

Extracting Value from Stress Testing⁺

July 9, 2018

Sanjiv Talwar* and Stuart Turnbull**

Introduction

Supervisory stress testing has become a regulatory requirement for financial institutions in most developed jurisdictions since the Global Financial Crisis. Regulators describe a set of conditions, both macro-economic and firm specific, that will impact the firm over a specified horizon. When done well, stress testing, or more aptly referred to as scenario analysis, provides an assessment of the proforma financial statements that would result from adverse economic scenarios. We will explain that all firms, financial and non-financial, can benefit from employing scenario analysis to address a wide array of issues.

In the US, the Dodd-Frank Act mandates stress testing which is referred to by regulators as the Dodd-Frank Act Stress Test (DFAST). DFAST has become a valuable tool for evaluating whether financial firms are holding sufficient capital and the dispersion of capital levels under the different scenarios. This process is comprised of four main steps.¹

1. Firms must provide the Federal Reserve with standardized data on their securities holdings, trading positions, counterparty exposures, revenues and balance sheets.
2. The Federal Reserve specifies macro-economic and financial market scenarios. These scenarios involve different degrees of adversity and duration.
3. The Federal Reserve inputs the data from the firms into its own models to estimate for each scenario, over a nine-quarter planning horizon, revenues, losses and
4. The results from the exercise are disclosed to the public.

While DFAST is useful, it does not set any capital limits or restrain capital actions (paying dividends or buying back shares). These functions are described in the Comprehensive Capital Analysis and Review (CCAR), where the Federal Reserve assesses the overall capital adequacy of the firms. In particular it assesses whether:

- (a) a firm has sufficient capital during the different scenarios,
- (b) the firm's capital planning processes are appropriate,
- (c) the firm's risk management processes are capable of addressing the array of issues that arise in the different scenarios,
- (d) the firm's planned dividend and share repurchases impact its ability to remain a viable financial firm.

* Sanjiv Talwar, Principal, Financial Risk Group. Thinking presented herein was developed while Sanjiv Talwar was employed at Bank of Montreal where his accountabilities included enterprise stress testing.

** Stuart Turnbull, Director, Glen Lyon Risk Management, Professor Emeritus, University of Houston.

¹ See Daniel K. Tarullo, "Next Steps in the Evolution of Stress Testing", Board of Governors of the Federal Reserve System, September 26, 2016.

Compliance with the regulatory requirements impose significant costs upon firms along many dimensions:

- (a) Collection of data and standardization of formats.
- (b) The demands on the IT structure within the bank arising from legacy systems.
- (c) The ability to model the different portfolios within a business and across the bank. This raises the challenging issue of modeling the correlations of revenue and loss drivers across the businesses. Given the need for modeling different macro-economic environments, this requires an emphasis on understanding the factors that affect the risk drivers.
- (d) Managerial ability to comply with the increased regulatory requirements. This requires the ability to meet the demands of regulators on a timely basis. It also requires the ability to understand the analysis and to convey the implications to senior management and the firm's board of directors.

The increase in regulatory compliance comes at a cost. In a recent survey of global and domestic systemically important banks, 25 percent estimated their annual spending on regulatory stress testing exceeds over \$100 million USD, with more than half of the banks taking three or more months to complete end-to-end stress testing.² However more than half of the banks found that stress testing could help with business planning, budgeting and assessing the risk/return profile. In this paper, we explain how the methodologies underlying the required stress testing can be used to enhance analysis of a wide array of issues facing banks and corporations in general.

It should be noted, though not discussed here in depth, that the management of data collection and reconciliation represents one of the major costs to banks in stress testing.³ Product and customer data must be accessed across different businesses and geographic locations. Often these businesses collect different types of data and employ different formats. Consequently, different businesses within the bank will have different protocols designed to meet their particular needs. The different IT systems and silo mentality that often exists within a bank, reinforces the desire to maintain different formats and protocols. However, regulatory requirements impose the need for standardization, thereby forcing management to introduce some level of standardization. Introducing this standardization is costly as it involves having to rewrite protocols, change business culture and negotiating compromises across different businesses. The changes often must be implemented retrospectively in order to allow meaningful quantitative analysis.

The increased volume and complexity of regulation places great demands on senior management, risk managers and the board of directors. The demands span two different areas.

