Efficiency of the Philippine Stock Market

Abstract

The study examines the efficiency of the Philippine stock market using stock price movements during the period July 1987 to May 2004. Characterizing stock price movements as an AR(1) process with Laplace residuals, the statistical evidence support the hypothesis that the Philippine stock market is weak-form efficient. An examination of major events that could plausibly affect share prices and large price movements from an event study perspective indicates fairly rapid absorption by the market of information, except in cases of extreme stress caused by political and economic shocks. Furthermore, factors other than information about fundamentals appear able to cause major share price movements. Given these, the support for the semistrong-form efficiency of the stock market is mixed.

I. INTRODUCTION

This study examines the efficiency of the Philippine stock market. The first part looks at the statistical properties of stock price changes to determine the presence of characteristics that characterize weak-form market efficiency in the sense of Fama (1970). The second part examines semistrong-form efficiency, motivated by the study of Cutler, Poterba and Summers (1989), using public information relating to major events that could plausibly affect stock prices. Cutler et al. chose the 50 largest daily changes in the Standard & Poor 500 stock index (S&P 500) and looked for explanations in the following day's *New York Times*. They noted that ample evidence existed that showed that share prices do react to news about corporate and macroeconomic developments that could plausibly affect fundamentals. This, as well as the speed at which these information are incorporated in prices, is examined in this study using event study techniques. In addition, the stronger assertion that only information affects asset values as implied by the market efficiency assumption is also examined.

In the following sections, the statistical properties of movements in the Philippine Stock Exchange composite index or Phisix[1] from July 14, 1987 to May 25, 2004 are examined (4,314 trading days). Then, sample major political, economic and even natural events that are likely to affect the stock market are examined relative to the movements in the Phisix ten days around the event date. Next, the top 50 relative changes in the Phisix are tabulated against the explanations offered in the business newspapers, specifically the *Business World* (from July 22, 1987-May 25, 2004), *Business Star* (July 14, 1987-October 1994) and *Business Daily* (November

1994-December 1998). The properties of these extreme movements are also examined. The final section concludes.

II. STATISTICAL ANALYSIS OF DAILY PRICE CHANGES

Let P_t be the Phisix level at the end of trading day t. Then $\Delta P_t = \ln P_t - \ln P_{t-1}$ represents the continuously compounded daily price changes in the stock market. It is commonly conjectured that ΔP_t is not normally distributed although Aquino (2002-2003) noted that they converge gradually toward normality in diversified portfolios as changes are aggregated over periods of two months or so. Also ΔP_t seems to be characterized by an AR(1) process with a statistically significant first-order autocorrelation coefficient of 0.18. Although R^2 is quite low at 0.032 (such that the chances of earning excess profits on the basis of information on past prices alone are so small) the assumption that the realizations of ΔP_t are identically and independently distributed (iid) necessary for fitting a distribution function (df) is not entirely true. Thus, the distributional characteristics of the residuals given an AR(1) process are examined instead[2]. Non-normality is confirmed in Figure 1 where the normal curve is superimposed over the empirical frequency distribution of AR(1) residuals. An alternative, the Laplace (or double exponential) distribution is therefore considered. The Laplace is characterized by its density function

$$f(x) = \frac{1}{2}\phi^{-1}\exp\left[\frac{-|x-\theta|}{\phi}\right], \quad -\infty < x < \infty,$$

where X represents the residuals and θ and ϕ the location and scale parameters of the distribution, respectively. The Laplace density is more peaked and has fatter tails than the normal distribution[3]. Visual inspection shows this to be a better fit (Figure

1). In both cases, the parameters are estimated by employing an optimization routine to minimize the Kolmogorov-Smirnov (KS) goodness of fit statistic. The parameter estimates for the distributions considered in this study are robust in the presence of outliers and are consistent (Weber, Leemis and Kincaid, 2005). Table 1 shows the estimation results and the corresponding KS statistics that favor the Laplace distribution. The Laplace distribution can be interpreted to mean that the residual (in excess of the location parameter which is also equal to the estimated population mean) has a 50:50 chance of being positive or negative and that its absolute value ($|X-\theta|$) has a exponential distribution (Ross, 1998)[4]. Except for the small enough predictive power due to the first-order autocorrelation, the statistical evidence appears on the whole to support the hypothesis that the stock market is at least weak-form efficient.

