Effects of Interest and Exchange Rate Volatility on Stock Index Returns: A case study of Karachi Stock Exchange

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ABSTRACT

This study has investigated the impact of volatility of interest rates and exchange rates on the stock index returns. We have Examined stock index behavior via exogenous variables of interest rate and exchange rate for a period of July-1991 to June-2009 and applied the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models: one without the effect of exogenous variables of interest rates and exchange rates and other with the effect of exchange rates and interest rates for volatility and return behavior of the indices.

The result has established that volatility of interest and exchange rates have a strong forecasting and explanatory power for the returns of stock indices. The result of the study is specifically crucial for risk management, portfolio selection, and policy formulation in financial sector. The financial sector in any economy is characterized by the interactions of the three important variables i.e; interest rates, exchange rates and return on stocks. Researchers have taken particular interest in examining the interactions among three variables for two reasons; their implications in the overall economy and availability of more reliable and authentic data.

Key Words: Volatility, Index Return, Interest rate, Exchange rate and Capitalization

INTRODUCTION

Return on stocks has been a potent determinant of the status of stock exchange in any economy. Where empirical evidence has shown return on stocks to be directly related to capitalization of the market, it has also exposed it to be sensitive to changes in the nominal interest rate and exchange rate. This sensitivity of return on savings manifests itself in variation in stock prices. Such a variation in the stock prices in a given time is known as stock return volatility and like the time value of money investors takes this account as risk factor.

Karolyi (2001) has established volatility to be higher and hence the associated risk with downward movement in stock prices than upward movement. Ehramannand Fratscher (2004) has found the stock prices to be affected in portfolio manner by the interest rate. Similarly, exchange rate variations affects the future cash flows and hence the value of a firm in its forward or future contracts. The mechanism is, that a volatile exchange rate results in appreciation of risk which depreciates the confidence of the investors and businessman in the economy, due to which the rate at which the firms discount its future profits also appreciates which in turn, reduces the value of that firm.

Adler and Dumas (1984) segregated the firms between those that operate widely in domestic market and those that have international market orientation and founded that the impact of exchange rate volatility is more severe for the later than the former. Owing to its highly volatile nature, this paper has chosen Karachi Stock Exchange (KSE) as an emerging

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market, defined by its increasing capitalization. Since the responsiveness of each sector may be different to volatility in one exogenous variable, therefore each sector has been examined separately.

Objectives of the paper:

- To study the impact of interest rates and exchange rates variation on the volatility of stock index returns.
- To formulate policy recommendations in the light of empirical evidence gathered in this study.

Hypothesis:

The data has analyzed under the following assumptions and hypothesis.

H_o = Stock returns have correlation with the volatility of interest rates and exchange rates.

H_1 = Stock returns have no correlation with the volatility of exchange and interest rates.

LITERATURE REVIEW

The research studies like Fama (1981), Aggarwal (1981) and Soenar and Hanniger (1988) have established correlation between macroeconomic variables like interest rates and exchange rates and return on stocks. Bren et al., (1989) applied GARCH model and evaluated economic relevance of forecasting variations in stock markets. Their analysis showed a lag varying conditional variance which they took as an evidence to prove that one month interest rates is sufficient to forecast the signs and extent of fluctuations in the Return on Stocks (ROS). Whitelaw (1994) studied the impact of time variations and co-variations on volatility in stock market. Using correlation and Vector Auto Regression, Whitelaw (1994) analyzed empirical relationship between conditional mean and volatility and established that volatility affects the expected return on stocks.

Similarly, Malik and Hassan (2004) analyzed the events which change the volatility pattern in money and capital market assets and applied algorithm of cumulated sum of square for the variation in volatility. The result of the analysis of five major sectors concluded the volatility shifts in the estimated volatility persistently gets reduced by applying a GARCH model.

Rigobon and Sack (2004) studied the NASDAQ Index and founded that short term increases in the interest rates has an adverse impact on stock prices. Volatility in Istanbul Stock Exchange (ISK) was examined by Erden et al., (2005). Their study founded a spillover effect and predicted one sided causation from macroeconomic variables to stock price index.