1. The bank must thoroughly understand the complex regulatory requirements in order to ensure compliance is achieved and maintained.
2. The bank must successfully undertake the regulatory tests as well as interpret the results. It must also demonstrate that it has effectively challenged extant methodologies.

² KPMG International, 2016. Stress Test: A Benchmark Analysis of Systemically Important Financial Institutions. www.kpmg.com

³ See KPMG 2016

The platforms designed to comply with regulatory requirements provide management with a set of tools to address some of the challenges facing businesses. In this paper, we show how it is possible to extract value from the different platforms in order to improve decision making abilities.

Use of Scenario Analysis

The Federal Reserve uses scenario analysis in its assessment of financial institutions individually and to understand the dynamics of the entire inter-connected financial system. It describes a particular set of economic conditions occurring over a specified period of time and asks banks to determine the impact on (a) regulatory capital and (b) the actions of management.

Scenarios are not forecasts. They are not business plans. They are a description of a series of events that might impact an institution or the broad economy. They do not represent a consensus view. They serve to challenge preconceptions about the future and to overcome “group think”. They are designed to provide the basis around which management can talk about different strategic issues and the management issues that will arise in the different scenarios. One of the benefits of scenario analysis is that it can include intangible aspects that arise as a scenario unfolds.

The use of scenario analysis has a long history, being applied in a wide array of fields: military planning, insurance contingent planning, capital budgeting, production and supply chain analysis, to mention a few applications. Scenario analysis provides firms with the opportunity to explore a wide array of situations and to ask “what if” type of questions and to challenge the status quo. ***If used thoughtfully, the analysis allows a firm to identify possible strategies that will generate potential advantages over its competitors.*** A bank can do this by examining the factors that can generate change and the reactions of competitors to any initiatives undertaken by the firm. Shell Oil Company, a pioneer in the use of scenario analysis, explored the factors that would affect the price of oil in western Europe. Shell planned its investments, cognizant of changes in technological development, to grow through a series of small investments. The strategy helped it to benefit when OPEC was unable to control supply.⁴

Maack (2001), describes how the World Bank uses scenario analysis as a tool to help making strategic decisions. It helps decision makers consider the consequences of different strategic decisions in different types of environments. McLaren Technology Group has employed scenario analysis to improve the performance of its F1 motor racing group: “We will have a pre-determined plan for any possible scenario”.⁵ This objective is similar to that underlying the use of flight simulators in training pilots, where flight simulators are used to expose pilots to a wide array of different situations, most of which the vast majority of pilots are (hopefully) never exposed to during actual flying. GlaxoSmithKline, wanting to improve its medical research and manufacturing abilities, entered into a partnership with McLaren Technology Group, given the Group’s experience in using scenario analysis and data analysis.⁶

Financial institutions face many different types of challenges. Some can be broadly classified as “known unknowns” – issues where a bank is knowledgeable (the “known” part), though the precise details are vague (the “unknown” part). For example, consider a bank operating in an environment where there are a small number of competitors of similar size and it is trying to determine an investment strategy to

⁴ A more detailed description is given in “Scenario Analysis: A Tool for Task Managers”, Maack (2001).

⁵ <http://wired.co.uk/article/mclaren-technology-innovation>

⁶ <https://www.mclaren.com/technologygrop/case-studies/case-study-gsk/>

improve its return on capital. The bank knows that all other firms are attempting to solve the same issue, but how is unknown (this is the unknown part).

Many of the exercises that regulators mandate, fall into the category of “known unknowns”. For example, for the last few years, consumer debt has been increasing. Interest rates are expected to increase, causing mortgage rates and loan rates to increase. The duration of the increases and magnitude are unknown. The unknowns include the impact of mortgage and consumer loans on customer default rates, the impact on collateral due to the supply/demand dynamics based on changing house prices and how the bank’s competitors will react in terms of tightening or loosening credit availability.

There is another class of challenges that financial institutions face that can be classified as “unknown unknowns” – issues that are purely hypothetical. For example, senior management is concerned about the types of digitization technology that will affect the bank over the next ten to fifteen years and wants a strategy to prepare the bank to be in a position to respond. Today, it does not know the nature of the challenges that it might face in the future. While scenario analysis will most likely not predict the *exact* circumstances of the “unknown unknowns” it will at least provide the bank an opportunity to react with forethought.