III. MAJOR EVENTS AND STOCK PRICE MOVEMENTS

Event studies usually assume that daily stock price changes are normal and independently distributed. These assumptions are not supported here. Assuming instead that expected price changes are given by the AR(1) model, the residuals represent abnormal (in event study terminology) price changes. Then, using the results that the absolute value of the deviation of the residuals from the Laplace location parameter has an exponential distribution and that the sum of iid random variables has a gamma distribution, the probabilities corresponding to abnormal price changes during the event day and the days before and after an event can be estimated. Define

$$Y_N = \sum_{i=1}^{N} |X_i - \theta|,$$

the sum of the absolute deviation of residuals from the location parameter over N days. For N=1, the variable of interest is the abnormal residual during the event day itself. Under the assumption that the $|X - \theta|$'s are iid, the gamma distribution with parameters α and ϕ is fitted to the observed Y_N's for N = 1 and 2. Table 1 shows the results indicating good fit. If the variables are indeed iid, the fitted parameter α and the ratio of the estimated variance for N = 2 to the variance for N =1 should be close to 2. Table 2 shows this to be 2.18. While this is not the result of a formal test, the gamma distribution, with α = N and ϕ equal to that resulting from the fitted Laplace distribution, is nevertheless used in the event studies as an improvement over the normal.

Table 2 shows 18 sample major political, economic and natural events that occurred during the period under study together with the movements in the Phisix five days leading to the event day[5] itself and five days after the event. For purposes of this study, the observed value of Y_N is significant if there is a small enough probability of observing a greater than or equal value, i.e., $P(Y_N \geq y) \leq 0.05$. The last two columns of the table show the average absolute residuals during the periods before and after the event and the probabilities that values greater than or equal to these averages are observed.

In the sense described above, only eight of the major events appear to affect stock prices. In four of these events (three related to coup attempts against President Aquino and the 1987 Black Monday in Wall Street) there were already significant prior movements in the market, indicating that these events were already being anticipated and partly discounted by the market. In four of the significant events (the coup attempts, Black Monday and the departure of President Estrada from the Presidential Palace), the effects continued to be felt as indicated by the significant cumulative absolute residuals during the days after the event. This is suggestive of lingering uncertainty and gradual absorption of information by the market in times of extreme political and economic stress. In the remaining four significant events, the major effects on the market were only felt during the day immediately after these events. These events are the Mount Pinatubo eruption, the 9/11 terrorist attacks in the US, two local political events, and a major crisis in Iraq. The events that were seemingly ignored by the market include the 1990 devaluation of the peso, the 1998 presidential elections won by President Estrada (who was not favored by the business sector) and the 2001 EDSA[6] III riots that threatened the government of President Arroyo.

IV. MAJOR STOCK PRICE MOVEMENTS AND EXPLANATIONS

Table 3 shows the 50 largest relative changes in the Phisix and the explanations provided by the business newspapers the day after, oftentimes from interviews with stock brokers and analysts. When there were two major business newspapers in circulation, i.e., up to December 1998, the explanations given by both newspapers were generally in agreement. Note that 18 of the top 50 largest movements occurred in the politically-turbulent last 5-1/2 months of 1987. In contrast, only 12 of the largest movements occurred during the last 6 months of 1997 and the whole of 1998 in the midst of the Asian financial crisis. This highlights the dominance of political events and even rumors over economic news in explaining stock price changes.

