The Pakistan Development Review
38 : 4 Part II (Winter 1999) pp. 777–786

The Response of Karachi Stock Exchange to Nuclear Detonation

ATTIYA Y. JAVED and AYAZ AHMED

1. INTRODUCTION

Stock markets are highly reactive to internal and external developments. News of major events take no time to impact, the Stock Exchange that quite often serves as a barometer of the good and bad for the market. The importance of particular events and their effect on the stock market has been a subject of study in financial literature. Such studies attempt to assess the extent to which stock markets' performance stray's from the normal around the time of the occurrence of subject events. The stock market crash in the USA of October 1987 and related crash in the Far East later in January 1998 led to several studies of the event.

On October 14, 1987, the US stock market began the steepest decline of its history, culminating in the crash of October 19, when the Dow Jones Industrial Average fell 508 points (22.6 percent). Certain aspects of the event of Black Monday as it is called emphasised the need for research to explore what fundamental economic factors triggered the large decline and the institutional and structural factors that were inherent in the trading strategies of investors. Michell and Netter (1989) have presented evidence that a tax bill containing anti takeover provision proposed by the U.S. House Ways and Means Committee of Oct. 13, 1987 was the economic event that triggered the October 19 crash. Other events and economic conditions during October 14–16 have been cited in the literature including higher than expected trade deficits, rising interest rate and increased worries about the government deficit and fear of inflation by many studies. Certain trading strategies such as index arbitrage and portfolio insurance has been cited by the Report of Presidential Task Force (1988). Roll (1988) has argued the crash did not begin in US since many other world markets experienced a severe decline on October 19 before US markets opened. Lelland and Rubinstein (1988) have claimed several institutional investors who were aware of

Attiya Y. Javed and Ayaz Ahmed are Research Economists at the Pakistan Institute of Development Economics, Islamabad.

Authors' Note: We are highly indebted to Dr Eatzaz Ahmad, Associate Professor at Quaid-i-Azam University and Dr Fazal Husain, Senior Research Economist at Pakistan Institute of Development Economics, Islamabad for their valuable suggestions.

arching tried to sell on early 19th, before the portfolio insurance sales adding to downward price pressure. Secondly October 14–16 decline was news itself.

The present study attempts to analyse the consequences of nuclear detonation by India followed by Pakistan in May 1998 on the activities at Pakistan's major stock market, the Karachi Stock Exchange (KSE). India conducted nuclear tests on 11 May, 1998. Pakistan followed suit on 28 May, 1998. The intervening period between these two events was marked by a generally held expectation that Pakistan will also test its nuclear devices. The major uncertainty was about the timing of the test. The stock market strongly reacted to the Indian detonation and the KSE-100 index declined by a massive 137.80 points within three trading days (from 1551.91 to 1412.36). As the expectation of a Pakistani response in kind held firmer ground the index continued to decline till 28 May when Pakistan did respond as expected. During the subsequent period Pakistan was subjected to imposition of financial sanctions and economic curbs from the world community and the stock market could not recover from the recession for the remaining months of 1998.

It is interesting to note that the stock market's response to the two events in May 1998 was quite different. The declining trend in the share prices between the two events was not only a reaction to the Indian detonation; it was also the result of pessimistic expectations in the light of expected response from Pakistan. The response to Pakistani detonation was rather mild because most of the reaction had already been absorbed in the wake of expectations. The market however reacted to the financial curbs imposed on Pakistan from outside and the unexpected freeze on foreign currency account. The market remained highly volatile after 28 May 1998 with no clear direction.

In the light of the above background this study analyses changes in the behaviour of stock market around May 1998. In particular we study the effects of the two events on the average rate of return in the market, its volatility and trading volume at Karachi Stock Exchange (KSE). The study is based on daily data and it covers the period April 1995 to June 1999.

2. MARKET OVERVIEW

It is also interesting to present a brief overview of the market specially its performance during these two events. The Karachi Stock Exchange (KSE) came into existence on September 18, 1947. Though two other stock exchanges were later established in the country, in Lahore and Islamabad in 1970 and 1992 respectively, the KSE remains the main centre of activity where 75–80 percent of current trading takes place. It gained momentum in 1960 and made significant progress in listings and capitalisation. However it lost momentum in 1970 due to political unrest and then nationalisation policies adopted by the government. The policy of greater reliance on private enterprise restored the market sentiment in the 1980s. However the market actually regained its momentum in early 1990s when it was opened to international

investors. This put a new life in the market giving rise to an unprecedented bullish trend. The size and depth of the market was also improved. In terms of its performance the market has been ranked third among emerging markets. Unfortunately the market could not maintain its performance in later years because of political and economic instability.

