

Measure of Financial Market Stress for Pakistan

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1. Introduction

The persistence of global financial and economic crisis of 2008-09 has compelled the policy makers to analyze the behavior of financial variables before making policy decisions. This trend has also motivated many researchers, particularly at central banks, to identify and develop some sort of composite indicator to measure the level of stress in financial markets.

Pakistan's financial sector has witnessed several reforms during the past two decades. These reforms have also paved the way for the enhancement of financial market activities, particularly during the last two decades. Development of bond market, deepening of secondary market trading, gradual liberalization of capital and foreign exchange markets are some of the broad reforms which have increased the role and impact of financial variables in economic decisions.

In this backdrop, we develop a composite indicator to measure financial market stress for Pakistan. The index tries to capture the stress coming from money market, foreign exchange market and equity market based on daily observations. The constructed index captures quite well all the known periods of stress like situations in Pakistan's financial market during the selected sample period. Importantly, from the policy perspective, and to keep it simple, few definitions are suggested to identify moderate or highly stressful periods based on index values.

The rest of the note is organized as follows. The next section briefly discusses the available literature on the construction of financial stress indicators. The third section identifies some major differences between financial stress and financial condition indices; another important concept that emerged during the recent global financial crisis. The fourth section describes the construction and development of the financial stress indicator for Pakistan. The fifth section makes the concluding remarks.

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2. What is Financial Stress and how it can be Measured? A Brief Literature Review

In simple words, as suggested by Hakkio and Keeton (2009), financial stress can be defined as an interruption of normal functioning of financial markets at any given point in time. However, literature is still missing in terms of identifying any single consensus definition of financial stress as many researchers have also provided other definitions as well. Illing and Liu (2006) discuss stress in the financial system in terms of a shock that may have negative effects on the real economy. Balakrishnan et al. (2009) define financial stress as a period when the financial system is strained and its capacity to fulfill its intermediation function is impaired. Moreover, they identify the signs of stress such as financial turmoil, exchange rates pressure along with depreciation and depletion of foreign reserves, dwindling capital inflows, withdrawals from emerging economy equity and debt funds, and scaling back of bank lending.

The selection of variables and methodology to measure financial stress also differs across different researchers. Table 1 summarizes the selected research on this issue.

Table 1: Selected Literature Review on the Construction of Financial Stress Indices (FSI)

Authors Country	Variables (Frequency)	Methodology	Evaluation method
Hanschel and Monnin (2005) - Switzerland	Stock price index, yield spread, interbank deposits, return on assets, variations in bank capital, provision rate, and assets of the banking system. (Quarterly)	Variance-equal weight approach	The identification of stress periods was based on known facts and the index constructed was compared with these periods of high stress.
Illing and Liu (2006) – Canada	Banking sector beta ² , exchange rate volatility, corporate bond spread, funding risk premium, bid-ask spread, yield spread, and stock prices volatility. (Daily)	Principal component analysis (PCA), credit weights, variance-equal approach, simple CDFs	An event was characterized as highly stressful if the index was above a two standard deviation threshold.
Cardarelli et al. (2009) – 17 advanced economies	Yield spread, TED spread, banking sector beta, corporate bond spread, stock market returns, stock prices volatility, and volatility in NEER. (Quarterly)	Variance-equal weight approach	Episodes of financial stress are identified as those periods where the index is greater than one standard deviation from its trend.
Grimaldi (2010) – Euro area	Corporate bond spread, Sovereign bond spread, bank stock prices, earnings per share, TED spread, implied stock prices volatility, and expected interest rates. (Weekly)	Logit mode	The index was compared with the implied volatility VSTOXX index in order to assess its signal/noise content.

² Banking sector beta is generally defined as a measure of risk. It combines the volatility of bank shares and their correlation with the equity markets. The higher beta indicates the higher cost of equity.

Authors Country	Variables (Frequency)	Methodology	Evaluation method
Hakkio and Keeton (2009) - US	TED spread, swap spread, treasury spread, corporate bond spread, corporate premium, junk bond spread, ABS risk premium, stocks and treasury correlations, stock prices implied volatility, VIX, and returns on bank stocks. (Daily, Monthly, Quarterly)	PCA	The index was compared to known periods of financial stress.
Duca and Peltonen (2011) – 10 advanced and 18 emerging economies	TED spread, stock prices returns, stock prices volatility, volatility in NEER, and volatility in short-term yield of government paper. (Quarterly)	Simple average of the transformed variables range from 0 to 3.	The index was compared to known periods of financial stress.
Morales and Estrada (2010) – Colombia	Return on assets, bank deposits, liquidity spread, and banks provision of losses. (Monthly)	PCA, variance-equal weight approach, qualitative response approach	The index was compared to known periods of financial stress.
Park and Mercado (2013) – 15 advanced and 25 emerging economies	Banking sector beta, exchange market pressure index, stock prices volatility, and sovereign bond spread. (Monthly)	PCA, variance-equal weight approach	Episodes of financial stress are identified when the index exceeds its long-run trend by one point for the summed variance-equal weights and half point for the PCA.
Louzis and Vouldis (2013) – Greece	Sovereign bond spread, yield realized volatility, correlation between stock prices, banking sector beta, realized volatility of bank stock index, bank bond spread, deposit gap, loan gap, interest margin, stock prices volatility, and TED spread. (Monthly)	PCA, portfolio based approach	The index was compared to known periods of financial stress.

