

# **Does Predicted Macroeconomic Volatility Influence Stock Market Volatility? Evidence from the Bangladesh Capital Market**

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## **Abstract**

According to the famous Capital Asset Pricing Model, market return, proxied by return from a broad-based market index should be related to the risk associated with macroeconomic health of the economy as the latter affects an individual firm's cash flows and the systematic risk component. Therefore, the overall performance of a firm in terms of its contribution to the market portfolio return, in turn, can be evaluated based on some macro variables like GDP growth, inflation, etc. In this paper, the main aim is to examine how the macroeconomic risk associated with industrial production, inflation, and exchange rate is reflected to the stock market return in the context of Bangladesh capital market. Monthly data for the 1990.01-2004.12 period are considered for the study. Since many macroeconomic variables and stock returns are believed to follow GARCH (Generalized Autoregressive Conditional Heteroskedasticity) process, this technique is used to find predicted volatility series for the variables considered in the study. Finally, VAR (Vector Autoregression) is employed to investigate the relation between the variables. Results show that there is significant unidirectional causality going from industrial production volatility to market return volatility and from market return volatility to inflation volatility, the latter being inconsistent with the findings. Considering all the findings, it can be concluded that there is a relation between stock market volatility and macroeconomic volatility, but it is not that strong as suggested by standard finance theory warrants further study confirming the result in other emerging markets. of factor models.

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## **1. Introduction**

As far as a risk averse investor is concerned, uncertainty is the most important factor in pricing any financial asset. According to most asset pricing theories, uncertainty or risk is determined by the covariance between asset return and the market portfolio. Although it has been recognized for quite some time that the uncertainty of speculative prices, as measured by the variances and covariances, is changing through time, it was not until recently that financial economists have started explicitly modeling time variation in second- or higher-order moments. Sufficient evidences are still to come from emerging markets like the Dhaka Stock Exchange (DSE) in Bangladesh.

Chowdhury and Rahman (2004) have studied the relationship between the predicted volatility of DSE returns and that of selected macroeconomic variables of Bangladesh economy. They have followed the methodology of Schwert (1989; 1990) to calculate the predicted volatility of the variables used in the study. They have calculated volatility from errors after using an autoregressive and seasonality adjusted forecasting model. The volatility series derived from such process has some limitations, which have been corrected in Generalized Conditional Autoregressive Heteroskedasticity (GARCH) models developed by Bollerslev (1986). For example, empirical research has found evidence of large changes in stock prices are followed by small changes of either signs. Therefore GARCH models, which take into account the

volatility-clustering phenomenon of security prices, is more suitable in modeling volatility of financial assets and macroeconomics variables like exchange rates, industrial production, inflation and so on.

In the context of present value model of asset pricing, stock price depends on future cash flows as well as on discount rates. Since future macroeconomic condition obviously has impact on the future cash flow of a firm, it surely adds to the volatility of stock return when there is uncertainty about the future health of the economy. In this study we try to find out the relation between the volatility of stock returns and that of some selected macroeconomic variables. Considering the nature of financial assets and macroeconomic variables, we use GARCH (1,1) models to estimate the predicted volatility of the asset returns and other variables (industrial production, exchange rate and inflation) used in the study. Since there is a strong link between macroeconomic health of the economy and the stock market return, any shock to macro economy must impact the stock market return. This is obvious since any shock to macroeconomic variables is a major source of systematic risk and there is no way that even a well-diversified portfolio like market portfolio constructed from stock market index can shift it to anywhere else. After calculating the predicted volatility series, we are set to use some econometric tools. Since there can be delayed response from any shock to any of the variables, we perform the Granger causality test. Finally all the variables are considered in Vector Autoregression (VAR) to see more precisely how any shock to one of the variables is transmitted to affect others in a dynamic framework.

This paper is organized as follows. Next section discusses the notable findings of the research on the risk-return relationship in the context of the DSE and developed markets. Section 3 gives the details of how the data are collected and then processed to obtain the volatility series and what methodologies are used in the study. Section 4 analyzes the empirical results found from the econometric models. Section 5 concludes the paper with

synthesis of results, policy implications, and possible remedial measures to develop the market.

## **2. Empirical Evidence of Risk-Return Relation**

Many researchers have studied the volatility of stock market in the context of developed markets. Officer (1973) shows that aggregate stock volatility increased during the Great Depression, as did the volatility of money growth and industrial production. He also shows that stock volatility was at similar levels before and after the depression. Black (1976) and Christie (1982) find that the stock market volatility can partially be explained by financial leverage. French *et al.* (1987) and Schwert (1989) measure market volatility as the variance of monthly returns of market index. French *et al.* fail to find a direct positive relation between expected return and volatility. Schwert also fails to explain much of the change in market volatility over time using macroeconomic variables. In addition, he finds that the market volatility changes over time. Schwert (1990) analyzes the behavior of stock return volatility around stock market crashes. He finds that stock market volatility jumps dramatically during the crash and returns to low pre-crash levels quickly.

