

# Predictability and Efficiency of the Philippine Stock Exchange Index

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**Abstract:** This study applied the autoregressive fractionally integrated moving average (ARFIMA) and the ARFIMA-fractional integrated general autoregressive conditional heteroskedasticity (ARFIMA-FIGARCH) models on the daily stock returns of the Philippine Stock Exchange Index (PSEi) from January 4, 2000 to December 29, 2011 and found significant long-memory processes in both return and volatility of the PSEi. The Chow breakpoint test was used to identify the structural break during the subprime mortgage crisis. Positive dependence in both return and volatility was evident before the structural break, but predictability was only observed in volatility after the breakpoint. The log-likelihood value consistently showed that the combined ARFIMA-FIGARCH model better characterized the PSEi.

**Key words:** long-memory; ARFIMA-FIGARCH; Philippine Stock Exchange Index **JEL codes:** G11, G14

## **1. Introduction**

The Philippine Stock Exchange (PSE) is the national stock exchange of the Philippines and is one of the oldest in Southeast Asia, conducting continuous operation since its establishment on August 8, 1927. It was the product of the merging of the Manila Stock Exchange and the Makati Stock Exchange. The PSE Composite Index (PSEi) is the main index of the bourse, which is composed of 30 listed companies and additional six sub-sectors aside from the PSEi, namely, financial, industrial, holding firms, property, services, and mining and oil indices. As of December 2010, the PSE had a total market capitalization of USD 202 billion, with 253 companies and 184 trading participants listed. The PSEi is the most monitored index in the Philippines and is also one of the most observed economic indicators.

The strong potential of the Philippine economy has been recognized with its inclusion as one of the top 16 economies of the world by 2050, as predicted by the Hong Kong and Shanghai Banking Corporation (HSBC). Such forecast increased the confidence on the economic position of the country in the global arena. The Philippine economy's 27-notch improvement 40 years from now, which ranked 41st in 2010, will be of great interest to the international investing community. The PSEi, as one of the economic indicators of the country, should gain renewed interest from both academicians and investors. The possible prediction of the Philippine stock market, particularly PSEi returns, is currently a primary interest because of its immense possibility to propel upwards.

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The efficient market hypothesis (EMH) of Fama (1970) is a viable explanation for the difficulty or even the impossibility of predicting stock returns, especially those of developed markets. The reason is that price movements occur accordingly in the market. On the contrary, several studies (Bekaert, 1995; Bekaert & Harvey, 1995; Wright, 1999) have cited that emerging market returns, such as the Philippines, could possibly be more persistent than the more developed markets. This condition may be a sign of market inefficiency and a probable long-memory property, and it may be exploited by investors to earn excess returns. According to Wright (1999), another reason why emerging markets are desirable for portfolio diversification is their low correlation with developed markets and their obvious potential for profitability. These contexts are evident in the Philippines, as indicated by HSBC's current research findings.

This study contributes to the literature on stock market returns by examining the dual long-memory properties of the Philippine stock market, particularly, the PSEi, in its conditional mean and variance. To investigate the hypotheses, this study utilizes the autoregressive fractionally integrated moving average (ARFIMA) process. The ARFIMA was first mentioned in Granger and Joyeux (1980) and Hosking (1981), in which the difference parameter is allowed to be a non-integer. Similarly, the current paper adopts the fractional integrated general autoregressive conditional heteroskedasticity (FIGARCH) model to verify long memory in return and volatility, as suggested by Baillie et al. (1996). To the best of our knowledge, no formal empirical literature has studied the dual long-memory properties of the PSEi and its efficiency based on the aforementioned models. However, Aquino (2006) concluded that the Philippine stock market supports a weak-form efficient hypothesis using the AR(1) process, which is weak in terms of not considering higher AR lag operators and lagged values of the error term provided by the MA process. Literature on ARFIMA-FIGARCH models has been proved to capture the long-memory properties of time series data. The studies of Floros et al. (2007), Kang and Yoon (2007), McMillan and Thupayagale (2008), Korkmaz et al. (2009), and Tan and Khan (2010) utilized the models to examine stock market returns. Beine et al. (2002) used it to illustrate exchange rates, and Choi and Hammoudeh (2009) adopted it for commodities.

