# Study of Causality, Shocks and Risk Return Trade-off in Multifactor Asset Pricing Models

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**ABSTRACT**

In this study, attempts are made to understand the causality of factors, lead lag relationship, impact of measured shocks on returns, and predictive ability of multi-factor models in volatile moments using VAR, IRF, and GARCH-Mean tests. Findings only favour the market premium in Granger causing the returns of double sorted portfolios and momentum portfolios at twelve lags. The perseverance of shocks of double sorted portfolios and momentum portfolios are short lived. Risk return trade-off is also preserved only in thirty percent portfolios of the test assets. Results are of high importance for portfolio managers, retail and institutional investors and regulators to avoid the risk emanating from risk on/off phenomenon.

**Keywords:** Asset Pricing Models, Granger Causality, Risk on/off

## 1. INTRODUCTION

Various multi-factor models have occupied prominent role in return generating process using priced factors emanated from various CAPM anomalies. Few of them are three factors model (Fama & French, 1993), four factors model (Carhart, 1997) model, and five factors model (Durand et. al.,2011) model. Fama and French (1993) extend the capital asset pricing model (1964, 1965) by using various fundamental factor evidences. Fama and French (1993) identify three common risk factors in the returns on stock viz. overall market factor, size and BE/ME. On the other side, there is parallel development of short term continuation anomaly (Jegadeesh and Titman, 1993) which is further accommodated as priced factor in four factor model controlling survivorship bias. Later, five factor model (Durand et al., 2011) accommodate this factor by the introduction of VIX in the asset pricing model in order to capture the market expectation of future volatility using a forward looking measure. Thus, there is substantial departure from one factor model to multi-factor asset pricing model in return generating process.

## 2. REVIEW OF LITERATURE

Despite tremendous support for three factor model, it has its own limitations at industries level on one side and the negative loadings on size and value factor on the other side. Few studies strongly deny the relevance of momentum premium (Campello et al., 2008) and it is only relevant in short term return generating process (De Bondt, 2008). It is also observed that momentum is absorbed by investment factor. Few markets yield negligible size and value loadings with significant momentum loadings advocating partial Carhart (1997) model. Asset pricing models are strongly refuted in the days of global crisis owing to the one sided movement of investors (Lee, 2012). Return generating process is augmented by the construction of smart beta and smart alpha portfolios. Investors are warned to remain congruent to risk and return grid rather than that of portfolios (Jacobs and Levy, 2014). There are arguments that the additional return emanates from the capability of investors for identification of smart factors, design of smart portfolios, and application of appropriate asset pricing model on factors and portfolios (Amenc et al., 2014). Thus, the interaction and understanding between these three aspects gives the clue of additional return. Previous studies argue the relevance of factors and their loadings but have scant literature support with reference to lead lag relationship, impact of shock on returns and compensation of assets in volatile days.

## 3. OBJECTIVES AND HYPOTHESES OF THE STUDY

Thus, this study is accomplished with following objectives.

I. To assess the Granger causality between test portfolios and priced factors of multi-factors asset pricing model (Durand et al., 2011; Carhart, 1997; Fama and French, 1993) and to appraise the lead lag relationship among them.
II. To measure response of test portfolios with respect to one standard deviation innovations in various priced factors.
III. To assess the compensation of asset pricing model in the highly volatile time to appraise the predictive ability of multi factor models.

Null Hypothesis ($H_{0i}$): i. e. $\gamma = 0$

Alternate Hypothesis ($H_{1i}$): $\gamma > 0$

## 4. METHODOLOGY AND DATA SOURCES

This study uses the portfolios and priced factors of previous study (Kumar and Rao, 2014) in order to investigate the lead lag relationship and the predictive ability of multi factor asset pricing models. In order to accomplish the above objectives, dynamic tools namely Granger Causality test, Vector Auto Regression (VAR), Impulse Response Function and GARCH-in-Mean are used on nine double sorted portfolio and ten momentum portfolios ( Kumar and Rao, 2014).

Further, GARCH-in-mean test is used in order to assess whether formal risk return relationship is capable to compensate the fluctuations of volatility or not. If the conditional volatility ($\gamma$) is appropriately priced by multi factor models, the regression coefficients of the conditional volatility must be positive and significant. In this test, RVIX is used as exogenous independent variable in multifactor models.