Generating Scenarios

The starting point is to identify a number of contingents a bank may face. These could be a single event, such as the default of a major borrower or a large change in price of a single asset (e.g., oil) or asset class. It could also be a series of external economic events, similar to the scenarios used by regulators.

Generation of scenarios will require input from the decision makers, board members, as well as with major clients and external experts (economists, academics and consultants). Once a set of scenarios have been identified, resources within the bank should be used to generate background material, analysis, and the quantitative impact of the scenarios. Discussion papers should then be prepared and distributed to the decision makers for analysis and review.

The following subsections are few areas where banks might want to think about when developing their scenarios.

Responding to the Environment

One of the many lessons learned from the Global Financial Crisis is the failure of senior management and regulators to understand the macro economic consequences of a drop in US house prices and how this could impact the global economy. Scenario analysis would have allowed management to explore the consequences of house prices falling across the United States. Questions such as “If house prices fell across the nation, what are the consequences?” and “what circumstances in the economy would precipitate a national fall in house prices?” could have been presented to subject matter experts to start the discussion.

The credit crisis reminded many financial firms of the old adage “financial liquidity is always available until you need it”. Scenario analysis provides management with a platform to improve liquidity management. To start the analysis, the firm needs to identify its demand for liquidity over different horizons and how will this change with the economic environment. What inventory of assets does the

firm have to provide liquidity and how long will it take to utilize the different sources of liquidity? What are the implications if demand for liquidity dramatically increases in the economy?⁷

A central bank is usually viewed as a “lender of last resort”. However, the freedom of a central bank to provide liquidity to an individual financial institution may be constrained.⁸ What are the implications for the firm and how will it respond? Scenario analysis provides an ideal platform to develop a firm liquidity strategy. A good starting point is to incorporate the framework first described by Gordon Donaldson (1961)⁹ and then explore the implications as market liquidity deteriorates.

Scenario analysis does not need to assume that management is a passive watcher. In a well-designed scenario process, management can undertake adjustments in planning. For example, consider a scenario where management observes that revenue is dramatically declining. Management can take action to reduce its exposure, cognizant that other firms may be taking similar actions with feedback effects on the environment. It is this type of action that allows management to identify the possible risks it might face in the scenario. It can also allow management to identify situations where it might gain a first mover advantage.

Analysis of Investment Decisions

Strategic investment analysis often involves exploring the implications of different types of investment decisions. Each type of investment can be analyzed by estimating the expected change in the cash flows of the business and calculating the net present value by using an appropriate discount rate. Often the rate is management’s desired cost of capital. By using such a rate, the implicit assumption is that the investment project has the same risk as the bank’s existing assets. While this traditional form of analysis provides a basis for determining if the project will enhance the value of the bank, it does not consider the risk profile of the project and it does not consider the implicit options that naturally arise with different investment decisions. For example, the option to change contract specifications if credit conditions change.

Scenario analysis can be used to examine how an investment decision affects the other businesses within the bank and aid in understanding of the risk/return profile of the business along with its impact on the bank. Businesses within the bank are not independent. Many of the common value drivers have been identified in the risk analysis of the bank. However, with a major change in the business, the sensitivities to these drivers could change. While some of the interdependences are challenging to quantify, scenario analysis can be used to describe these changes. The return distribution can be generated and the risk/return profile examined. By aggregating across the businesses within the bank, changes in the risk/return profile can be generated.

⁷ Bai, Krishnamurthy and Weymuller, have developed a liquidity mismatch index that provides a measure of the mismatch between the market liquidity of assets and funding liquidity of liabilities – *Journal of Finance*, (2018), 51-93.

⁸ Stanley Fischer, “The Lender of Last Resort Function in the United States”, paper presented at the “Lender of Last Resort: An International Perspective” conference, Washington, D. C., February 10, 2016.

⁹ G. Donaldson, (1961), *Corporate Debt Capacity*, Division of Research, Graduate School of Business Administration, Harvard University, Boston.

