

Modeling Philippine Stock Exchange Composite Index Using Time Series Analysis

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Abstract. This study was conducted to develop a time series model of the Philippine Stock Exchange Composite Index and its volatility using the finite mixture of ARIMA model with conditional variance equations such as ARCH, GARCH, EGARCH, TARCH and PARCH models. Also, the study aimed to find out the reason behind the behavior of PSEi, that is, which of the economic variables – Consumer Price Index, crude oil price, foreign exchange rate, gold price, interest rate, money supply, price-earnings ratio, Producers' Price Index and terms of trade – can be used in projecting future values of PSEi and this was examined using Granger Causality Test. The findings showed that the best time series model for Philippine Stock Exchange Composite index is ARIMA(1,1,5) – ARCH(1). Also, Consumer Price Index, crude oil price and foreign exchange rate are factors concluded to Granger cause Philippine Stock Exchange Composite Index.

1. Introduction

Stock market is a set of connections that gives a platform for about each economic transaction in the business world at a dynamic rate entitle the stock value that is based on the market equilibrium. It is an extremely nonlinear vibrant system whose performance is manipulated by a number of factors namely inflation rates, interest rates, economic atmosphere, political issues, and many more. In particular, stock markets are characterized by uncertainty. Some sections of the associated stock market are measured using the stock market indices. There are indices that were used in specific collection of stocks that satisfy the set criteria while there are so-called broad-based indices that measure the general movement of the market. Philippine Stock Exchange Composite Index (PSEi) is the sole broad-based index used by Philippine Stock Exchange. By estimating the changes in the stock prices of the chosen listed companies, the PSEi provides a “snapshot” of the market's overall condition. Forecasting is tricky and may lead you to uncertainty for it needs too much risk in deriving the desire outcome. Inconsistency of some factors such as interest rates and foreign exchange rates, is one of the reasons why forecasting is a sort of dilemma.

2. Objectives

This study has two (2) main goals, to construct a time series model for PSEi and to determine which of the nine (9) economic variables can be used in predicting PSEi. To do this, the study sought to answer the following questions.

- 1) What is the movement of time series of PSEi?



- 2) What are the time series models formulated using the mixture of ARIMA model with ARCH models and some of its extensions?
- 3) Among the constructed models, what is the best model for Philippine Stock Exchange Composite index?
- 4) Among the factors, what is/are Granger cause(s) the PSEi?

3. Methodology

This section discusses the techniques used in the research method, the data gathering procedure, and the analytical method. The purpose of the study is to formulate a mathematical model PSEi using a time series process and to find out some economic variable influencing the PSEi.

3.1. Data Gathering Procedure

The researchers collected data about the PSEi from January 2, 2002 to December 27, 2013. The daily closing prices of PSEi are only considered. These data came from PSE

Data of economic variables, pertaining to the factors, were gathered in different sectors in the Philippines, precisely National Statistics Office (also available at www.census.gov.ph) – for Consumers Price Index (CPI), Export and Import or Term of trade (TOT), and Producers Price Index (PPI); and Bangko Sentral ng Pilipinas (also available at www.bsp.gov.ph) – for foreign exchange rate (FE), interest rate (IR), money supply (MS) and price-earnings ratio (PE). The respective departments are the main offices just located in the cities of Manila. While, crude oil price (COP) and Gold price (GP) in the international market are available at www.indexmundi.com.

3.2. Time Series

The time series $\{y_1, y_2, \dots, y_t\}$ data consists of stretch of (roughly) equidistant chronologically ordered observation which are being collected and monitored over a regular period of time. The time series, $\{y_t\}$, is said to be strictly stationary if the joint distribution of the random vector $\{y_t, y_{t+1}, \dots, y_{t+k}\}$ is equal to the one of the $\{y_s, y_{s+1}, \dots, y_{s+k}\}$ for all combinations of t, s and k . The time series, $\{y_t\}$, is said to be weakly stationary or simply stationary if (1) $E(y_t) = \mu$, (2) $Var(y_t) = \sigma^2$, and (3) $Cov(y_t, y_{t+h}) = \gamma_h$ for all lags h .

