

Note on Revising the Margining of Stock Index Futures in India¹

Concerns about the current system

From the time they were introduced in the beginning of this decade, the Indian equity derivative market has worked without any serious defaults on settlement failures despite large volumes and high levels of volatility. To this extent, the risk containment system has worked quite well.

Nevertheless, there have been several serious concerns about the system:

- It has been argued with some justification that the high frequency with which margins are revised is itself a source of systemic risk:
 - If margins are revised at a frequency that exceeds the ability of the payment system to mobilize funds from the ultimate client, then large price movements can result in panic unwinding of levered positions that exacerbates the original price movement. This can set up a vicious circle of accelerating volatility and margin calls.
 - There is anecdotal evidence to suggest that some of the extreme price movements in recent years (particularly May 17, 2004 and January 21/22, 2008) have witnessed this phenomenon.
 - The frequency of margin revision in India is far higher than in all major international derivative markets.
- Though margin calls are made at end of day and are based on close-to-close volatility, the exchanges have been concerned about intra-day movements. When the exchanges monitor the positions in real time, extreme intra-day fluctuations can appear solvency threatening, even though at the end of day that most of the movement has been reversed.
- There has been a growing disconnect between the “Value at Risk” methodology to which the risk containment framework pays lip service and the actual system (modelled on SPAN) that is closer to modern coherent risk measures like “Expected Shortfall”. The 99% Value at Risk can be regarded as the best of the worst 1% outcomes while the Expected Shortfall corresponds to the average of the worst 1% outcomes.
- The actual risk containment system with a multiplicity of margin components (including the $\sqrt{2}$ scaling as well as additional components known variously as exposure margin, second line of defence or extreme loss margin) delivers protection levels much higher than the 99% Value at Risk level enshrined in

¹This is a revised version of a note dated August 25, 2008. The main differences are as follows. The λ parameter which was earlier set to an ad hoc value of 0.999 is now estimated by maximum likelihood and set at 0.995. The margin multiplier which was earlier 7.94 standard deviations has now been rounded to 8 standard deviations. The data period for back tests has been extended back to 1990.

the stated regulatory goal. The 99% level is also increasingly out of tune with modern global best practices:

- It implies a margin failure every six months or so which is far more than the regulatory risk tolerance in India or elsewhere in the world.
- Data from international rating agencies would suggest that 99% corresponds only to a BB credit rating while a clearing corporation should be AAA rated.
- The market risk amendment to Basel-I in 1996 used 99% (and this is probably what influenced the LC Gupta recommendation) but the 10 day holding period in this amendment effectively made it a much higher confidence level.
- Basel-II credit risk models in initial drafts (early 2001) used 99.5% VaR levels corresponding to credit rating at the border line between BBB- and BB+. The final Basel-II credit risk model is based on 99.9% confidence level corresponding to a credit rating falling a little short of A-.
- The exclusive reliance on margins and near neglect of capital adequacy requirements is increasingly out of tune with the emerging market structure.
 - Since margins could be paid out of borrowed funds, the system does not constrain the overall leverage in the system. It only ensures that when the excessive leverage leads to a failure, the losses fall on external sources of leverage and not on the counterparties or on the exchanges. Leverage (whether embedded or external) can be a source of systemic risk.
 - With increasing corporatization of intermediaries and improvements in their governance and accounting, it is difficult to maintain the position that capital adequacy measures are too unreliable to be useful.

Proposed Margining System

This note presents a comprehensive set of proposals to address the above concerns. The proposals are based on analysis using data on the Nifty index for the periods 1996-2008 and 1990-2008².

The main proposals can be summarized as follows:

- Margins (as a percentage of the underlying) would be revised only once a month and changes would be announced with sufficient notice to the markets. Specifically, the margin percentage for the next month would be based on data available on the 15th of the current month so that even after allowing for lags in computation and dissemination, it is possible to provide reasonable notice to the market.

²The Nifty values on an intra day basis are available from April 1996 and therefore the design of the margin system was done using this data. For back test purposes, the period was extended back to July 1990 using back-calculated values of the Nifty.

- To allow margins to be kept constant for such long periods, it is necessary to estimate the volatility also with lower weight on the last few days of data and more weight on longer stretches of data. Specifically, it is proposed that the smoothing parameter (λ in RiskMetrics/IGARCH) be set to 0.995 as opposed to the 0.94 used currently³.
- It is proposed to set margins at a level equal to the expected shortfall at confidence level of 99.95%.
 - In terms of international rating agency standards, 99.95% corresponds roughly to A levels.
 - It would be necessary to rely on clearing corporation capital, broker capital and other cushions to achieve AAA safety for the clearing corporation while margins themselves provide only A level of safety. It is doubtful whether it is possible to achieve AAA or even AA safety through margins alone because a AA rating would have to be based on the 99.99% tail (and AAA would require the 99.997% tail) and these extreme tails are not amenable to reliable statistical estimation for fat tailed distributions.
 - The expected shortfall risk measure at the 99.95% confidence level corresponds to the average loss on the worst 0.05% days. (By contrast, 99.95% VaR would correspond to the best of the worst 0.05% days.) To set margins to cover this average loss, a margin equal to eight standard deviations is proposed⁴. In other words, the margin level on any day would be set equal to eight times the estimated standard deviation (volatility estimate as on the 15th of the previous month).
- It is proposed that the margins must be set to cover only the end of day loss and not the intra-day loss as well.