The KSE depicted handsome improvement when the previous government assumed office in Feb. 1997. Due to some extraneous factors, where Government has no control, like sharp fall in the Far Eastern capital markets and heavy drop in the value of their currencies, the international fund managers started to offload their holdings in the region. The shock waves emitted by that market badly affected our stock market as well. The selling pressure by foreign fund managers resulted in the fall of KSE-100 index which came down to 1746.31 points on January 1, 1998 and due to unremitting selling pressure further declined to 1609.16 points on January 28, 1998.

The stock market came under severe stress following the Indian nuclear tests on May 11, and 13, 1998, when KSE-100 index dropped to 1514.11 points on May 11 from 1551.91 points on May 8, 1998 and 1412.36 points on May 14, 1998. This downward slide continued due to unable security environments created by the detonation of nuclear devices and belligerent statements by Indian leaders. The stock market further declined when Pakistan conducted its own nuclear test on May 28, 1998 and due to multifarious reasons like repercussions arising out of sanctions imposed by the United States of America, western countries, Australia and Japan followed by the World Bank, IMF and the Asian Development Bank. The down-grading of Pakistan's credit by Moody's South Asian Crisis, freezing of foreign currency accounts and panic selling by foreign fund managers further accentuated the situation and the market continued sliding and touched the lowest level of 765.74 points on July 14, 1998. The recessionary tendencies continued to affect the stock markets in the aftermath of these monumental events. Government took several steps to stabilise the economy and successfully concluded an agreement with the IMF and rescheduled its foreign debt with the Paris club and subsequently with the London Club. These steps substantially reduced the pressure on our economy. The government also announced unification of the exchange rate. These steps gradually started impacting the stock market in a positive manner, the KSE-100 index improved to 976.55 points on September 1, 1998, 1104.68 points on October 1, 1998. The Stock market depicted improvement during second week of November 1998 due to partial lifting of sanctions by USA and Japan, expected resumption of IMF support and fading of prospects of sovereign default risk. The market had been moving in the range of 950-1050 till the third week of April 1999. Thereafter it started showing improvement as reflected in KSE-100 index which was 1416.62 on May 24, 1999 due to stabilisation measures initiated by that Government. However flare-up of conflict on the line of control in Kashmir with India in Kargil has adversely affected the market and looming dangers of

war depressed it. Thus the gain made during several months was eroded, the index came down to 1052.19 points on June 18, 1999. The stock market has continued to remain listless and directionless ever since and has been moving in the range of 1100-1250 points.

The present government has taken some steps for the rescue of the stock market. The results of these measures have not come out so far.

The paper is organised in four sections. After the introduction, the inquiry will proceed as follows: Section 2 provides the analytical framework and the third section discusses the data, estimation and results. The final section offers conclusions.

3. ANALYTICAL FRAMEWORK

As mentioned in the introduction, this paper studies the effects of India's and Pakistan's nuclear tests in May 1998 on the activities at the KSE. The three indicators of stock market activities used for analysis are average return, volume and volatility on the basis of daily data. While trading volume at KSE is readily available, the return series can be computed by taking the logarithmic first difference of the series on the general price index. For the measurement of daily volatility, we shall use the series of ARCH variance derived from the best-fitted ARCH (Autoregressive conditional heteroskedasticity) model to the series of return (see Enders (1995) for ARCH models).

The ARCH models, originally introduced in Engle (1982) are useful in the study of the pattern of volatility clusters in a series. The ARCH models are frequently used for analysing financial time series [see Engle, Lillen and Bellerslev (1987); Agairy (1989) and Chou (1988)] and their application to event studies has been done by Jong, Kemma and Klock (1992). These models have been quite successfully applied to stock market data in Pakistan as well [see, for example, Uppal (1993) and Ahmed and Rosser (1995)]. An ARCH model consists of two parts, an autoregressive moving average (ARMA) equation and an ARCH equation. The generalised version of ARCH model, called GARCH model includes the following ARMA process:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{j=0}^{q} \beta_j \varepsilon_{t-j}, \beta_0 = 1 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where p and q are the orders of autoregressive (AR) and moving average (MA) terms to yield an ARMA (p, q) model. It is assumed that the random error term has mean equal to zero and no autocorrelation at any lag. To specify an ARCH process it is assumed that

$$\varepsilon_t = v_t \sqrt{h_t} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

According to the above equation the random error term is decomposed into, v_t, which is homoskedastic with, $\sigma^2_{v_t}$ =1 and $\sqrt{h_t}$, which is heteroskedastic with the ARMA process:

$$h_t = \phi_0 + \sum_{k=1}^{r} \phi_h \varepsilon^2_{t-k} + \sum_{m=1}^{s} \lambda_m h_{t-m} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

where r and s are the orders of MA and AR terms in the heteroskedastic variance. The above equation is called ARCH equation, in which the parameter ϕ_k is the ARCH coefficient of order k and λ_m the GARCH coefficients of order m.