3. What is the Difference between Financial Stress and Financial Condition Indices?

In the wake of recent global financial crisis, parallel to financial stress indicators (FSIs), many researchers (both from academia and policy circles) have also put their efforts in measuring the impact of unconventional policies on overall economy. For this purpose, most of them relied on developing another composite index, known as Financial Conditions Index (FCI). Although, in an event of any negative shock to the economy, both FSIs and FCIs are expected to move together,³ however, they still have some differences, particularly in terms of variables selection.³

³ For details, see Hatzius et al. (2010) and Kliesen et al. (2012)

Broadly, FCIs measure financial shocks, exogenous shifts in financial conditions that influence or otherwise predict future economic activity. The selection of financial variables in FCIs, hence, reflects their relationships with the economic growth of a country. Furthermore, FCIs tend to contain quantities, prices, and other macroeconomic indicators. Importantly, FCIs can be used to gauge central bank's monetary policy stance and can also be used to predict economic business cycles [Hakkio and Keeton (2009)].

FSI, on the other hand, primarily reflects the behavior of financial market participants through changes in prices. Since participants of financial markets are generally forward looking, hence any erratic movements in FSIs indicate the increase in likelihood of a crisis or default like situation. Importantly, unlike FCIs, FSIs are always viewed as having negative implication for the financial system. Furthermore, the inclusion of macroeconomic indicators in FCIs restrict them to be evaluated in certain longer term perspective. In contrast, the prompt availability of FSIs variables makes them helpful for the policymakers to identify not only the level of stress but also the sources of stress in the financial markets in real-time.

4. Financial Stress Index (FSI) for Pakistan

Before going into details about the variables and methodology used to construct the FSI, it is pertinent to highlight some important stylized facts about Pakistan's financial sector;⁴

- With average share of 88 percent in the total assets of the financial sector during the last 15 years, banks are unarguably the dominant player of Pakistan's financial market.
- Furthermore, out of total assets of the banking system, 44 percent of the assets are concentrated in government securities by the end of December 2015.⁵
- Up till the end of FY15, government has issued 99 percent of the total outstanding domestic debt securities, which indicates almost non-existence of corporate debt market in Pakistan.
- While the daily average trading volume in domestic market (including repo and outright transactions) stands at Rs90 billion, the daily average volume in foreign exchange market (including ready, swap and forward transactions) is around US\$1.0 billion in recent years.

⁴ For more details about the evolution of financial sector in Pakistan, see various issues of Financial Stability Reviews.

⁵ Here, the total assets of the financial sector excludes the outstanding amount of government national saving schemes since they are generally treated as non-tradable instruments in the secondary market.

- Market capitalization of Karachi Stock Exchange (KSE) increased from Rs339 billion at the end of FY01 to Rs7421 billion at the end of FY15.

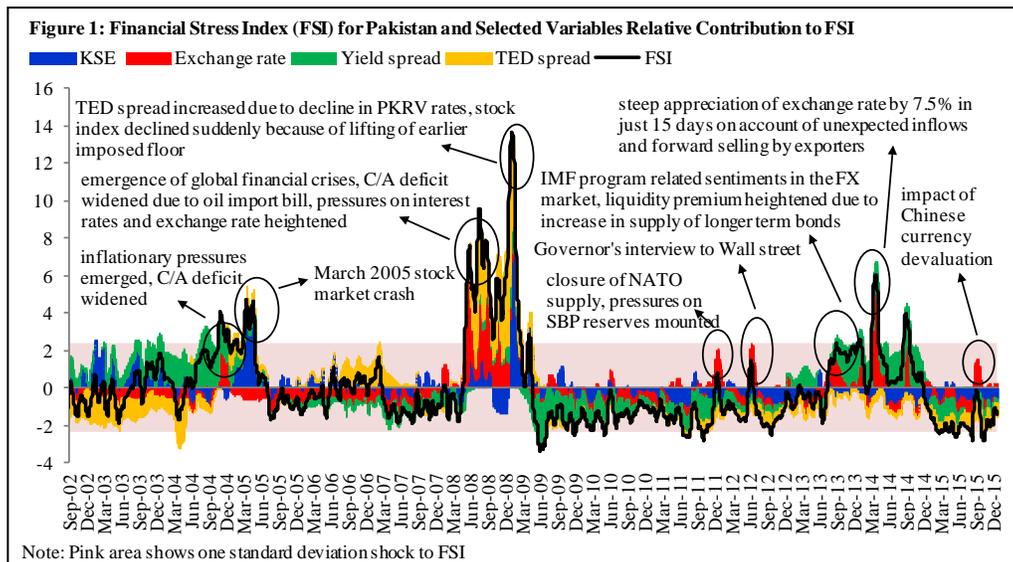
In light of the brief facts stated above, we have made the selection of following variables for the construction of FSI for Pakistan.

