

# Scenario Capability for Central Banks

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Central banks play critical roles in banking systems that require them to operate in financial markets, staying abreast of financial innovation and understand and leverage technological developments. The difficulties of performing the risk-based responsibilities of a central bank is, however, magnified by the momentum of financial markets to grow, innovate and integrate. Their work place is in a constant state of flux.



A key value that a central bank brings to a market place is its ability to decipher relevant information, understand the risk dynamics of economies and being able to instigate market-stabilizing action at appropriate times. This demands a risk system technology that allows the dynamics of the market place to be absorbed into their process without impacting upon the consistency of past, present or future risk analysis or policy decisions.

In the context of the various roles that central banks perform, this article examines the risk management challenges they face and the need for a risk management framework that can provide a platform that supports risk awareness and policy development. It is argued that scenario based risk systems that are currently available in the market are the beginnings of such a risk management framework with the observation that more central banks are adopting simulation capability to support their open market, supervisory and risk management responsibilities.

## The Need for a Risk Analysis Framework

Financial markets continue to evolve and change due to numerous macro and micro economic factors. Entities continue to merge to form global, full service financial institutions. In addition, the complexity of these larger entities is a key driver to increase the prominence of risk management practices. Continued high profile failures such as Barings Bank, Long Term Capital Management and Tiger Asset Management underscore the need for continued evolution in the ways institutions and policy makers manage, monitor and think about risk.

The efforts of the industry have been focused on bedding down techniques and processes within an information framework that drives a better understanding of total risk, delivering efficiencies in organization wide information processing, delivering proper corporate governance procedures and supporting the innovation and growth of businesses. As a result, the mindset of enterprise wide risk management emerged in the early 1990's with the aim of delivering technology and technique frameworks that solve the risk information problem.

The objective of a risk information framework is to provide a generalised strategy under which the development of risk management techniques can occur in a consistent and unified fashion. The desired result is the delivery of "useful information" through time and an enduring investment of intellectual capital over time. Common sense would suggest that if an organisation does not have a framework in place, it is at risk of being continuously plagued with new vogue techniques, legacy systems and changing management mindsets.

The question of an appropriate framework is not a new challenge for prudential regulators who have had to deal with their own dilemma of how to cast an enduring prudential and regulatory framework across financial markets. Reference is made to some of the recent remarks made by Greenspan in relation to the challenges faced by the Federal Reserve in its role as a prudential regulator. One particular comment that deserves recital here is a prudential risk management process should be "necessarily dynamic and evolutionary....In particular, we should avoid mechanical or formulaic approaches that, whether intentionally or not, effectively "lock" us into particular technologies long after they become outmoded. We

should be planning for the long pull, not developing near-term quick fixes. It is the framework that we must get right.”<sup>1</sup>

If such a framework is attainable, and is implemented and operated by a central bank for its supervisory and own internal risk management purposes, then the opportunity is afforded for central banks to set risk management standards by the way they directly interact with the support and maintenance, growth and innovation of the financial markets that they oversee. The potential result is a better level of transparency being created across the risk taking elements of the economy and the ability for regulators to benchmark participating organizations’ risk management practices.

Evidence suggests that there is an industry trend towards such a framework in the form of risk scenario simulation systems. Examples of institutions using risk based scenario simulation systems include to generate useful risk management information include AIG, Morgan Stanley and Commerzbank to name a few.

## Scenario Simulation

Unlike parametric approaches that blend several risk factors into generalized views of risk, scenario simulation is a transparent view of the risk drivers of an organization through scenario results that can be viewed either as a group or discretely.

