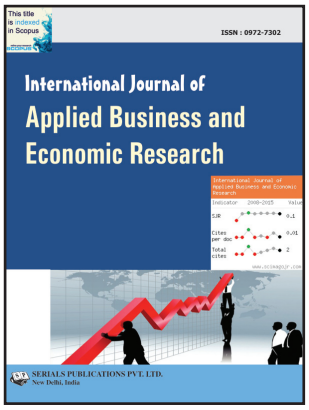


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# Dynamics of Financial Stress and Economic Performance of India

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**ABSTRACT**

After the 2008 credit crisis of US banking industry and financial meltdown of many countries, the importance of financial stress on the real economic system has been recognized as an important research area. There are a growing number of articles surrounding the concept of estimating the financial stress in different markets and also for different countries; however, the studies regarding the dynamics between the financial stress and the macro-economy are very limited. Policymakers have a very limited understanding of the impact of these financial stresses on the country's economic activity and vice versa, assessing this impact is thus a very important topic. The objective of this paper is to analyse the impact of macro-economic performance on the financial stress, understanding the key macro-economic parameters plays an important role because of the positive-feedbackeffect (unstable) between the economic and financial system.

***Keywords:*** Financial stress, financial stability, macro-economy and financial markets.

## 1. INTRODUCTION

Nine years have elapsed since the troubles in the United States sub prime mortgage market erupted in the summer of 2007, which lead to liquidity shortfall in USA banking system. It contributed to the failure of key businesses, declines in consumer wealth estimated in the hundreds of trillions of U.S. dollars, substantial financial commitments incurred by governments, and a significant decline in economic activity.

Financial stress is defined as "the force exerted on economic agents by uncertainty and changing expectations of loss in financial markets and institutions. It is a continuous variable with a spectrum of values, where extreme values are called financial crises". The crises are nothing but the extreme values of the uncertainties or the expected loss in the financial markets, these shocks transmit through the whole economic system, and intern disturbs the financial system, which becomes a positive feedback

system, this causes substantial erosion of wealth and severe decline in the economic activity of the nation.

The financial stress of 2008 pushed the world economy into its most severe recession since the Great Depression. Despite the apparent risk financial stress poses to the real economy, the relationship between financial stress and economic activity is complex and not well understood.

The financial and economic crisis are not infrequent, recent years have been characterized by various episodes of significant financial crises; some important events of financial erosions are Asian crisis, Long Term Capital Management crisis, the high-tech boom and bust of dot com bubble and the 2008 global financial crisis. Many years have passed from the 1991 Asian crisis to 2008 credit crisis but still our minds are filled with fearful memories because of their negative impact on the global financial and economic conditions.

Until the global financial crisis, the majority of macroeconomic forecasting models did not include variables signaling financial market movements such as stock market volatility, capital market spreads, indicators of misalignments in the interbank market. As a consequence, the traditional macroeconomic models significantly underestimated the scope of the global financial crisis and this has focused the recent attention on including financial market variables in these models.

Due to huge financial meltdown, the shock is transmitted across all the financial segments like Stock Market, Bond Market, Forex Market and the Banking system as a whole. The increase in the uncertainties around all the financial markets causes a stress like situation. Stress is defined as the force exerted on economic agents by uncertainty and changing expectations of loss in financial markets and institutions. It is a continuous variable with a spectrum of values, where extreme values are called financial crises (Illing and Liu (2006)).

The financial stress definition clearly says that the crises are nothing but the extreme values of the uncertainties or the expected loss in the financial markets, these shocks transmit through the whole economic system, and intern disturb the financial system, which becomes a positive feedback system, this causes substantial erosion of wealth and severe decline in the economic activity of the nation.

Policymakers have a very limited understanding of the impact of these financial stresses on the country's economic activity, assessing this impact is thus a very important topic (Li and St-Amant (2010)). The objective of this paper is to analyse the impact of macro-economic performance on the financial stress, understanding the key economic parameters is important because of the positive feedback effect between the economic system and financial system.

The paper is arranged as follows, section 2 deals with the literature review on the quantification of stress index and dynamics between financial stress and economic activity, section 3 describes the empirical methodology adopted in the present study, section 4 discuss the results and major findings of the study and section 5discusses conclusions and future scope of work.

## 2. LITERATURE SURVEY

The taxonomy of the literature survey is arranged as follows, the first part of the literature survey is about the quantification or measurement of the financial stress variables, the second part is about the research studies which talk about the interaction of financial stress and the macro-economy globally.

## 2.1. Quantification of Financial Stress

The financial stress has been estimated using many techniques and a variety of variables, the final stress time series is called as the FSI (Financial Stress Index). As mentioned in Illing and Liu (2006), the BCA and Bordo *et. al.*, (2000) styles of FSI fail to capture a large number of stressful events. This is not surprising, since both measures use variables that appear to be more cyclically influenced than event-driven. For example, the BCA's FSI uses consumer confidence, the long-term yield curve, and several debt measures. The Bordo *et. al.*, (2000) style FSI uses bank loan-loss rates and corporate bankruptcies, which tend to lag the economic cycle. On the other hand, nine of the eleven stress measures that are calculated in Illing and Liu (2006) outperform the BCA and Bordo FSI's.

Many of the variables in these stress measures capture extreme movements, usually in market prices, driven by short-term shocks. Most of the standard and refined stress measures capture 75 to 85 per cent of the stressful events highlighted by the survey. The GARCH variable indexes did not perform as well. The factor-analysis weighting technique performs poorly, with high Type I errors.

Illing and Liu (2006) finally concludes that, in terms of best overall performance, the credit-weighted standard-variable index has the lowest Type I error, at 13 per cent, and the lowest Type II error, at 33 per cent. This is one of the simplest indexes to construct of the thirteen considered.

Recently, many central banks are trying to develop their own financial stress index, including more or less the broad variables given by Illing and Liu (2006), most notable among them are St. Louis Federal Reserve Financial Stress Index (STRFSI) for USA, (National Economic Trends, 2010) and Financial Stress Index for India developed by Reserve Bank of India, (Financial Stability Report, 2013). As discussed above, after understanding the financial stress index it is very important to relate it to the macro-economic activity to take strategic policy decisions. The section below covers the interaction of financial stress and economic dynamics.

## 2.2. Financial Stress and Economic Activity

The global financial crisis of 2008-2009 showed that strong increase in financial stress have dramatic effects on the economy. The collapse of Lehman Brothers led to a full-blown systemic crisis in the financial system that triggered the sharpest and severest downturn in economic activity since the Great Depression. In the euro area, this crisis was exacerbated by a sovereign debt crisis, which is associated with a systemic crisis in the euro area banking system.

Beside this very recent evidence from the worldwide financial crisis and the euro area sovereign debt crisis, there is also empirical and theoretical evidence that financial stress leads to widespread financial strains and financial instability, which may cause severe financial crises and recessions in general (Borio and Lowe (2002), Borio and Drehmann (2009), and Bloom (2009)).

Hatzius *et. al.*, (2010) calculate an alternative financial stress indicator using 45 variables to explore the link between financial conditions and economic activity in the United States and show that during most of the past two decades, including the last five years, the indicator exoalined future economic activity better than existing indicators. Their major innovation is that they estimate an unbalanced panel, which makes it possible to calculate the indicator back to 1970.

Ng (2011) examines the predictive power of the indicators developed by Hatzius*et. al.*, (2010), the Basel Committee's Indicator (Bank for International Settlements (2010)), and Domanskiand Ng (2011). He comes to the conclusion that using financial stress indicators as additional predictors improves forecasting U.S. GDP growth performance at horizons of 2 to 4 quarters. Bloom (2009) took a somewhat different approach to explore the link between financial stress and economic activity in the United States by analyzing the impact of uncertainty shocks, measured by the volatility index (VIX) of the S&P500, on industrial production. He uses avector autoregressive model (VAR) and found that the stock market volatility affects industrial production significantly.

Hollo *et. al.*, (2011) develop a composite indicator of systemic stress (CISS) which is thought to measure the current state of financial instability of the financial system in the euro area. They employ a threshold bivariate VAR model including the CISS and industrial production. They show that impact of stress in financial markets depends on the regime, i.e. while the impact of financial stress on economic activity in low-stress regimes is insignificant; the impact in high stress regimes significantly dampens economic activity considerably in the months after the shock.

Mallick and Sousa (2013) use a financial stress indicator in a Bayesian VAR (BVAR) model and a sign-restriction VAR model to examine the real effects of financial stress. They found that unexpected variation in financial stress leads to significant variations in output. Grimaldi (2010) derives a financial stress indicator for the euro area and studies its ability to detect periods of financial stress. She found that the indicator is able to extract information from an otherwise noisy signal and that it can provide richer information than simple measures of volatility.

There are also several articles in the recent literature that deal with various comparable financial stress indicators that can be used across countries. These indicators have been used recently by the IMF to improve the assessment of economi cactivity in the World Economic Outlook (International Monetary Fund(2011)). Matheson (2011), for example, developed the indicators for the United States and the euro area and Unsal *et. al.*, (2011) developed indicators for several Asian countries and Australia. Cardarelli *et. al.*, (2011) use an augmented indicator including more variables from the banking sector and examine why some financial stress periods lead to a downswing in economic activity in 17 advanced economies over 30 years. They found that financial stress often but not always precede a recession.

Bjorn (2012) estimated a financial market stress indicator (FMSI) for Germany using a dynamic approximate factor model and has used TVAR measure to understand the impact of financial stress on the economic activity for Germany. He has found that if the indicator exceeds a certain threshold, an increase in financial stress causes economic activity to decelerate significantly, whereas if it is below this threshold financial stress does not significantly matter for economic activity.

Li and St-Amant (2010) uses the FSI developed by Illing and Liu (2006), they then we use a threshold vector autoregression model to capture asymmetries and regime switching implied by theoretical models. The econometric specification for the threshold vector autoregression model allows the economy to switch between two regimes. The economy is in the high financial stress regime if the financial stress conditions are higher than a threshold value; otherwise it is in the low financial stress regime. The empirical findings of Li and St-Amant (2010)reveal that (i) contractionary monetary shocks typically have a larger effect on output than expansionary monetary shocks; (ii) the effects of large and small shocks are approximately proportional; (iii) expansionary monetary shocks have larger effects on output in the high financial stress

regime than in the low financial stress regime; (iv) large expansionary monetary shocks increase the likelihood of moving to, or remaining in, the low financial stress regime; (v) typically, high financial stress regime has been characterized by weaker output growth, higher inflation, and higher interest rates.

It is has been explained in the literature that the dynamics between financial stress and economic activity is a complex phenomenon, because of this the policy makers have less understanding about policy actions to be taken in the future. This tells that there is great need to understand the policy inputs required at a particular time based on the non-linear behaviour the financial and economic systems.

The review of literature clearly shows that the research studies regarding the estimation of financial stress and the integration of the financial stress with the economic activity is rather scarce in the India context. The aim of the present study is to understand the dynamics of financial stress and economic activity in India.

## 3. RESEARCH METHODOLOGY: EMPIRICAL RESEARCH

### 3.1. Data Requirements

The present research study will be based on financial market data of the four major pillars in the composite financial stress index like stock market index (National Stock Exchange of India, NIFTY index), bond market (Government Securities index), banking (NIFTY Bank index) and forex market (Exchange rate between INR/USD). The data for all the four financial market variables are collected from Bloomberg data base.

To study the interaction between the macro economic variables and financial stress, the following variables are selected, real GDP growth rate, inflation index (WPI), index of industrial production, money supply and RBI repo rates. The macro-economic variables data considered in the present study are also collected from the Bloomberg data base. The present study has consider 13 years of data from 2002-2014 on a quarterly frequency.

### 3.2. Proposed Framework

The present study is divided into two parts, first part deals with the estimation of the financial market stress and the second part deals with the dynamic interaction of the financial stress with the economic activity, the overall framework of the proposed methodology is presented in Figure 1.1.

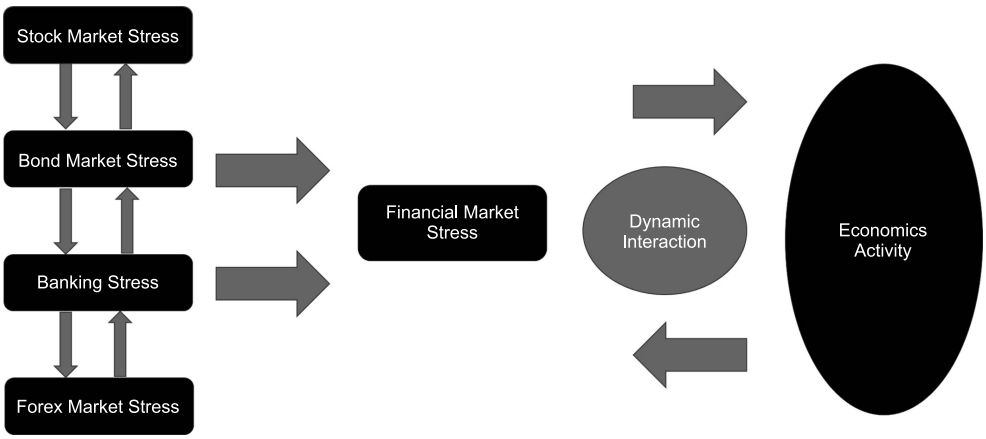


**Figure 1.1: Proposed framework for the dynamics of financial stress and economic activity**

The first phase of the study is to develop an empirical model for the composite financial stress index using the stress proxies of stock, bond, bank and forex markets. The credit weights method will be used for the integration of individual stress components. The weights are based on the market share of each of the four components considered in the financial stress construction. The second phase of the study is to develop an empirical model which captures the dynamics of macroeconomic variables and financial stress.

### 3.3. Data Analysis and Statistical/Mathematical Models

The data collected will be processed using advanced statistical and mathematical techniques. The analysis will be presented in two parts; financial stress index construction and the interaction of stress with the economic activity.

#### *3.3.1. Models for Financial Stress Index Construction*

The financial stress is a composite index constructed from the four market stresses (Stock, Bond, Banking and Forex). To construct the index, the stress in each market is estimated using two methods discussed below;

1. *Historical standard deviation:* The standard deviation of the historical returns is estimated using a rolling window which is detailed in Illing and Liu (2006).
2. *Value at Risk (VaR):* The rolling volatility method calculates the average deviation from the mean, but stress is the extreme event that occurs in the tails of the distribution.

Value at Risk is a statistical technique used to measure and quantify the level of financial risk within a firm or investment portfolio over a specific time frame. Value at risk is used in order to measure and control the level of risk which the firm undertakes.

Value at Risk is measured in three parameters: the amount of potential loss, the probability of that amount of loss, and the time frame. For example, a financial firm may determine that it has a 5% one month value at risk of $100 million. This means that there is a 5% chance that the firm could lose more than $100 million in any given month. Therefore, a $100 million loss should be expected to occur once every 20 months.

Once the individual market stresses are estimated the financial stress index is constructed using the credit weights method which is detailed in Illing and Liu (2006). The credit weights used are stock market capitalization for the stock market stress, total bonds outstanding (both private and government) for the bond market stress, government debt outstanding in dollars for the forex market stress and bank credit for the banking market stress. The sum of weights which is the total credit will be 100%, more the credit level of an individual market more weight age will be given for that particular market stress.

#### *3.3.2. Model for Dynamic Interaction of Financial Stress and Economic Performance*

The dynamic interaction between the financial stress and economic activity is studied using Vector Error Correction model. The VECM allows the flow of information between different interconnected regression models and also considers the interaction of different variables through error correction. The section below discusses the VECM used to model the interaction between financial stress and economic activity.

Suppose that each component of a K-dimensional time-series $y$ is I(1). Then VAR($p$)

$$y_t = \mu + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p}\ t = 1, \ldots, T \qquad (1.1)$$

Equation 1.1 is not appropriate formulation of its model because the terms $y_t, y_{t-1}, \ldots y_{t-p}$ all are nonstationary. However, by substituting,

$$A_1 = I_k + \Gamma_1$$
$$A_i = \Gamma_i - \Gamma_{i-1} i = 1, \ldots, p-1$$
$$A_p = -\Gamma_{p-1}$$

In Equation 1.1, rearranging the terms and using that $\Delta y_i = y_i - y_{i-1}$ for all I, we may rewrite this equation as,

$$\Delta y_t = \mu + \Gamma_! \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + \mu_t \quad (1.2)$$

Naturally, both equations describe the same model, but we prefer to use Equation 1.1 when $y_t$ is I(1), because each term in Equation 1.1 is stationary in this case. So, when $y_t$ is I(1), we may find an appropriate model for $y_t$ by differencing each component of $y_t$ once, and performing the regression based on Equation 1.1.

However, then we have not taken into account that there may be dependencies between some of the components of $y_t$, e.g., two of the components may have a common trend, or there may exist a linear combination of the components of $y_t$ which is stationary. For example, if $y_t$ consists of two interest rates of different maturities, the difference between the two interest rates often is stationary, while each of the interest rates is I(1).This problem is generally solved by including an error correction term $\pi y_{t-1}$ in Equation 1.1 where $\pi$ is a (K × K) matrix which has rank $rk(\pi) < K$, because if $\pi$ has full rank K, then $\pi$ is invertible such that the non-stationary variable $yt_{t-1}$ may be written as a sum of stationary terms by using this equation, which is an inconsistency.

So, $rk(\pi) = r < K$ which implies that there exist $(K \times r)$ – matrices $\alpha$ and $\beta$ of rank $r$ such that $\pi = \alpha\beta'$. Then, each of the $r$ rows of $\beta' y_{t-1}$ is a stationary linear combination of the components of $y_t$, and is called a co-integration relation. The number $r$, which is equal to the number of co-integration relations, is called the co-integration rank. As the matrix $\beta$ contains all the coefficients of the co-integration relations, it is called the co-integration matrix. The matrix $\alpha$ which is the coefficient matrix of the stationary term $\beta' y_{t-1}$ in Equation 1.2 is calling the loading matrix. Thus, we have arrived at the vector error correction mode (VECM):

A VECM of order $p$ is defined by

$$\Delta y_t = \mu + \alpha\beta' y_{t-1} + \Gamma_! \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + \mu_t \, t = 1, \ldots, T \quad (3.3)$$

Where $y_t = [y_{1t}, \ldots, y_{Kt}]'$ is a (K × 1) random vector, $\mu$ is a (K × 1) constant vector, $\alpha$ and $\beta$ $(K \times r)$ matrices such that $rk(\alpha) = rk(\beta) = r$ with $0 < r < K$, the $\Gamma_i$ are fixed (K × K) coefficient matrices, and $u_t$ is a K-dimensional white noise process, i.e. , $E(u_t) = 0$, $E(u_t u_s') = 0$ when $t \neq s$ and $E(u_t u_t') = \Sigma_u$ [] where $\Sigma_u$ [] is non singular.

## 4. RESULTS AND MAJOR FINDINGS

### 4.1. Quantification of Financial Stress Index for India

The financial stress index has been constructed using the credit weights method; this is a weighted summation method which is also called as 100% correlation method. To understand the interaction between economic system and financial system, the economic system is characterized by the macro variables identified in the data section, the financial system is characterized with the financial stress. Since the financial system has

multiple dimensions like the stock, bond, forex and banking systems, the financial stress in all these markets are integrated into one single index called Financial Stress Index (FSI). The present section elaborates the methodology used in constructing the financial stress index and the process of aggregation. Since the data collected for all the macro-economic variables is on a quarterly basis, so the financial stress index have to be calibrated with quarterly dynamics.

The financial stress index or total financial stress is estimated using the quarterly stress data from each individual market. The aggregation of the financial stress is done using the credit weights methods. It is nothing but the simple weighted summation of all the four stress variables into a single index called the FinancialStress Index (FSI). The credit weights used in the present study are the proxies given for each market and the performance of credit weights methods over all other methods like factor analysis have been compared using the Type-I and Type-II errors in the Illing and Liu (2006). Table 1.1 details the credit weight proxies used for the present study.

**Table 1.1**
**Proxies for credit weights**

| *Market* | *Credit Proxy* |
|---|---|
| *Stock* | Stock Market Capitalization |
| *Banking* | Bank Credit |
| *Forex* | Total Government Debt |
| *Bond* | Bond Market Capitalization (Private and Government) |

The credit weights are converted into percentage, which means the weight given by each stress variable tells about the significance, since the credit weights are time varying the aggregation process is updated or re-calibrated every quarter. If a particular country is exposed to a forex market stress for example at a point in time and if the credit weight for the forex market is high at that point, than a huge portion of the FSI will be impacted from the forex market stress. The values of the credit weights for all the four markets are given in Table 1.2, since each weight is in percentage terms, the total weight should be equal to one, which is evident from the last column in the table.

**Table 1.2**
**Credit weights (in percentage terms)**

| *Date* | *Stock Market* | *Banking* | *Forex Market* | *Bond Market* | *Total Weight* |
|---|---|---|---|---|---|
| *2002* | 0.128 | 0.292 | 0.426 | 0.154 | 1.00 |
| *2003* | 0.211 | 0.262 | 0.384 | 0.142 | 1.00 |
| *2004* | 0.239 | 0.256 | 0.371 | 0.134 | 1.00 |
| *2005* | 0.273 | 0.240 | 0.348 | 0.139 | 1.00 |
| *2006* | 0.329 | 0.233 | 0.310 | 0.128 | 1.00 |
| *2007* | 0.454 | 0.188 | 0.244 | 0.114 | 1.00 |
| *2008* | 0.233 | 0.299 | 0.330 | 0.139 | 1.00 |
| *2009* | 0.316 | 0.254 | 0.272 | 0.158 | 1.00 |
| *2010* | 0.339 | 0.257 | 0.257 | 0.147 | 1.00 |
| *2011* | 0.230 | 0.315 | 0.289 | 0.166 | 1.00 |
| *2012* | 0.275 | 0.312 | 0.271 | 0.142 | 1.00 |
| *2013* | 0.267 | 0.322 | 0.280 | 0.132 | 1.00 |

The Standard deviation and Value at Risk approaches are yielding a similar stress pattern, either of these stress indices can be selected for the economic system integration. Figure 1.2 clearly shows that the maximum stress occurred during the 2008-2009 crisis period in India, but the stress has quickly reverted back to the normal stress level during 2011 period.

The Y-axis in Figure 1.2 has been normalized to compare the broad stress patterns using Value at Risk and Standard Deviation. The interpretation for the normalised stress value, using the square root of time for standard deviation, the maximum value of 0.02% per day loss is translated into 32.5% annual loss. This means during the crisis period the maximum loss in a portfolio is around 32% in the Indian financial system. Hypothetically, Nifty at 8000 points can drop to 5440 points during a financial crisis. If the loss is translated to 95% confidence level it will create an annual loss of around 59%.

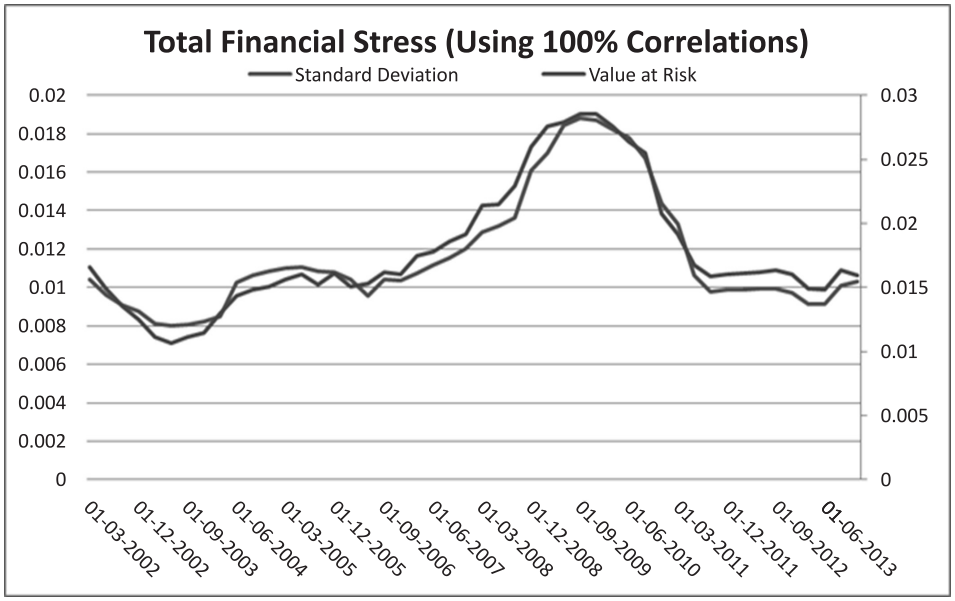


**Figure 1.2: Financial Stress Index using 100% correlation**

## 4.2. Interaction of Financial Stress and Macro-Economy

The dynamics of financial stress tries to understand the evolution of financial stress and the significance of the macro-economic variables in explaining the stress. A two way interaction of the financial stress with the macro-economy has been strongly supported by recent studies as discussed in the literature review section. This paper analyses the impact of macro-economic variables on the financial stress.

A linear Vector Error Correction Model (VECM) with 4 lags has been adopted using the AIC to understand the dynamics of financial stress with the all the macro-economic variables. The regression results in Table 1.3 clearly explain that the financial stress and GDP growth are inversely related and the industrial production is also inversely related. Interest rate and money supply has directly proportional relationship and inversely proportional relationship at different lag lengths. The increase in money supply may slowly build-up stress in the long term, this may be attributed to the valuation problems in the market with excess money available. This correction in the valuation or readjustment of the financial system can be understood as crisis or financial stress in the economy.

The result clearly explains that macro-economic variables along with the auto-regressive terms yielded an R-sqr of 94%. GDP growth is not very significant, means the change in GDP will mildly impact the

financial stress, the increase in GDP during the post crises period may not be related to reducing the financial stress in 2011-2012 periods.

The Industrial production growth is also not significant to understand the financial stress dynamics. Industrial production growth has a negative relationship with the financial stress. Inflation rate is not very significant in determining the financial stress dynamics in India. Interest rate plays a significant role in understanding the financial stress in a county. The 1$^{th}$ lag and 4$^{th}$ lag of the IR is very significant while the second lag has some predictive power with low statistical significance. Money supply rate is very important in understanding the financial stress dynamics; it has significance at different lags, which means the financial stress can be impacted by money supply rate in the short term as well as in the long term.

**Table 1.3**
**Prediction of Financial Stress**

| *Financial Stress Index (Adjusted R – Squared 0.94)* | | | | |
|---|---|---|---|---|
| *Variables* | *Co-efficient* | *Standard Error* | *t-Value* | *P-Value* |
| $GDP_{t-1}$ | –0.09 | 0.08 | 1.07 | 0.29 |
| $IP_{t-1}$ | –0.06 | 0.04 | –1.31 | 0.20 |
| $INF_{t-1}$ | 0.07 | 0.16 | 0.44 | 0.66 |
| $IR_{t-1}$ | –0.60 | 0.43 | –1.83 | 0.07* |
| $MS_{t-1}$ | –0.19 | 0.11 | –1.80 | 0.08** |
| $FS_{t-1}$ | 1.14 | 0.21 | 5.31 | 0.00*** |
| $GDP_{t-2}$ | 0.13 | 0.10 | 1.34 | 0.19 |
| $IP_{t-2}$ | 0.07 | 0.05 | 1.62 | 0.12 |
| $INF_{t-2}$ | 0.14 | 0.14 | 1.03 | 0.31 |
| $IR_{t-2}$ | 0.68 | 0.56 | 1.19 | 0.25 |
| $MS_{t-2}$ | 0.29 | 0.16 | 1.78 | 0.10* |
| $FS_{t-2}$ | –0.32 | 0.33 | –0.98 | 0.34 |
| $GDP_{t-3}$ | –0.15 | 0.10 | –1.47 | 0.16 |
| $IP_{t-3}$ | –0.06 | 0.05 | –1.30 | 0.20 |
| $INF_{t-3}$ | –0.05 | 0.14 | –0.38 | 0.71 |
| $IR_{t-3}$ | –0.65 | 0.58 | –1.13 | 0.27 |
| $MS_{t-3}$ | 0.11 | 0.19 | 0.6 | 0.55 |
| $FS_{t-3}$ | –0.02 | 0.32 | –0.07 | 0.93 |
| $GDP_{t-4}$ | –0.04 | 0.10 | –0.34 | 0.73 |
| $IP_{t-4}$ | 0.13 | 0.06 | 1.92 | 0.06* |
| $INF_{t-4}$ | –0.05 | 0.11 | –0.47 | 0.64 |
| $IR_{t-4}$ | 0.71 | 0.42 | 1.72 | 0.09* |
| $MS_{t-4}$ | –0.15 | 0.16 | –0.95 | 0.35 |
| $FS_{t-4}$ | –0.03 | 0.23 | –0.14 | 0.88 |
| ECT | –0.64 | 0.24 | –1.81 | 0.07* |
| Constant | –0.63 | 2.72 | –0.23 | 0.82 |

Finally money supply plays a very significant role in understanding the stress dynamics; money supply has both short term as well as long term dynamics in predicting the financial stress. In short term the money supply is seen to reduce financial stress and in the long run it may reinforce the financial stress or in other words it may create the collapse of the financial system.

Since most of the macro-economic variables are interrelated, we can understand the groups of macro variables which are important in predicting the financial stress. GDP and Industrial production are related and has mild impact on the financial stress. Inflation rate did not show much significance with 90% confidence level. Interest rates and money supply are related to each other and they have a significant role in predicting the financial stress dynamics.

Recent US financial crisis shows that the collapse of the financial system will impact the economic system is a rapid manner so that the GDP growth will decline very quickly, industrial production will slow down and lot of money has been pulled out of the traditional financial systems like stocks, bonds and currency. The investors look for flight to quality to other markets like bullion and safe commodity markets for a short term escape from the financial system collapse. The money supply has played an important role in building-up this stress and surprisingly monetary authorities have to again fill the money which has been pulled from the market using different QE (Quantitative Easing) programs. The present analysis clearly emphasis and explains what has been observed during the recent financial crisis of US in general and India in particular during 2008 crisis.

The prediction of financial stress using the 4 lag VECM regression is shown in Figure 1.3. The graph clearly shows that the realized and predicted financial stress values are very close to each other with an R-square of 94%. The predicted financial stress is based on 4 auto-regressive lags of the financial stress and the lags of all other variables, in which interest rates and money supply has played an important role. The model accurately predicts the 2004-2005 small raise in the financial stress; it has also accurately predicted increase in financial stress during 2008-2009 periods. The model has also reacted to the down fall of the financial stress immediately after the crisis during 2010 to 2011 periods.

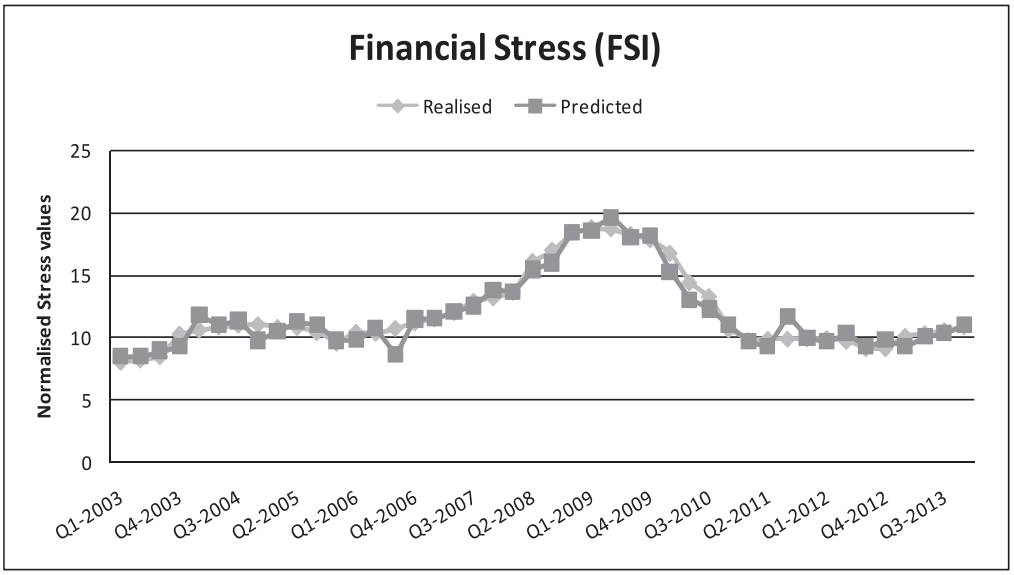


**Figure 1.3: Prediction of Financial Stress using VECM**

### 4.3. Financial Stress Impulse and Economic Activity

The impulse response of financial stress equation on each time series variable considered is analyzed in this section. The impulse is given by one standard deviation to the financial stress equation (around 490 basis points) and the response of the time series variables along 10 quarters has been observed.

The impulse response of financial stress on GDP growth is shown in Figure 1.4. It is clearly seen from the figure that a positive one standard deviation to the financial stress equation (490 basis points) has decreased GDP growth of about negative 60 basis points within three quarters, the negative impact on GDP growth at its lowest level is observed till 5 quarters after the financial shock. After 5 quarters the GDP growth has raised form the negative levels and corrected to almost zero growth or constant growth within 9 quarters of the shock.

The financial shock took one quarter to really impact the GDP growth, it is seen from the impulse response that GDP growth was mildly positive immediately after the financial shock. It took almost three quarter to recognize the complete impact of the financial stress shock on GDP growth. The financial stress shock has strong and negative impact on the GDP growth and can last for more than 2 years in Indian scenario.

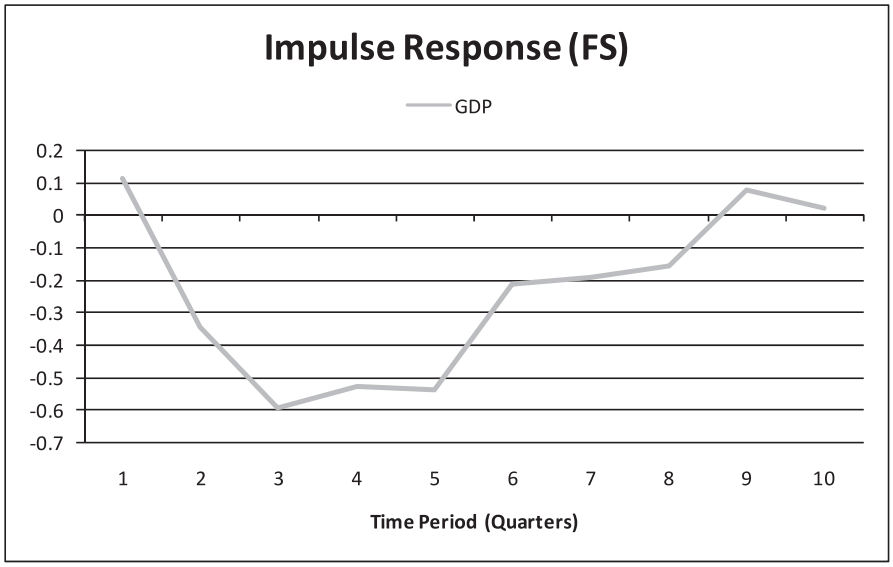


**Figure 1.4: Impulse response of financial stress on GDP growth**

The impulse response of financial stress on industrial production growth is shown in Figure 1.5. It is clearly seen from the figure that a positive one standard deviation to the financial stress equation (490 basis points) has decreased industrial production growth of about negative 140 basis points within three quarters, the negative impact on industrial production growth at its lowest level is observed till 8 quarters after the financial shock. After 8 quarters the industrial production growth has raised form the negative levels and corrected to almost zero growth or constant growth within 10 quarters of the shock.

The financial shock immediately impacted the industrial production growth, it is seen from the impulse response that industrial production growth was strongly negative immediately after the financial shock.

It took almost three quarter to recognize the complete impact of the financial stress shock on industrial production growth. The financial stress shock has very strong and negative impact on the industrial production growth and can last for more than 2 years in Indian scenario.

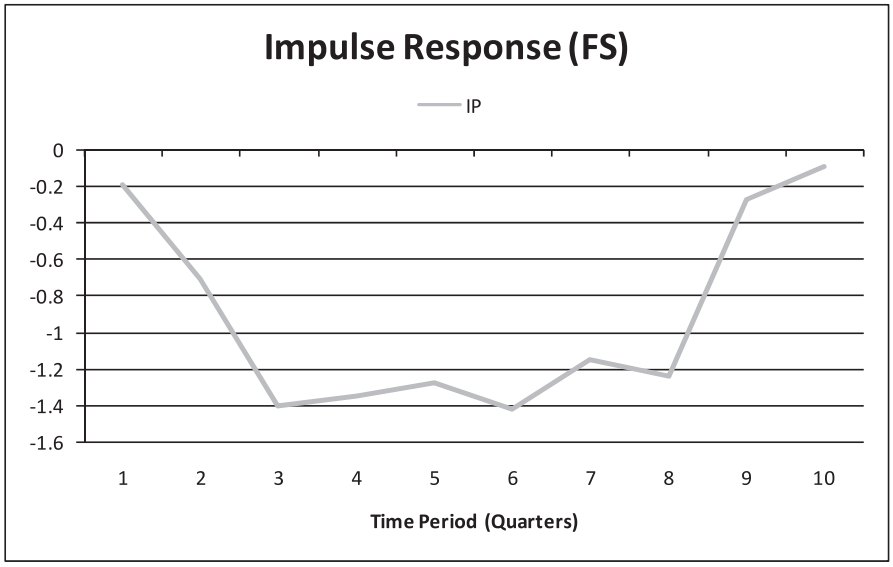


**Figure 1.5: Impulse response of financial stress on IP growth**

The impulse response of financial stress on inflation rate is shown in Figure 1.6. It is clearly seen from the figure that a positive one standard deviation to the financial stress equation (490 basis points) has decreased inflation rate of about negative 12 basis points within one quarter, this may be because the financial shock information took two quarters to really impact the inflation rates. After four quarters the inflation rate raises and reached positive 50 basis points with 6 quarters of the financial shock. The increase in the inflation rates can be attributed to the loss in the industrial production after 3 quarters that can lead to the raise in the inflation rates in India.

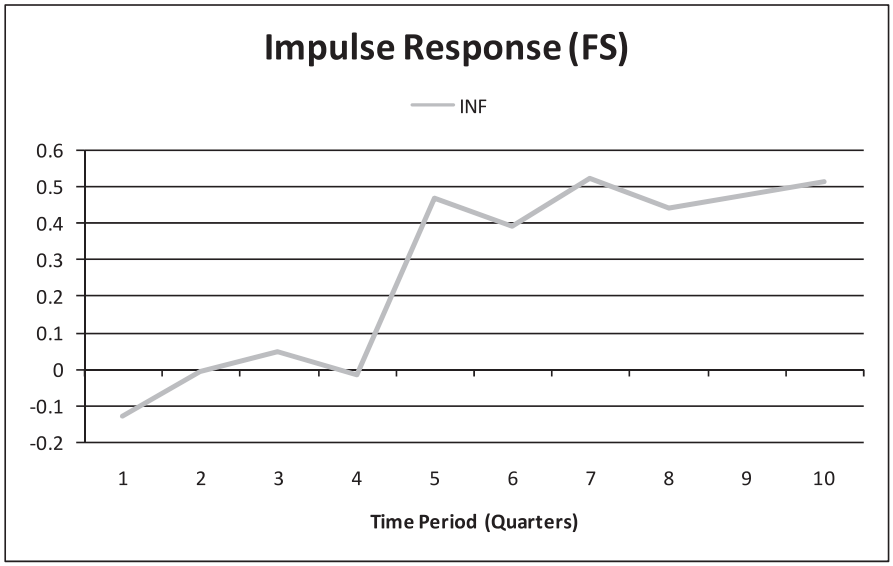


**Figure 1.6: Impulse response of financial stress on Inflation rate**

The inflation rates got saturated after 6 quarters to the 50 basis points level; this is because the industrial production has reached to positive or constant growth levels after 6 quarters. The financial shock took four quarters to really impact the inflation rate, it is seen from the impulse response that inflation rate was mildly negative immediately after the financial shock. It took almost five quarters to recognize the complete impact of the financial stress shock on increasing the inflation rates. The financial stress shock has moderate and positive impact on the inflation rates and can last for more than one year in Indian scenario.

The impulse response of financial stress on interest rate is shown in Figure 1.7. It is clearly seen from the figure that a positive one standard deviation to the financial stress equation (490 basis points) has decreased interest rate of about negative 60 basis points within seven quarters, the negative impact on interest rate at its lowest level is observed till 9 quarters after the financial shock. After 9 quarters the interest rates has raised form the negative levels to moderate negative levels till 10 quarters of the shock.

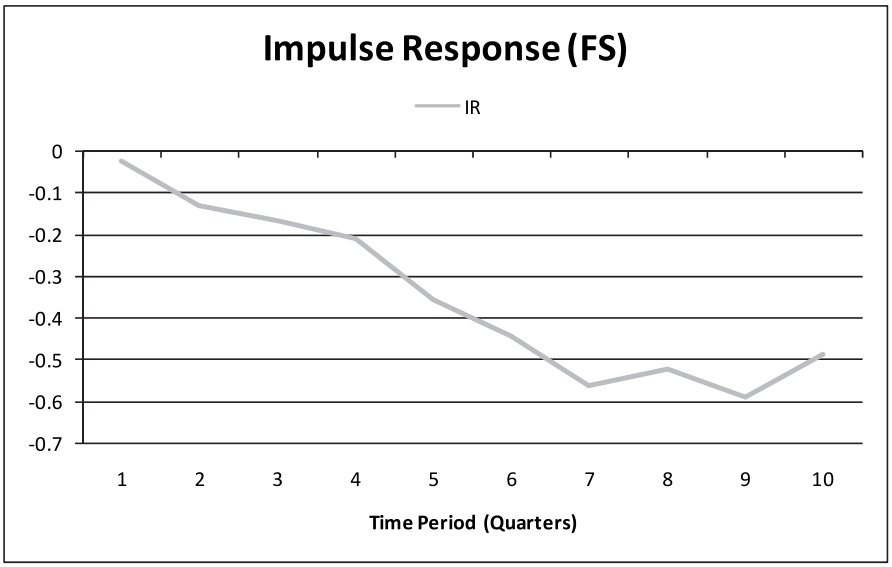


**Figure 1.7: Impulse response of financial stress on interest rates**

The financial shock took seven quarters to really impact the interest rates, it is seen from the impulse response that interest rates was mildly negative immediately after the financial shock. It took almost six quarter to recognize the complete impact of the financial stress shock on interest rates. The reduction in the interest rates may be attributed to the central banks act of reducing interest rates to provide liquidity to the damaged financial system or maintain the low interest rate regime which has really damaged the financial system. The financial stress shock has strong and negative impact on the interest rates and can last for more than 2 to 3 years in Indian scenario.

The impulse response of financial stress on money supply is shown in Figure 1.8. It is clearly seen from the figure that a positive one standard deviation to the financial stress equation (490 basis points) has increased the money supply rate of about positive 50 basis points within two quarters, the positive impact on money supply at its highest level is observed till three quarters after the financial shock. After three quarters the money supply rate has fallen from the positive levels and corrected to almost negative 40 basis points levels within 6 quarters of the shock. After 6 quarters of the shock the money supply rate got saturated and remained at negative 40 basis points.

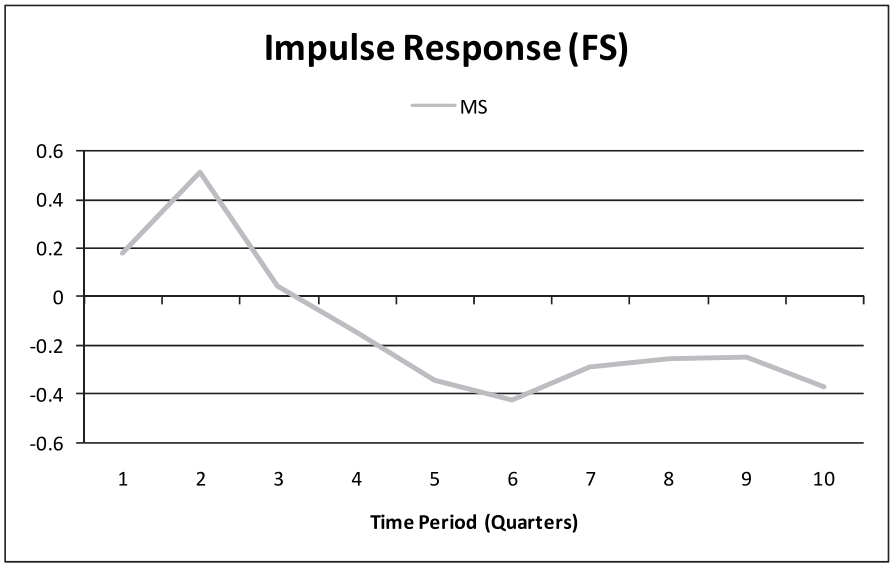


**Figure 1.8: Impulse response of financial stress on money supply rate**

The financial shock took four quarter to really impact the money supply rate, it is seen from the impulse response that money supply rate was moderately positive immediately after the financial shock. It took almost four quarters to recognize the complete impact of the financial stress shock on money supply rate. The financial stress shock has moderate and positive impact on the money supply rate in the short term. The financial stress shock has strong and negative impact on the money supply rate in the long term and can last for more than 2 years in Indian scenario.

## 5. CONCLUSIONS AND FUTURE SCOPE

The present paper discusses the brief summary and important conclusions of the current study. After the 2008 credit crisis of US banking industry and financial meltdown of many countries, the importance of financial stress on the real economic system has been recognized as an important research area. There are a growing number of articles surrounding the concept of estimating the financial stress in different markets and also for different countries; however, the studies regarding the dynamics between the financial stress and the macro-economy are very limited. Recently, central banks of Canada, Germany and USA have recognized the importance of the interaction between the financial stress and economic activity. Similar empirical works in the context of India is rather scarce.

To clearly understand "The financial stress definition says that the crises are nothing but the extreme values of the uncertainties or the expected loss in the financial markets, these shocks transmit through the whole economic system, and intern disturb the financial system, which becomes a positive feedback system, this causes substantial erosion of wealth and severe decline in the economic activity of the nation."

The first phase of the study deals with the development of an empirical model for the composite financial stress index using the stress proxies of stock, bond, bank and forex markets. The credit weights method has been used for the integration of individual stress components. The second phase of the study deals with the development an empirical model which captures the dynamics of macroeconomic variables

and financial stress. The Vector Error Correction (VECM) model with all the macro variables described earlier and financial stress index has been built to study their interaction.

In the later phase the dynamics of financial stress and the impact of macro-economic variables on financial stress variable have been analyzed. The dynamics of financial stress tries to understand the evolution of financial stress and the significance of the macro-economic variables. The impact of financial stress and its relationship to economic system is captured using the Vector Error Correction model. The dynamic impact is studied using the impulse response function of the VECM model.

It has been found that Interest rates and money supply growth plays an important role in predicting the financials stress. GDP growth, Inflation and Industrial production rate are less significant in changing the financial stress.

It is has been found in the present study that the dynamics between financial stress and economic activity is a complex phenomenon, because of this the policy makers have less understanding about policy actions to be taken in the future. This tells that there is great need to understand the policy inputs required at a particular time based on the non-linear behaviour the financial and economic systems.

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