The ARCH Equation (3) allows heteroskedasticity in the time series of residuals. This heteroskedasticity in time series represents the special feature of financial variables, especially stock prices. It is typically observed that stock price series contain periods of large volatility followed by periods of relative stability. The instability in stock markets introduced by some major shock usually initiates a sequence of continuing fluctuations. These fluctuations partly reflect the genuine response of agents to continuously revising information. Another reason could be that not all the agents jump on the 'band-wagon' of 'mass psychology' and, therefore, some of the reaction to the shock could be delayed. Furthermore, agents may have stocky expectations regarding the consequence of the shock on share prices.

It is also important to note that the volatility clusters generated by any shock are not made of shocks in the same direction. For example following a bad news not all the price fluctuations are in the downward direction; the period of volatility would include negative as well as positive changes, reflecting 'technical correction' and reaction to delayed information respectively. Therefore the inertia in volatility causes autocorrelation in the size of random fluctuations ignoring their algebraic signs and it cannot be properly captured by the conventional linear autocorrelation in residuals. The ARCH equation that captures this inertia is a simple ARMA process in squared residuals. Since the squared residuals approximate variances at each point, the ARCH equation basically parameterises heteroskedastic residuals in time series.

It is to be noted that ARCH model is applicable to a stationary series. Therefore appropriate unit root tests need to be applied on the series under consideration in order to determine the order of its integration and subsequently taking the difference of the series by the required number of times.

Once the ARCH model is estimated, the next step in our context is to estimate the series of ARCH variance given by Equation (3). This series along with the series of average return and volume are then studied to determine their responses to nuclear detonations in India and Pakistan on 12 and 28 May 1998 respectively. The period between these two dates was crucial for the stock market because it triggered intense

speculations regarding the likely response from Pakistan. Most of the statements from the relevant official departments lent support to the general perception that Pakistan was preparing for a rigorous response by conducting its own detonations. As it turned out, the perception turned into reality on 28 May 1998.

Since the event of 28 May was anticipated, the stock market response was rather mild. The reason was that probably most of the adjustments had already been made in anticipation during 12 to 28 May. What followed from 28 May onward was a reaction more to economic hardships that Pakistan faced from outside than to the detonation itself. Thus we shall consider the response of stock market to the events of May 1998 as having two phases, the first corresponding to the period of speculation from 12 to 28 May and the second to economic sanctions and curbs against Pakistan from world community from 28 May onwards.

Thus to analyse the effects of these events on the KSE we define two event-dummies. One of these event-dummies, denoted $D1$, corresponds to the period intervening between 12 and 28 May, when India and Pakistan conducted nuclear experiments respectively, while the second event-dummy, denoted $D2$, corresponds to the period from 29 May onwards, that is

$D1$ = 1 for the days from 12 May to 28 May,
= 0 otherwise.
$D2$ = 1 for the days from 29 May onwards,
= 0 otherwise.

To determine the response of KSE to the two events we postulate the following relationships:

$$R_t = \alpha_0 + \alpha_1 D1 + \alpha_2 D2 + \sum_{i=1}^{p} \alpha_i R_{t-i} + \sum_{j=1}^{q} \beta_i \varepsilon_{t-j} \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

$$h_t = \alpha_0 + \alpha_1 D1 + \alpha_2 D2 + \sum_{i=1}^{p} \alpha_i h_{t-i} + \sum_{j=1}^{q} \beta_i \varepsilon_{t-j} \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

$$V_t = \alpha_0 + \alpha_1 D1 + \alpha_2 D2 + \sum_{i=1}^{p} \alpha_i V_{t-i} + \sum_{j=1}^{q} \beta_i \varepsilon_{t-j} \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

In these equations R_t, h_t and V_t denote return, ARCH variance and the natural log of trade volume respectively.

4. DATA, ESTIMATION AND RESULTS

We use daily data on trading volume and the general share price index prepared by the State Bank of Pakistan (SBP). The index is adjusted for cash dividends, bonus shares and right issues. Therefore no further adjustment is required

for the computation of returns from price index. The study is based on 998 daily observations covering the period from April 1995 to June 1999.

