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A VAR Approach to Estimate Financial Conditions Indexes for India

Ammar Hafeez[1], Sujata Kar[2]

Abstract

This paper attempts to construct monthly financial conditions indexes (FCIs) for India using VAR models. The FCIs are expected to reflect financial fragility or soundness of an economy. Two alternative indexes were calculated with data on variables from 6 different markets for a period of 2001:1 – 2016:1. FCI (WPI) was constructed with impulse responses generated through shocks to a real sector variable, WPI inflation, while FCI (NEER) had responses from shocks to nominal effective exchange rate (NEER). The indexes were assessed in terms of their causal relationship with macroeconomic indicators like GDP and IIP growth rates, and directional predictions with respect to financial variables. Strong bi-directional causality was observed between the indexes and the macroeconomic indicators while good directional predictions were obtained against only SENSEX and NEER, and percentage changes in them. More specifically, FCI (WPI) recorded very good co-movements with respect to SENSEX.

Keywords: *Financial Conditions Index, Granger Causality Test, Impulse Responses, Vector Autoregressive Model.*

Introduction

The world in the past decade and a half has witnessed a number of crises resulting in the hardship of the economies to flourish. Economies that were predicted to be the front-runners in setting up the pace of the world economies have been held back directly or indirectly. In this scenario, the advanced economies have been hoping for the emerging economies to come forward and make their mark while the emerging economies are short of a meaningful direction. During the past 15 years, the world economies have experienced 60 percent of the crises it faced in the whole of the 19th century. Logically, all the advances in the technology should have helped to resolve these types of crises. This period of uncertainty or to be precise information asymmetry hinders the growth of the world as a whole.

[1] **Corresponding author. Research Scholar, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand. Email: ammarhafeez@gmail.com**

[2] **Assistant Professor, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand.**

The crisis period as defined by Hakkio and Keeton (2009) is characterized by at least one of the five circumstances: uncertainty over the fundamental value of financial assets, uncertainty over other investors' behavior, information asymmetries, substantial increase in the demand for assets with very low liquidity (flight to quality) and substantial increase in the demand for assets with very good liquidity (flight to liquidity). However, these distressed events on a macro level could take different forms like speculative bubbles, credit crisis, currency crisis, banking crisis, etc. Understandably, the absence of financial crises does not imply that a country has not been subjected to financial stress in the past, or that accumulated financial imbalances would not result in financial crises in the future. From both a theoretical and an empirical perspective, the financial conditions prevailing in an economy should be under continuous monitoring. With this purpose, the developed economies started estimating an index, called the monetary conditions index. From the beginning of the 21st century, the index was broadened with the inclusion of macroeconomic variables in its construction and was consequently termed as financial conditions index (FCI).

Thus, an FCI is an index depicting the current state of the economy with an ability to forecast the immediate future conditions as well. It reflects the policies of the Central bank. The FCI poses to be a superior indicator of the prevailing financial conditions compared to each of its variables considered individually.

In the words of Hatzius et al. (2010), an FCI is said to summarize information about the future state of the economy contained in current financial variables. Ideally, an FCI should measure the impact of financial shocks, i.e. exogenous shifts in financial conditions that influence or otherwise predict future economic activity.

A financial conditions index attempts to bridge the divide between the state of financial markets and the real economic activity. It summarizes the current state of financial variables which are linked to the real economic activity. Financial variables which influence economic activity contain information about and are also assumed to affect the future state of economic activity. Thus, FCI is a summary indicator based on current financial variables that should, to some extent, be able to presage the future state of economic activity (M. Debuque-Gonzales and M. Socorro Gochoco-Bautista, 2013).

This study focuses on estimation of an FCI in the Indian context. The importance of constructing an FCI for India lies in the fact that the country continues to progress at a five-year average growth rate of 7.6 percent. Sound monetary policies combined with pragmatic fiscal decisions have

ensured the stability of the country's growth. A recent research at Harvard University predicted that India could have the world's highest growth rate over the next decade. These predictions place the country on the next level. To maintain this solidity in the minds of the investors, information asymmetry has to be minimized. Therefore, there arises a need to assess, monitor and report the economic conditions of the country on a regular basis, for providing information both to its ultimate users and policy makers. In the said direction, this paper makes an effort to develop an index for measuring the financial conditions of India. Hence, the two main objectives of the paper are

1. To construct alternative FCIs for India,
2. To assess the validity of the FCIs following certain benchmark practices from the literature.

The paper is organized as follows. Section 2 provides a review of the literature on FCIs. Section 3 describes the research methodology used in this paper. In Section 4, results and analysis are presented. Section 5 concludes the paper.

2. Literature review

The concept of FCI was preceded by a similar yet more conservative concept of the Monetary Conditions Index (MCI) in the 1990s in the developed nations. Later MCIs were broadened, revised and replaced by FCI which gained prominence in the 21st century and specifically after the global financial crisis of 2007-09. In a similar fashion, in India also the RBI first constructed MCIs, though they were not published. Later, works on the estimation of FCI were published by RBI as well as a few individual academics. The literature on FCI can be categorized into studies conducted in the international context and in the Indian context. However, some of the international studies also included India as part of a group of countries to compare the performance of FCIs across them.