$\varepsilon_t = z_t \sqrt{ht}$ where $z_t \sim N(0,1)$

$$h_t = \alpha_0 \alpha_1 \varepsilon^2_{t-1} + \beta_1 h_{t-1} \quad (1)$$

$h_t$ is the source of conditional volatility

## 5. RESULTS AND DISCUSSION

### *Granger causality of factors and VAR (vector auto regression) results*

Granger causality test results are presented in table 1. Majority of the null hypotheses are rejected at ten percent level of significance for market premium leading to the fact that market premium does Granger cause returns of double sorted portfolios and momentum portfolios except the returns of large sized and growth portfolios (LG) at twelve lags. Other factors viz. size premium, value premium and momentum premium, fear premium have negligible role on double sorted portfolios. The other factors play analogous role except momentum premium. Thus, it substantiates the weaker role of fundamental factors on dynamic basis. And market premium is a consistent causing agent with higher lags. Thus, VAR is conducted only on market premium. VAR results infer that returns of all nine double sorted portfolios hardly have any correlation with its lagged values. But the returns of fifty percent of double sorted portfolios are relatively dependent on lagged values of market premium. Time of complete decay varies between two to three months in all double sorted portfolios (Figure 1 to Figure 3). Thus, the shock is short lived and reduces to negligible level in three months. However, the memory of shock in large sized portfolios is one month larger than small sized ones. It is also evident that returns of fifty percent of momentum portfolios have correlation with its lagged values and the lagged values of market premium. Duration of complete decay varies between three to four months in all momentum portfolios (Figure 4 to Figure 8). Thus, the shock is short lived and reduces to negligible level in three months. However, the memory of shock in 36 winner and 39 winner portfolios is one month larger than that of other momentum portfolios. It is important to note that VAR yields higher value of intercepts and moderately lower value of R square attributing to the possibility of inclusion of other factors in multifactor model. These findings corroborate the regression results (Kumar and Rao, 2014) and superiority of multi factor asset pricing models.

Generally, it is believed that risk return model should compensate with higher return in highly volatile market (positive GARCH sensitivity coefficients). In this analysis, RVIX is treated as proxy of fear in the stock market. It is commensurate with the risk return trade-off theory. Table 2 presents the GARCH-in-Mean results on returns of nine double sorted portfolios. Results

**Table 1:** Presents the granger causality results and impulse response function results. Values of other factors are not presented due to insignificant values

| Returns on portfolios | Market premium F statistic (P value) | Period of decay (months) | Returns on portfolios | Market premium F statistic (P value) | Period of decay (months) |
|---|---|---|---|---|---|
| R_SG | 1.86 (0.04) | 2 | R_36L | 3.36 (0.00) | 3 |
| R_SB | 2.08 (0.02) | 2 | R_36W | 1.64 (0.08) | 4 |
| R_SV | 2.07 (0.02) | 2 | R_39L | 3.36 (0.00) | 3 |
| R_MG | 2.02 (0.02) | 3 | R_39W | 1.64 (0.08) | 4 |
| R_MB | 1.64 (0.08) | 2 | R_63L | 3.27 (0.00) | 3 |
| R_MV | 2.18 (0.01) | 3 | R_63W | 2.02 (0.02) | 3 |
| R_LG | 1.22 (0.27) | 3 | R_66L | 3.27 (0.00) | 3 |
| R_LB | 1.60 (0.10) | 3 | R_66W | 2.01 (0.02) | 3 |
| R_LV | 1.59 (0.10) | 3 | R_93L | 3.37 (0.00) | 3 |
| | | | R_93W | 2.20 (0.01) | 3 |

**Table 2:** Presents the GARCH in Mean tests on portfolio returns. In this table, asset pricing models are regressed with exogenous regressor RVIX in order to appraise whether price discovery models are adequate enough to capture the fluctuations of the market or not

| Double sorted portfolios | GARCH mean coefficients | Momentum portfolios | GARCH mean coefficients |
|---|---|---|---|
| R_SG | –3.42 | R_36L | –30.92 |
| R_SB | 2.99 | R_36W | –30.92 |
| R_SV | 10.12 | R_39L | –0.97 |
| R_MG | 6.77 | R_39W | –0.97 |
| R_MB | –21.58 | R_63L | –0.86 |
| R_MV | –8.34 | R_63W | –15.53 |
| R_LG | 13.50 | R_66L | –0.86 |
| R_LB | –14.80 | R_66W | –15.53 |
| R_LV | –67.94 | R_93L | –6.85 |
| | | R_93W | 32.85 |

