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Impact of Macroeconomic Uncertainty on Stock Market Return Volatility in India: Evidence from Vector Autoregressive (VAR) Analysis

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This paper empirically analyzes linkages between key macroeconomic and policy variables uncertainties, namely Inflation, Output, Gold price, Exchange Rate, Money Supply, Interest Rate and stock market volatility in India over some recent periods starting from January 2005 to June 2011. Macroeconomic variables and stock market volatility series are derived using Univariate GARCH model proposed by Bollerslev (1986). Further Vector Autoregressive (VAR) model is used to analyze the dynamic linkages between the variables. Impulse response and variance decomposition analysis are reported to understand the response of stock market volatility to one standard deviation change in each of the macroeconomic volatilities and proportion of stock market volatility that is explained by the volatility in each of these macroeconomic variables respectively. The whole analysis prove that the investors can have a look the macroeconomic variables especially money supply, industrial production and gold price as the main sources of systematic risk when formulating hedging and portfolio diversification strategies.

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Introduction

According to the efficient market hypothesis, championed by Fema (1970), financial markets are informationally efficient. An informationally efficient market reflects all available information so that there is no scope to make gain from the information inefficiency. If stock prices accurately reflect the underlying fundamentals, then the stock prices should be employed as leading indicators of future economic activities, and not the other way around Maysami et al (2004). Thus the studies on the relationship between macroeconomic variables and stock prices are important.

The world has been witnessing a surge in stock market activities in the last few decades. Emerging markets accounted a huge portion of the surge in world's stock markets. Fast developing financial sector in emerging markets has attracted a huge amount of capital into their economy. Estimates show that Asia's market capitalization has more than doubled in US dollar terms to $13.7 trillion, 30 percent of world capitalization and the liquidity of Asian stock markets has more than doubled in relation to GDP (IMF, 2006). This development in emerging market has accelerated the studies on the importance of stock market in economic growth (Kunt and Levine (1993), Levine and Zervos (1998), Durham (2002)).

Further, increasing role of stock market in the economic growth of developing countries has fired up the studies on the determinants of stock market in these countries. It has been often observed that the monetary policy and macroeconomic events have large impact on the

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stock market return volatility. The previous studies have highlighted some basic macroeconomic determinants of stock market return are as interest rate, exchange rate and inflation . A number of studies have tried to capture the impact of macroeconomic variables on stock market return in different countries. Arbitrage Pricing Theory by Chen, Roll and Ross, (1986) argued that industrial production, changes in risk premiums, and changes in the term structure to be positively related to the expected stock returns, while both the anticipated and unanticipated inflation rates were negatively related to the expected stock returns.

Apart from the above seminal work there are several empirical literatures on the relationship between the stock price and macroeconomic variables related with the advanced countries. For example Fama (1981, 1990), Campbell and Shiller (1988), Fama and French (1989) Bulmash and Trivoli (1991), Abdullah and Hayworth (1993), Dhakal, Kandil and Sharma (1993), Mukherjee and Naka (1995), Choi (1995), Ajayi and Mougoue (1996), Cheung and Ng (1998), Nieh and Lee (2001), Kim (2003), Chaudhuri and Smiles (2004), Bredina, Gavin and O'Reilly (2005), Ratanapakorn and Sharma (2007), Humpe and Macmillan (2009), Rahman and Khan (2009), Wang and Lim (2010). These studies employ the macroeconomic variables like real GDP, money supply, consumer price index, interest rate, exchange rate, foreign interest rate, foreign stock market index and other relevant variables. They have observed that these variables have varying degrees of effect on the stock prices of respective countries.

We have a few studies in the Indian context on the relationship between stock price and macroeconomic relationship. Darat and Mukherjee (1987) examined the relationship between stock returns and selected macro-economic variables in VAR framework over the period 1948- 1984. This paper finds a significant causal (lagged) relationship between stock returns and some selected macro variables, including money supply, implying market inefficiency in the semi-strong sense. In a Johansen's Vector Error Correction Model (VECM) framework Naka, Mukherjee and Tufte (1996) analyses the relationship between stock price and macroeconomic variables. This study gives evidence for the existence of three long-run equilibrium relationships among the chosen variables and further establishes that the domestic inflation and domestic output are the two most prominent factors influencing stock prices. Pethe and Karnik (2000) went on analyzing the cointegration and causality between the stock price and some macroeonomic variables. However empirical evidence fails to establish any long-run relationship between the variables under study. Using long-run Granger non-causality analysis Bhattacharya and Mukherjee (2002) found that the index of industrial production leads the stock price in India and there exists a two way causation between stock price and rate of inflation.