³ The parameter λ was estimated by maximum likelihood or more precisely quasi maximum likelihood because the normal distribution was used in the estimation (quasi maximum likelihood is known to be a consistent and robust estimator for Garch type models even if the distributions have fat tails). The (quasi) maximum likelihood estimate was 0.9969 for the period 1996-2008 and 0.9953 for 1990-2008. The rounded value of 0.995 has been chosen for convenience. The difference between the rounded value (0.995) and the estimate for the full period (0.9953) is not statistically significant.

⁴The multiplier of eight was arrived at as follows. The absolute value of the percentage price change on each day was divided by the estimated standard deviation (volatility estimate as on the 15th of the previous month) and the 99.95th percentile of this ratio was determined. Using close-to-close price changes for April 1996 to June 2008, the 99.95th percentile corresponds to 6.361 standard deviations. The days on which the price movement exceeded this threshold were identified and the average was computed of the price movement (in standard deviations) on these days. The average price movement on these extreme days turned out to be 8.015 standard deviations. This multiplier was rounded to 8. (For the longer period from July 1990 to August 2008, the value at risk multiplier is 6.575 and the expected shortfall multiplier turns out to be somewhat lower at 7.502 but this too rounds to 8.)

- Under the log normal diffusion assumption, the intra-day fluctuations in the price can be expected to about 167% (or $\sqrt{4\ln 2}$) of the close-to-close fluctuations. Actual data for 1996-2008 indicates a somewhat smaller ratio than this (approximately 150%) and therefore the intra-day fluctuations are not by any means excessive in relation to theoretical expectations.
- Since margin calls are to be made only end of day, it is perhaps unnecessary to cover intra-day losses. This could lead to over-margining.
- Reliance on an expected shortfall measure at a high confidence level of 99.95% obviates the need for all other margin supplements (previously known as exposure margin, second line of defence, extreme loss margin).
- Given the more stringent margining basis as well as the fact that volatility is not changed intra-day, it is also proposed to eliminate the multiplier of $\sqrt{2}$ that is employed currently.
- The current system involves a minimum margin of 5% (ignoring the $\sqrt{2}$ scaling). Adding the 3% of second level margins, would bring this minimum up to 8%. This minimum is proposed to be retained, but it does not make any difference in the actual computations because the actual margins never go below this level.

Back-test results

Though derivative markets have been in existence only since 2000, it is necessary to consider longer time periods to design the margining system and to back-test it.

- During the design phase, the period 1996-2008 was considered (The starting date was determined by the fact that intra-day Nifty values are available from April 1996).
- For back-test purposes, it was considered necessary to go further back and include the period of the early 1990s when the markets experienced extreme turbulence because of the securities scam. The sample period was therefore extended back to July 1990 using the back-calculated values of the Nifty.
- Since the starting point is close to the scam period, the model was further stressed by starting out with an initial volatility estimate⁵ of 1% corresponding to the 8% minimum margin discussed above. This volatility is not only low by historical standards but also much lower than that prevailing in mid 1990.

⁵Using a high value of λ means that the volatility estimate takes into account a much longer period of historical data. When λ is 0.94, the most recent 11 days account for half the weights and the most recent 37 days account of 90% of the weights. When λ is raised to 0.995, the corresponding numbers are 138 days and 459 days. Therefore the effect of a wrong initial volatility estimate lasts for about 1-2 years when $\lambda=0.995$. On the other hand, with $\lambda=0.94$, the initial value affects the estimates only for the first month or so. It is proposed that when $\lambda = 0.995$ is used, the volatility estimates should be initialized on a date at least 3 years in the past so that the initial value has a negligible impact on the current volatility estimate.

The back-test results show that margin violations are well under control in a sample of over 4,300 trading days (August 1990 to August 2008⁶).

- The only margin violation is on May 17, 2004. The loss of 12.24% (8.63 standard deviations) on this day exceeds the margin of 11.34% by 0.90%.
- If the expected shortfall multiplier had been rounded down⁷ to 7½ standard deviations instead of 8 standard deviations, the only margin violation would have been only on May 17, 2004, but the loss in excess of margin would have risen to 1.61%.
- The use of an expected shortfall measure (7½ or 8 standard deviations) instead of the value-at-risk measure⁸ (6.36 or 6.58 standard deviations) is what allows the margining system to handle two other big moves – the 12.85% move on March 24, 1992 (7.10 standard deviations) and the 10.44% move on March 1, 1997 (6.96 standard deviations).

The average margins and the range of margins are tabulated below. During the recent period, the margins range from around 9% to around 16% with an average of about 12%. The margins are higher in the more volatile 1990s.

Average, minimum and maximum margins			
	1990-2008	1996-2008	2001-08
Average	13.54%	12.71%	12.09%
Minimum	Not meaningful ⁹	9.02% (August 2003)	9.02% (August 2003)
Maximum	23.94% (June 1992)	16.85% (June 2000)	16.24% (May 2008)

⁶Since the previous month standard deviation is being used, margins cannot be computed for July 1990 though it is part of the sample.

⁷See footnote 4 above

⁸See footnote 4 above

⁹Since the margin computations were started off from an artificially low level in July 1990, the margins in the first month are low (about 8%), but this is a meaningless number.