Despite the significance of volatility issue in portfolio decision-making, little research has so far been done to find how the investors show their attitudes toward risk in Bangladesh capital market. Chowdhury (1994) investigates the time series behavior of returns in the DSE using EGARCH-M (exponential GARCH in-the-mean) model. The return series is found to be conditional heteroskedastic and both the first and second moments of the returns are time-dependent. The conditional variances of the return series depend upon past volatility shocks and conditional variances are, therefore, predictable using past information. The significance

of the asymmetry coefficient shows that positive return shocks in the market lead to higher increases in conditional volatility.

Hassan *et al.* (2000) use GARCH models to empirically examine the issue of market efficiency and time varying risk-return relationship for Bangladesh. The returns display significant serial correlation, implying stock market inefficiency. The results also show a significant relationship between conditional volatility and the stock returns, but the risk-return relationship is negative and significant, a result, which is completely inconsistent with portfolio theory. Hassan and Maroney (2004) examine the efficiency of the DSE by giving due consideration to some stylized facts of the market like non-linearity, thin trading, and structural change. They find non-linearity after correcting for thin-trading in some of the years under study. However, due to parameter instability, the ability to make profitable trading strategy is very limited. Chowdhury and Rahman (2004) investigate how predicted volatility of macroeconomic variables is related with that of stock return in Bangladesh. Vector Autoregression (VAR) is used to find the relationship. Findings show that macroeconomic volatility strongly causes stock market volatility, but not the other way around. Moreover, any shock to macroeconomic volatility takes long time to be absorbed into the stock prices. Imam and Amin (2004) find that the volatility of the stock return of Bangladesh capital market follows a GARCH (1,1) process and there is persistence in volatility and the conditional volatility after the crash of 1996 is mean reverting. This finding suggests that current information has no effect on the long run forecasts, rather volatility shocks (random errors) to the volatility estimated at earlier period influence more in estimating volatility.

Findings of Chowdhury and Iqbal (2005) show that DSE returns have high volatility persistence and tend to go away from mean infinitely. However, when data of few months before and after the crash of 1996 are omitted, volatility persistence has reduced and has the

tendency to go back to mean volatility after its departure from mean. Investors do not differentiate between positive and negative shock to volatility. The most important but not so surprising finding is that the market does not give risk premium to additional risk takers since risk-return relationship is found to be insignificant. They have also found that variance is predictable from information about past variance. Instead of using traditional measure of volatility derived from index returns, Chowdhury *et al.* (2005) use firm-level returns data to measure the cross-sectional market volatility. They find that there is weak relationship between risk and return and shock to return and volatility stays in the system for a long period of time, indicating inefficiency of the DSE.

### **3. Data and Methodology**

Monthly composite DSE index, industrial production index, foreign exchange rate and consumer price index for the period January 1990 through December 2004 have been considered for the study. Stock market index data are collected from the Dhaka Stock Exchange Monthly Reviews. Industrial production index and exchange rate data are collected from the IFS (International Financial Statistics). Consumer price index data are collected from the Economic Trend published by Bangladesh Bank, the central bank of Bangladesh.

Market return, inflation, and rate of change in the industrial production and exchange rate are calculated as the log differences of the respective variable between time ' $t$ ' and ' $t-1$ ' multiplied by hundred. In order to find the volatility series of these variables, we apply AR(1)-GARCH(1,1) process for each of the variables. An AR(1)-GARCH(1,1) process can be shown as given below.

$$y_t = \mu + \phi_1 y_{t-1} + u_t \quad (1a)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \quad (1b)$$

Where  $y_t$  is the conditional mean of the variable,  $\sigma_t^2$  is the conditional variance of the variable and  $u_t$  is the error term.  $\sigma_t^2$  gives us the predicted volatility of all the variables used in the study. We first apply Granger causality test to find the existence and direction of relation. If the total economy is integrated, then predicted volatility of any of them should affect others. In such a situation VAR is thought to be an effective tool to capture the relation between all the variables in a dynamic setting since all the variables are considered simultaneously. Therefore we use Granger causality test and the VAR for the analysis. A VAR can be expressed mathematically as follows.

$$X_t = A_0 + \sum_{i=1}^g A_i X_{t-i} + \varepsilon_t,$$

$$X_t = \begin{bmatrix} \sigma_{1t-1,t} \\ \vdots \\ \sigma_{4t-1,t} \end{bmatrix} \quad (2)$$

Where  $\sigma_{t-1,t}$  is the volatility of each of the variables from  $t-1$  to  $t$ , and  $g$  is the order of the VAR. Since the frequency of data is monthly, we arbitrarily employed a VAR of order 12.