- The TED spread: Basically, the TED spread is the difference between the interest rate on an unsecured interbank loan (1-month KIBOR in this case) and interest rate on a secured loan (1-month PKRV in this case).⁶ Generally, the international trends suggest that money market includes loans with maturities up to one year. Banks (and companies) seek short-term funding through the money market, for instance, through interbank loans. As the money market constitutes an important source of short-term funding for banks (and companies), disruptions to this market may rapidly lead to consequences for the financial system. Hence, 1-month TED spread is used as an indicator of stress on the money market as 95 percent of the secondary market transactions are settled up to 1-month tenor in Pakistan.
- The yield spread: Unlike advanced economies, the term premium mostly remains positive in emerging economies due to historically high levels of inflation. Any negative shock to the financial system quickly shifts the creditors' interest towards shortest tenors which exert pressure on debtors by increasing their debt-servicing costs. This development also entails a liquidity risk to the financial market. Specifically, for this reason, spread between government securities maturing in 3-year and 6-month tenor has been used for the construction of FSI for Pakistan.
- Volatility in stock prices: The equity market is an important source of funding for companies, either through Initial Public Offerings (IPOs) or new issues where companies acquire their own capital. There are several ways of measuring financial stress in the equity market. One of the most common is volatility of stock prices. When investors are uncertain of the value of a share, they tend to react more strongly to new information when pricing the share than they would otherwise do. This leads to increased volatility. Therefore, volatility, as measured by coefficient of variation of Karachi Stock Exchange (KSE) 100 index is used for FSI for Pakistan.
- Exchange rate volatility: Compared to advanced economies, emerging economies are more prone to developments in their external sector. In case of Pakistan, as indicated above, the daily volume of foreign exchange transactions are higher than the local currency transactions in rupee terms. Further, 30 percent of the country's total debt is denominated in foreign currency. Hence, any erratic movement in Pak rupee exchange rate (and unexpected depreciation) can lead to stress like situation in financial market. This may lead to losses of central bank reserves if it has a policy to stabilize

⁶ KIBOR = Karachi Interbank Offered Rate; PKRV = Pak Rupee Revaluation Rate

exchange rate movements. Therefore to include this angle of stress in financial market, volatility, as measured by coefficient of variation of nominal Pak rupee exchange rate vis-à-vis US dollar is used for FSI for Pakistan.⁷

Since the aim of this study is to try to reflect the degree of financial stress in a simple and comprehensive way, an index constructed may entail higher volatility. Figure 1 plots the FSI for Pakistan with relative contribution from each selected indicator.⁸ The index captures all known stress periods in financial market quite well. For instance, the stock market crash of March 2005, 2008 balance of payments crisis, and recent pressures in the foreign exchange market are all well captured by the constructed FSI for Pakistan. Furthermore, it can be observed that in post-2008 period most of the spikes in FSI related to foreign exchange market. This highlights the secular decline in foreign private inflows towards Pakistan and consequent pressures on SBP's foreign exchange reserves in the same period. Importantly, when FSI is above one standard deviation shock, the period can be considered as stressful compared to other periods.