3.2.1. White Noise Process. A stochastic process $\{\varepsilon_t\}$ is called a white noise process if it is a sequence of uncorrelated random variables from a fixed distribution with (1) $E[\varepsilon_t] = 0$ for all t , (2) $Var[\varepsilon_t] = \sigma^2$ for all t , and (3) $Cov(\varepsilon_t, \varepsilon_{t+k}) = \gamma_k = 0$ for all $k \neq 0$.

3.2.2. Unit Root Test. It is used study to determine if the time series is stationary or not. The researchers used Augmented Dickey-Fuller test statistics. The Augmented Dickey-Fuller test is an improved Dickey-Fuller test, derived from the regression model $y_t = \alpha y_{t-1} + \varepsilon_t$. Where the null hypothesis is unit root exists and hence the series is non-stationary versus the alternative hypothesis, unit root does not exist and hence stationary.

3.2.3. Autoregressive (AR) Process. Let the time series $\{y_t\}$ be stationary, the autoregressive process of order p , $AR(p)$, is given by

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \varepsilon_t.$$

It is very common model for time series. It is a stochastic process used in statistical calculation in which future values are estimated based on a weighted sum of past values.

3.2.4. Moving Average (MA) Process. Let the time series $\{y_t\}$ be stationary, the moving average process of order q , $MA(q)$, is given by

$$y_t = \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_p \varepsilon_{t-q} + \varepsilon_t.$$

It is widely used as indicator in technical analysis that helps smooth out price action by filtering out the “noise” from random price fluctuations. MA is a trend-following or lagging indicator because it is based on past prices.

3.2.5. Autoregressive Moving Average (ARMA) Process. Let the time series $\{y_t\}$ be stationary, the autoregressive moving average process of order p and q , ARMA(p,q), is given by

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_q \varepsilon_{t-q} + \varepsilon_t.$$

3.2.6. Autoregressive Conditional Heteroskedasticity (ARCH) Test. ARCH test is a test statistics that is computed from an auxiliary regression

$$e_t^2 = \beta_0 + \beta_1 e_{t-1}^2 + \beta_2 e_{t-2}^2 + \dots + \beta_q e_{t-q}^2 + \varepsilon_t.$$

This examines the null hypothesis that there is no ARCH effect, that is, the variance of the residual term is constant through time against the alternative hypothesis that the variance is not constant.

3.2.7. Autoregressive Conditional Heteroskedasticity (ARCH) Process. The Autoregressive Conditional Heteroskedasticity, ARCH(1) models are discrete time representation of the conditional variance,

$$\hat{\sigma}_t^2 = c + \alpha_1 \varepsilon_{t-1}^2.$$

ARCH process was introduced by Robert F. Engle. This process allows the conditional variance to change over time as a function of past errors leaving the unconditional variance constant.

3.2.8. Generalized ARCH (GARCH) Process. The Generalized ARCH, denoted by GARCH(1,1) is an equation of conditional variance of the form,

$$\hat{\sigma}_t^2 = c + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \hat{\sigma}_{t-1}^2.$$

GARCH process is an extension of the ARCH process which allows for a longer memory and a much more flexible structure. According to this model, conditional volatility is dependent on the past error terms and on its previous own lags.

3.2.9. Exponential GARCH (EGARCH) Process. The Exponential GARCH, denoted by EGARCH(1,1) is of the form,

$$\log(\hat{\sigma}_t^2) = c + \alpha_1 \left[\frac{\varepsilon_{t-1}^2}{\sqrt{\hat{\sigma}_{t-1}^2}} \right] + \beta_1 \log(\hat{\sigma}_{t-1}^2) + \gamma_1 \left[\frac{\varepsilon_{t-1}}{\sqrt{\hat{\sigma}_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right].$$

EGARCH process is one of the extensions of ARCH model that accounts for an asymmetric response to a “shock”. EGARCH eliminates the non-negativity constraints of GARCH models by formulating the conditional variance equation in logarithm.