The top 50 largest residuals from an AR(1) process in Table 3 are all significant at least at the 0.01 level. It is known that the distribution of the largest value realized from an exponential distribution converges to the Gumbel distribution (Mood, Graybill and Boes, 1974) with df

$$H(x) = \exp(-e^{-z}),$$

where

$$z = \frac{Y_n^n - a_n}{b}.$$

Given n realizations of Y, $Y_n^n = \max\{Y_1, \ldots Y_n\}$. The norming parameters a_n (= $E[Y_n^n]$) and b_n are approximated by $\hat{\phi} \ln n$ and $\hat{\phi}$, respectively, where $\hat{\phi}$ is the estimated scale parameter of the Laplace distribution discussed earlier. For n = 4,313, the expected largest value, a_n, is 10.22 %. Only 8 of the top 50 movements have residuals larger than this value. Denote the probability of observing the largest value of the residuals greater than a value y as $P(Y_n^n > y)$, this is less than 0.01 only for the largest residual in Table 3. There are also only 5 events for which $P(Y_n^n > y) < 0.10$. Thus, with the possible exception of the top 5 events, the assumption that the Y's are generated by the exponential distribution is given additional support. As a further (albeit indirect) support, Figure 2 shows the quintile or QQ plot (see Gumbel, 1958), of maximum values from a partition of the sample into 43 non-overlapping sub-samples of 100 (101 for 13 sub-samples) against the inverse Gumbel df. If the

Gumbel distribution is the limiting df of z, the plot must be approximately linear. This appears to be the case in Figure 2.

Table 4 groups the explanations into six general categories. In a significant number (8) of the top 50 stock price changes, there were no major political, economic or corporate news reported that could have caused the market to move. In an even more significant number of cases (12), rumors or noise seemed to be the major factors that caused prices to change. Cutler et al. noted that a hypothesis that stock prices move in response to news that is observable by market participants but not by investigators studying the market is obviously irrefutable. However, they were skeptical of this possibility and argued that news important enough to account for large swings in the demand for stocks should be detectable in economic statistics or in media reports. However, some have suggested (e.g., Romer, 1994) that changes could also be due to rational investors revising their views of market fundamentals even without discernable news. Others (e.g., Roll, 1984) suggest that the trading process itself causes prices to move. Both explanations are plausible in times of great market uncertainty.

Similar computations to those in Table 2 are made with respect to the top 50 price movements with large price movements serving as proxies for unobserved events. In more than half of the 50 cases (32), there were lingering abnormal residuals in the days after the event. This confirms the observation made in the previous section on the gradual absorption of information by the market in times of extreme stress.

V. CONCLUDING REMARKS

The study showed that stock price movements in the Philippines are better characterized by an AR(1) process with residuals following the Laplace distribution rather that the normal distribution usually assumed. The statistical evidence appears to support the hypothesis that the Philippine stock market is weak-form efficient. An examination of major events that could plausibly affect share prices and large price movements from an event study perspective indicates fairly rapid absorption by the market of information, except in times of extreme stress due to political and economic shocks that appear to generate a great deal of market uncertainty. Furthermore, factors other than information about fundamentals appear able to cause major share price movements. Given these, the support for the semistrong-form efficiency of the stock market is mixed.