A scenario is an imagined view of the future state of the world, from today. This view will encompass several different risk factors that are required to be combined into a single value consequence. If a rich set of profit and loss scenarios are generated, then sufficient information is delivered that allows scenario simulation to form the basis of a risk framework given:

- The combination of several different sources of risk, namely positions, market volatilities and correlations into a single measure of risk that can be decomposed into discrete scenarios. By reviewing the risk-reward drivers of risky portfolios through discrete scenarios, insights into the effects of extreme market conditions can be made. Examples of such insights include structural market changes, emergence of additional risks, contracting liquidity of assets and broken correlations across assets and across markets;
- The calculation of VaR and stress testing can be conducted in a unified way by allowing risk to be understood more completely by beginning with the expectation (price), understanding the rates of change of value (sensitivities), determining and assessing expected losses (value at risk) and contemplating unexpected losses (stress testing), all within the same simulation framework. In this way the spectrum of quantitative approaches to risk measurement are combined through common mathematical processes. As a result different types of risk can be viewed together, such as market and credit risk;
- The science of scenario generation can be combined with market and economic judgments of risk through the use of scenario grading techniques. Scenarios can be graded by incorporating the views of economists, traders, key industry and government advisors etc. Given the decomposition properties of scenarios, a specific risk factor concern can be incorporated into the assessment of a scenario, regardless of how many risk factors are involved in the construction of that scenario;
- Risk analysis that is not necessarily dependent upon historical information and constant investment horizons and liquidity constraints; and
- The provision of common views of risk across many risky portfolios thereby providing risk-benchmarking information.

Technology and methodological barriers have existed in delivering the number of scenarios required to completely assess the risk of an organisation. Given the increase in computing power available and recent

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<sup>1</sup> Remarks by Chairman Alan Greenspan, *The evolution of bank supervision*  
Before the American Bankers Association, Phoenix, Arizona, October 11, 1999

developments in delivering Monte Carlo analysis in more computationally efficient ways, the scenario simulation capability that is required to support risk analysis of an organisation is now economically available.

Several scenario approaches exist that provide an insight into risk exposure. These range from modelling single risk factors over single time steps to modelling multiple risk factors over many future periods while incorporating changes in desired risk profiles.

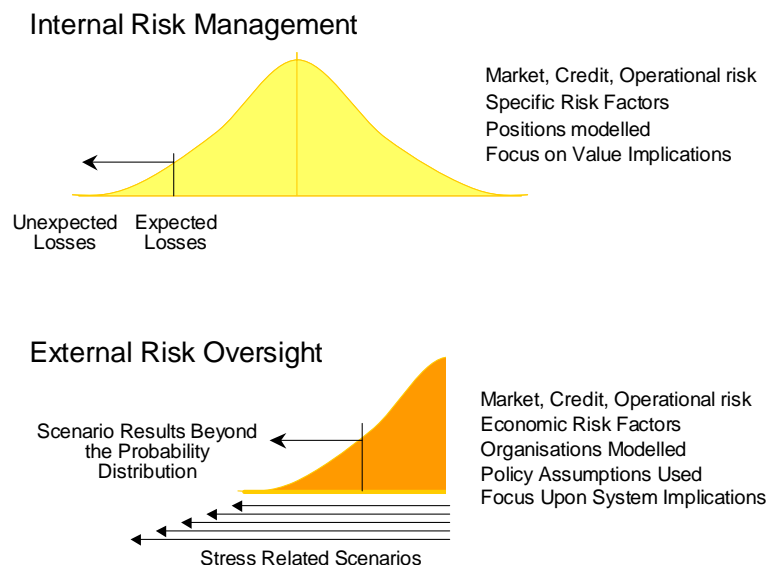
The latter approach to scenario simulation is considered the most sophisticated and useful given it allows the user to not only take into account the elements of change and risk over time but also allows the mapping of the effects of changes of time on the construct of the portfolio. Central Banks would obtain value from such a simulation approach as changes to reinvestment, hedge, trading and investment decisions with respect to changing market conditions and time and policy decision rules can be incorporated.

## Scenario Simulation for Central Banks

The analytic needs of central banks can be divided between their internal needs for risk management and their external responsibilities to oversee and manage organizations and macro-market factors. In order to satisfy internal risk management needs, central banks focus on the value drivers of their organization and are concerned with what can go wrong. In this way, they are concerned predominantly with the loss possibilities of risk taking.

Supervisory and market management responsibilities require the central bank to understand the risk profiles of financial organizations, the payments system and macroeconomic impacts on the stability of the financial system.

Given central banks are primarily concerned with the loss possibilities resulting from various forms of risk taking, their role is partly focused upon what factors can lead to things going wrong and what mitigating action can be taken. In this way, central banks become purveyors of financial scenarios with a key focus on those that threaten their own value proposition or the stability of the financial system. This is where scenario simulation and stress testing have a vital importance.



Examples of central banks using scenario analysis to assist in their risk based responsibilities include:

- Banco de Mexico uses a scenario based risk management system to aggregate all the positions of Mexican banks. Key financial instruments had been identified and applied market based systemic

shocks to create a systemic value at risk (VaR). In this way, the bank is using its risk system for macroeconomic regulatory purposes. Also, Banco de Mexico are considering extending its scenario generation capability to assisting with the implementation of monetary policies, where the risk engine may be used to assess the optimal choice of securities and bonds to buy or sell. For example, correlating various economic factors such as oil price with interest rates has the potential to provide information on which Government bonds are due for early maturity;

- Denerlandsche Bank is implementing a scenario based risk system to manage the risks embedded in the foreign exchange and debt portfolios they manage on behalf of the government. Value attribution and benchmarking analysis may also be conducted to performance assess the management of debt portfolios against market based debt indices; and
- Bank of Canada uses stress scenarios to isolate various sources of risk. In order to understand the effects of extreme market movements and their probability of realization, Extreme Value Theory techniques are being used to compliment scenario analysis..

These examples show an interest of central banks in scenario-based techniques. Scenario based risk systems can make several contributions to the performance of central bank risk-based responsibilities. In the context of the various role performed by central banks, those contributions are described as follows:

**Portfolio Management:** Central banks are required to manage the foreign currency reserves and debt portfolios either on their own account or on the account of the government. These activities require an understanding of market dynamics, Government return and liquidity requirements and portfolio management. Scenario simulation supports these activities by:

- **Portfolio management:** measurement of market and credit risk through sensitivity and scenario based VaR techniques, and the understanding of correlation and market shocks through the use of stress testing simulation. These techniques assist in the understanding of how risk factor changes affect the value of portfolios and the support of profit and loss attribution analysis through time;
- **Performance attribution:** tracking of the relative performance of portfolios that are managed against benchmarks through scenario based tracking measures and marginal risk analysis;
- **Control Processes:** risk setting tolerances can be described as scenario loss or liquidity tolerances;
- **Cultural Factors:** By having to work with and understand economic and market based scenarios and their interaction, the organization is investing in its literacy and awareness of risk. A natural result is the building of a risk-based culture that uses scenarios as the basis of communicating risk.

**Regulatory and Supervisory Responsibilities:** Some central banks monitor, supervise and set regulations over the financial activities of participating financial institutions. Supervision is becoming increasingly risk-oriented with the purpose of understanding the activities that pose significant risks to individual participants, as opposed to the risk relationships between participants. In order to cover the amount and complexity of information available in a review context, scenario simulation assists central banks by:

- Providing evaluation tools that determine the quality of participant risk management systems and internal risk controls. This could range from analysing the assumption sensitivities of particular models used, to benchmarking the output of a financial institution's VaR models used for regulatory purposes. An example of the desire of central banks to benchmark VaR results is the experience of the Reserve Bank of Australia (RBA) and the Australian Prudential Regulatory Authority (APRA), which, in a joint study, compared the VaR results of 22 participating banks.<sup>2</sup> The results varied widely with VaR estimates generally differing from high to low by a factor of four. In this case a risk system could be calibrated to a sample of bank outputs to seek a better understanding of the assumptions that had been made when calculating VaR estimates;

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<sup>2</sup> [Gizycki, M and N. Hereford, Assessing the Dispersion in Banks' Estimates of Market Risk: The Results of a Value-at-Risk Survey, Australian Prudential Regulation Authority Discussion Paper 1, October 1998, http://www.apra.gov.au/policy/.](http://www.apra.gov.au/policy/)

