Estimating the Systemic Risk Contribution of Indian Banks using State Space framework

(Abstract)

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The recent global financial crisis has given one important lesson that, the traditional approach of managing the soundness of the banks needs to be supplemented by a system-wide macro-prudential approach. Hence, there is a pressing need for containing this system wide risk. However, prior to containing the systemic risk and form the regulations we need to measure this risk properly and study its sources. I in this paper propose a state space modelling framework to estimate a systemic risk measure "Systemic Expected Shortfall(SES)". This measure was introduced by Acharya et al. (2010) on the basis of a two period model of the economy having $N$ banks but the authors did not present any estimation methodology to estimate this unobserved ex-ante measure of risk over a period of time.

Let there be $N$ banks or financial firms in the economy then $SES^i$ is the contribution of bank $i$ towards the total systemic risk. $SES^i$ is the expected amount a bank’s equity $w^i_1$ falls below a target $za^i$ when whole system is in crisis ($W_1 < zA$)(Here subscript $t = 0, 1$ is for period one or two, $a^i$ is total assets of bank $i$, $z$ is a fraction, $W_1$ is total banking capital in period 2 and $A$ is total assets of banking system):

$$SES^i = \exp_{t=0}[za^i - w^i_1|W_1 < zA]$$

Rearranging the terms in $SES^i$ we get:

$$\frac{SES^i}{w^i_0} = \frac{za^i}{w^i_0} - 1 - \exp_{t=0}[\frac{w^i_1}{w^i_0} - 1|W_1 < zA]$$

In the equation (2) $\frac{za^i}{w^i_0}$ is the leverage in first period and $r^i = \frac{w^i_1}{w^i_0} - 1$ is the net equity return of the bank $i$ in the second period. Also the systemic event ($W_1 < zA$) can alternatively can be written as the event when the market return $R$ is less then a target level $C$. Equation (2) can be re written as

$$\frac{SES^i}{w^i_0} = zLEV^i_0 - 1 - \exp_{t=0}[r^i|R<C]$$

Brownlees and Engel (2010) called this $\exp_{t=0}[r^i|R<C]$ as "Marginal Expected Shortfall(MES^i)". and SES devided by the initial period equity is called scaled SES or the SES in percentage term and I denote it by $SES^i_{t,\%}$. Since big banks will have large amount of risk but also large cashflows so we are more interested in this scaled risk measure ($SES^i_{t,\%}$) We see that scaled $SES^i$ is increasing in MES^i and if we consider only two periods then LEV is already decided in the initial period so $MES^i_{t-1}$ can be taken as a noisy signal of scaled $SES^i$. Brownlees and Engel
(2010) has given a method to estimate one period ahead \( \text{MES}^i \). Therefore I can write the observation equation of my state space model as following

\[
\text{MES}_t^i = \alpha - \text{SES}_{t,\%}^i + \nu_t \tag{4}
\]

Let the return on asset \( j \) for the bank \( i \) is given by,

\[
r_j^i = \eta_j^i - \delta_i \epsilon_j^i - \beta_{i,j} \epsilon_m
\]

Where \( \eta_j^i \) follows a thin tailed distribution like normal and \( \epsilon_j^i \) and \( \epsilon_m \) follows the fat tailed distributions like power law distributions with tail exponent \( \zeta \). Under this formulation Acharya et. al (2010) showed that the \( \text{SES}^i \) can be expressed as following,

\[
\frac{\text{SES}_w^i}{w_0} = \frac{za^i}{w_0} - 1 + k \text{MES}_{t,05}^i + \Delta_i \tag{5}
\]

Where, \( \text{MES}_{t,05}^i \) is the expected value of net equity returns of bank \( i \) during the normal bad events which are assumed as the worst 5 percent market outcomes at daily frequency and denoted by \( I_{t,05} \).

\[
\text{MES}_{t,05}^i = - \exp\left[\frac{w_i}{w_0} - 1\right]/I_{t,05}
\]

\( \Delta_i \) is very small adjustment quantity depending on the excess cost of distress and excess returns due to credit risk.

As a consequence of the relation in equation (5) Leverage and \( \text{MES}_{t,05}^i \) are the predictors of \( \text{SES}_{t,\text{scaled}}^i \), therefore my state equation can be written as,

\[
\text{SES}_{t,\%}^i = \gamma \text{SES}_{t-1,\%}^i + \text{LEV}_t^i + \text{MES}_{t,05}^i + \omega_t \tag{6}
\]

Where \( \nu_t \) and \( \omega_t \) are white noises with usual assumptions of the state space framework. \( \text{LEV}_t^i \) can be approximated by the help of balance sheet data and market value of equity.

Equations (4) and (6) specify my proposed state space model. Kalman filtering will be used to filter the time series of Systemic Expected shortfall. I will use this proposed new methodology to estimate the systemic risk contribution of Indian banks and long term forecasting of systemic risk. Stock market and balance sheet data of publicly listed banks will be taken from CMIE data base.

1 Research Contribution

To the best of my belief this is the first attempt to estimate the time series of systemic expected shortfall and there is no study on the measurement of the riskiness of Indian Banks.

2 Main references