Aloui (2006) studied the phenomenon by taking three factor transmission mechanisms of mean, volatility and causality for the markets of developed economies like USA and EU. To clarify asymmetry of the volatility, he used EGARCH model and showed that there was a strong relationship in mean and variance for foreign exchange rates in terms of stock prices. In a subsequent study Hyde (2007) studied the relevant markets in France, Germany, UK and Italy and concluded that the there was a significant relationship between interest rate risk and fluctuations in stock prices in Germany and

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France only whereas exchange rate fluctuations had significant impact in all the four economies.

Tahir et al., (2008) took monthly return of KSE with T-bills based on 90-day timeframe for 2002-06 and analyzed the impact of interest rate on KSE. This study concluded that conditional market return has an indirect and inverse relationship with interest rates. This study used GARCH (1, 1) model for the analysis of interest and exchange rates and used one model for the effect of interest and exchange rates and the other without the effect of interest rates and exchange rates. This study determined that variations in interest rates have a strong forecasting validity for expected stock returns but not for volatility in stock returns.

This brief literature review has shown that empirical research conducted in different economies over the last thirty years has not reached common conclusion. For instance, studies of Aggarwal (1981), Mukarjee and Naka (1995) found a significant positive correlation between interest rates and stock prices whereas studies of Kwon and Shin (1992) and that of Maysami and Koh (2000) concluded a negative relationship. It is in view of these conflicting results that the present study is conducted to evaluate the interaction of the before mentioned variables in KSE.

MODEL, METHODOLOGY & DATA

The data analyzed in the paper is time series and has been subjected to ARCH and GARCH models. The ARCH model has taken care of the current error term which is a function of the previous terms as a square of variances. The study has analyzed the data by splitting the requisite models into mean and variance equation models. 1st Model has been employed without exogenous variables whereas the 2nd model has been employed with the effect of exogenous variables of interest rates and exchange rates.

Model 1:

$$Y_t = 0_o + 0_1 Y_{t-1} + \varepsilon_t$$

$$h_t = \alpha_o + \alpha_1 \varepsilon^2_{t-1} + \beta_1 h_{t-1} \quad (1.1)$$

Model 2:

$$Y_t = 0_o + 0_1 Y_{t-1} + 0_2 exc_t + 0_3 \, int_t + \varepsilon_t$$

$$h_t = \alpha_o + \alpha_1 \varepsilon^2_{t-1} + \beta_1 h_{t-1} + \gamma exc + \lambda \, int_t \quad (1.2)$$

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In the above equations, 1.1 & 1.2, Y_t represents the return of KSE Stock Index, Y_{t-1} the return regarding lag values, θ_o is the constant terms while ε_t are the error terms in the equation 1.1 & 1.2. In the variance equation (1.2), h_t is a dependent variable and known as variance of the residuals extracted from the above equation 1.1. This can also be interpreted as current day variability of KSE Stock Index return. h_{t-1}, represents one period lag of h_t. This can also be known as previous days residuals error or volatility of KSE, which is also known as GARCH term referring as current or today's fluctuations with the effect of yesterday's fluctuations. ε^2_{t-1}, is known as previous periods squared residuals, referred as previous day's index information about volatility, which is known as ARCH term. Equation (1.2) can be referred as GARCH (1, 1) model as we see one ARCH term (ε^2_{t-1}) and similarly one GARCH term (h_{t-1}).

Domestic exchange rates have been measured with foreign exchange rates taking US dollars with respect to host currency and interest rates are measured taking Treasury bill rates (TB-rates). The variables have been used to demonstrate the significance of interest rates and exchange rates for the underlying index volatility.

For summary statistic interest rates and exchange rates are contained on Skewness, Kurtosis, Jerque-Bera statistic, minimum, maximum, standard deviation and LJung-Box Q statistics.

DATA

The study has taken monthly data on index returns from KSE for the period July 1991-June 2009, whereas monthly data on interest rates and exchange rates has been taken from International Financial Statistics (IFS).