This study has the following objectives. First, it examines the long-memory properties in the returns and volatilities of the PSEi. Second, it identifies the structural break point using the Chow (1960) test in the recent subprime mortgage crisis and examines if changes exist in the long-memory property of the exchange before and after the structural break. Third, it verifies if EMH exists in the Philippine stock market, as long memory in time series implies that lagged returns can be utilized to predict future returns. Lastly, it aims to determine the existence of a dual long memory in returns and volatilities in PSEi returns, similar to the findings of Kang and Yoon (2007) in the Korean stock returns.

This paper is organized as follows. Section 2 explains the data and the ARFIMA-FIGARCH models; Section 3 discusses the empirical results; and Section 4 presents the conclusion.

#### 2. Data and Methodology

Daily closing prices of the PSEi stock market returns during the last decade from January 4, 2000 to December 29, 2011 were obtained from the Yahoo Finance Website. This study divided the original time series into two to determine changes in the long-memory properties of the index before and after the structural break caused by the recent subprime mortgage crisis. Period 1 covers January 4, 2000 to October 24, 2008, and period 2 encompasses October 30, 2008 to December 29, 2011. Data modeled by both ARFIMA and FIGARCH processes are explained below.

According to Granger and Joyeux (1980) and Hosking (1981), the ARFIMA model is a parametric approach used to examine long-memory properties of time series. This model is distinctive because it enables the difference parameter to be a non-integer and considers the fractionally integrated process I(d) in the conditional mean. The ARFIMA (p,d,q) model satisfies both stationarity and invariability conditions. It is expressed as

$$\Phi(L)(1-L)^{d}Y_{t} = \Theta(L)\varepsilon_{t}, \varepsilon_{t} \sim (0, \sigma_{\varepsilon}^{2})$$
(1)

where *d* is the fractional integration real number parameter, *L* is the lag operator, and  $\varepsilon_t$  is the white noise residual. The fractional differencing lag operator  $(1-L)^d$  is expressed in the following equation:

$$(1-L)^{d} = 1 - dL + \frac{d(d-1)}{2!}L^{2} - \frac{d(d-1)(d-2)}{3!}L^{3} + \dots$$
<sup>(2)</sup>

The process is stationary when the ARFIMA model is -0.5 < d < 0.5, in which the effect of shocks to  $\varepsilon_t$  decays at a gradual rate to zero. The process also has a short memory if d = 0, in which the effect of shocks decays geometrically. A unit root process is exhibited when d = 1. A long memory process or the so-called positive dependence among remote observations exists when 0 < d < 0.5. Intermediate memory or anti-persistence exists when -0.5 < d < 0 (Baillie, 1996). The process is non-stationary if  $d \ge 0.5$  and is a stationary but non-invertible process if  $d \le -0.5$ , thus making the time series impossible to model by any autoregressive process.

As proposed by Baillie et al. (1996), the FIGARCH model captures long memory in the return and volatility of econometric time series. The model provides further flexibility in examining the conditional variance, encompassing the covariance stationary GARCH for  $\bar{d}=0$  and the non-stationary IGARCH for  $\bar{d}=1$ . The FIGARCH ( $p,\bar{d}, q$ ) model is written ashhf

$$\phi(L)(1-L)^d \varepsilon_t^2 = \omega + [1-\beta(L)]v_t \tag{3}$$

where  $v_t$  is the innovation for the conditional variance. The root of  $\phi(L)$  and  $[1-\beta(L)]$  is conditioned to lie outside the unit root circle.

## **3. Empirical Results**

Table 1 shows that the average PSEi returns for the entire 11 years gains 1.2%, sub-period 1 has an average loss of -10.9%, and period 2 incurs average gains of 11.5%. Period 1 could have been affected by significant losses from the subprime mortgage crisis, whereas period 2 benefitted from the general upward trend after the crisis. The sample of the entire period posted the highest volatility, with a standard deviation of 1.32. Between sub-periods 1 and 2, the former experienced a slightly higher volatility of 1.298 compared with 1.286 of the latter. This finding may be evidence of the modern portfolio theory of Markowitz (1952), which indicates that the greater is the dispersion of returns, the higher the risk of an investment possibly attributed to the predominantly downward trends and heightened volatility of sub-period 1 because of the crisis. All sample periods are negatively skewed and contain leptokurtic distributions. The Jarque-Bera statistics for residual normality shows that the PSEi returns are under a non-normal distribution assumption. Based on the results of the Lagrange multiplier (LM) test, samples have no serial correlation. The minimum value of the Akaike information criterion is utilized to identify the orders of the ARFIMA and ARFIMA-FIGARCH models. This paper used the ARCH-LM process to test the ARCH effect and to show that we could apply GARCH models in the chosen sample because the null hypothesis was rejected for PSEi returns.