Studies conducted in the International Context

Goodhart and Hofmann (2001) constructed two alternative sets of FCI. The first one was based on the reduced form aggregate demand equations and the second one on VAR impulse responses. They were constructed for the G7 countries using quarterly data for the period from 1973 to 1998. A high correlation was reported between the VAR-based FCI and future inflation. The VAR-based FCI peaked at an earlier quarter than the FCI based on the reduced form estimates. The Granger Causality test results suggested that the lagged values of the FCI were quite helpful to predict current CPI

inflation. Also, in-sample and out-of-sample predictions were obtained. It was reported that the FCI based on the reduced form estimates had better out-of-sample performance than the FCI based on the VAR impulse responses. However, the out-of-sample forecasting performance of the FCIs was disappointing. As an additional in-sample exercise, bivariate VAR models were estimated with CPI inflation and each of the two FCIs. Impulse Responses were generated with respect to CPI Inflation with a lag order of 5. Impulse responses were strong and highly significant for both the FCIs.

Mayes and Viren (2001) constructed an FCI using IS curve approach and studied its relationship with house and stock prices. Monthly data on the short-term interest rate, exchange rate, stock market price index and house prices for the period of 1985 to 2000 were considered for the analysis. Results revealed that asset prices, in particular house and stock prices, provided useful indications of future changes in output and inflation.

Gauthier et al. (2003) constructed eight FCIs for Canada based on 3 approaches- An IS curve based model, Generalized Impulse response function from a VAR and Factor Analysis. For all the three methods, the same set of variables having monthly data spanning from 1981 to 2000 were used. The data were detrended using two alternative methods, namely HP filter and first differencing, on the assumption that the data had deterministic and stochastic trends, respectively. The FCIs were judged on six performance parameters, namely, estimated weights of its components, graphical presentation and dynamic correlation versus the output gap, dynamic correlation with year-on-year core inflation as well as it's in and out-of-sample performance in a simple forecasting exercise. Out of a total of eight FCIs, two of them performed well following all six parameters. They were the Summarized Coefficient IS based FCI (for predicting near-term output growth) and the Impulsive response based FCI (for predicting long-term output growth); both constructed using first differenced data.

Beaton et al. (2009) constructed two quarterly FCIs for the United States. The first one called SFCI (SVECM based FCI) used data ranging from 1982 to 2009. The other one, MFCI (MUSE BASED FCI), applied large-scale macroeconomic model and used data period of 1994-2009. The paper proposed to estimate the effects of current and past shocks to financial variables on US GDP growth. The authors found that both the SFCI and the MFCI were correlated to quarterly annualized real GDP growth. Additionally, the correlation between the FCIs was 0.77. SFCI was found to be more volatile. Most important variable in both the models was financial wealth (derived from the Federal Reserve's flow of funds accounts). A survey measure as a

means of robustness check was conducted. The FCIs were successfully able to match the stress events highlighted in the survey results.

Hatzius et al (2010) explored the predictive power and the linkages between the financial conditions and economic activity in the United States. Quarterly data on 45 variables between 1970 and 2005 were used to construct a financial condition index following the principal component analysis. The author initially gauged the predictive power of FCIs with single variable financial indicators through in-sample and out-of-sample predictions (Bernanke, 1990). A broad stock market index was identified to be a key predictor over the next 2-4 quarters. Some of the FCIs outperformed the stock market single predictor while some couldn't. The results revealed that the relative predictive performance of the FCI was unstable over time.

Brave and Butters (2011) focused on the construction of high-frequency weekly indexes to gauge financial stability and to forecast economic activities over short and medium horizons. A total of 100 indicators consisting of 47 weekly, 29 monthly and 24 quarterly variables was taken for the period of 1971-2009 and aggregated through the principal component analysis. The forecasting framework of Hatzius et al. (ibid.) suggested construction of an adjusted FCI to isolate the source of the shock to the financial conditions. The standardized residuals obtained from the regression of all the 100 variables on current and lagged values of Chicago Fed National Activity Index and three-month total inflation was used to construct the adjusted FCI. To forecast economic conditions, FCI residual was also constructed. It focused on that portion of the adjusted FCI which was not explained by its historical dynamics in order to forecast future economic activities better. Results revealed that the FCI and the adjusted FCI combined could serve as useful policy tools as it revealed how tight or easy were the operating conditions of the financial markets relative to historical norms.

Osorio et al. (2011) constructed FCIs for a group of 13 Asian economies (Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand and Taiwan Province of China) based on two approaches. The first FCI was based on quarterly data between 1990 and 2010 and followed VAR approach. The second FCI was based on monthly data spanning from 2000 to 2011 and followed generalized dynamic factor modeling. The work examined the evolution of financial conditions in Asia and the impact of such developments on GDP. The authors also aimed to identify the leading indicator for both the FCIs. Results through both in-sample and out-of-sample tests revealed that the financial conditions in Asia tightened substantially earlier in the global crisis.

While the FCIs constructed proved to have comparable performance, their combination turned out to have better predictive power in forecasting GDP. The Leading indicator for both the FCIs was found to be significant.

Debuque-Golzales and Gochoco-Bautista (2013) developed individual FCIs for five Asian economies, namely Hong Kong, China, Japan, Republic of South Korea, Malaysia, and Singapore. Factor analysis was applied to quarterly data ranging from 1970 to 2011. Results showed that the FCIs captured both crisis episodes and periods of relative financial stability quite well. To assess their predictive power, comparisons with single financial indicators were done on the lines of Bernanke (ibid.). Higher frequency FCI could be constructed only for two countries, namely, Japan and Republic of South Korea, due to the availability of relevant data. Results showed that the FCIs tend to convey accurate signals about the future state of the economy.