3.2.10. Threshold ARCH (TARCH) Process. The Threshold ARCH, denoted by TARCH(1,1), is given by

$$\hat{\sigma}_t^2 = c + \beta_1 \hat{\sigma}_t^2 + \alpha_1 \varepsilon_{t-1}^2 + \gamma_1 \varepsilon_{t-1}^2 I_{t-1}^- \text{ where } I_{t-1}^- = \begin{cases} 1 & \text{if } \varepsilon_{t-1} < 0 \\ 0 & \text{otherwise} \end{cases}$$

TARCH process is also one of the extensions of ARCH models that capture the important asymmetric impact of news on volatility. Also, TARCH considers the past square residuals and past volatility.

3.2.11. Power ARCH (PARCH) Process. The Power ARCH, denoted by PARCH(1,1,1), is the equation

$$\hat{\sigma}_t^\delta = c + \beta_1 \hat{\sigma}_{t-1}^\delta + \alpha_1 (|\varepsilon_{t-1}| - \gamma_1 \varepsilon_{t-1})^\delta, \text{ where } \delta > 0.$$

PARCH process is an extension of ARCH model that uses the conditional standard deviation as a measure of volatility instead of the variance. Also, PARCH model includes the past residuals, previous conditional standard deviation and leverage effect.

3.3. Engle – Granger Methodology for Testing Co-integration

The researchers decided to use the proposed method of Engle – Granger in testing co-integration between PSEi and each variable. The following is the two steps process of Engle – Granger test of co-integration:

- i. Estimate a regression using ordinary least square on $I(1)$ data; and
- ii. Apply stationarity test to the residual of the estimated regression.

3.3.1. Granger Causality Test. The Granger Causality test investigates whether a time series can help in predicting another time series. In this study, researchers will examine which of the economic variables can be used in forecasting Philippine Stock Exchange Composite Index.

After satisfying stationarity and co-integration, lag selection is identified. The number of lags which has least Akaike Information Criterion (AIC) will be chosen. To apply Granger Causality test, it is necessary to assume a particular autoregressive process of order p ,

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \dots + \alpha_p y_{t-p} + \beta_1 x_{t-1} + \dots + \beta_2 x_{t-p} + \varepsilon_t.$$

where y_t and x_t are stationary time series. An F-test is conducted to the null hypothesis,

$$H_0: \beta_1 = \beta_2 = \dots = \beta_p = 0$$

that x_t does not Granger cause y_t against the alternative hypothesis that x_t does Granger cause y_t . To be able to reject null hypothesis, F-test statistics probability must not exceed 0.05.

4. Results and Discussion

This section explains the nature and summary statistics of PSEi and the nine (9) economic variables. In addition, this section presents the test for the assumption, model specification and verification, forecasting of PSEi, and the test for the causality between the PSEi with nine economic variables.

4.1. PSEi

The daily closing price of Philippines Stock Exchange Composite index (PSEi) is used in this study. The study period covers from January 2, 2002 to December 27, 2013 which contains 2944 trading days.