Pratnik and Vina (2004) looked into the relationship between the real economic variables and the capital market employing both VAR and Neural Network analysis over the period 1994 to 2003. The analysis revealed that variables like the interest rate, output, money supply, inflation rate and the exchange rate has considerable influence in the stock market movement in the considered period, while the other variables have very negligible impact on the stock market.
Nair (2008) tries to fill up the gap in this area by studying the relationship between stock market developments and macroeconomic variables in VECM framework. Empirical evidence propose that variables like real income and its growth rate, interest rate and financial intermediary development significantly affect stock market development in the short run.

All the above mentioned studies try to examine the linkages between stock prices or stock market

development and some selected macroeconomic aggregates at first moment level. Most of them have confirmed a strong relationship between the stock price and macroeconomic variables. This evidence can use to extend the idea that any shock in macroeconomic variables will present a source of systematic risk that will affect any market portfolio, irrespective of how well diversified the portfolio is (Chowdhury et al., 2006). Studies in this strand look at the relationship between the conditional variance of stock return and macroeconomic variables (Fraser and Power (1994), Morelli (2002), Chowdhury and Rahman (2004), Arnold and Vrugt (2006), Beltratti and Morana (2006) Chowdhury et al. (2006), Corradi et al. (2006), Diebold and Y?lmaz (2007), Teresiene et al. (2008), Chinzara (2011)). However the findings of these studies give little evidence for a strong relationship between the risk/ volatility of stock market return and macroeconomic variables. In authors best knowledge there is no studies which explore the relationship between the volatility of stock market return and macroeconomic uncertainty in Indian context.

The present study examines the relationship between stock market return volatility and macroeconomic uncertainty in India. We employ a sample period covering some recent periods, starting from January 2005 to June 2011 for the analysis purpose. Selection of the periods of study can be justified since it represents liberalized era and the recent financial crisis. It is well established in the literature that investors have the potential to react differently to the same type of news during different periods in the economy (Li and Hu, 1998). During a recession a slight fall in expected industrial production could initiate panic among investors if they think that the economy is sinking deep into recession. Thus they will hastily short their positions, causing an increase in stock market volatility. Alternatively, if the same news occurs after a long period of expansion, investors might view it as temporary, thus they might not short their position (Chinzara (2011)). Therefore it can be observed that the relationship between stock return volatility and macroeconomic uncertainty is very strong during the crisis period.

The rest of the paper is organized as follows. In section two we discuss data and methodology. In sections three we investigate the time series properties of the data and the relationship between macroeconomic and stock market volatility. Finally, in section four we conclude.

Data and Methodology

Data

The data used in this study is retrieved from the Handbook of Statistics on the Indian Economy, Reserve Bank of India 2011. The sample period consists of 78 monthly observations spanning from January 2005 to June 2011. CNX nifty index is introduced as the stock market variable. Macroeconomic variables include Money Supply (M3), Call Money Rate, Exchange Rate (INR/USD), wholesale Price Index (WPI), Index of Industrial Production (IIP) and Gold price (Rs. /10 grm). Stock market return is estimated using logarithmic subtraction of present index from the previous index. Macroeconomic variables are transformed into growth rate using the same technique. The definitions of each variable are described in Appendix Table 1.

Methodology

The present study investigates the relationship between stock index return volatility and key macroeconomic and policy variables uncertainty. Following are the methodology used for the analysis:

Volatility Variable

Stock market return and macroeconomic and policy volatility series are derived from the Generalized Autoregressive Conditional Hetroscedaticity (GARCH (1, 1)) model proposed by Bollerslev (1986). The

heteroscedastic nature of the price series has been recognized by Engle (1982) who introduced the Autoregressive Conditional Heteroscedasticity (ARCH) model, later on Bollerslev, (1986) provided a Generalized Autoregressive Conditional Hetroscedasticity (GARCH) model.