Disruptive Technology

Most companies face the threat of disruptive technology. How can the bank identify potential disruptors? What are the consequences for a bank and how will the bank respond? Another far more difficult set of issues is to consider the impact of technologies that are not currently on the horizon. Forward thinking is essential for a bank to prosper.

The starting point is to identify current disruptive technologies and to consider how they might develop over the next ten years. For the bank, there are a number of questions that naturally arise. What businesses are most exposed to the risk of disruption and how will they respond? What technologies should the bank be developing either in-house, making acquisitions or by funding start-ups? Does the bank have sufficiently qualified people? In all cases, the aim is to identify future contingences and to develop plans listing the expected consequences and responses of the different businesses.

Cyber Threats

The rapid changes in technology and financial applications brings many advantages to banks as well as challenges. The number of individuals using online banking continues to increase.¹⁰ If the user's online device has been compromised by malware, this poses a threat to a bank's network each time the user banks online.

Financial applications are now generating, on a daily basis, large amounts of consumer data. Analysis of large data can provide the bank new insights into consumer behavior. The analysis often necessitates accessing different data across the bank on a timely and consistent basis, which raises the need for data standardization, transparency and designing data systems that readily allow access from across the bank. However, with this need comes a new form of risk: cyber security.

The increased use of financial applications requires employees that understand the different applications, model assumptions, data collection and analysis. This requires the bank to hire talented people. It also places a responsibility on risk management and senior management to both understand the applications and the inherent risks.

There are different types of threats and different players. Banks can only effectively protect from cyberattacks if they prepare scenarios that provide guidance on how to respond. A scenario could be a foreign country has hacked into the bank's system and stole data and is holding the bank to ransom. Another threat is some essential services are disabled. How does the bank respond? What steps can the bank take to minimize the consequences of cyberattacks? What are the advantages of forming industry centers focusing on cyber threats?

Reputational risk can appear in many different forms: inappropriate behavior of the CEO or poor managerial behavior, such as recent events at Wells Fargo.¹¹ One type of reputational risk that is often over looked, is contagion risk: an event at one firm may cast a long shadow over firms in the same industry. For example, hackers might gain access of personal consumer information at a bank and this immediately raises the question of how secure is personal information at other banks? Senior

¹⁰ The Canadian Bankers Association estimates that 72 percent of Canadians primarily do their banking online. See Andrew Ross, October 26, 2017. "CBA's Remarks re a Study on Cyber Security and Cyber Fraud", Remarks to the Senate Committee on Banking, Trade and Commerce.

¹¹ See M. McGrath, "Legal Troubles Take a \$1 billion Bite Out of Wells Fargo Third Quarter Earnings", Forbes, November 13, 2017.

management could use scenario analysis to design appropriate actions and responses to this and similar contingences. It could start the analysis by asking what type of cyber contingencies does the bank expect to face? How effective are current measures? If a cyber event occurs at a competitor, will this affect the bank due to “guilt by association”? What defense mechanisms can the bank employ to minimize the risk? How does it communicate an effective response so the effects of contagion are reduced? Scenario analysis provides a platform to discuss these questions and to formulate a playbook on how to respond to external contingences.

Example: What Will Be the Impact on the Bank from a Single Factor?

Scenario analysis can be used to determine the sensitivity of different profit centers to changes in a single factor. Senior management can be unaware of the sources of a bank’s exposure to a single factor. Concentration risk in this form is often overlooked due to its opacity. For example, what is the impact on the bank if the price of oil drops by forty percent and is expected to remain low for a few years?

The bank must determine the primary and secondary impact on its different businesses. The price shock may impact equity positions in trading portfolios and wealth management, the value of loans to oil exposed firms, uses of lines of credit and the costs associated with hedging. It will also affect secondary firms and their employees.¹² Mortgages and auto loans may be adversely affected.

To undertake this type of analysis, the sensitivity of the different businesses within the bank to the single factor needs to be determined. This form of analysis is often undertaken within the risk management group in order to analyze correlation. However, the scenario may involve significant macro-economic changes, implying that estimates based on past data may be unreliable. During the credit crisis, default correlations across different regions in the U.S. went from being traditionally low, to being very high over a relatively short period of time.