#### 4. Analyses of Empirical Findings

Table1 presents the summary statistics of variances (volatility) of all the variables used in the study. Mean variance of market return and industrial production is very high compared to inflation and exchange rate. Market return variance has high mean and very high standard

deviation, a phenomenon, which is completely different from other variables. The results give important information about the Bangladesh capital market that it is much more volatile than the economy- major macroeconomic variables.

**Table 1. Descriptive Statistics**

	Mar. Ret Vol.	Ind. Prod. Vol.	Inf. Rate Vol.	For. Ex. Vol.
Mean	68.5925	60.9051	0.5378	1.0942
Median	32.9030	59.3270	0.4320	1.1114
Maximum	975.9670	85.9752	1.8549	4.0730
Minimum	15.9661	55.1952	0.2975	0.0000
Stan. Dev.	117.3896	5.5083	0.3001	0.2751
Skewness	4.9632	2.1946	2.2777	6.6880
Kurtosis	31.8631	8.7811	8.4821	81.3724
Observation	178	178	178	178

Table 2 gives pair-wise Granger causality test results. Since there are 4 variables, we have 12 different causal relationships. Results show significant unidirectional causality going from industrial production volatility to market return volatility and from market return volatility to inflation volatility.

**Table 2. Pairwise Granger Causality Tests (12 month lag)**

Null Hypothesis:	Obs.	F-Statistic	Probability
Ind. Prod. does not Granger Cause Mar. Ret.	166	1.9358*	0.0348
Mar. Ret. does not Granger Cause Ind. Prod.		0.8827	0.5659
For. Ex. does not Granger Cause Mar. Ret.	166	0.0815	0.9999
Mar. Ret. does not Granger Cause For. Ex.		0.2373	0.9960
Inf. Rate does not Granger Cause Mar. Ret.	166	1.4638	0.1446
Mar. Ret. does not Granger Cause Inf. Rate		10.1825*	0.0000
For. Ex. does not Granger Cause Ind. Prod.	166	0.2802	0.9915
Ind. Prod. does not Granger Cause For. Ex.		0.2088	0.9978
Inf. Rate does not Granger Cause Ind. Prod.	166	0.3908	0.9650
Ind. Prod. does not Granger Cause Inf. Rate		1.1221	0.3469
Inf. Rate does not Granger Cause For. Ex.	166	0.4052	0.9596
For. Ex. does not Granger Cause Inf. Rate		0.1158	0.9998

\* indicates significance at 5% level.

The earlier relation is logical although financial economists believe that stock market volatility should precede industrial production volatility since there are many qualified analysts who follow the stock market even on daily basis. However, in the absence of sufficiently large number of institutional investors and qualified security analysts in the market, the market may be inefficiently analyzed thereby reflecting incorrect prediction leading causality from industrial production to market return.

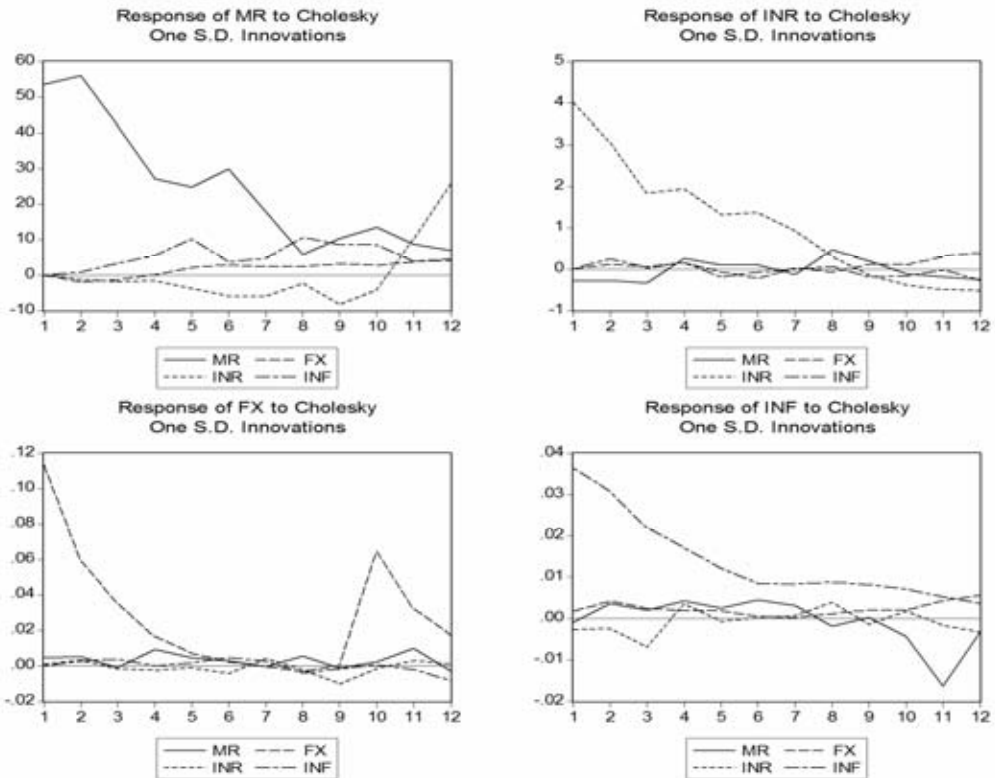
On the other hand, it is not conceivable why market volatility Granger-causes inflation volatility, the second significant finding. This finding is highly justifiable in a developed market where skilled investors dominate. In a frontier market like Bangladesh the opposite causality should have happened mainly due to the dominance of non-institutional

investors, information asymmetry among investors and scope for manipulation. Theoretically there should be positive relation between inflation uncertainty and stock return volatility, which should ultimately increase expected returns and decrease stock prices. The limitation of Granger causality test is that it does not provide the sign of relationship, which is very important in order to have a clear perception of the direction of significant relationships as well.

Impulse response graphs are shown in Figure 1. All the volatility series are basically sensitive to their own shock.<sup>1</sup> Variance series are usually thought to be persistent and this phenomenon is quite evident in the impulse response graphs. One important feature impulse response is that shock to any of the variables stay in the system for a very long period of time and does not tend to die away even after 12 months. We have already found market volatility granger-causes inflation volatility. In this connection, first graph confirms that any shock to the error-term of the market volatility causes positive shock to the inflation uncertainty (volatility). Top-right graph shows that any shock to industrial production volatility does not affect market volatility in a systematic manner. Therefore, the sign of relation between industrial volatility and market volatility is not clear.

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<sup>1</sup> This finding is also supported by variance decomposition test, which is not reported in the paper.



MR= Market Return Volatility; FX=Exchange Rate Volatility; INR=Industrial Production Volatility; INF=Inflation Rate Volatility.

**Figure 1. Impulse Response Function**

## 5. Conclusion

This paper investigates how predicted macroeconomic volatility is related to the predicted stock market volatility in Bangladesh. Since macroeconomic volatility is a source of systematic risk, it should increase the volatility of stock market and risk-adjusted expected rate of return. GARCH(1,1) model is used to find the predicted volatility of all variables used in the study. VAR is then used to capture the relation between the variables in a dynamic framework.

Results show that the relation between stock market and macroeconomic variables is not strong. It is found that industrial production volatility Granger-causes stock market volatility and stock market volatility Granger-causes inflation uncertainty (volatility). The later result contradicts the theoretical prediction in an efficient and complete capital market. However, in the absence sufficiently large number of investors and analysts in Bangladesh capital market, it might have reflected the investors reaction in reverse direction. The dearth of qualified analysts and institutional investors is a well-known fact in the emerging markets like the one in Bangladesh. Anyway, this finding needs to re-examined to be sure of the cause of reverse causality issue. .

Non-existence of the relationship between stock market and exchange rate fluctuation can be explained by the fixed exchange rate regime followed throughout the period except for the last couple of years when the country moved toward flexible exchange rate regime. Impulse response function shows that market return is basically influenced by its own shock. Moreover, any shock to market return volatility does not affect other factors that much. More generally, all the volatility series are mainly sensitive to their own shock and almost insensitive to shocks to other variables. Finally, volatility shocks to every variable seem to be very persistent and take very long period of time to die away.

Findings of the study appear to be slightly different from that of Chowdhury and Rahman (2004) where they have found that predicted volatility of macroeconomic variables is related with that of stock return in Bangladesh capital market with causality running from macroeconomic volatility toward stock market volatility. However, they have used different volatility series and macroeconomic variable with different time frame. Since a better model is used to calculate the predicted volatility series in this study, its findings are more acceptable compared to the previous one.

However, one must be cautious in using these findings in policy making. Further research confirming the results in similar countries may provide deeper understanding of the relationship between the variables in emerging markets.

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