The GARCH (1, 1) model can be specified as

$$Y_t = \mu_0 + \mu_t Y_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where

$\varepsilon_t / \Omega_{t-1} \sim$ iid $N(0, \sigma_t^2)$

Ω_{t-1} the past information set

$$\sigma_t^2 = c + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Where (1) and (2) represents return and variance equations respectively. Volatility series derived from an autoregressive conditional hetroscedasticity model would be time varying and well capture the time varying characteristics of stock market return and macroeconomic variables. The empirical out put on the GARCH (1, 1) analysis is presented in the appendix Table 2.

Vector Autoregressive (VAR) Model

Recently Vector autoregressive (VAR) model has become a widely used technique to understand the dynamics between variables, especially macroeconomic variables. The world has recognized the importance of vector autoregressive model in analyzing the empirical research on cause and effect in the macro-economy through awarding Economic Nobel Prize to Christopher Sims and Thomas Sargent in 2011. One of the advantages of the VAR approach is that variables are endogenously determined. Secondly, the VAR approach allows the variables depending more than white noise terms or lag of variables. Thus VAR model becomes more flexible than AR models and since the VAR approach includes most properties of data, it offers a strong structure. Moreover, every equation may be solved by OLS (Ordinary Least Squares) because there is no simultaneous terms right side of the equation.

To analyze whether macroeconomic and policy variables uncertainty are affecting the stock index return volatility the present study utilize the Sim's (1980) reduced form of vector autoregressive (VAR) model.

$$\sigma_t + \alpha + \sum_{i=1}^{p} \phi_i \sigma_{t-i} + \varepsilon_t \quad \ldots\ldots\ldots (3)$$

Where is 7×1 vector of volatility series under study, is a 7×1 vector of intercept, , (i=1, 2, . . ., p) the 7×7 matrix of autoregressive coefficients , lagged is the 7×1 vector of white noise with zero mean and positive definite covariance matrix, and p denotes the lag order of the system.

In this study, the unrestricted VAR (p) system given by Eq. (3) is used to ascertain possible lead-lag relationships between the volatility series and, additionally, to examine the transmission of shocks in the volatility of one series on the other volatilities in the system. Further impulse response analysis and variance decompositions are applied to interpret the estimated VAR (p) system. In general impulse response function is used to understand the time profile of the effect of shocks at a given point in time on the (expected) future values of variables in a dynamical system and traces out responsiveness of the dependent variables in the VAR to shocks to each of the variables. In this paper, Impulse response analysis is used to trace the impact of a shock in volatility of macroeconomic and policy variables on the future values of stock return volatility. The speed at which the stock market reacts to macroeconomic volatility can be interpreted as a measure of the degree of its weak-form efficiency. Moreover, impulse response analysis reveals the persistence of shocks in the system, and hence, enables the assessment of the time structure of volatility transmission. In order to avoid problems

with the ordering of the variables in the system, the generalized impulses proposed by Pesaran and Shin (1998) are applied in the impulse response analysis.

Further we report variance decomposition analysis to capture the information about the relative importance of the error/innovation of each of the volatilities of the macroeconomic and policy variables in explaining stock market volatility. Hence the variance decomposition splits the variations in one stock market into component shocks in the VAR. This can distinguish the proportion of the movements in the stock market volatility that is due to "own" innovations from those that are due to macroeconomic and policy variables. However the experience of the previous studies show that own series innovations tend to explain most of the forecast error variance of the series in the VAR (Brooks (2002) Lamba and Otchere (200) Chinzara and Aziakpono (2009). Therefore, it is expected that past stock market volatility would explain its current volatility better than macroeconomic volatility would do.

Empirical Analysis and Discussion

It has often been argued that the macroeconomic variables are characterized with unit root, and if not treated it would influence the statistical behavior of estimates. We follow standard procedure of unit root testing by introducing two tests namely Augmented

Table 1: Augmented Dickey Fuller (ADF) and Philips-Perron (PP) tests on Unit-root

Variable	ADF	PP
Growth Rate		
SMR	-3.6889*	-6.1887*
EXR	-8.0690*	-8.1077*
GGP	-9.2578*	-9.2578*
GMS	-7.1638*	-9.5840*
IIP	-5.3701*	-19.5212*
CMR	-3.3463*	-3.3721*
WPI	-4.7872*	-4.8991*
Conditional Variance		
SMRV	-4.20784*	-4.10712*
EXRV	-7.12918*	-7.12996*
GGPV	-7.12686*	-7.12883*
GMSV	-3.88437*	-3.88437*
IIPV	-4.35344*	-4.35344*
CMRV	-8.06418*	-8.05040*
WPIV	-4.73532*	-4.73532*

Source: Handbook of statistics on Indian Economy (2009) and Author's own estimates. *significant at 1%. For ADF and PP, Ho = Variable has a unit root. SMR, EXR, GGP, GMS, IIP, CMR and WPI are stock market return, exchange rate, growth of gold price, growth of industrial production, call money rate and growth of whole sale price index (inflation) respectively.