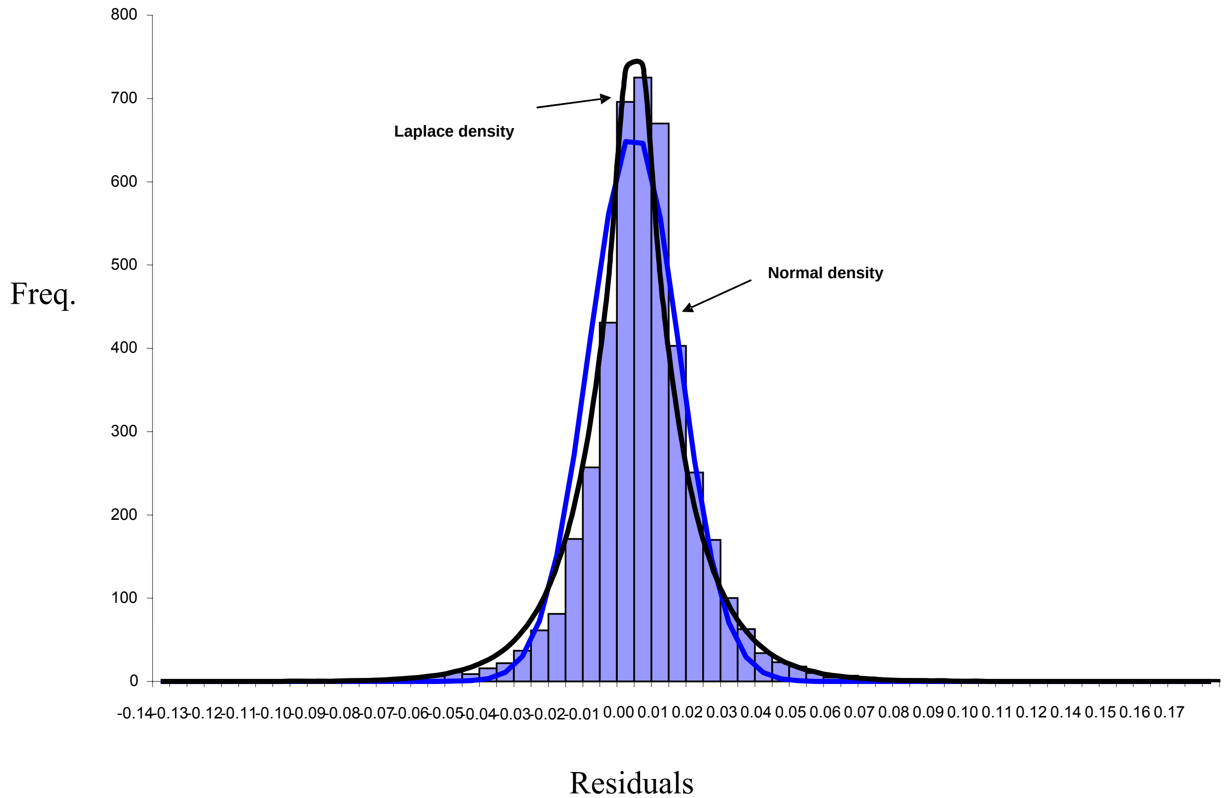

Fig. 2 – Frequency Distribution of AR(1) Residuals with Fitted Normal and Laplace Densities