For the estimation of the ARCH model we first test the stationary properties of the series of share price index. An application of Augmented Dickey-Fuller (ADF) tests indicates that the series of natural log of share price index has a unit root, that is, it is non-stationary. We then applied the ADF tests on the series of return (logarithmic first difference of the series of price index). The results indicate that the return series is stationary, that is, the series of the natural log of price index is integrated of order one. Therefore the ARCH model as specified by Equations (1), (2) and (3) is applicable for the logarithmic first difference of the share price index.

In order to diagnose the ARCH models we start with correlograms for the series of return and make a rough guess about the autoregressive (AR) and moving average (MA) terms on the basis of the shapes of autocorrelation and partial autocorrelation functions. The selected ARIMA equation is estimated and correlograms for residuals are studied to determine the precise specification of ARIMA equation. In addition correlograms for squared residuals are also studied to determine the nature of heteroskedasticity in residual variance, which is used for the specification of ARCH equation. The specified ARCH model is estimated and the correlograms for residuals and squared residuals are again studied in order to make further improvements in the specification.

This step-wise procedure is continued until the regression residuals approximate white noise. To confirm that the residuals are white noise, the χ^2 test with Q-statistic is applied on the cumulative autocorrelation coefficients for sufficiently lengthy lags [see Maddala (1992) for Q-statistic]. We chose lag one to 36 for the application of χ^2 test.

The final estimate of the ARCH model is given in Table 1. The ARIMA equation shows the presence of strong autocorrelation of autoregressive variety, suggesting inertia in the series of returns over a long period though it diminishes geometrically over time. We also observe the presence of significant ARCH effect indicating clusters of volatility. The ARCH coefficient is small but statistically significant. This coefficient shows that about 15 percent of a volatility shock in the current period is carried to the next period. The GARCH coefficient is much larger and highly significant. The estimate suggests that about 82.4 percent of the volatility shock in, say period 0 is carried to period 1, 67.9 percent (82.4 percent of 82.4 percent) to period 2 and so on. This means that ARCH effect is persistent, causing strong inertia in volatility. The insignificance of Q-statistics at lags one to 36 indicates that the specified model appropriately captures autocorrelation as well as heteroskedasticity.

Using the estimated ARCH model, we have estimated the series of ARCH variance to be used for the study of the two events on the activity at the KSE. The results of estimation for Equations (4), (5) and (6) after removing autocorrelation in residuals by appropriate AR or MA terms, are presented in Table 2.

Table 1

Results of ARCH Model for Daily Return

ARIMA Equation	
Intercept	–0.000109
	(–1.16)
AR(1) Coefficient	0.156
	(4.76*)
AR(3) Coefficient	0.075
	(2.40**)
ARCH Equation	
Intercept	0.000012
	(4.64*)
ARCH(1) Coefficient	0.155
	(9.53*)
GARCH(1) Coefficient	0.824
	(75.77*)
R^2	0.016
F-Statistic	3.28*
D.W. Statistic	2.07
Q-Statistics for Residuals (lag 1 to 36)	All Insignificant
Q-Statistics for Squared Residuals (lag 1 to 36)	All Insignificant

*Significant at 1 percent level.
**Significant at 5 percent level.

Table 2

The Event Effects on Stock Market Activities at the KSE

	Rate of Return	ARCH Variance	Natural Log of Trading Volume
Intercept	–0.00011	0.00028	17.178
	(–0.14*)	(4.34*)	(106.91*)
Coefficient of D1	–0.027	0.00020	0.803
	(–4.53*)	(1.60)	(3.05*)
Coefficient of D2	0.00013	0.00046	1.137
	(0.08)	(4.13*)	(4.41*)
AR(1) Coefficient	0.097	0.885	0.965
	(3.06*)	(52.68*)	(100.19*)
MA(1) Coefficient			–0.622
			(–21.55*)
MA(2) Coefficient		0.215	
		(6.19*)	
MA(4) Coefficient		0.110	
		(3.27*)	
R^2	0.036	0.897	0.775
F-Statistic	12.27*	1720.09*	855.30*
D.W. Statistic	2.00	1.94	1.90
Q-Statistics (lag 1 to 36)	All Insignificant	All Insignificant	All Insignificant

*Significant at 1 percent level.
**Significant at 5 percent level.