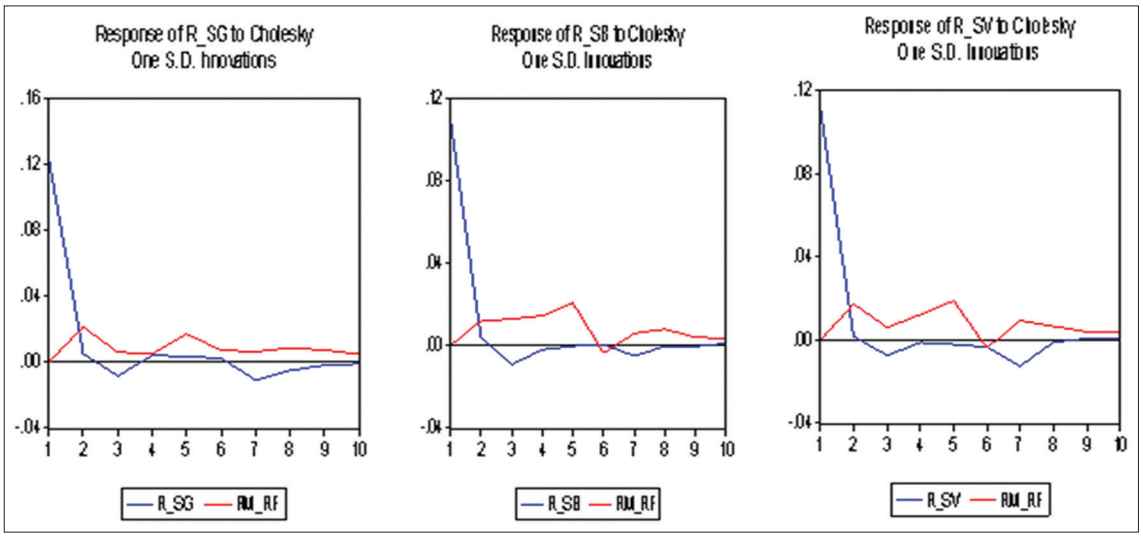


**Figure 1:** Impulse response function of small sized portfolios

indicate that fifty percent double sorted portfolios are having positive GARCH sensitivity coefficients reflecting commensurate risk return trade off in SB, SV, MG, LG portfolios return. Thus, there is growing consensus that these four portfolios are having