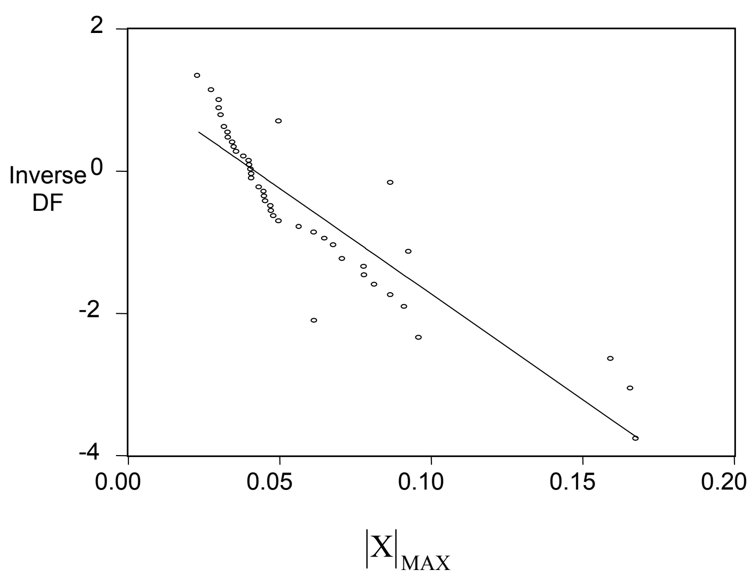

Fig. 3 – Quantile Plot of Sample Extreme Residual Values

Table 1 – Distribution Fit Statistics for AR(1) Residuals

Statistics	Normal	Laplace	Gamma (1)	Gamma (2)
KS statistic (Note)	0.0269	0.0176*	0.0105*	0.0251*
Location parameter	-0.00007	0.00007	1.1127	1.8924
Scale parameter	0.0133	0.0122	0.0101	0.0116
Variance	0.00018	0.00030	0.00011	0.00026
Variance ratio	n.a.	n.a.	1.0	2.18
No. of observations	4313	4313	4313	2157
Critical values: 0.05	0.0207	0.0207	0.0207	0.0263
0.01	0.0248	0.0248	0.0248	0.0327

* The goodness of fit hypothesis is not rejected at both 0.05 and 0.01 significance levels. Critical values are from Rohatgi (1976).

Table 2 - Sample Events That May Affect Market

Date	Event	Abnormal Residuals from AR(1) Process: Nth Tr. Day Before and After Event					Mean Abs. Resid.	$P(Y_N \geq y)$	$P(Y_1 \geq y)$
		-4/+1	-3/+2	-2/+3	-1/+4	0/+5			
Friday, August 28, 1987	Coup attempt against Pres. Aquino	-0.072	-0.024	0.073	0.035	n.t.	0.051	**0.000**	**0.017**
		-0.050	-0.031	0.038	-0.029	-0.027	0.031	**0.009**	
Monday, October 19, 1987	US stock market Black Monday	0.023	0.034	-0.001	-0.002	0.063	0.024	**0.030**	**0.006**
		-0.138	0.098	0.040	-0.048	-0.069	0.064	**0.000**	
Friday, December 01, 1989	Coup attempt against Pres. Aquino	-0.014	-0.003	-0.020	-0.087	n.t.	0.031	**0.009**	0.256
		-0.017	-0.048	-0.022	-0.059	-0.003	0.033	**0.006**	
Tuesday, July 17, 1990	Powerful earthquake hits Luzon and Manila	-0.002	-0.002	-0.006	0.011	0.005	0.005	0.906	0.642
		-0.019	-0.001	0.005	-0.001	0.003	0.006	0.906	
Thursday, August 02, 1990	Iraq invades Kuwait	0.003	0.009	-0.001	0.001	0.001	0.004	0.967	0.917
		-0.022	-0.020	-0.024	0.002	0.000	0.013	0.362	
Sunday, October 07, 1990	Coup leader Noble surrenders	0.007	0.018	-0.065	0.009	n.t.	0.025	**0.040**	**0.000**
		0.093	-0.004	-0.038	-0.016	0.012	0.018	0.170	
Friday, November 02, 1990	Peso devalued from 25.75 to 28.00 pesos per U.S. dollar	-0.004	-0.021	-0.011	0.025	-0.024	0.016	0.252	0.142
		0.005	0.022	-0.014	-0.018	0.001	0.012	0.471	
Wednesday, January 16, 1991	US starts air war against Iraq	-0.002	0.008	0.028	-0.024	0.014	0.015	0.261	0.327
		0.043	0.045	-0.034	0.009	-0.002	0.027	**0.017**	
Saturday, June 15, 1991	Mount Pinatubo eruption	-0.010	0.004	-0.003	-0.004	n.t.	0.005	0.897	**0.036**
		-0.041	-0.002	0.027	-0.015	-0.015	0.015	0.293	
Sunday, May 10, 1992	Presidential election	0.000	-0.030	0.022	0.000	n.t.	0.013	0.393	**0.003**
		0.071	-0.006	-0.002	-0.014	0.017	0.022	0.073	
Tuesday, July 15, 1997	Peso depreciates by 9%; Asian financial crisis	-0.038	-0.023	0.078	-0.010	-0.021	0.037	**0.002**	0.174
		-0.023	0.017	0.017	-0.013	0.005	0.015	0.268	
Sunday, May 10, 1998	Presidential election	0.024	-0.030	-0.005	0.011	n.t.	0.017	0.178	0.986
		0.000	-0.024	-0.012	0.002	-0.002	0.010	0.602	
Tuesday, October 12, 1999	BW Resources share price drops 30%	0.000	0.007	-0.005	0.004	-0.003	0.004	0.953	0.808
		-0.008	-0.001	-0.016	-0.005	-0.003	0.006	0.873	
Monday, January 08, 2001	EDSAII	-0.032	0.007	0.016	-0.007	0.018	0.016	0.244	0.237
		0.021	-0.003	-0.012	0.019	0.014	0.014	0.328	
Saturday, January 20, 2001	Pres. Estrada leaves Presidential palace	-0.014	-0.060	-0.003	0.013	n.t.	0.022	0.066	**0.000**
		0.160	-0.057	0.007	0.016	0.006	0.049	**0.000**	
Tuesday, May 01, 2001	EDSA III	0.011	-0.020	-0.009	-0.028	n.t.	0.017	0.196	**0.024**
		0.046	-0.011	0.009	-0.009	-0.002	0.015	0.243	
Tuesday, September 11, 2001	Terrorist attacks in the U.S.	0.001	0.023	0.006	-0.002	-0.003	0.008	0.725	**0.034**
		-0.041	0.009	-0.006	-0.047	0.032	0.027	0.013	
Wednesday, March 19, 2003	US attacks Iraq	0.001	0.003	-0.005	0.007	0.013	0.004	0.952	0.335
		0.015	-0.011	0.002	-0.010	0.006	0.009	0.699	

n.t. – no trading

Note: values in bold are significant at least at the 0.05 level.

Table 3 – 50 Largest Phisix Changes and Explanations (1987-2004)

DATE	Phisix	Residual	No.	Business Newspapers' Explanation
Monday, January 22, 2001	1708	0.161	1	Buying exuberance after Pres Estrada left presidential palace
Monday, November 06, 2000	1500	0.152	2	Foreign buying triggered by hastened impeachment proceedings for Pres. Estrada
Tuesday, July 28, 1987	1146	0.151	3	Technical rebound; congress opening; positive reaction to Pres. Aquino's speech
Friday, September 18, 1987	819	0.148	4	Chief of Staff Gen. Ramos' press conference expressing full military support to Pres. Aquino's government
Friday, July 24, 1987	1072	-0.142	5	Market correction
Tuesday, October 20, 1987	799	-0.127	6	Dow Jones crashes 508 points (Black Monday)
Monday, September 07, 1987	885	-0.115	7	Political rumors/uncertainty
Thursday, September 17, 1987	706	-0.106	8	Rumor of Gen. Ramos breaking from Pres. Aquino's government
Thursday, August 28, 1997	2072	-0.098	9	Economic growth numbers confirm fears of slowdown; foreign investors' panic selling
Monday, February 02, 1998	2146	0.096	10	Return of foreign funds to the region; PLDT rise in NYSE
Monday, October 08, 1990	566	0.093	11	Surrender of coup attempt leader in Mindanao
Monday, December 11, 1989	1200	-0.091	12	No major news; jittery investors unloading in near panic
Thursday, October 29, 1987	738	-0.089	13	Reports that Tara oil well may be dry
Friday, January 09, 1998	1518	-0.088	14	Currency concerns; regional uncertainties
Thursday, October 01, 1987	822	0.086	15	Substantial stock dividends in key mining and oil stocks
Monday, July 27, 1987	986	-0.084	16	Market correction
Friday, January 30, 1998	1948	0.081	17	PLDT rise in NYSE; better than expected GNP/GDP data
Friday, September 18, 1998	1175	-0.078	18	PLDT shares dumped
Wednesday, April 10, 1991	1075	-0.078	19	Bombings; dispute on military chief appointment
Monday, July 20, 1987	1336	0.077	20	No major news
Monday, October 26, 1987	812	-0.076	21	Technical correction; anticipated drop in Hong Kong stocks
Thursday, September 17, 1998	1269	0.075	22	Speculative buying on PLDT due to news of takeover talks
Wednesday, October 21, 1987	862	0.075	23	Technical rebound
Thursday, October 08, 1987	757	-0.075	24	Coup and labor strike rumors
Wednesday, May 30, 1990	803	-0.075	25	Warning of possible coup made by Armed Forces Chief of Staff
Friday, July 11, 1997	2701	0.072	26	Peso devaluation causes massive buying sprees
Wednesday, May 13, 1992	1340	0.072	27	Orderly elections and emergence of 2 frontrunners acceptable to business sector

