening of BSE. It was also found that the adjusted R square is 0.440921, which implies that 44% of the variation in the opening of the BSE is explained by the variations in the opening of the mentioned 4 markets.

References

[1] Asma Mobarek, 2012, Global Stock Market Integration and the Determinants of Co-movements: Evidence from developed and emerging countries, Stockholm University.

[2] Bracker, K. and Koch, P.D., 1999, Economic determinants of the correlation structure across international equity markets, *Journal of Economics and Business*, 51, 443-471.

[3] Bracker, K., Docking, D.S. and Koch, P.D., 1999, Economic determinants of evolution in international stock market integration, *Journal of Empirical Finance*, 6, 1-27.

[4] Chen CS, Tzeng YM and Hwang JC, 1996, The application of artificial neural networks to substation load forecasting, *ElectricPowerSystRes*, 38:153–60.

[5] Chou, R. Y., Lin, J. and Wu, C., 1999, Modeling the Taiwan stock market and international linkages, *Pacific Economic Review*, vol. 4, No 3, pp. 305-320.

[6] D. A. Dickey and W. A. Fuller, 1979, Distribution of the Estimators for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Association*, vol. 74, pp. 427-431.

[7] Ghosh, A., R. Saidi, and K.H. Johnson, 1999, Who moves the Asia-Pacific stock markets–US or Japan? empirical evidence based on the theory of cointegration, *The Financial Review*, 34, 159-170.

[8] Golaka and C. Nath, 2003, Integration of Global Equity Markets – A case for India, *NSE News*, November, pp.11–16.

[9] Gurcharan Singh and Pritam Singh, 2010, Chinese and Indian Stock Market Linkages with Developed Stock Market, *Asian Journal of Finance & Accounting*, Vol. 2, No. 2, PP 21-39.

[10] Johnson, R. and Soenen, L., 2009, Equity market risk premium and global integration, *Journal of Centrum Cathedra*, 2, 12-22.

[11] Solnik, B.H., 1995, Why Not Diversify Internationally Rather than Domestically?, *Financial Analysts Journal*, 51(1), 89-94.

[12] Huang B-N, Yang C-W and Hu J, 2000, Causality and cointegration of stock markets among the United States, Japan, and the South China Growth Triangle, *International Review of Financial. Analysis*, 9:3, 281-97.

[13] Lin, C.H. and Cheng, W.H., 2008, Economic determinants of co-movement across international stock markets: the example of Taiwan and its key trading partners, *Applied Economics*, 40, 1187-1205.

[14] Pauer, Franz, 2005, Financial Market Integration and Financial Stability, *Oesterreichische National Bank Monetary Policy & The Economy*, Q2, pp. 144-151

[15] Tan, K. B., and Y.K. Tse., 2002, The Integration of the East and South-East Asian Equity Markets, *International Center for the Study of East Asian Development Working Paper* No. 2002-11.

[16] Van E, Robert J., 1997, The application of neural networks in the forecasting of share prices. Haymarket, VA, USA: Finance & Technology Publishing