- Providing an understanding of the volatility behavior of markets, market stress effects, system liquidity, interaction of markets (eg. debt and equity) in order to support margin setting requirements and macro economic simulation;
- Risk attribution analysis to understanding the sensitivities of the banks major portfolios to risk factor changes. For example, bank balance sheets can be a major source of exposure to interest rate and foreign currency changes that can well exceed the exposures carried by their trading operations. Scenario simulation would provide an understanding of the risks embedded in the balance sheet that would provide some transparency over the level of reinvestment risk that a bank is exposed to, the value of the balance sheet and the risk taking appetite of the organization, and how time (theta) affects the value of banks balance sheets and the validity and effects of their reinvestment, portfolio growth and their economic assumptions; and
- Assists in audits through the provision of scenario based audit tools and greater risk literacy and training of examiners

**Payments System Oversight and Development:** Payment settlements incur a great deal of risk that requires supervision. The payment system will often result in exposures well in excess of an economy's GDP. In the US, 1994 payment flows exceeded the economy's GDP by seventy times. (BIS 1995).

The payments system provides a channel for spreading liquidity and solvency problems that could potentially threaten financial stability (Freixas et al, 2000) Given the demand for funds resulting from settlement activity, central banks make decisions as to how much credit is necessary to support the payments system, how to structure its own balance sheet and the price at which it will deal funding transactions. In this way a central bank will have exposure to credit risks, which are predominantly intra-day in nature.

Scenario simulation allows central banks to manage their policy settings in the payments system by:

- Allowing exposures to system gridlock to be simulated and managed;
- Simulating the stability of the banking system as it is affected by the patterns of payments across different market participants and locations;
- Assisting the determination of central banks credit policy by simulating different combinations of prices, collateral, and quantity limits. The central bank's preferences for systematic and liquidity risk and the cost of collateral are also taken into account (cite); and
- Simulating the ability of the banking system to withstand the insolvency of a bank and whether the closure of one bank generates a chain reaction on the rest of the system.

**Open Market Operations and Economic Policy Implementation:** By buying and selling assets in the open market, or bilaterally with individual financial firms, central banks affect the liquidity positions of participants and influence the availability of credit. Open market activities allow central banks to guide the financial system that is consistent with economic policy. Scenario simulation serves an integral role in this endeavor by:

- Assisting in the management of the macro economy of financial institutions through the conduct of macro economic simulation that identifies risks that are common to a number of system participants, markets or payment networks. Such factors as interest rates or exchange rate fluctuations, inflation developments, asset price "bubbles", market correlation shocks, excessive loan or borrowing concentrations, flight to quality capital transfers, or excessive leverage ratios for borrowers could lead to problems for a number of banks;
- By modeling macro economic scenarios, a central bank can monitor such developments and assess the necessary action if financial stability is threatened or assess the relevant information that may be passed on to assist other market regulators or supervisors to apply necessary measures. Such analysis is particularly useful for those markets that are frequently subject to liquidity and market shocks, such as emerging markets; and
- Scenario analysis assist in the implementation of monetary policy by providing an understanding of the effects of monetary adjustments on yield curve shapes, system liquidity, effects on financial institution values, other markets (FX, equity etc).

## **Conclusion**

Central banks play a unique role in the maintenance, support and development of the financial system. Their responsibilities extend from managing their own financial risk exposures to supervising financial institutions, implementing economic policy and being an active participant in the payments system.

The key value that a central bank brings to a market place is its ability to instigate market-stabilizing action at appropriate times.

Given the diversity of their roles, their position in the market place and the rate of financial and technological developments, some central banks have looked into the successes of the industry in analytically understanding risk and developing techniques that address their risk management requirements.

A complete scenario generation capability affords the transparency and flexibility that is required by central banks. Such a capability assists central banks to protect themselves and the financial system against the occurrence of risky scenarios and to operate more efficiently and promptly when financial stability is threatened.