Dickey-Fuller (ADF) test and Philips-Perron (PP) test. Philips-Perron test incorporate the low power limitation of ADF test. Table 1 reports the result of unit root test on stock return, growth and conditional variance

Table 2: Results on Vector Autoregressive (VAR) Model Analysis

	SMRV	CMRV	EXRV	GGPV	GMSV	IIPV	WPIV
SMRV(-1)	0.723451	-0.012582	-88.71359	0.084285	0.001930	-0.000383	0.001119
	(0.07495)	(0.25725)	(160.764)	(0.04815)	(0.00131)	(0.00329)	(0.00089)
	[9.65278]	[-0.04891]	[-0.55182]	[1.75037]	[1.47786]	[-0.11626]	[1.25266]
CMRV(-1)	0.026026	0.575228	11.42683	-0.050520	-0.000275	-0.000755	-0.000280
	(0.03412)	(0.11711)	(73.1886)	(0.02192)	(0.00059)	(0.00150)	(0.00041)
	[0.76277]	[4.91173]	[0.15613]	[-2.30457]	[-0.46275]	[-0.50376]	[-0.68772]
EXRV(-1)	0.000014	0.000041	0.497354	0.000013	0.000000	0.000002	0.000000
	(0.00000)	(0.00017)	(0.10611)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
	[-0.27232]	[-0.24295]	[4.68722]	[-0.42203]	[0.14513]	[-0.70049]	[-0.50294]
GGPV(-1)	0.343203	0.008956	82.04638	0.723254	-0.000451	-0.004062	-0.001800
	(0.12017)	(0.41246)	(257.762)	(0.07721)	(0.00209)	(0.00528)	(0.00143)
	[2.85605]	[0.02171]	[0.31830]	[9.36785]	[-0.21554]	[-0.76916]	[-1.25729]
GMSV(-1)	6.085177	-9.150605	5177.890	-16.24203	0.560528	0.000856	-0.011977
	(6.76622)	(23.2242)	(14513.7)	(4.34721)	(0.11792)	(0.29739)	(0.08062)
	[0.89935]	[-0.39401]	[0.35676]	[-3.73619]	[4.75327]	[0.00288]	[-0.14855]
IIPV(-1)	0.474131	-1.313422	-1061.921	0.824257	-0.029341	0.581073	-0.015395
	(2.21283)	(7.59524)	(4746.57)	(1.42171)	(0.03857)	(0.09726)	(0.02637)
	[0.21426]	[-0.17293]	[-0.22372]	[0.57976]	[-0.76080]	[5.97447]	[-0.58385]
WPIV(-1)	5.626040	-21.12076	15280.53	-3.315842	0.161519	0.373984	0.499425
	(8.84691)	(30.3659)	(18976.8)	(5.68403)	(0.15419)	(0.38884)	(0.10542)
	[0.63593]	[-0.69554]	[0.80522]	[-0.58336]	[1.04755]	[0.96178]	[4.73763]
C	-3.054931	11.44226	3273.405	1.100999	0.212141	1.878363	0.115825
	(10.4233)	(35.7767)	(22358.3)	(6.69686)	(0.18166)	(0.45813)	(0.12420)
	[-0.29309]	[0.31982]	[0.14641]	[0.16441]	[1.16777]	[4.10005]	[0.93256]
Adj. R-squared	0.770393	0.322994	0.188023	0.758820	0.424734	0.343649	0.263657
F-statistic	36.94933	6.111704	3.481020	34.71008	8.910638	6.609730	4.836379