Lu et al (2013) constructed two financial conditions indexes for Poland for the period 2004 to 2013. Factor analysis and VAR modeling were the approaches adopted. The authors found a high correlation between the FCIs and GDP growth. The in-sample test suggested that the forecasting power of the FCIs' was stronger than the composite leading indicator (CLI) of the OECD. Results for the out-of-sample forecasting were reasonable. The models were estimated with data up to 2009 and out-of-sample forecasts were generated for the sub-sample of 2010-12. Then root mean squared errors (RMSE) were obtained to assess the forecast performance. The two alternative estimates of FCI registered a high correlation of 0.78 between each other.

Charleroy and Stemmer (2014) developed an FCI for the BRICS nations using monthly variables for the period from 2001 to 2013. Five-year rolling window VAR model featuring short term Cholesky decomposition for variable ordering was used to simulate shocks on each financial variable under study. The robustness of the results was confirmed through Granger Causality test, out-of-sample forecasting exercises, and the Diebold-Mariano test. The FCI captured both domestic developments and global spillover effects. Granger Causality tests yielded a significant relationship between the FCI and the GDP. The correlation of the FCI with GDP in out-of-sample forecasts was higher as compared to the previous works by Swiston (2008), Beaton et al (2009) and Lu et al (ibid.). Finally, the results from Diebold-Mariano test further confirmed that the differences in MAE and RMSE values with respect to FCI and the leading indicator were significant.

Wacker et al. (2014) developed FCIs for three Industrialized (US, Japan, UK) and five Emerging economies (Brazil, Russia, India, China, Turkey)

using Principal Component Analysis. Quarterly data starting from 1997 till 2012 was used. To assess the forecasting performance, relative root mean squared error (RRMSE) as used for the out-of-sample and rolling window forecast. The RRMSE's results were reasonable enough with respect to the first quarter only. Thus, it was concluded that the FCI performed well in forecasting over shorter horizons for major non-Euro area economies.

Studies conducted in the Indian Context

The level of integration of the Indian financial system with the global financial system is still weak enough for India to experience a full-fledged financial crisis-like situation. Even when the developed nations were reeling under the 2007-09 global financial crisis with delayed recovery processes for nearly half a decade, India experienced only a slowdown in its growth rates with sporadic volatility or uncertainty in some segments of its financial markets. Such a scenario would not really suggest the need for construction of financial condition indexes for India. However, the scenario is changing fast with the pro-industry and pro-business policies of the current government, along with a faster pace of the liberalization process. Additionally, the persistent vulnerability of some of the Asian and some European economies constantly signal for remaining alerted, specifically with respect to the financial markets. Consequently, from 2010 onwards the need for a financial condition index drew the attention of academic as well as policy makers.

Premsingh (2010) constructed an FCI as a single point indicator reflecting India's financial condition. The work aimed to assess the relationship between FCI and a few economic indicators, namely, GDP, IIP, and interest rate (repo and reverse repo both). Monthly data for the period of 2004-2009 was used. Call rates, USD/INR exchange rate, and SENSEX were standardized using base year conversion, with 2005 as the base year and aggregated into a single index through the weighted index approach. The highest weight was accorded to exchange rates, succeeded by equity prices and interest rates, respectively. The results revealed that the FCI and GDP moved in tandem with each other and that FCI was able to predict the trend of GDP. With reference to IIP and FCI, there were low correlation and the predictive strength was also weak compared to that of GDP and FCI. The FCI also had bi-directional causality with respect to the repo rates, but no significant relationship was found with the reverse repo rates.

Roy et al. (2014) developed a Financial Conditions Composite Indicator (FCCI) to find the leading indicator of the Indian economy. Variables were

taken from the money market, FOREX market, bond market, and equity market. The study employed monthly data from 2004 to 2014. Variables were first standardized using the Cumulative Distribution Function and then aggregated into a single FCCI through the principal components approach. Further, the threshold value of the FCI was estimated using the Kernel Density approach. To validate results, an opinion survey of experts' was conducted. Results indicated that the month of October 2008 was the most stressful period for the Indian economy. The 3 main leading indicators were aggregate deposits, assets with banks and net foreign exchange assets. The threshold value for FCCI at 90th and 95th percentile levels stood at 1.04 and 1.51 respectively. Further, the opinion survey method confirmed that the stressful events were well captured by the FCCI.

Shankar (2014) constructed an FCI to reduce information asymmetry and to assess the relationship between the FCI and the real economic activity. Monthly variables for the period of 2004 to 2013 were used. They were standardized using Z-Scores and individual indices were constructed which represented each segment of the markets selected. Principal component analysis was then applied to aggregate them into a single index. The index showed that tight financial conditions in one market could offset accommodative conditions in some other market. Therefore, it was recommended to account for financial conditions in all markets simultaneously in the conduct of policy. Also, the general direction of movements in aggregate FCI and growth rates in IIP and GDP was quite similar. It was concluded that periods of high stress were followed by low growth in IIP and GDP.

A joint study by IBA and CII (2015) constructed an FCI for India based on a Financial Conditions Expectation Survey, a quarterly survey of major banks and financial institutions on their expectations of key financial and economic variables. 4 sub-indexes with equal weights were formed namely cost of funds index, funding liquidity index, external financial linkages index and economic activity index. A total of 47 banks and financial institutions participated in the survey. Individually, the cost of funds index recorded the highest weighted average value of 83.0 implying that the respondents expected both the short term and the long term cost of funds to ease in the April-June quarter. The funding liquidity index stood at 78.8 signifying the respondents' confidence in the RBI to continue to manage the liquidity effectively. At 65.4, the external financial linkages index was the lowest among the four sub-indices. Though, contrary to its weighted average value, respondents expected no major threat from the anticipated hike by the US Fed in the interest rate. Last, the economic activity index observed a value

of 69.1 depicting a mixed performance across the selected macroeconomic indicators. Also, while the foreign banks were most optimistic about improvements in the financial conditions, the NBFC's were the most conservative. The aggregate value of the financial conditions index was reported to be 74.1 for the April-June 2015 period resembling the positive outlook of the respondents overall.