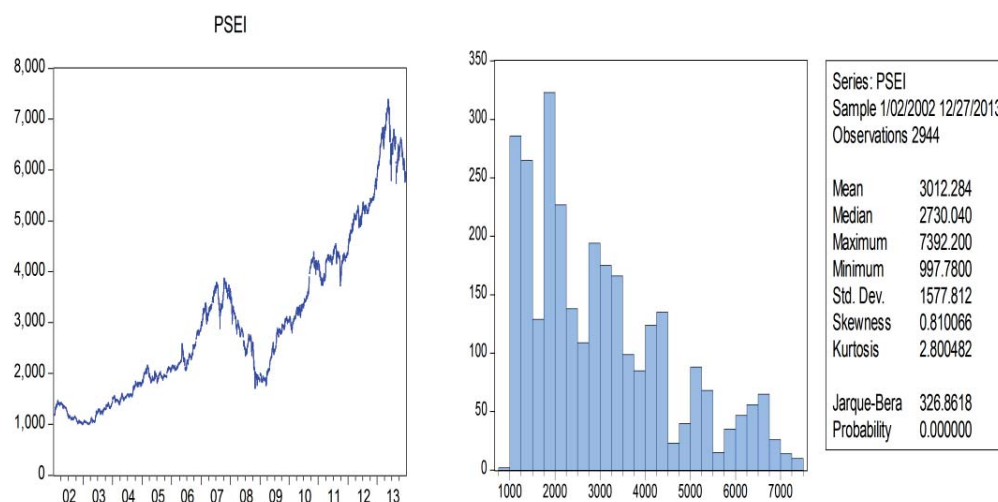


Figure 1. PSEi Daily Closing Price

Figure 1 shows the time series, histogram and summary statistics of PSEi from 2002 to 2013. For the past years, PSEi reached Php 7,392.20, its highest closing price last May 15, 2013 and attained its lowest closing price on December 19, 2002 with Php 997.78. Figure 1 also reveals that PSEi is

leptokurtic, kurtosis greater than 0.263, and is positively skewed. As per Jarque-Bera statistics, PSEi is non-normal, since the probability, 0.00, rejects the null hypothesis, the series is normally distributed.

4.2. Time Series Modelling

One of the objectives of this study is to construct a model Philippine Stock Exchange Composite index using Autoregressive Integrated Moving Average (ARIMA) and Autoregressive Conditional Heteroskedasticity (ARCH) models.

4.2.1. Unit Root Test. In order to test for the existence of unit root, the researchers used Augmented Dickey-Fuller (ADF) test

Table 1. Unit Root Test for PSEi

Include in Test Equation	ADF Test Statistics	Mackinnon Critical Values		
		1% level	5% level	10% level
Intercept	-0.056326	-3.432385	-2.862325	-2.567232
Trend and Intercept	-2.145997	-3.961161	-3.411334	-3.127512
None	1.772261	-2.565749	-1.940932	-1.616627

Table 1 reveals the daily closing price of PSEi is non-stationary at level, since the absolute values of the computed ADF test statistics are less than the absolute value of Mackinnon critical values. In order to achieve stationarity, we need to transform the data to its first difference logarithm.

Table 2. Unit Root Test for DLOG(PSEi)

Include in Test Equation	ADF Test Statistics	Mackinnon Critical Values		
		1% level	5% level	10% level
Intercept	-47.45259	-3.432382	-2.862324	-2.567231
Trend and Intercept	-47.44452	-3.961161	-3.411334	-3.127512
None	-47.39008	-2.565748	-1.940932	-1.616627

Table 2 summarizes the unit root test of PSEi at first difference logarithm. Since the absolute values of the computed ADF test statistics are greater than the absolute value of Mackinnon critical values, first difference logarithm of PSEi is already stationary.

4.2.2. Lag Specification. The appropriate autoregressive and moving average terms are identified using the Partial Autocorrelation Function (PACF) and Autocorrelation Function (ACF) of the time series, which indicates the significant lags for the AR and MA terms.

Significant spikes of ACF and PACF are the candidates for the terms of MA and AR, respectively. Lags 1, 3, 4, 5, 11 and 12 are the candidates for moving average term. While lags 1, 3, 4, 5, and 11 are the candidates to be the autoregressive term. To check if there are other significant lags, we need to check the correlogram of residuals. According to the correlogram of residuals, it shows that there are no other significant spikes. And since there are no other significant terms, we can proceed in identifying the ARIMA model. Only the ARIMA model with significant terms are considered and the model with highest R^2 and log-likelihood and least Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) will be chosen.