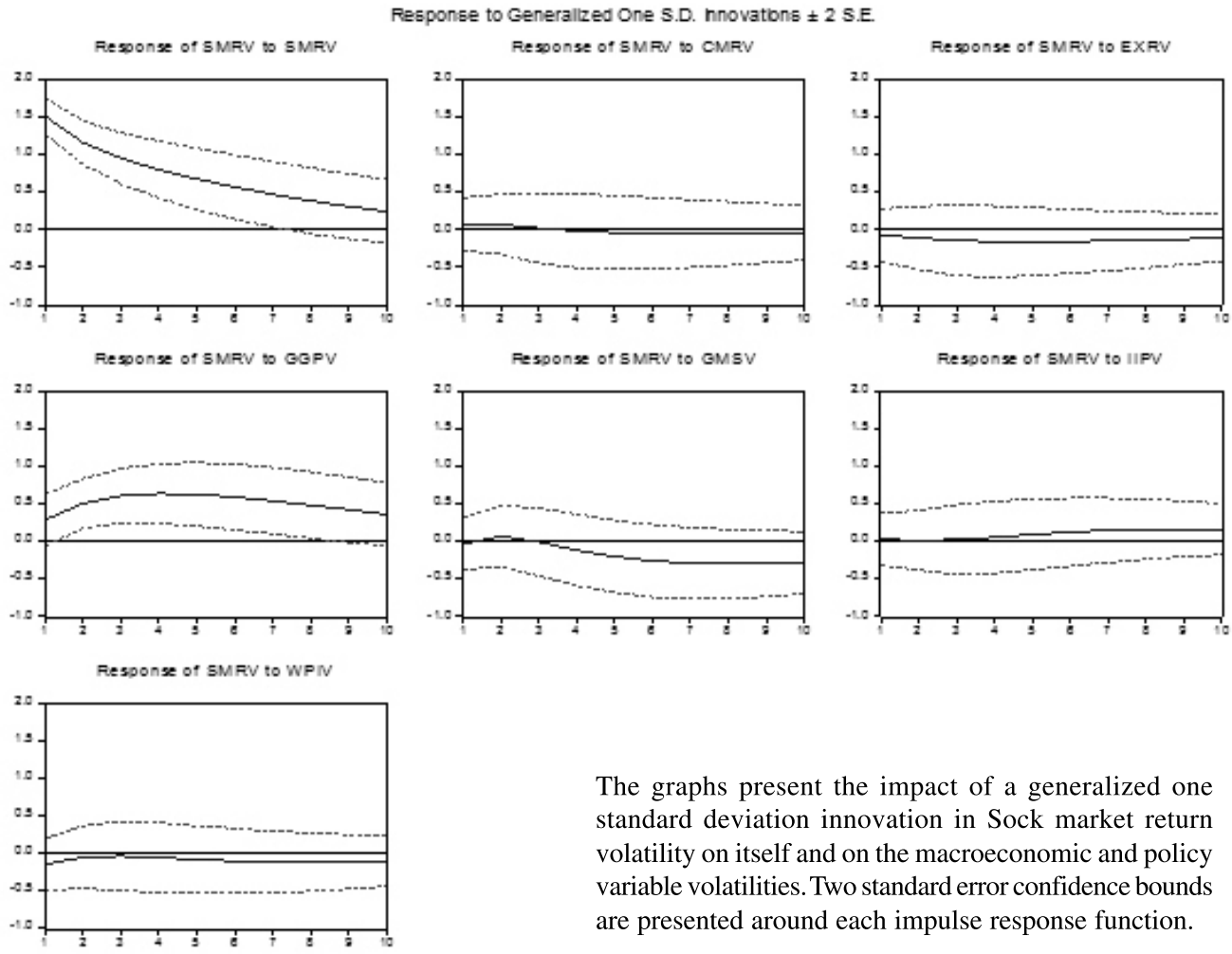
Source: Handbook of statistics on Indian Economy (2009) and Author's own estimates. SMRV(-1), CMRV(-1), EXRV(-1), GGPV(-1), GMSV(-1), IIPV(-1), WPIV(-1) are 1 period lagged volatility variables of stock market return, call money rate, exchange rate, growth of money supply, growth of industrial production and inflation derived from whole sale price index respectively. Standard errors and t-statistics are reported in the parenthesis (.) and brackets [.] respectively.

(volatility) series.

The appropriate lag length is obtained using Akaika Information Criteria. Both ADF and PP tests show that all variables in growth as well as volatility form are stationary at level. That means all variables are integrated order zero i.e. I (0) at level. This result justify the selection of vector autoregressive (VAR) model to understand the affects of macroeconomic and policy uncertainty on stock market volatility.