Thursday, August 23, 1990	688	-0.071	28	Bombing; coup and gulf war anxieties
Monday, December 20, 1993	2903	0.071	29	PLDT's record close in NYSE; buoyant foreign markets
Wednesday, February 06, 1991	867	0.070	30	Foreign markets rise; entry of foreign investors
Tuesday, September 25, 1990	569	-0.069	31	Oil price increase and drops in foreign markets due to Iraq crisis
Wednesday, September 11, 1991	902	-0.069	32	Probable rejection of US bases treaty
Friday, October 16, 1998	1437	0.068	33	Unexpected Fed rate cut and resulting euphoria in regional markets
Thursday, October 25, 1990	615	0.068	34	Well-publicized nationwide strike fizzled out
Wednesday, August 22, 1990	738	-0.067	35	Coup rumors
Wednesday, August 26, 1987	1049	0.067	36	Reaction to rollback in fuel prices
Monday, August 24, 1987	1017	-0.066	37	Disclosure that EEI, a major company, overstated income
Tuesday, October 28, 1997	1740	-0.066	38	Massive selling in Wall St.; Dow Jones drops 7.18%
Tuesday, August 18, 1987	1043	-0.065	39	Congress proposal to raise transaction tax on stocks
Tuesday, February 05, 1991	810	0.065	40	Dow Jones jumped 42 points
Wednesday, February 11, 1998	2218	0.065	41	Interest rate cut; stronger peso; foreign buyers into property shares
Friday, December 15, 1989	999	-0.064	42	Rumors of another coup
Thursday, July 23, 1987	1235	-0.064	43	Market correction
Monday, October 19, 1987	907	0.063	44	Record high metal prices
Thursday, June 18, 1998	1829	0.063	45	Strong yen rally; world stocks uptick
Tuesday, September 24, 1991	973	0.062	46	News on possible compromise on US bases
Wednesday, June 13, 1990	860	0.062	47	Peaceful independence day celebrations
Thursday, October 04, 1990	518	-0.062	48	Military mutiny in Mindanao
Wednesday, January 17, 2001	1459	-0.062	49	Fear of Pres. Estrada's acquittal; stockbrokers brief walkout
Wednesday, January 14, 1998	1686	0.057	50	Steadier peso and rising regional markets

Table 4 – Summary of Top Price Movements and Explanations Offered

Explanations Offered	Significant Movements: Event Day Only	4 Days Before Event	5 Days After Event	Days Before and After Event	Totals
Political events	3	2	2	1	7
Foreign political / economic news	1	4	4	2	11
Rumors	3	1	4	3	12
No major news	1	1	2	6	8
Domestic economic news	1	1	2	2	7
Corporate developments	0	0	0	4	5
Totals	9	9	14	18	50

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ENDNOTES

[1] The Phisix is a market-value-weighted index of 30 representative companies from different sectors of the local bourse. Data is from the Philippine Stock Exchange.
[2] The hypothesis that the residuals represent white noise is not rejected at tight levels of significance.
[3] The Laplace distribution belongs to the family of elliptical distributions important in finance theory. See Johnson and Kotz (1970) for an extensive reference on this distribution.
[4] Alternatively, Linden (2001) showed that the Laplace distribution can be derived from a conditional normal distribution with stochastic variance.
[5] For external events, the event day is the following day, Philippine time.
[6] EDSA is the name of the major road where protestors against the government congregated.