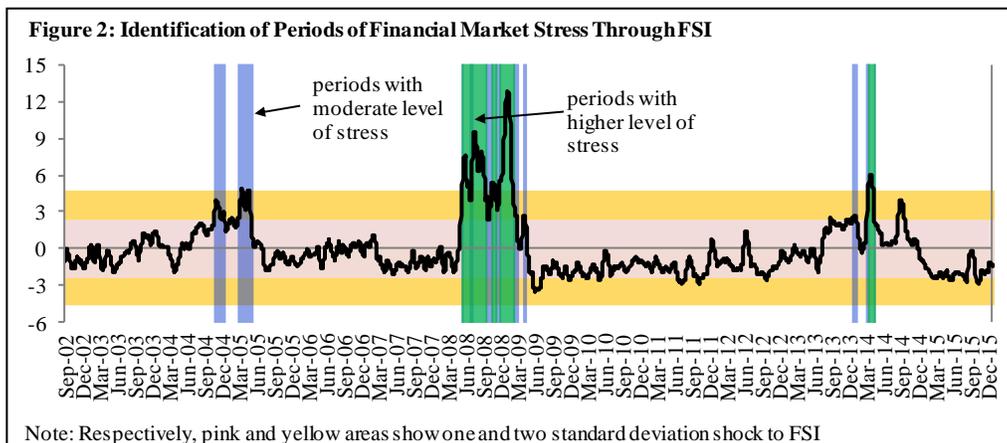


From the policy perspective, however, there is a need to define crisis periods based on FSI. Since the constructed index is based on daily data, to compare its performance with certain macroeconomic indicators through econometric models, hence, requires use of sophisticated methods. Therefore, to keep it simple to understand, this note used an ad hoc definition to identify moderate and highly stressful period in Pakistan's financial market. Specifically, if index remains above its one standard

⁷ While data source for interest rates and exchange rates is SBP, Karachi Stock Exchange is the source for stock prices series.

⁸ See Annexure for technical details.

deviation then the period is classified as having moderate level of financial stress. Similarly, if index values remains above the sample's two standard deviation then the period is classified as having higher level of financial stress and requires some immediate policy intervention (Figure 2).



5. Conclusion

Given an increase in the importance of behavior of financial variables in economic policy circles, we have attempted to develop a composite indicator to measure financial market stress for Pakistan. The index captures the stress coming from money market, foreign exchange market and equity market based on daily observations. The constructed index captures quite well all the known periods of stress like situations in Pakistan's financial market during the selected sample period. Importantly, from the policy perspective and to keep it simple, few definitions are suggested to identify moderate or highly stressful periods based on index values. This may further enrich the regular analysis of financial markets at SBP.

However, like any other empirical study, this study also has some limitations which suggest future research directions. For instance, sensitivity of FSI values to different econometric models needs to be assessed thoroughly. Since, PCA technique attaches fixed weights to the variables, empirical approach based on time-varying parameters can be more useful in understanding the behavior of financial variables. And last, but not least, relationship of FSI with other important macroeconomic indicators needs to be explored through proper empirical testing.

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Annexure: Technical Specification of the Calculation of FSI for Pakistan

Four broad indicators have been identified as a base to create a general and simple FSI for Pakistan. The index uses three stress indicators from domestic market; namely, the TED spread, the yield spread, volatility in stock prices, and one indicator from foreign exchange market, i.e. exchange rate volatility.

After the variables selection, to make the series comparable, the daily data from 1st September 2002 to 31st December 2015 was used to construct the FSI. Where the data is not available previous value is used to fill the gap. Further, before calculating the index, 30-days moving average of each variable is calculated. Then, each series is normalized by using the following formula;

$$X_i^{norm} = \frac{X_i - \mu}{\sigma}$$

Where X_i is the each observation of selected series, and respectively, μ and σ are sample mean and standard deviation of each respective series.

For weighting each indicator, Principal Component Analysis (PCA) approach is applied on the normalized sample series. The main idea behind using the principal component analysis is to represent each component of the financial stress index into a single variable by forming linear combinations of each component. Through this approach, the resulting stress index captures the most common information from all components. The resulting index is derived from the first principal component which refers to the coefficients of the linear combination that maximizes the variance of the resulting composite financial stress index.⁹ The first principal component captures around 45 percent of information available from each component. Formally, the index is calculated as follows for all t;

$$FSI_t = (\alpha_1/\gamma)X_{1t} + \dots + (\alpha_4/\gamma)X_{4t}$$

Where α_n is the first eigenvector and γ is the first eigenvalue derived from PCA. Following tables present the values obtained from first PCA and correlation between selected variables;

First PCA			Correlations				
Indicators	Eigen vector	Eigen value	Indicators	YS	TS	KSE	ER
Yield spread (YS)	0.12113	1.80277	YS	1.00	0.33	0.29	0.22
TED spread (TS)	0.36373		TS	-	1.00	0.37	0.23
Stock price volatility (KSE)	0.18134		KSE	-	-	1.00	0.31
Exchange rate volatility (ER)	0.33380		ER	-	-	-	1.00

⁹ Since to measure the frequent developments in the financial markets, the data used for this exercise is based on daily observations, and so in an event of stress, the first principal component is more relevant here for extracting the behavior and interaction of selected variables.