The appropriate lag length for the VAR model is selected based on three criteria namely Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ) and Final prediction error (FPE) . These three criteria suggest VAR (1) as the best model to be fitted. Table 2 reports the estimates on Vector Autoregressive (VAR (1)) model analysis. The adjusted R square and F- statistics of the stock market return volatility equation is 0.77 and 36.94 respectively. This appears to indicate that stock return volatility is fairly well explained by lagged variables used in the model. This implies that macroeconomic and policy uncertainty variables used in the model have significant role explaining stock return volatility. That is, fluctuations in the macroeconomic and policy variables result in stock return volatility. Now a critical analysis concerning the sign of relationships and how long it would take for the impact of the volatility to work through the system is warranted.

Fig 1: Impulse Response Functions



The graphs present the impact of a generalized one standard deviation innovation in Sock market return volatility on itself and on the macroeconomic and policy variable volatilities. Two standard error confidence bounds are presented around each impulse response function.

We report impulse response function to trace the impact of a shock in volatility of macroeconomic and policy variables on the future values of stock return volatility. Result of impulse response function analysis is presented in the figure 1. The VAR system has seven variables; a total of 49 impulses could be generated. However, the primary aim of this paper is to examine the impact of macroeconomic and policy variable volatility on stock market return volatility. Thus figure 1 only traces out the responsiveness of SMRV to a one standardized innovation of its own and other six variables. In general stock market return volatility highly response to its own transitory shock and to the volatility of gold price growth. Further, all figures show that the SMRV to the macroeconomic and policy innovations is persistent. SMRV responses to gold price volatility and industrial production volatility innovations are positive. While response to exchange rate, money supply and inflation innovations are negative.

Table 3: Variance Decomposition Function

Variance Decomposition of SMRV:								
Period	S.E.	SMRV	CMRV	EXRV	GGPV	GMSV	IIPV	WPIV
1	1.518327	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	1.942058	96.71913	0.005718	0.081743	2.370067	0.536459	0.023863	0.263020
3	2.212054	93.10304	0.015609	0.254393	5.684578	0.447919	0.049750	0.444717
4	2.411643	89.45135	0.064716	0.458390	8.917707	0.522854	0.097376	0.487606
5	2.569176	85.83032	0.133357	0.653599	11.67663	1.061271	0.183661	0.461162
6	2.696291	82.41345	0.199848	0.823660	13.86072	1.967817	0.313067	0.421435
7	2.798693	79.35689	0.254403	0.965296	15.50411	3.050111	0.476821	0.392365
8	2.880078	76.74582	0.295441	1.080404	16.69329	4.147386	0.659109	0.378546
9	2.943530	74.59928	0.324807	1.172346	17.52542	5.157582	0.843608	0.376961
10	2.991932	72.89158	0.345154	1.244602	18.08945	6.028923	1.017285	0.383008

Source: Handbook of statistics on Indian Economy (2009) and Author's own estimates. Cholesky Ordering: SMRV CMRV EXRV GGPV GMSV IIPV WPIV

Variance decomposition (VDC) gives the proportion of the movements in the dependent variables those are due to their "own" shocks, versus shocks to the other variables. The VDC technique decomposes the total variance of the volatility in each of the future periods and determines how much of this variation each macroeconomic volatility variable explains. As mentioned earlier the primary aim of this paper,

however, is to examine the impact of macroeconomic and policy variable volatility on stock market return volatility, we only present the results of variance decomposition of SMRV over a period of a 10 month time horizon for other variables. Table 3 presents forecast error variances of stock return volatility. It can be noted from the table that the forecast error variances of SMRV is largely due to its own innovations although over time the innovations of other variables show a tendency to increase gradually. The result indicates that large percentage of forecast error of SMRV is due to its own innovations (about 73% up to 10th month) while the innovations of CMRV, EXRV, GGPV, GMSV, IIPV and WPIV explain about 0.3%, 1.2%, 18.0%,6.0%,1.0% and 0.4% respectively.

Concluding Remarks

This Paper examines the affect of macroeconomic and policy variable uncertainty in to the stock market return volatility over a period of 78 months starting from January 2005 to June 2011. Macroeconomic variables namely inflation and output and policy variables like exchange rate, short term interest rate (call money rate) and money supply and gold price volatilities are employed to capture the dynamics. Uncertainty series were derived from a univariate GARCH (1, 1) model. Vector autoregressive (VAR) model, impulse response function and variance decomposition analysis are carried out to understand the dynamic linkages between stock return volatility and macroeconomic and policy variable uncertainties.