The above discussion shows that the studies conducted in the Indian context so far have considered only principal component analysis, opinion survey and weighted averaging methods of index construction. This paper considers more advanced methods, namely VAR models for estimating FCIs for the Indian economy. Validating an index for its effectiveness and usefulness is rather more difficult and to some extent gets impacted by subjectivity. Nevertheless, some standard practices of examining directional causality and graphical proximity with important macroeconomic variables have been considered to assess the usefulness of the indexes constructed. The methods employed and the data used are discussed in the following section.

Methodology

Data

Taking cue from the literature, first of all, the important markets and the variables from each market were identified. Based on that, the study considered monthly data for the period January 2001 to January 2016 on fourteen variables presented in Table 1. The variables were selected from six different sectors or markets. However, depending on the availability of data on monthly frequency, the correlation among the variables and a particular variable's significance in the VAR model, the final models used to construct FCIs considered only nine variables. They are marked with asterisks in Table 1.Besides, quarterly estimates of GDP at current market prices (with 2004-05 base) and monthly IIP (2004-05 base) were considered as macroeconomic indicators for assessing whether the FCIs' are able to reflect macroeconomic vulnerabilities linked to financial weaknesses or not. All the data were collected from various online sources, including the statistics published by the RBI, Indiastat, Economic and Political Weekly and World Bank.

Table 1: Variables Selected.

Market	Variable
Stock Market	Stock Market Capitalization
	SENSEX*
	Foreign Institutional Investment(FII)
Debt Market	10-year government bond yield*
Foreign Exchange Market	Nominal Effective Exchange rate(NEER)*
	Real Effective Exchange rate(REER)
	Foreign Exchange Reserves*
Money Market	3-month T-bill rate*
Macroeconomic Indicators	WPI Inflation*
	External Commercial Borrowings
	Trade Balance*
Banking Sector	Call Rate*
	Bank Rate*
	Repo Rate

Prior to estimating the models, the data was checked for the presence of unit root using the ADF test. The works of Guichard and Turner (2008) and Swiston (2008) was followed in deriving FCIs fromVAR models of the following form:

$$X_t = A_0 + \sum A_i X_{t-i} + \varepsilon_t$$

where X is a vector of endogenous variables, A_0 is a vector of constants, A_i is the matrix of the coefficients, and ε is the vector of error terms. Endogenous variables include the nine final selected variables listed in Table 1.

Vector autoregressive (VAR) model considers variables as endogenous, which allows for dynamic developments between the variables. The advantages with VAR models are that it doesn't require fulfillment of any Gaussian assumptions. The model remains free from any form of

Table 2: ADF Unit Root Test Results

Variable	ADF Statistics
SENSEX	-4.470040
10 year Govt. Bond Yield	-3.541464
Bank Rate	-6.236012
Call Rate	-4.635904
NEER	-3.537157
Foreign Exchange Reserves	-3.998586
3 month T-Bill Rate	-3.537260
WPI Inflation	-10.20053
Trade Balance	-6.291548
Monthly IIP growth rate (y-o-y)	-4.82008*
Monthly IIP growth rate (month averages)	-12.8954*
Quarterly GDP growth rate	-7.13548

The VAR model was estimated with the 9 variables to check the VAR stability condition through the AR root table and also to determine the optimum lag length to be taken. The VAR stability condition confirmed that no root lied outside the unit circle. For the choice of lag length, all three criteria, namely AIC (Akaike Information Criterion), SBC (Schwarz Bayesian Criterion), and HQC (Hannan Quine Information Criterion) suggested an optimum lag length of 2.

The variables were ordered using the Cholesky Decomposition i.e. with respect to decreasing sluggishness. Cholesky Decomposition determines the position of a variable according to the degree of responsiveness to shocks in other variables, moving from exogenous variables to endogenous variables. The 20 months averaged impulse responses recorded from the variables are listed below in Table 3.

specification bias. Weights are not rigid and are based on the importance of the variables to the economy at a certain time period. Hence, the model allows representing enough dynamism symmetric to the changes in the real economic environment.

The VAR models are further used to generate impulse responses through simulated shocks to the dependent variables and the resultant responses of the endogenous variables are recorded. Because of their relatively better correlations with all the variables, WPI inflation (real sector variable) and NEER (financial sector variable) were selected as the dependent variables to generate impulse responses. The FCI generated using alternative sets of impulse responses by WPI inflation and NEER would be referred to as FCI (WPI) and FCI (NEER), respectively hereafter.

The FCIs were estimated using the following formula

$$FCI = \Sigma\, w_i (a_{it} - \bar{a}_{it})$$

where, w_i = weight given to variable *i.*

a_{it} = value of variable *i* at *t*.

$\bar{a}_{it}$ = long-run trend of variable *i* at *t*.

The weights are obtained from 20-month averages of the impulse responses generated by each variable. Table 3 provides the long run trend of a variable which has been calculated using 12-month moving averages.[3]

Results and Analysis

Unit Root Test Results

The variables were checked for the presence of unit root through ADF tests. The ADF critical value at 5 percent level of significance is -3.43. All the nine variables used in the calculation of FCI were found to be stationary at their level. However, of the three macroeconomic indicators considered for Granger causality tests, monthly IIP growth rates, both y-o-y as well as month averages, were non-stationary at their level. They were found to be stationary at first differences and are marked with asterisks. The results are presented in Table 2.

[3] **Long run trend of a variable was also calculated using the Hodrick-Prescott (HP) filter. However, for almost all the variables the trend adjusted series exhibited very high volatility and substantial deviations from the original series for the later periods starting from 2012 onwards, which also had its impact on the FCIs. Therefore, 12-month moving average was preferred over HP filter for construction of the indexes.**

- Goodness-of-fit measures namely PDPC (percentage of the directional predictions that are correct).

The Granger-causality test results, for variables having only a significant relationship are reported in Table 4. It is evident from the results that FCI (WPI) has significant bi-directional causality with respect to quarterly GDP growth rate. Additionally, one-period lagged GDP growth rate has predictive content for FCI (WPI). This implies that though not directly incorporated into the index calculation, the index is well formulated to reflect macroeconomic fluctuations as a contemporaneous as well as a lead indicator. Further, the index's repercussions are reflected in contemporaneous GDP growth rate. On the other hand, FCI (NEER) was found to have a similar causal relationship with the IIP growth rate, both impacting each other. However, the causal relationships between FCI (WPI) and IIP growth rate, and FCI (NEER) and GDP growth rate, were unidirectional running only from the macroeconomic variables to the indexes.

Table 4: Granger Causality Results

FCI (WPI)	GDP growth rate
FCI (WPI)	1 period lagged GDP growth rate
FCI (WPI)	y-o-y IIP growth rate
FCI (NEER)	GDP growth rate
FCI (NEER)	1 period lagged month average IIP growth rate
FCI (NEER)	Month average IIP growth rate
FCI (NEER)	y-o-y IIP growth rate

Note: A→B denotes causality running from variable A to variable B; ↔ denotes bidirectional causality.

Next, we plotted the FCIs against GDP and IIP growth rates. Some basic statistical features of the FCIs, as well as the IIP and GDP growth rate, are mentioned in Table 5. The statistics reveal that the FCIs are characterized by very high volatility compared to the macroeconomic indicators. Therefore, plotting these series on the same plane required certain data adjustment in order to ensure visible compatibility between them. This adjustment was done only to track co-movements between various series and not for any statistical calculation.

Table 3: Average Values of Impulse Responses

	With Respect to WPI Inflation	With Respect to NEER
Variables	**Average IR**	**Average IR**
WPI Inflation	0.67	-4.44
10 Year Govt. Bond Yield	-0.06	-1.68
Call Rate	-0.10	-0.77
3-Month T-Bill Rate	-0.10	-11.01
FOREX Reserves	-0.01	-4.23
NEER	0.00	13.21
SENSEX	-0.05	0.28
Trade Balance	-0.02	9.34
Bank Rate	-0.05	-7.51

These impulse responses represent the weights assigned to different variables in the index construction process. As evident from Table 3, the impulse responses generated by a shock given to WPI Inflation dry out quickly, whereas the impulse responses generated by a shock given to NEER have a longer stay over the undertaken period. Consequently, FCI (WPI) turned out to be a much less volatile series compared to the FCI (NEER); refer to Table 5. This might be because of the fact that the former is estimated with impulse responses generated through shocks given to a real sector variable; hence, the impulse responses were very weak. On the other hand, NEER being a financial variable generated a much stronger response from other closely associated financial market variables.

With the stated procedure, we estimated two alternative FCIs, namely FCI (WPI) and FCI (NEER). The usefulness of these FCIs in terms of their ability to act as a leading indicator of financial conditions and as well as of the overall macroeconomic situation was assessed using the following criteria:

- Granger-Causality test with respect to macroeconomic indicators like GDP growth rate and IIP growth rate,
- Graphical presentations of various series against the FCIs to examine the proximity between them, and

Table 5: Statistical Properties of FCIs and Macroeconomic Indicators

Variables	Minimum	Maximum	Mean	Standard Deviation
FCI (WPI)	-1865.76	2037.92	36.15	604.37
FCI (NEER)	-5566.01	4883.32	-267.77	1673.20
Y-o-y IIP growth rate	-7.24	19.97	6.39	5.66
Month average IIP growth rate	-14.26	14.94	0.68	5.67
GDP growth rate	-1.69	5.04	1.76	1.15

First, to plot FCI (WPI) against GDP growth rate, the latter was adjusted for mean by subtracting the mean from individual values while the FCI series was adjusted for the standard deviation (SD) because of its very high volatility. FCI (WPI) was plotted against both current as well as one period lagged GDP growth rate. It was observed that FCI (WPI) moved in close alignment with one period lagged GDP growth rate, depicted in Figure 1, specifically till Q2 2010. From 2011 onwards fluctuations in GDP growth rate subsided, while FCI remained more volatile. Second, in order to plot FCI (WPI) against IIP growth rate, the former was simply divided by 100 while the latter was adjusted for mean only. Further, plotting monthly data for a period of nearly sixteen years could not reflect on any co-movements between the series with clarity. Therefore, we plotted them in two panels in Figure 2 where the upper panel covers the data period from 2001 to 2007, prior to the Global Financial Crisis, and the lower panel presents data for the later period, that is 2008 until January 2016.