The results show that the nuclear detonation by India had significant adverse effect on the daily rate of return at the KSE, which declined by 2.7 percent on average. The event also resulted in a significant increase in trade volume. The increased volume obviously resulted from extra-ordinary selling pressure as the investors attempted to off-load their holdings. Besides these two effects the Indian detonation also resulted in increased level of volatility, though the increase was statistically insignificant. The event of nuclear detonation by Pakistan, on the other hand, did not have any significant effect on the average rate of return. However it resulted in an increase in volatility and trade volume.

The above results have interesting interpretations. The decrease in average return, and increase in trade volume during the period between the nuclear detonations by India and Pakistan clearly indicate that the agents had firm expectations for the upcoming recession in the stock market. Furthermore since there was no significant increase in volatility, the agents seemed to be quite certain about the pessimistic outlook. These expectations were formed in the backdrop of generally held perception that Pakistan was actively preparing for a response in kind to the Indian detonation despite political and economic pressures from abroad. These expectations indeed turned out to be true on 28 May 1998.

Following the almost certain expected response from Pakistan, the stock market became highly volatile with no change in the average return, which had already dropped to the record low level as a result of pessimism prevailing during 12 to 28 May. The uncertainty can mainly be attributed to an initial severe reaction from the USA, World Bank and the IMF, which later softened. Besides the economic sanctions and curbs there were so many other factors that contributed to the increased uncertainty. Three important factors were the uncertainty about the outcome of negotiations for debt rescheduling from the London and Paris clubs of lenders, stalling of the negotiations with the IPPs (independent power producers) on power tariff rates and general degradation in political and law-and-order situation in the country. One or the other of these factors continued to haunt the investors.

5. CONCLUSION

This study has examined the effects of nuclear experiment in India on 11 May 1998, shortly followed by the one in Pakistan, on the activities at the KSE. The three indicators of stock market activities considered are average return, volume and volatility. For this analysis we have applied the ARCH model by using daily data of KSE.

The results show that the nuclear detonation by India had significant adverse effects on the daily rate of return at the KSE, while trading volume and the level of volatility increased. The event of nuclear detonation by Pakistan, on the other hand, did not have any significant effect on the average rate of return. However it resulted in an increase in volatility and trade volume.

The decrease in average return, and increase in trade volume during the period between the nuclear detonations by India and Pakistan clearly indicated that the event was anticipated and most of the adjustment had already been made. After 28 May onward the reaction was more due to economic hardships that Pakistan faced from internal recession and the outside sanctions.

The reaction of the stock market to the nuclear detonations by India and Pakistan was therefore not uncharacteristic in any sense; it was quite consistent with the common expectations.

REFERENCES

Agiray, V. (1989) Conditional Heteroscedasticity in Time Series of Stock Returns: Evidence and Forecasts. *Journal of Business* 1: 55–80.

Ahmed, E., and J. B. Rosser Jr. (1995) Non-linear Speculative Bubbles in the Pakistani Stock Market. *The Pakistan Development Review* 34: 1 25–41.

Chou, R. (1988) Volatility Persistence and Stock Valuations: Some Empirical Evidence Using GARCH *Journal of Applied Econometric* 56: 3 701–714.

Enders, W. (1995) *Applied Econometric Time Series.* New York: John Wiley & Sons.

Engle, R. E. (1982) Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrical* 50: 987–1007.

Engle, R. F., D. M. Lilen, and Bollerslev (1987) Estimating Time Varying Risk in the Term Structure: The ARCH-M Model. *Econometrica* 55: 391–407.

Jung, Frank De, Angelien Kemma, and Teun Klock (1992) The Contribution to Event Study Methodology with an Application to the Duch Stock Market. *Journal of Banking and Finance* 16: 11–36.

Lelland, Hayne, and Mark Rubinstein (1988) Comments on the Market Crash: Six Months After. *Journal of Economic Perspectives* 2: 45–50.

Maddala, G. S. (1992) *Introduction to Econometrics*, Second Edition. New York: MacMillan.

Michell, M. L., and Jeffrey N. Natter (1989) Trigging the 1987 Stock Market Crash. *Journal of Financial Economics* 24: 37–68.

Report of Presidential Task Force on Market Mechanism, Nicholas F. Brady (1988) Chairman, January 8.

Roll, Richard (1988) The International Crash of Oct 1987. In R. Kamphuis, R. Kormendi and J. Walson (eds) *Black Monday and Future of Financial Markets* (Irwin Homewood II).

Uppal, J. (1993) The Internationalisation of the Pakistani Stock Market: An Empirical Investigation. *The Pakistan Development Review* 32:4 605–618.