Using Scenarios

Decision makers can explore the implications of different possible scenarios and attempt to identify the key driving factors and their relevant importance in influencing the outcomes. They can also identify the macro economic implications for the bank. A good analysis will describe the possible courses of action undertaken by the bank in response to the unfolding scenario. The end results should be described in accessible terms and disseminated within the senior ranks of the organization. The analysis may result in the bank undertaking actions to correct identified deficiencies. It may also result in the bank identifying pockets of value that it can capitalize.

The bank now has a playbook or contingency plan that can be used should the particular or similar scenario actually materialize. The scenarios a bank has considered should be posted on the bank’s intranet site. In some cases, firms are making scenarios public on their external website.¹³ This functions

¹² The effect of a primary firm on a loan portfolio containing secondary firms is analyzed in S. M. Turnbull, “Primary Firm Driven Portfolio Loss”, *Journal of Credit Risk*, 13, 2, (June 2017), 33-52.

¹³ Royal Dutch Shell makes the scenarios it has considered publicly available, “Shell scenarios, modelling and decision making”, September 6, 2017: http://www.shell.com/investors/news-and-media-releases/investor-presentations/2017-investor-presentations/shell-scenarios-modelling-and-decision-making-webcast/jcr_content/par/textimage_158f.stream/1504689440088/c43ed694792ad785ce1bc062ecc82f68b27f24

as a library for senior management. When new situations arise, the library can be searched to identify if similar situations have been analyzed.

Effective Challenge

Quantitative models are widely used in banks for a wide array of activities: underwriting of retail and commercial loans, valuing asset exposures for many different asset classes, risk management and determining economic capital reserves. In most models, simplifications are made, given data limitations and the need to speed up computation. How robust are these simplifications? As economic conditions change, the accuracy and robustness of the model may be compromised.

Following the Global Financial Crisis, where many participants had blind faith in some models, regulators introduced in April 2011 the idea of “effective challenge”.¹⁴

‘A guiding principle for managing model risk is “effective challenge” of models, that is critical analysis by objective, informed parties who can identify model limitations and assumptions and produce appropriate changes.’

Responsibility for effective challenge rests with senior management and the board of directors.

The underlying basis for scenario analysis is to challenge given assumptions and to explore the consequences of alternative assumptions. It is a natural tool to use to examine the consequences when a given economic regime changes. For example, in the run-up to the credit crisis, economic conditions underwent major changes. The correlations between house price changes in different states of the U. S., which traditionally had been quite low, greatly increased. This was one of the driving forces behind the crisis. In effective challenge, management should have asked, “what are the consequences if price correlations increase across between states?” “How will this affect the pricing of tranches on a diversified basket of mortgage backed securities?” As the credit crisis demonstrated, changes can occur very quickly.

Corporate Governance

Establishment of a strong risk management framework is one of the many responsibilities of a bank’s board and senior management. Part of that mandate is the ability to think “outside of the box”. To borrow from Donald Rumsfeld (February 12, 2002), “... But there are also unknown unknowns – the ones we don’t know we don’t know.” The board has the responsibility to think about events that could affect the bank and to actively participate in the choice of scenarios chosen by senior management. The whole point of scenario analysis is to think about different states of the economy and how the bank will be affected, and how to respond.

Failure on the part of a board to be attentive to the actions of management or to acquiesce to management decisions, might attract the attention of institutional investors who have a self-interest to monitor board activity. How will the board respond if an institutional investor starts a campaign

[ab6d316c8dee1ea824c7254c82/scenarios-modelling-and-decision-making-presentation-new-york-6-september-2017.pdf](https://www.federalreserve.gov/newsevents/pressreleases/ab6d316c8dee1ea824c7254c82/scenarios-modelling-and-decision-making-presentation-new-york-6-september-2017.pdf)

¹⁴ Board of Governors of the Federal Reserve System, Office of the Comptroller of the Currency, April 4, 2011. “Supervisory Guidance on Model Risk Management”.

opposing company shareholder recommendations? Recent events at Newell Brands Inc.¹⁵ and Deutsche Bank¹⁶ again high light the need for good corporate governance and an appropriately qualified board. It is up to the board to be proactive and to consider both its own actions and how external investors might react. Scenario analysis can be used as a tool to consider the consequences of board behavior. However, it does require qualified board members.

Case Study

While the emphasis of the discussion has focused on financial firms, scenario analysis is applicable to all firms, large or small. In this short case study, we consider a non-financial firm: Facebook Inc.

Background Material

Facebook belatedly acknowledged that it had allowed Russian bots to post misleading information about the American election in 2016, in an attempt to aid one of the candidates. More recently, Facebook acknowledges it allowed an academic at Cambridge University to collect personal data about Facebook users. The academic subsequently sold the data to a firm for commercial use. Facebook claimed this was a violation of its contract, the academic disputes this claim. Approximately 85 million records of Facebook users were sold. The CEO of Facebook waited a few days before making any public statements, despite massive media attention.

The European Union's General Data Protection Regulation (GDPR) comes into force May 25, 2018. This will have a major impact on firms that use personal data.

Issues

Q1. How will Facebook protect the privacy of its users? What rights will users have? Will Facebook be in compliance with GDPR?

Q2. How will Facebook establish the identity of its users, in order to avoid a repeat of bots spreading misleading information?

Q3. How will the change in privacy requirements affect Facebook's business model?

Q4. When Facebook sells to a firm access to its data, how will Facebook monitor the use of its data?

Q5. How can Facebook reestablish trust with its users? Should Facebook be taking the lead in the discussion about privacy of its users, instead of waiting for politicians to set regulation?

Q6. All firms face cyber risk. What category of risks does Facebook face and how will it respond if there is a cyber incident?

The benefits that flow from this form of analysis provide Facebook with an inventory of responses to possible future contingencies, such as providing guidance about re-establishing trust with its users. Facebook can either wait for politicians and/or regulators in different countries to set the discussion about user privacy or it can start to lead the discussion. Facebook at this point can ill-afford to be caught

¹⁵ Letter sent by Newell management to shareholders, March 14, 2018.

¹⁶ P. Jenkins, "Deutsche Bank and VW Highlight Perils of Poor Governance", Financial Times, April 17, 2018.

flat footed the next time a crisis happens. It needs a playbook to cover a wide range of possible contingencies and using scenario analysis could offer great benefit at this point.

Questions the Board Should Ask for Effective Risk Management

Interpreting the results from a scenario analysis requires skill. It often generates many new questions. Results from the analysis should be communicated to the Board, as this may generate a new set of questions. One of the functions of the board is to think about the risks the bank is facing. Many board questions center around the “known unknowns”. The following is a small sampling of such questions.

- Q1. What are the major revenue generators for the bank as a whole and for individual businesses? What are the risk profiles for the bank and for the individual businesses?
- Q2. What changes are envisaged over the next five to ten years and how will the bank respond?
- Q3. How robust are the current assessments of the risk/return profiles for the bank to the expected changes in the economy over the next five years?
- Q4. How does realized performance of a business compare to expected performance? What is the basis for compensation?
- Q5. How does the bank’s mix of businesses differ from its competitors? What are the causes for any differences and how what are the consequences?

An important function of a board is to raise question about the “unknown unknowns”, that is, to think about events that could have a major impact, either positive or negative, on the bank. Examples of such questions are given below.

- Q6. What steps is the bank taking to identify the next wave of cyber threats. What forms would the threat take if the perpetrator is a foreign government?
- Q7. Over the next 10 to 15 years, how will technology affect the bank and what steps is the bank taking to ensure it has the talent and resources to remain competitive?
- Q8. How is the bank enhancing effective challenge and scenario analysis for its risk management of its major exposures?
- Q9. How is the bank attempting to identify and analyze different investment strategies in the presence of increased cyber threats and rapidly changing technology?
- Q10. What are key emerging issues facing the bank and what are the implications for each line of business and the bank as a whole?

All of these questions are challenging senior management to move away from their comfort zone and to think about the known unknowns and the unknown unknowns.

Summary

In response to regulatory requirements, financial institutions have developed platforms allowing them to undertake scenario analysis. These platforms provide an invaluable set of tools to address a wide array of issues that financial and non-financial firms face: investment decisions that consider feedback

effects, a strategic response to the impact of disruptive technology, cyber threats, reputational risk, corporate governance, strategic decisions and effective challenge. While effective challenge is a regulatory requirement, it is an issue that all firms, irrespective of industry and size should undertake. With scenario analysis both senior management and the board have a tool that can improve their decision making ability.