Figure 1. FCI (WPI) against 1-Period Lagged GDP Growth Rate

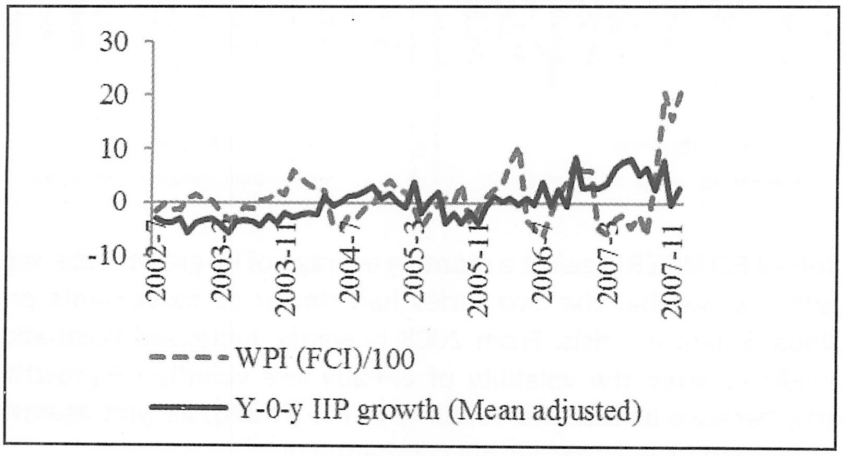
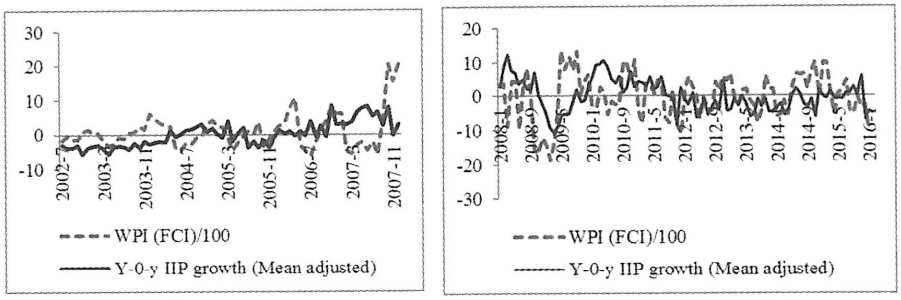
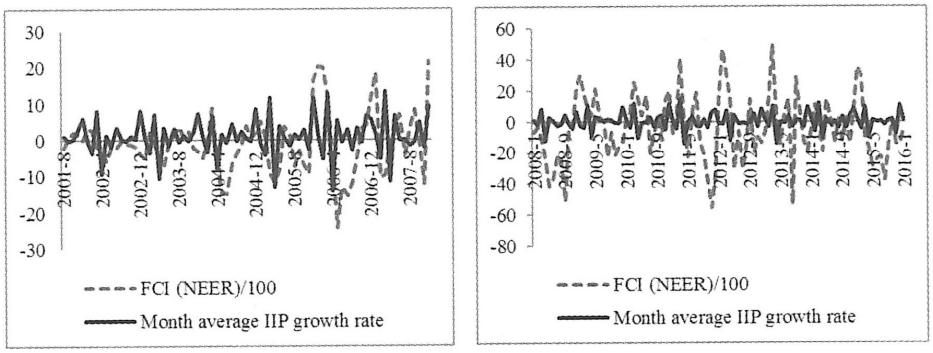


Figure 2. FCI (WPI) against y-o-y IIP Growth Rate



Both the panels show significant co-movements between the series, specifically in terms of the broad pattern of fluctuations between the series. For instance, between 2002 - 06 and again 2011 - 14, the patterns of volatility in the two series matched closely with each other. It should be noted that the period between 2007 and 2010 contained the Global financial crisis when the financial markets of global leading economies almost collapsed. During this period, India's financial markets received its impact from late 2008 onwards while the real sector took even longer to react and recede. Our estimated FCI (WPI) designed to capture fluctuations in the financial market tend to exhibit greater volatility much ahead of fluctuations recorded in IIP growth rates. This may also imply that growth rates in IIP fail to act as a predictor of financial conditions during turbulent economic times.

Figure 3. FCI (NEER) against Month Average IIP Growth Rate



The plots of FCI (NEER) against a monthly average of IIP growth rate depicted in Figure 3 show that the two series had similar co-movements prior to the Global Financial Crisis. From 2008 onwards, increased fluctuations in FCI (NEER) dwarfed the volatility of already less volatile IIP growth rate. Similarly, because of extreme volatility in FCI (NEER), its plot against GDP growth rate didn't yield any visible compatibility.

Next, plotting the FCIs against the financial variables was considered. Noteworthy co-movements were found between

(i) FCI (NEER) and annualized percentage changes in NEER, and

(ii) FCI (NEER) and mean adjusted percentage change SENSEX for the period 2010 - 16.

These graphs are shown in Figure 4 and 5, respectively. The volatility in percentage change in NEER increased after 2007 as evident from Figure 4. Consequently, FCI (NEER) was found to be more volatile from 2007 onwards. On the contrary, SENSEX was highly volatile compared to FCI (NEER) during the initial period. As a result, the two series drifted substantially from each other till 2009, despite being adjusted for mean and/or standard deviation. For the later period, increased fluctuations in the FCI (NEER) resonated well with market sentiment represented by the percentage change in SENSEX.

Figure 4. FCI (NEER) against Percentage Change in NEER

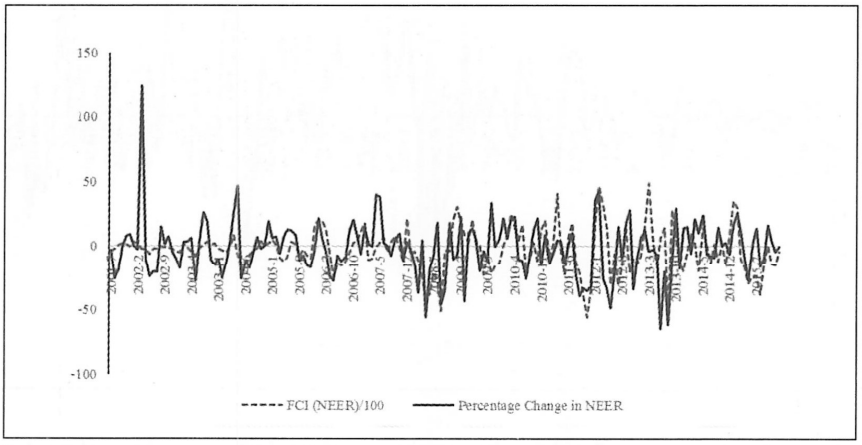
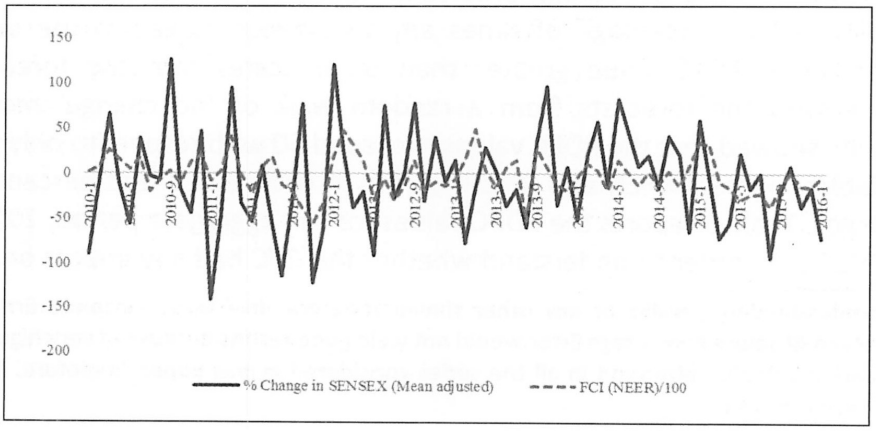
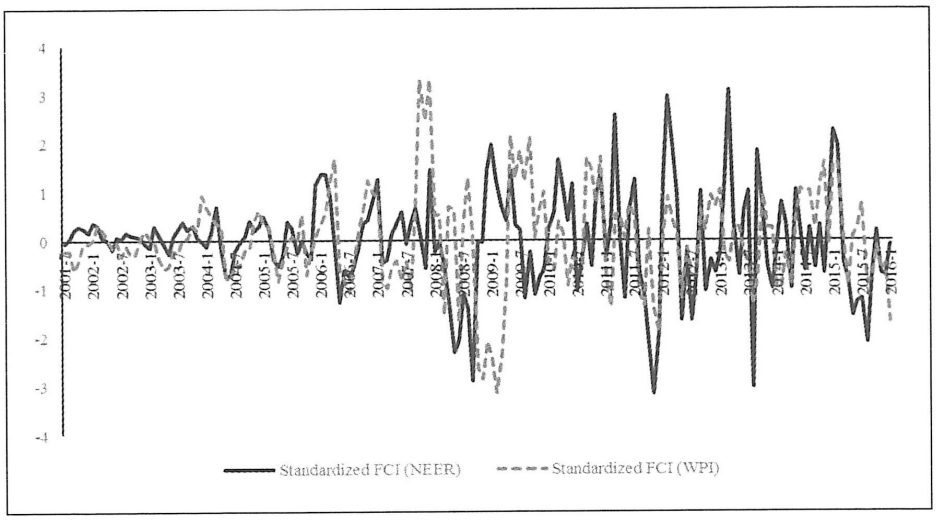


Figure 5. FCI (NEER) against Mean Adjusted Percentage Change in SENSEX



Additionally, a graphical analysis between the two FCIs was performed. As stated above in Table 5, the two FCIs had huge differences in terms of their minimum, maximum, mean values and standard deviation. Therefore, in order to capture a snapshot of the two series, we first standardized them. The plots are given in Figure 6 below. Interestingly, both FCIs moved closely with each other till 2007 and started drifting away gradually with increased fluctuations thereafter. This seems to support the proposition that with the onset of the Global Financial Crisis (GFC) of 2007-09, the real and the financial sectors in India responded differently in terms of magnitude and intensity. However, this also becomes evident that though not devastating, but the GFC had an impact on the structure of the Indian economy as well.

Figure 6. Standardized FCIs



Now in order to quantify the observations that followed from the graphs presented above, we considered a goodness-of-fit measure, namely percentage of the directional predictions that are correct (PDPC).[4] PDPC calculates the percentage of times any two series moved in the same direction. A PDPC value greater than 50 indicates that the forecasts outperform the forecasts from a random walk or 'no change' model. Results showed that the PDPC values exceeded 50 with respect to only two variables, namely NEER and SENSEX, both in their levels and percentage changes. Table 6 reports the PDPC values for the aggregate period, 2001:7 to 2016:1. In order to understand whether the GFC had any impact on the

[4] **Understandably, RMSE or any other similar measures like Mean Absolute Error or Mean Absolute Percentage Error would not yield good results because of very high and varied volatility observed in all the series considered in this paper. Therefore, PDPC was preferred.**

co-movements between these series, PDPC values were also calculated for various sub-periods, like the period that preceded the onset of the GFC (2001:7 – 2007:12) and the period after that (2008:12 – 2016:1) along with the period during which India received the maximum impact of the GFC (2008:1 – 2009:12).

The results suggested that both the FCIs have good directional co-movements with respect to SENSEX and percentage changes in it. Specifically, movements in FCI (WPI) and SENSEX had very high directional similarity at 83, which was nearly uniform for the sub-periods as well. Further, the PDPC value between them was as high as 96.3 percent for the two-year period of 2008-09. Between FCI (WPI) and the percentage change in SENSEX, the PDPC value increased from 68.8 percent (for first sub-period) to 82.3 percent (for second sub-period). Here also it was noted that the PDPC value was even higher at 87.5 percent for the two periods of financial turmoil, spanning between 2008 and 2009. With respect to FCI (WPI) and NEER, the co-movements have been the weakest (below 50 percent). FCI (WPI) does not seem to have strong co-movements with respect to the percentage change in NEER either.

On the other hand, FCI (NEER) was found to have directional co-movements in the range of 63 to 66 percent against all the variables barring NEER. Further, with respect to the percentage change in NEER and percentage change in SENSEX, the PDPC values corresponding to the second sub-period improved only moderately while during the period of turmoil the co-movements rather declined compared to the whole period.

Table 6: PDPC Values

Variables	PDPC
FCI (WPI) and Percentage change in NEER	56.3
FCI (WPI) and SENSEX	83.3
FCI (WPI) and Percentage change in SENSEX	76.4
FCI (NEER) and NEER	55.2
FCI (NEER) and Percentage change in NEER	64.9
FCI (NEER) and SENSEX	63.2
FCI (NEER) and Percentage change in SENSEX	65.5
FCI (NEER) and FCI (WPI)	63.8

Note: The results reported here pertain to the aggregate period i.e. 2001:7 – 2016-1.

Additionally, a comparison between the two FCIs indicated reasonable directional co-movements between the two series which remained almost the same for the sub-periods as well as for the entire period.

Overall, the above discussion suggests that the estimated FCIs have statistically significant causal relationship with real sector macroeconomic variables. However, these series appeared graphically closer only till the end of 2007 i.e. prior to the GFC's impact reached the Indian economy. On the contrary, with respect to the financial variables, like NEER and SENSEX, better directional co-movements were observed for the period after the onset of the GFC. While the Indian financial market responded promptly to the breakdown of the US financial markets, the real sector responded to the GFC with a lag of nearly 2-3 years when exports started receding leaving its impact on industrial production and income. Consequently, the FCIs based on a handful of financial variables should ideally track the movements in the financial sector better while the real sector lags behind. Therefore, the graphical representation depicted that an increase in the volatility of the financial variables in the post-crisis period was reflected well in the FCIs. Broadly, it appears that our estimated FCIs could track the pulse of the financial market even during the times when markets were destabilized by external factors as well as during the times of gradual stabilization.

Conclusion

Increased global interconnectedness of financial markets and the consequent increased vulnerabilities of the financial systems have made it pertinent to examine and monitor financial conditions of economies on a regular basis. It has also become a common practice to construct and observe financial conditions index in a number of developed economies. The present study aimed to construct financial condition indexes for India. Financial variables and macroeconomic indicators selected as representative of various market segments were combined into an index using Vector Autoregressive Model. Variable selection, as well as time duration chosen for the study, was restricted by non-availability of data. The research work has its novelty in the adoption of the VAR approach in the Indian context. Two alternative FCIs were developed; one based on a real sector variable, namely WPI Inflation

and the other one based on financial sector variable, NEER. The FCI (NEER) reported stronger impulse responses as compared to the FCI (WPI); much to the fact that NEER being a financial variable was closely associated with the other financial market variables.

The study was extended by examining the relationship between the FCIs and macroeconomic variables, namely GDP growth rate and IIP growth rate through Granger Causality test and graphs. While FCI (WPI) had a stronger causal relationship with GDP growth, FCI (NEER) had it with IIP growth. Graphically, FCI (WPI) moved in close tandem with GDP growth as well as IIP growth, specifically prior to the impact of GFC reached India in 2008. Similarly, FCI (NEER) and IIP growth rate had visible proximity in their movements till 2008 while, FCI (NEER) and GDP growth rate did not show any compatibility.

With respect to the financial variables, only FCI (NEER) showed some visible compatibility against percentage changes in NEER and SENSEX. SENSEX being a high mean and high standard deviation series (mean = 13785.94, standard deviation = 7642.37) would not show any graphical proximity with either of the FCIs. However, PDPC values showed strong co-movements between FCI (WPI) and SENSEX as well as percentage changes in SENSEX. This grew even stronger during the period of 2008-10 when Indian financial markets received the maximum impact of the GFC. FCI (NEER) had only reasonable co-movements with SENSEX and percentage changes in both SENSEX and NEER. Therefore, it might be concluded that if financial conditions are broadly reflected in the fluctuations in SENSEX, then our estimated FCI (WPI) could be a good representative measure of financial conditions, even during periods of economic turmoil. Additionally, it has the advantage of having significant bi-directional causality with GDP growth, the most commonly used macroeconomic indicator. Thus, FCI (WPI) is also expected to capture the impact of the financial sector volatility on the real economy and also receive the impact of the real economic activities, contemporaneously as well as with a lag.

FCI (NEER) also turned out to be useful in terms of having strong bi-directional causality with IIP growth rates, an alternative macroeconomic indicator of the growth in the real sector. However, since directional predictions were

only moderate between FCI (NEER) and the financial variables, FCI (WPI) would be a preferred index as a measure of financial conditions.

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