METHODOLOGY

Unit Root Test:

In GARCH (1, 1) model the study has taken monthly data for estimating the model and for stationarity, applied the unit root test under the environment of Dickey Fuller and Augmented Dickey Fuller tests, because for estimating the model, it is necessary to bring the data of all variables into stationarity.

After applying the test with intercept and first difference with two lags, the data became stationary. This was followed by the application of GARCH model. For lag selection, SIC (Schwarz Information Criterion) has been used to remove the residual autocorrelation in monthly data.

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Table 1. Diagrammatic Representation of ADF- Test

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.12522	0.0000
Test critical values:	1% level	-3.461478	
	5% level	-2.875128	
	10% level	-2.57409	

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(VOL_ER(-1))	-1.815601	0.149738	-12.12522	0
D(VOL_ER(-1),2)	0.463226	0.112149	4.130455	0.0001
D(VOL_ER(-2),2)	0.17371	0.06882	2.524118	0.0124
C	2.86E-07	1.97E-05	0.014491	0.9885

DATA ANALYSIS AND EMPIRICAL RESULTS

Result discussion of GARCH (1, 1) model (with the effect of interest and exchange rates) To evaluate the GARCH model, the study applied Normal Gaussian Distribution. Under this distribution it has been found that ARCH is significant, which implies that previous day's KSE Index information (ARCH) could influence current or today's KSE index volatility that is

Table 2. Diagrammatic Verification of the model:

Dependent Variable: Yt

Method: ML - ARCH (Marquardt) - Normal distribution

GARCH= $C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1) + C(5)*VOL\_ER + C(6)*VOL\_IR$

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.008156	0.002737	2.979323	0.0029

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000606	5.33E-05	-11.35906	0
RESID(-1)^2	-0.085878	0.021341	-4.024165	0.0001
GARCH(-1)	0.992131	0.024494	40.50623	0
VOL_ER	0.557737	0.164211	3.455251	0.0005
VOL_IR	0.000471	3.18E-05	14.77798	0

Result discussion of GARCH (1, 1) model: (without the effect of interest & exchange rates)

GARCH (1, 1) model has been used for the volatility of stock index returns with the effect of exogenous variables and without the effect of exogenous variables of interest rates and exchange rates. Under Normal Gaussian distribution test from 1st model mean equation and from the following table 3, it is evident that lagged returns have no close and significant impact on stock returns. 1st Model did not incorporate the effect of interest rates and exchange rates, indicates that autoregressive variable on the stock index return has no effect on the returns. From the same model it is evident that volatility persistency

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parameters are not identical which supports the prior findings of Aggarwal et al., (1999) while suggested that persistence in volatility can be explained by the information of exogenous variables, meaning that interest rates and exchange rates have an impact on the volatility of stock index returns.

In the 2nd model, the inclusion of interest rates and exchange rates from table (2.0), it is clear that autoregressive lag parameters have effect on the index returns. The study found that conditional return has significant association with the exogenous variables which is relevant to the study of Campbell (1987), Ferson (1989), Shanken (1990) and N.Dri Konan (2008). The results suggest that volatility in stock index due to inclusion of interest rates and exchange rates can be significantly prompted.

Table 3. Diagrammatic Verification of the model:

Dependent Variable: Yt

Method: ML - ARCH (Marquardt) - Normal distribution

$$GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)$$

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.00363	0.003184	1.140029	0.2543

Variance Equation				
C	0.000321	0.000455	0.705055	0.4808
RESID(-1)^2	0.015279	0.02903	0.526328	0.5987
GARCH(-1)	0.810186	0.259106	3.126855	0.0018

CONCLUSION & RECOMMENDATIONS

The analysis of this study revealed that stock market returns can be forecasted via analyzing interest rates and exchange rates. It is a general phenomenon that when interest rates shoot up people finds incentives in savings bank accounts rather to invest in stock markets because of the factor of systematic or unsystematic risks in the later. Further, interest rates and exchange rates have much wider than simply controlling money supply and credit conductions. Owing to sensitivity of stocks to interest and exchange rates, policy makers may play safe if these variables are taken into considerations. It will also help in determining the performance of a stock exchange or formulating a policy for stock exchange.

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