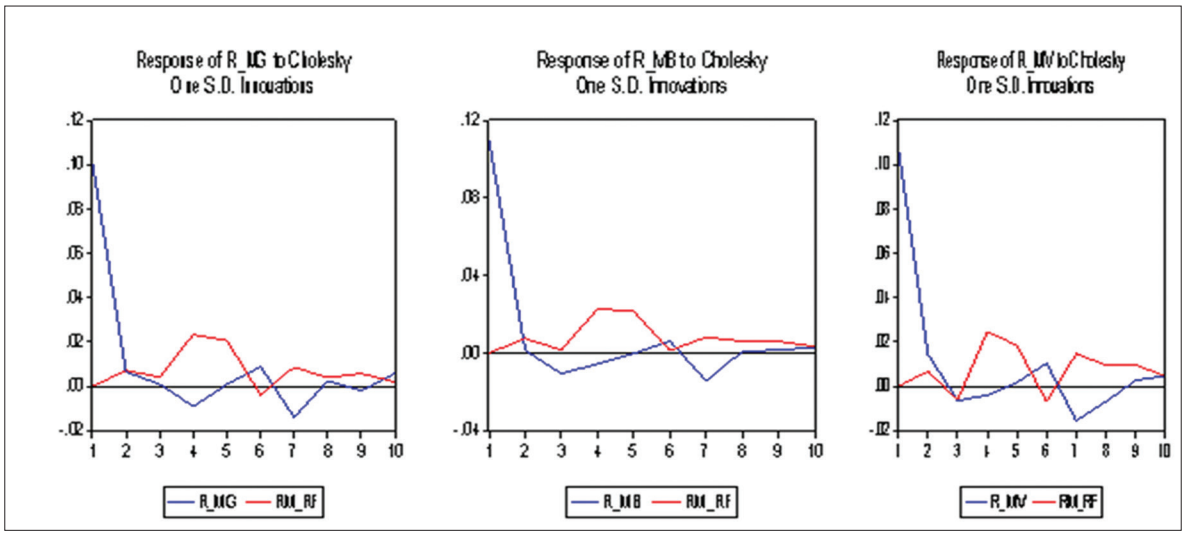


**Figure 2:** Impulse Response Function of Medium Sized Portfolios

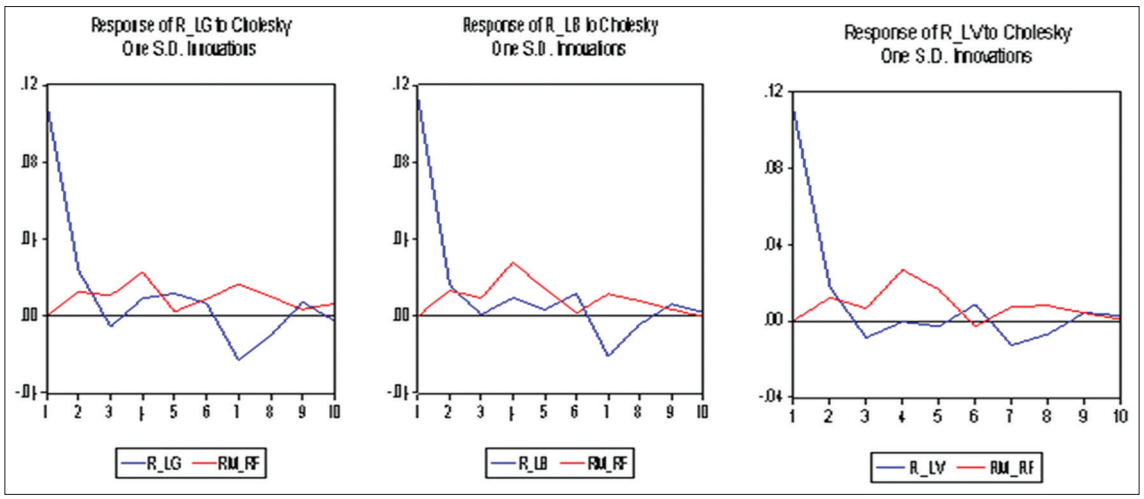


**Figure 3:** Impulse Response Function of Large Sized Portfolios

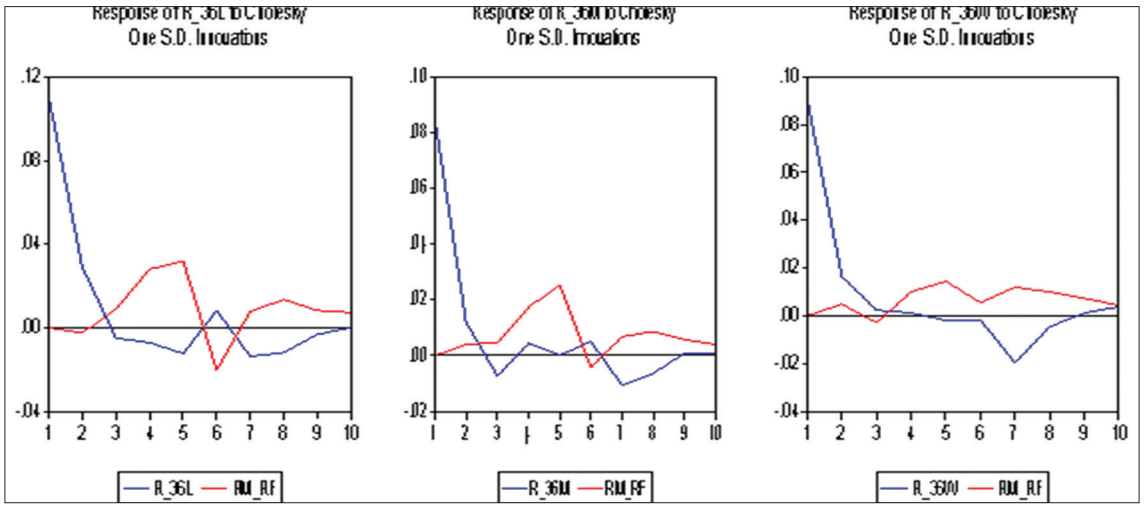


**Figure 4:** Results of Impulse Response Function of Momentum Portfolio 36

better price discovery mechanism as comparing to remaining ones even in volatile market scenario, whereas the momentum portfolios have contrast results reflecting the behavioural biases in the market.