Table 3. Summary of Candidates for ARIMA Models

Model	R^2	Log-likelihood	AIC	SBC
ARIMA(3,1,0)	0.002408	8523.566	-5.796984	-5.792911
ARIMA(4,1,0)	0.001655	8519.123	-5.795932	-5.791859
ARIMA(5,1,0)	0.003335	8518.229	-5.797296	-5.793222

ARIMA(11,1,0)	0.001579	8496.309	-5.794208	-5.792738
IMA(1,1)	0.017461	8555.649	-5.812877	-5.808808
IMA(1,3)	0.002401	8533.265	-5.797666	-5.793597
IMA(1,4)	0.001591	8532.071	-5.796854	-5.792785
IMA(1,5)	0.003290	8534.576	-5.798557	-5.794488
IMA(1,11)	0.001723	8532.265	-5.796986	-5.792917
ARIMA(1,1,3)	0.019635	8555.534	-5.814095	-5.807990
ARIMA(1,1,5)	0.020507	8556.843	-5.814985	-5.808880
ARIMA(3,1,1)	0.019623	8549.153	-5.813710	-5.807601
ARIMA(3,1,5)	0.005583	8523.252	-5.799491	-5.793383
ARIMA(3,1,11)	0.004119	8526.029	-5.798020	-5.791911
ARIMA(4,1,11)	0.003469	8521.794	-5.797070	-5.790960
ARIMA(5,1,1)	0.020478	8543.716	-5.813966	-5.807854
ARIMA(5,1,3)	0.005558	8521.509	-5.798849	-5.792737
ARIMA(5,1,11)	0.004886	8520.516	-5.798173	-5.792061
ARIMA(11,1,3)	0.003981	8499.841	-5.795925	-5.789813
ARIMA(11,1,4)	0.003349	8498.911	-5.795301	-5.789178
ARIMA(11,1,5)	0.004968	8501.293	-5.796926	-5.790804
Highest R^2 and Log-likelihood; Least AIC and SBC.				

Table 3 displays the candidates for ARIMA model for Philippine Stock Exchange Composite index. ARIMA(1, 1,5) has the highest R^2 , log-likelihood and lowest Akaike Information Criterion while ARIMA(0,1,1) or IMA(1,1) has the least Schwarz Bayesian Criterion. Though ARIMA(1,1,5) did not acquire all the necessary conditions, it is safe to say that the best ARIMA model among the candidates is **ARIMA(1,1,5)**. This can written as

$$\text{dlog(psei)}_t = 0.000548 + 0.131441 \text{dlog(psei)}_{t-1} - 0.054326 \varepsilon_{t-5} + \varepsilon_t.$$

4.2.3. Verification of the Model. The model is diagnosed to check the goodness of fit of the model. Researchers used Autoregressive Conditional Heteroskedasticity (ARCH) test for model diagnostic. The residuals of the estimated model is checked using ARCH test to examine if the existing model suffers from ARCH effect, that is, the variance of the residuals is not constant through time.

Table 4. ARCH Test for ARIMA(1,1,5)

Heteroskedasticity Test: ARCH	
F-statistic	Probability F(12,2917)
35.01592	0.0000

Table 4 represents the Autoregressive Conditional Heteroskedasticity test for the chosen ARIMA model. Constant variance should have F-statistic probability value greater than 0.05. In this case, the p-value of the F-statistic is 0.00 which is less than the critical value 0.05. Hence, the variance of error term is not constant through time, that is, the model has the volatility clustering effect. This empirical result agreed the characteristic of a financial time series, heteroskedasticity or time-varying variance.

4.2.4. Equation of Conditional Variance. Due to variance inconstancy, it is necessary to include variance equation to capture the ARCH effect in our time series. Therefore, the researchers decided to use ARCH model and some of its extensions. In finance, conditional volatility models such as ARCH/GARCH models usually describe “risks” perceived by investors.

4.3. Measures of Statistical Performance of the Models

To determine the best model for Philippine Stock Exchange Composite index, the researchers used statistical performance measures such as Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), Root Mean Squared Error (RMSE) and Theil Inequality Coefficient.

The table below summarizes the measures of statistical performance of mixture of ARIMA model with ARCH model and some of its extensions.

Table 5. Results of Statistical Performance of Models

Model	Statistical Performance Measurement			
	MAE	MAPE	RMSE	Theil-U
ARIMA(1,1,5) – ARCH(1)	28.10048	0.947536	43.75942	0.006432
ARIMA(1,1,5) – GARCH(1,1)	28.14948	0.948263	43.78427	0.006435
ARIMA(1,1,5) – EGARCH(1,1)	28.14739	0.947853	43.76435	0.006433
ARIMA(1,1,5) – TAR(1,1,1)	28.16023	0.948130	43.77616	0.006435
ARIMA(1,1,5) – PARCH(1,1,1)	28.15703	0.948067	43.77259	0.006434

The model having the least MAE, MAPE, RMSE and Theil Inequality Coefficient will be chosen. Table 5 shows the summary results of statistical performance of the forecasting models. It can be seen that ARIMA(1,1,5) – ARCH(1) outperforms the other models having the lowest Mean Absolute Error, Mean Absolute Percentage Error, Root Mean Squared Error. Therefore, it is safe to say that among the mixture of ARIMA model with ARCH and some of its extensions, **ARIMA(1,1,5) – ARCH(1)** is the best model.

4.4. Causation Between PSEi and Economic Variables

The study also aims to find out what is/are the economic variable(s) that can be helpful in predicting future Philippine Stock Exchange Composite index. Monthly closing price of PSEi from December 2001 to August 2013 is used to fit the frequency of the economic variables considered.

4.4.1. Co-integration. The Engle-Granger Methodology was used to test co-integration. This method is a two-step process; first, estimate an OLS regression on I(1) data and then a stationarity test (such as the ADF test) to the residual from this regression.

Table 6. Summary of Unit Root Test for Residuals

Variable	Include in Test Equation	ADF Test Statistics	Mackinnon Critical Values		
			1% level	5% level	10% level
COP	Intercept	-11.974920	-3.477835	-2.882279	-2.577908
	Trend and Intercept	-11.974470	-4.025426	-3.442474	-3.145882
	None	-11.736730	-2.581705	-1.943140	-1.615189
CPI	Intercept	-11.335040	-3.477835	-2.882279	-2.577908
	Trend and Intercept	-11.316990	-4.025426	-3.442474	-3.145882
	None	-11.214980	-2.581705	-1.943140	-1.615189
FE	Intercept	-11.420170	-3.477835	-2.882279	-2.577908
	Trend and Intercept	-11.396290	-4.025426	-3.442474	-3.145882
	None	-11.171580	-2.581705	-1.943140	-1.615189
GP	Intercept	-11.453950	-3.477835	-2.882279	-2.577908
	Trend and Intercept	-11.440260	-4.025426	-3.442474	-3.145882
	None	-11.209050	-2.581705	-1.943140	-1.615189
IR	Intercept	-11.468920	-3.477835	-2.882279	-2.577908
	Trend and Intercept	-11.445660	-4.025426	-3.442474	-3.145882
	None	-11.222960	-2.581705	-1.943140	-1.615189
MS	Intercept	-11.350670	-3.477835	-2.882279	-2.577908

	Trend and Intercept	-11.326900	-4.025426	-3.442474	-3.145882
	None	-11.167000	-2.581705	-1.943140	-1.615189
PE	Intercept	-11.491930	-3.477835	-2.882279	-2.577908
	Trend and Intercept	-11.457230	-4.025426	-3.442474	-3.145882
	None	-6.408769	-2.581827	-1.943157	-1.615178
PPI	Intercept	-11.401780	-3.477835	-2.882279	-2.577908
	Trend and Intercept	-11.359220	-4.025426	-3.442474	-3.145882
	None	-11.018630	-2.581705	-1.943140	-1.615189
TOT	Intercept	-11.072920	-3.477835	-2.882279	-2.577908
	Trend and Intercept	-11.048760	-4.025426	-3.442474	-3.145882
	None	-10.771390	-2.581705	-1.943140	-1.615189

Table 6 elaborates that the residuals of the nine (9) factors are stationary since the absolute value of ADF test statistics are greater than the absolute value of Mackinnon critical values for any test equations. Therefore, we say that PSEi is co-integrated for every economic variable considered.

4.4.2. Lag Selection. In selecting the lags, the researchers looked on the lag having the lowest Akaike Information Criterion (AIC). The table below displays the lag selection of each variable.

Table 7. Akaike Information Criterion of Each Variable at Different Lags

Lags	Variables								
	COP	CPI	FE	GP	IR	MS	PE	PPI	TOT
1	-4.902598	-11.20667	-8.017319	-5.967508	-7.570037	-7.367106	-5.529872	-8.099914	-4.342265
2	-5.005374	-11.23508	-8.086729	-6.088249	-7.565244	-7.503416	-5.676516	-8.255589	-4.506782
3	-5.052836	-11.23830	-8.207831	-6.125979	-7.540696	-7.587544	-5.726543	-8.290817	-4.646528
4	-5.017172	-11.25496	-8.211598	-6.094422	-7.522821	-7.545751	-5.732615	-8.276141	-4.682489
5	-5.134964	-11.24597	-8.204656	-6.113052	-7.518117	-7.728846	-5.811397	-8.335168	-4.723413
6	-5.143216	-11.23490	-8.166524	-6.125979	-7.483084	-7.692001	-5.768616	-8.304754	-4.757902
7	-5.147194	-11.26475	-8.141997	-6.010105	-7.571015	-7.636403	-5.706559	-8.250155	-4.757331
8	-5.127551	-11.27886	-8.137790	-6.021403	-7.527866	-7.594387	-5.652933	-8.258144	-4.691601
9	-5.091543	-11.27990	-8.092662	-5.995569	-7.520726	-7.535082	-5.661233	-8.222991	-4.762973
10	-5.041277	-11.25164	-8.254575	-5.982922	-7.465968	-7.535675	-5.636058	-8.154406	-4.718249
11	-5.058537	-11.25746	-8.271445	-5.925706	-7.410102	-7.566829	-5.606427	-8.224659	-4.696104
12	-5.016723	-11.23722	-8.225671	-5.913210	-7.434513	-7.518472	-5.565515	-8.203059	-4.664895

Based on Table 7, COP has lowest AIC at lag 7; CPI has lowest at lag 9; FE at lag 11; GP at lags 3 and 6; IR at lag 7; MS, PE and PPI having the lowest AIC at lag 5; and DTOT at lag 9.

4.4.3. Granger Causality Test. After determining at which lag will each variable has the lowest AIC, we can now able to identify among the factors are Granger-cause to the PSEi. Granger Causality is used to investigate whether a time series x_t can help forecast another series y_t .

Table 8. Economic Factors Granger Cause PSEi

Null Hypothesis	F-Statistic	Probability
COP does Granger Cause PSEI	3.00051	0.0062
CPI does Granger Cause PSEI	2.11531	0.0338

FE does Granger Cause PSEI	3.16663	0.0010
GP does not Granger Cause PSEI	2.08365	0.1055
IR does not Granger Cause PSEI	1.49110	0.1769
MS does not Granger Cause PSEI	1.68209	0.1438
PE does not Granger Cause PSEI	0.49951	0.7761
PPI does not Granger Cause PSEI	0.47528	0.7941
TOT does not Granger Cause PSEI	1.13146	0.3467

Among the nine (9) factors, Consumers Price Index, Crude Oil Price, and Foreign Exchange obtained the probability lower than 0.05 which only means that they influenced the fluctuation of Philippine Stock Exchange index. In addition to that, the shown table below 9 gave supplementary information which of the factors can PSEi affect.

Table 9. PSEi Granger Cause Economic Factors

Null Hypothesis	F-Statistic	Probability
PSEI does Granger Cause COP	2.94884	0.0070
PSEI does not Granger Cause CPI	1.47139	0.1671
PSEI does Granger Cause FE	2.02478	0.0328
PSEI does not Granger Cause GP	0.76229	0.5172
PSEI does not Granger Cause IR	0.36254	0.9222
PSEI does not Granger Cause MS	0.48218	0.7890
PSEI does not Granger Cause PE	0.65190	0.6606
PSEI does not Granger Cause PPI	1.06175	0.3849
PSEI does not Granger Cause TOT	1.39967	0.1967

Table 9 shows that the Crude Oil Price and Foreign Exchange are the factors influenced or caused by PSEi because they attained probability lower than 0.05. Since Crude Oil Price and Foreign Exchange also Granger cause the PSEi, it indicates that there is bi-directional causality between Crude Oil Price and PSEi, and Foreign Exchange and PSEi.

5. Conclusion

The study was conducted to construct a time series model for daily closing price of PSEi and to find out some variables that can influence the behavior of PSEi. The daily closing price of PSEi from January 2, 2002 to December 27, 2013 is used to estimate the time series model. Meanwhile, Consumer Price Index (CPI), crude oil price, foreign exchange rate (U.S Dollar versus Philippine Peso), gold price, interest rate, money supply(M4), price-earnings ratio, Producers' Price Index (PPI) and terms of trade were the economic variables considered by the researchers. The mixture of ARIMA models and conditional variance equation, ARCH models and some of its extensions such as GARCH, EGARCH, TARARCH and PARARCH, were the generated time series model for PSEi. Also, Granger Causality test is used to examine which of the variables causes PSEi.

The researchers found out that time series data tend to be leptokurtic and mostly to have a non-normal distribution. The data were examined for unit root test and the researchers concluded that all of the data are non-stationary series. Difference of logarithm is used as data transformation for all of the variables. Correlogram of ACF and PACF were utilized to specify the number of lags in ARIMA model. Also, the model was diagnosed to check whether the model suffers from ARCH effect. The researchers discovered that the variance is not constant over time and hence heteroskedastic. ARCH and some of its extensions were used to capture the ARCH effect. According to ARCH(1) and GARCH(1,1), the current volatility was affected by past residuals. Also, the presence of leverage effects were noted by EGARCH(1,1), TARARCH(1,1,1) and PARARCH(1,1,1). The best fit model was

chosen based on the statistical performance of the model. The researchers concluded that the best fit time series model for Philippine Stock Exchange Composite Index was ARIMA(1,1,5) – ARCH(1).

Granger causality test was applied by researchers in order to determine which of the considered economic variables could influence the future values of PSEi. Engle – Granger Methodology for testing co-integration was conducted. Afterwards, lags were determined based on Akaike Information Criterion. Granger causality test with the appropriate lags was executed. The researchers found out that out of nine (9) factors only Consumer Price Index, crude oil price and foreign exchange Granger cause PSEi. Additionally, it was also found out that PSEi can be used as a parameter for projecting future prices of crude oil prices and foreign exchange rate.

6. Recommendation

Upon the conclusion of the study, Philippine Stock Exchange Inc., players of the stock market, as well as investors may use this study as their basis in decision making. Also, they could seek the movement of Consumer Price Index, crude oil price and foreign exchange rate in order to project future stock prices.

One of the interests of the study was to develop a time series model for Philippine Stock Exchange Composite index using the mixture of ARIMA with some conditional variance equations such as ARCH, GARCH, EGARCH, TARCH, and PARCH. Thus, future researchers may use other conditional volatility models under the extensions of ARCH model.

The researchers concluded that using Granger causality test, Consumer Price index, crude oil price and foreign exchange rate can influence future values of the Philippine Stock Exchange Composite index. Hence, future researchers can utilize this finding in construction of factor models such as regression. In addition to that, other economic indicators may be used.

7. References

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