Table 2 illustrates the results for both ARFIMA and ARFIMA-FIGARCH models. The ARFIMA model shows that in the past 11 years, the PSEi exhibited positive dependence. Therefore, the Philippine index has a long-memory process in its returns, thus implying market inefficiency and the possibility of investors exploiting

such structure to earn excess returns is likely. The long-memory process in returns is similar to those in the studies of Kang and Yoon (2007) and Tan and Khan (2010) that probe into the South Korean and Malaysian stock market returns, respectively. The long-memory process was also observed in sub-period 1 or before the subprime crisis structural break. However, after experiencing crisis, the PSEi showed anti-persistence in sub-period 2, in which an intermediate memory became evident. This finding indicates not only the PSEi's efficiency after the subprime mortgage crisis but also its tendency to revert as well. In terms of return and volatility outcomes, the return and volatility of the PSEi for the entire sample period exhibited long-memory processes. Such findings are similar to those of Kang and Yoon (2007), Korkmaz et al. (2009), and Tan and Khan (2010), further implying that the PSEi return and volatility have predictable structures and are not a weak-form efficient market. The period of the current study may have produced contradicting results with the earlier findings of Aquino (2006), who finds that the Philippine stock market is a weak-form efficient using the AR(1) process. Long-memory processes in both return and volatility are also evident in sub-period 1, but sub-period 2 is characterized only by positive dependence in its volatility. The log-likelihood value consistently considers ARFIMA-FIGARCH to better characterize the PSEi compared with the ARFIMA model.

Table 1 The Sample Size and Period of PSEi Returns

PSE Index	Start of Data	End of Date	Obs.	Mean	Std. Dev.	Skew.	Kurt.	J-Bera	LM test	ARCH-LM
Whole Period	Jan. 4, 2000	Dec. 29, 2011	3013	0.012	1.320	-0.572	8.803	4392***	0.745	97.107***
Period 1	Jan. 4, 2000	Oct. 24, 2008	2238	-0.109	1.298	-0.359	6.144	969***	1.312	100.782***
Period 2	Oct. 30, 2008	Dec. 29, 2011	772	0.115	1.286	-0.045	5.354	178***	1.129	57.822***

Source: Yahoo Finance–January 2000 to December 2011; http://www.yahoo.com/finance.

Table 2	Summary Statist	cs of ARFIMA	and ARFIMA-	FIGARCH Models
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ARFIMA			Log-	ARFIMA-FIGARCH				Log-	
PSE Index	model	d-coeff. AIC		likelihood	d-coeff.	model	d-coeff.	AIC	likelihood
Whole Period	(2,1)	0.150 (0.031)**	3.371	-5071.986	0.153 (0.023)**	(1,2)	0.311 (0.000)***	3.212	-4827.918
Period 1	(2,1)	0.145 (0.058)*	3.342	-3733.828	0.187 (0.060)*	(2,2)	0.203 (0.045)**	3.225	-3598.075
Period 2	(2,2)	-0.134 (0.020)**	3.328	-1281.006	0.085 (0.333)	(2,2)	0.278 (0.000)***	3.150	-1207.189

Note: \*, \*\* and \*\*\* are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

## 4. Conclusion

The economic significance of predicting stock return and volatility of the Philippine stock exchange should be of interest to traders, especially as HSBC predicted the Philippines to be the 16th largest economy by 2050, ascending 27 notches from its 43rd position in 2010. This study addressed this concern by providing evidence on the stock return and volatility predictability of the PSEi. The ARFIMA model shows that the Philippine index exhibits long-memory process in its returns, which can be exploited by investors to earn excess returns. It is a clear sign of market inefficiency. Positive dependence was observed in sub-period 1. However, after the structural breakpoint of the crisis, the PSEi in sub-period 2 showed to have intermediate memory, indicating improved efficiency. The ARFIMA-FIGARCH model demonstrated long-memory processes in both return and volatility throughout the sample period. This predictable structure of the PSEi using lagged index returns contradicts the initial findings of Aquino's (2006) study, which characterizes it as a weak-form efficient. Positive dependence in both return and volatility is evident in sub-period 1; sub-period 2 is predictable only in its volatility. Between the

ARFIMA and the ARFIMA-FIGARCH models, the log-likelihood value consistently indicates that the latter best characterizes the PSEi.

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