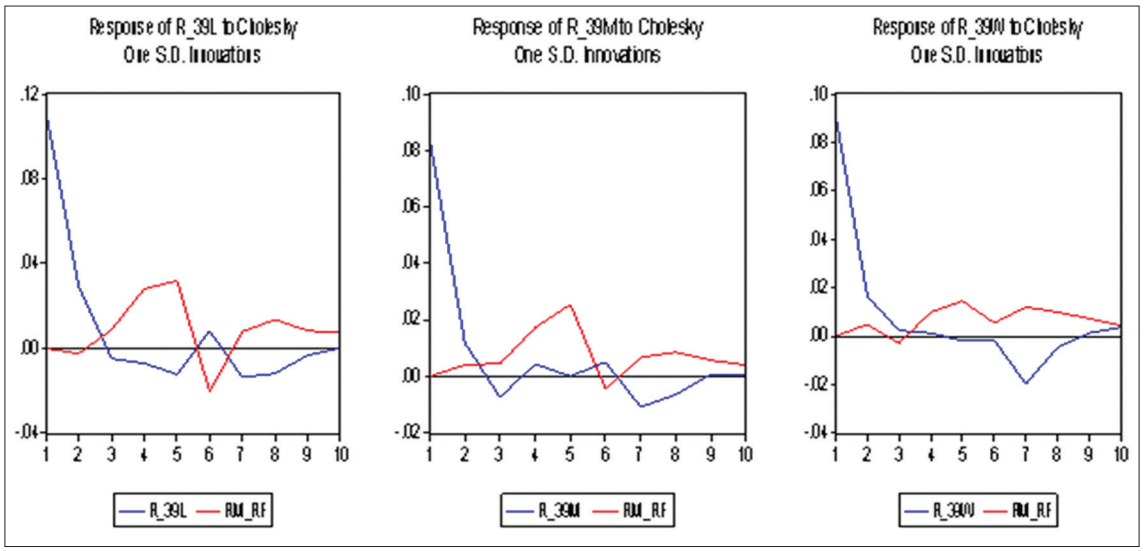


**Figure 5:** Results of Impulse Response Function of Momentum Portfolio 39

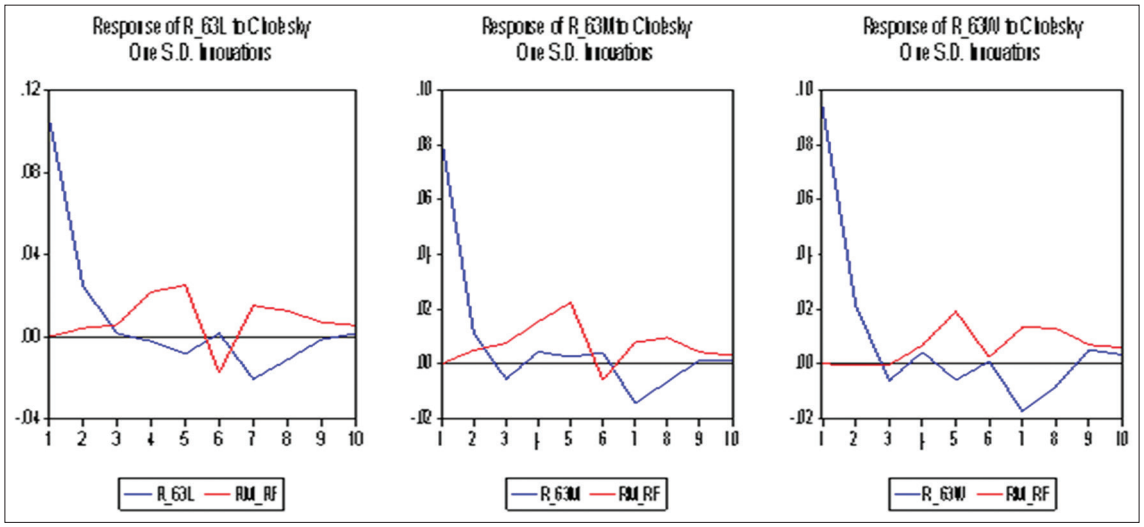


**Figure 6:** Results of Impulse Response Function of Momentum Portfolio 63

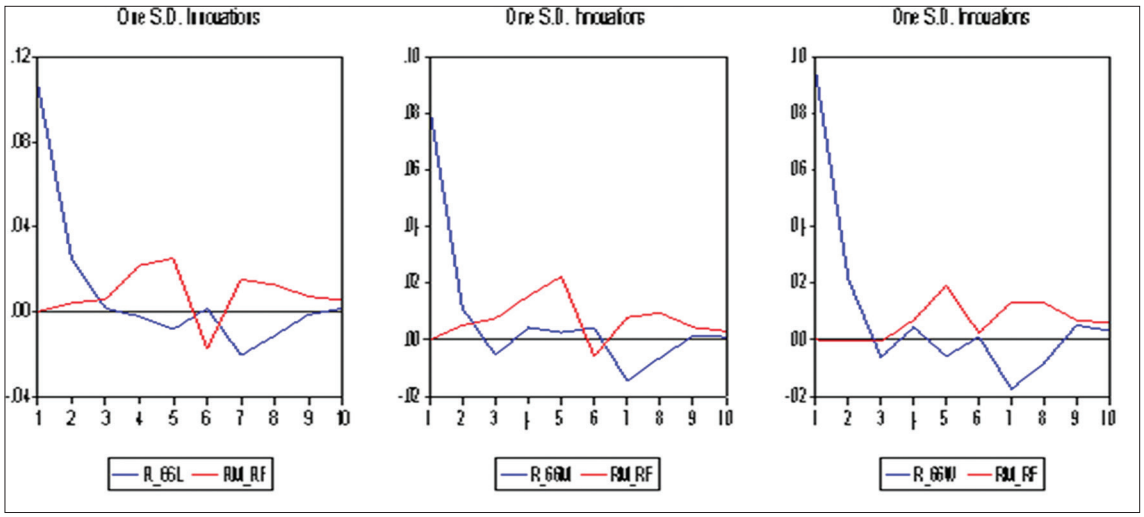


**Figure 7:** Results of Impulse Response Function of Momentum Portfolio 66

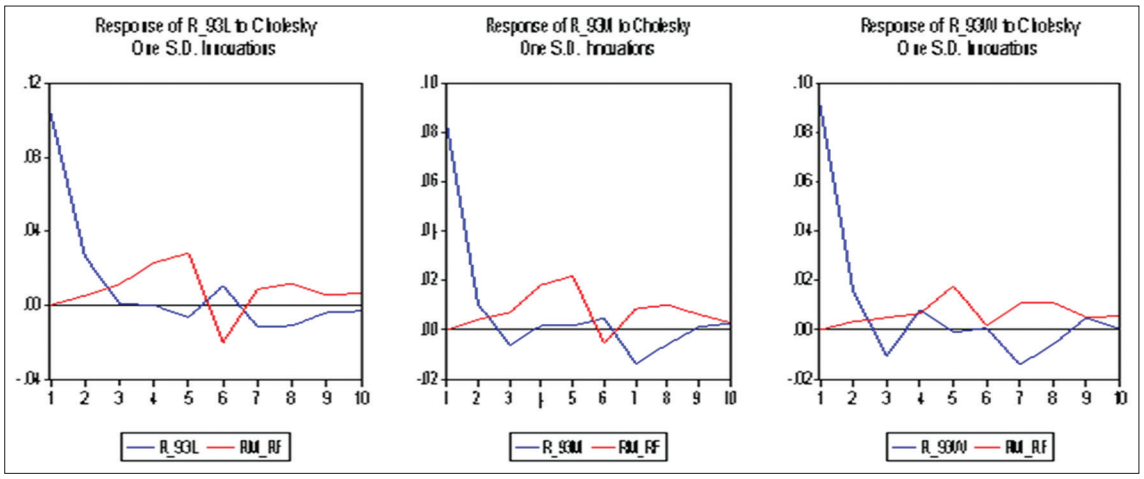


**Figure 8:** Impulse Response Function of Large Sized Portfolios

## 6 CONCLUSIONS AND RECOMMENDATIONS

Findings have revealed that out of five factors, only market premium Granger causes the returns of double sorted portfolios and momentum portfolios at twelve lags. Further shock memory of double sorted portfolios and momentum portfolios are limited to three and four months respectively. The study also concludes that multifactor models are able to ensure adequate risk return trade off in four samples of double sorted and only one sample of momentum portfolios .Momentum portfolios don't lend any support to risk return trade off theory. It seems that behavioural biases of investors are much more prominent in momentum portfolios defying the return generating process in bad days. Size and value sorted portfolios have better conformed to adequate risk return theory.

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