The present study, which deals the relationship between the macroeconomic uncertainty and stock return volatility in India, has some important implication since the previous literatures have confirmed the strong relationship between the stock prices and major macroeconomic variables at first moment in the same context. The high adjusted R square and F- statistics of the stock market return volatility equation in VAR model imply that macroeconomic and policy uncertainty variables used in the model have significant role explaining stock return volatility. Impulse response analysis shows that responsiveness of stock return volatility to gold price volatility and industrial production volatility innovations are positive. However the responsiveness of stock market return volatility to the innovations of other variables is small and negative but still persists. In general, the whole analysis prove that the investors can have a look the macroeconomic variables especially money supply, industrial production and gold price as the main sources of systematic risk when formulating hedging and portfolio diversification strategies.

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Appendix

Table 1: Definition of variables used to proxy the Indian stock market and the six macroeconomic variables.

SL NO:	Variable*	Definition
1	S&P CNX Nifty	S&P CNX Nifty is a well diversified 50 stock index accounting for 24 sectors of the economy.
2	Index of Industrial Production (IIP)	Index of Industrial Production (IIP) in simplest terms is an index which details out the growth of various sectors, like mining, electricity, Manufacturing & General, in the Indian economy.
3	Money Supply (M3)	M1 + Time deposits with the banking system. = Net bank credit to the Government + Bank credit to the commercial sector + Net foreign assets of the banking sector + Government's currency liabilities to the public – Net non-monetary liabilities of the banking sector.
4	Call Money Rate(CMR)	Also called the broker loan rate, the interest rate that banks charge brokers to finance margin loans to investors.
5	Wholesale Price Index (Inflation)	An index that measures and tracks the changes in price of goods in the stages before the retail level. Inflation rate is estimated from wholesale price index.
6	Exchange Rate(INR/USD)	The rate at which Indian national Rupee is exchanged for US dollar.
7	Gold Price	Monthly average price of gold (Rupees per 10gm)

*growth rate of these variables are employed to derive volatility series from GARCH (1, 1) model.

Table 2: GARCH (1, 1) Result on Stock Return, Macroeconomic and policy variables

	SMR	EXR	GGP	GMS	IIP	CMR	WPI
μ0	0.64469	9.19973	0.65132	0.61298	0.32993	9.42813	0.24673
	(0.26370)	(0.47170)	(0.00330)	(0.00000(	(0.06920)	(0.02600)	(0.00100)
μt	0.33359	0.53571	0.01375	-0.08630	-0.54983	0.96731	0.48690
	(0.04090)	(0.00000)	(0.91330)	(0.61310)	(0.00010)	(0.00000)	(0.03500)
c	0.85174	859.612	0.33398	0.07879	2.34692	0.48641	0.03810
	(0.40250)	(0.00120)	(0.43550)	(0.73100)	(0.77530)	(0.59340)	(0.22650)
α	0.08659	0.38865	0.18053	-0.04867	0.01326	0.73084	0.12172
	(0.44770)	(0.00000)	(0.15250)	(0.45290)	(0.82870)	(0.14840)	(0.19320)
β	0.82397	-0.04749	0.73728	0.73089	0.46676	0.27994	0.46494
	(0.00010)	(0.80810)	(0.00000)	(0.42120)	(0.79540)	(0.47920)	(0.21080)

Source: Handbook of statistics on Indian Economy (2009) and Author's own estimates. SMR, EXR, GGP, GMS, IIP, CMR and WPI are stock market return, exchange rate, growth of gold price, growth of industrial production, call money rate and growth of whole sale price index (inflation) respectively. Probability values are reported in the parenthesis.

Table 3: TVAR Lag Order Selection Criteria

Lag	LogL	FPE	SC	HQ
0	446.7482	9.84e-15	-12.16419	-12.29856
1	627.7003	2.41e-16*	-14.31958*	-15.39453*
2	673.9878	2.70e-16	-12.68161	-14.69714
3	705.0223	4.96e-16	-10.61397	-13.57009
4	748.0805	7.21e-16	-8.885027	-12.78172
5	802.8705	8.87e-16	-7.486558	-12.32384
6	900.0563	4.27e-16	-7.282337	-13.06020

* indicates lag order selected by the criterion, FPE: Final prediction error, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion