



“Extreme events in finance: some reflexions”

**Remarks by Jean-Pierre Landau
Deputy Governor of the Banque de France**

Conference on extreme events jointly organised by the Banque de France and Toulouse School of Economics (TSE)
September 3, 2008*

The current crisis is a strong reminder, if needed, that extreme events can occur inside the financial system. Over the last year, we have witnessed many episodes (1) whose outcome can reasonably be defined as "catastrophic" and, (2) which could not have been predicted according to probability based on past experience.

Here, I would like to develop four points: are financial systems prone to extreme events? Is this propensity aggravated by modern finance, as it evolved during the last decade? Does this problematic help us understand the current crisis? And, finally, what are the possible policy responses?

Are financial systems prone to extreme events ?

I can see at least two reasons why this may be the case.

1 - Financial systems are complex systems. They are based on interdependence between multiple actors and counterparties. Transactions occur through networks whose structure and architecture is constantly transformed by financial innovation and regulatory arbitrage. This potentially creates numerous feedback loops. It is well known that such systems can exhibit the following features: non linearity and discontinuities (a good example being liquidity freezes); path dependency; sensitivity to initial conditions. All this accounts for truly unpredictable behaviour. It creates uncertainty in the Knightian sense: even with full knowledge of the "fundamentals" it may be impossible to associate a probability distribution to future states of nature.

However, complexity creates the possibility of extreme events. It does not make them happen necessarily. Other factors may also contribute: one of them is human behaviour.

2 - Financial systems are "human" systems. Their dynamic is shaped by the way human beings react to changes in their environment. Those reactions can help and amplify initial shocks to a point that a real "catastrophe" may occur. Herd behaviour has long been known as an essential feature of financial markets. More subtly, individual reactions, by themselves rational, can, by the virtue of their mutual interaction, produce strong amplification effects. This has been luminously shown by Danielsson and Shin in their seminal article on "endogenous risk", based on the now famous parable of the Millennium Bridge.

* Updated November 23, 2008. I want to thank Benoit Coeuré and my colleagues Laurent Clerc, Sylvie Mathérat, Imène Rahmouni, Anne-Marie Rieu and Pierre-François Weber for their comments and suggestions on earlier versions.

Extreme events and modern finance

With slight exaggeration, a case can be made that modern finance has been built, in practice, if not in theory, on implicit tolerance and widespread ignorance of extreme events.

The use of models

Models are extensively used to assess risks and price assets. Nearly all models are based on the prevalence of "normal" (Gaussian) distribution as the basic tool. This means that abrupt changes in prices or risk have a very low probability. The fallacy of this assumption has been clearly shown by Mandelbrot for stock prices, and it has been further demonstrated in many recent (and non recent) episodes for other asset prices and risk premia.

Examples of the use of normal distribution in financial modelling would include the following:

- The most frequently used tool for risk measurement (VaR) frequently ignores "fat tail" risks. Many VaR measures are calibrated according to the expected loss of a portfolio under *normal* circumstances. Models with "fat tail" distributions are available, but seldom used, due to lack of reliable data over a sufficient period of time.
- Implied volatilities are usually extracted from option pricing, based on normal distribution. They are then used as inputs into trading strategies and models. As a result, the assumption of normal distribution widely "contaminates" the pricing, risk assessment and investment strategies across a whole range of markets and instruments.
- Finally, the pricing of many structured products is based on historical correlations among asset prices, with the assumption that those correlations are stable and do represent the ordinary state of nature. On the contrary, experience has shown that those correlations can change radically during a crisis, frequently collapsing to one, and take price movements to the extreme ends of the probability distribution.

Procyclicality

Many changes have been introduced in recent years to accounting and capital regimes in order to make them more risk sensitive. The benefits in terms of increased transparency and better risk management are very significant. Those same changes, however, may contribute to create new amplification mechanisms inside the financial system.

This is referred to as a "procyclicality" issue, by which we usually mean the tendency of financial system to accentuate fluctuations in real and financial variables around their trend. But amplification can also create persistence if the system is path dependant. We may thus have to broaden our definition of procyclicality, looking not only at fluctuations around a trend but also at changes in the trend itself, which would move the

equilibrium of markets and prices and potentially create extreme events. A very subtle question arises, which would deserve both theoretical and empirical investigation in this context: when do cyclical fluctuations degenerate into a more fundamental and permanent deviation and what could be done to prevent it?

Rating

By essence, the rating process is discontinuous. Changes in ratings therefore create non linear effects in the dynamics of financial markets. Those effects are stronger when there are a limited number of rating agencies with the same behaviour and methodologies. For that reason, we need to consider whether both our supervisory processes and market practices do not rely too much on rating. Such "hardwiring" of ratings in our financial infrastructure may amplify small and localised discontinuities, thus creating the possibility for more extreme events.

Understanding the current crisis

Arguably, one major problem underpinning the current crisis is the pricing of risk. For some years before the turmoil erupted, we have been puzzled by how low risk was priced in most credit markets. Again, with slight exaggeration, the case can be made that mispricing of risk occurred because extreme events – i.e. tail risks – were systematically ignored.

At a general level, complexity and opacity in the originate and distribute model made it difficult to understand the "true " nature of risk i.e. the probability distribution attached to specific instruments.

More subtly, I wonder whether the slicing and tranching process – which gave rise to structured products – has, intentionally or not, both created additional tail risk and contributed to conceal it.

Most managers, for instance, have been caught by surprise by the fast downgrading of AAA CDO tranches, which triggered massive write downs. With hindsight, we know that those tranches had lower average probability of default than the underlying loans – which provided the rationale for the AAA rating – but also possessed a much higher exposure to tail risk. That latest characteristic was not apparent from the rating. As a consequence, tail risk was clearly not priced in, which made those securities both very attractive and absolutely lethal.

Tail risk was not only deeply concealed in the complex structure of the instrument. It was also, to some extent, "created" by the instrument itself. As a result of the tranching process, an underlying portfolio with normal risk distribution was transformed into a different set of instruments. Some (equity tranches) had a with very high average default probability. Others (super seniors) had a low average default but proved extremely sensitive to tail risk. In that specific case, financial innovation produced extreme events inside the system, far beyond what the fundamentals would normally imply.

Policy responses

The standard prescription for preventing extreme events is to develop stress tests. This is certainly a prerequisite. But success will ultimately depend on our ability (1) to define the proper set of assumptions according to the whole range of possible extreme events; and (2) to act upon the results of those tests when there are very little incentives to do so. Typically this may involve keeping buffers for capital and/or liquidity well in excess of what appears necessary 95% of the time. Except in times of crisis, this approach is likely to be strongly challenged when it appears that its cost/benefit ratio is extremely high. It is not clear which institutional system could deliver such a result over the long run.

One should ask, therefore, whether insurance against extreme events has to be taken and organized at the level of each individual financial entity (with the costs associated); or should it be spread over the whole economy, which raises well known issues of moral hazard?

Implicitly the second approach has prevailed over the last decade: the financial system was allowed to take a huge amount of tail risk and, when those risks materialized, significant infusions of public money took place.

Looking forward, in trying to find the right balance, policy makers will face a number of trade-offs.

The first, and most obvious one, is between the robustness and resilience of the financial system, on the one hand, and its profitability, on the other. With hindsight, it may be that parts of the returns achieved by the financial industry in the last decade have resulted from too big a tolerance of tail risk. Conversely, one can theoretically increase, almost to a maximum, the resilience of the financial system to extreme events by piling up strong liquidity and capital cushions in all its components. Of course, since capital and liquidity are costly, the economic viability of such a system would be open to question.

A second trade-off appears between risk sensitiveness and financial volatility. We are increasingly expecting our prudential and accounting regimes to reflect precisely, at any moment in time, the level of risk embedded in every financial instrument. This does make sense: prudential requirements, in particular, should be tailored to the risk attached to specific activities. But financial systems are naturally procyclical. Risk – and risk appetite – move up and down with the economic cycle. It is an open question then, whether financial regulation does or not contribute to creating additional feedback loops in an already complex system, thus reinforcing the probability of extreme events.

Finally a trade-off appears between financial innovation and product standardization. Many economic activities are exposed to extreme risk, which (almost) never materialise. One striking example is the pharmaceutical industry, where very innovative, but also potentially dangerous, products are put on the market with (almost) no accident. The reason, of course, is that those products themselves are subject to strict, and costly, testing and approbation procedures. This cannot be transposed to the financial industry, where innovation takes place under a different regime (with no protection for intellectual property). Nevertheless, some product control or standardization may contribute to reducing extreme risk. For instance, those countries where loan to value ratios were strictly enforced tend to experience less credit accidents than others.

Those trade-offs may not be stable in time. For that reason, it is important that regulation and supervision become more responsive to changes in circumstances and the macro economic environment. This is the essence of the so called "macro prudential" approach to financial supervision. Implementing such an approach may prove very challenging. Early detection of incipient disequilibrium inside the financial system is conceptually difficult: no crisis looks like the previous one and the search for "early warning" indicators has not yielded fully convincing results. There is also an institutional challenge in bringing together different authorities with different mandates and approaches to financial stability. In the words of C. Borio "there is still considerable reluctance to calibrate prudential instruments more systematically from a macro prudential perspective".

Nevertheless, macro prudential supervision may represent our best chance to reduce the frequency of extreme events in the future and, more generally, to allow the authorities to choose between the often conflicting objectives of financial efficiency and stability.

REFERENCES

- **BORIO** (Claudio): "The macro prudential approach to regulation and supervision: where do we stand?" (forthcoming)
- **DANIELSSON** (Jon) and **SHIN** (Hyun Song): "Endogenous Risk", London School of Economics, September 2002
- **FEDERAL RESERVE BANK OF NEW YORK**: "New Directions for Understanding Systemic Risk", *Economic Policy Review*, November 2007
- **MANDELBROT** (Benoit) and **HUDSON** (Richard): "The (mis)behaviour of markets", Basic Books, 2004
- **UBIDE** (Angel). "Anatomy of a Modern Financial crisis", Bank of Spain : *Financial Stability Review*, No 14, April 2008