

by Adam Litke

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## who are the stakeholders and what do they expect?

When the board of a firm determines how much capital to hold they are trying to satisfy several different constituencies. Regulators set minimum levels of capital which they think are sufficient to pay back protected classes of liability and to allow the orderly unwinding of the firm. Rating agencies set minimum levels of capital to obtain a given rating which, in turn, has a direct impact on funding costs. Finally, equity holders want the amount of capital to be low enough to allow them to earn a decent return on their investments without losing control of the company. It is interesting to note that shareholders have no interest in how much money is lost once the equity layer is wiped out. Protection of senior liability holders is provided only to obtain better funding rates or satisfy regulations.

Investors are in the same position as corporate boards. The money that they have invested is usually set aside for a specific purpose such as paying pensions or maintaining the spending power of endowments. Just like boards, they have conflicting goals. On the one hand, they must preserve capital – possibly adjusted for inflation. On the other hand they want to maximize long term spending power or ensure that plan sponsors do not have to make more contributions to the fund.

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## asking the question

The fundamental question that we must ask when determining risk appetite can be phrased in one of two ways:

*Under what circumstances are we willing to let the firm go under, the pension fund turn insolvent, or the endowment lose its purchasing power?*

Or

*How much excess capital do we want to hold so that after a bad event which cripples most of our competition, we can continue to write business at highly profitable levels when they are paralyzed? How do we ensure that we have dry powder for investing when the markets are under stress and there are buying opportunities? How do we ensure that we can meet our spending needs in tough times without destroying future purchasing power?*

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## the answer is stress tests

The key idea in both of these questions is event. Models and their associated confidence levels can be used to help understand the variability of returns. They are useful for aggregating risks across disparate portfolios. They may even be useful for obtaining a basic understanding of portfolio behavior in extreme events. What models cannot do is determine what these events are. It makes little sense to talk about holding capital at some multiple of 99 percent VaR or at the 99.90 percent confidence interval for credit losses over the next year. In addition to the false comfort of relying on extrapolation from a limited data set these numbers do not necessarily correspond to events that mean something.

So what should our capital stewards do? Stress scenarios should start with reasonable worst cases for the risk factors underlying the firm's portfolio. For banks and other investment firms, including pension funds and endowments, this would include severe bear markets with no asset liquidity, negative GDP growth, unemployment spikes and concomitant default levels for loans. For insurance companies this would include extreme loss events in each significant portion of the portfolio with some consideration for supposedly uncorrelated events happening at the same time. Any time somebody says something like "This happened in the past but it cannot happen again" or "This happened in that other country but it can't happen here" it is a good bet that all of the appropriate events have not been considered. The numbers that come out of these scenarios may be higher or lower than those that come out of the models but they are an indispensable reality check on the way the business is managed.

There are some events that an institution cannot hope to survive and are implicit in the business model. The most obvious of these is home country default. This is the main reason behind allowing banks to hold home country sovereign debt denominated in local currency at a zero risk weighting. The government of the home country has ultimate control over any assets that are held within its borders. While we like to think of the laws governing financial assets as being stable, the decisions made by a country that is in economic distress are fundamentally political ones. If the rulers of the country decide that nationalization of assets is in their best political interest, local banks will be vulnerable to default. If a city or state can no longer pay its obligations a bankruptcy court can rewrite the rules governing which creditors get paid first. When determining risk appetite, we must remember that there is no point in holding capital against those events where capital does not provide a defense.

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## parameterization

The scenarios we have been discussing are stress tests, and the first thing we need to do when creating a stress test is to make sure that it is both bad and plausible. Then we need to turn our scenario into the parameters that drive our portfolio. There are several steps to this process.

- Make a list of scenarios you should be worried about. There are two issues that need to be considered. What are the large concentrations of risk, no matter how benign they may seem, in your portfolio? Under which scenarios do you expect to fail?

- Convert these stories into parameters. This may be as simple as turning to the parameters in a risk model and rerunning a past event. We see this when banks replay the 1987 stock market crash or the 2007-8 market collapse. Insurance companies often replay specific catastrophes, such as a severe hurricane, against their current portfolio. It can be more difficult if the event has not yet occurred. Then the best defense is to look at other markets. Even if the US stock market has never stayed down for a 30 year period, it doesn't mean that other markets haven't. Any long term US equity investor should, at a minimum, run a scenario on the US market corresponding to Japanese stock market data from 1990 to 2014. It may not be a highly probable event, but it should factor into risk appetite.

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## robust stress testing

Risk is not linear. We begin with the notion that knowing how much you lose in a stress test is not enough to manage risk. This can be seen in a simple example from the mortgage book. Let's say that a bank makes a mortgage loan on a \$1 million house with a 20 percent down payment. Now, assume that the borrower defaults. As long as the house is worth at least \$800,000 (net of foreclosure costs) the bank gets its principal back and doesn't incur a loss. If the house is worth less than \$800,000, then the bank suddenly begins to lose money one-for-one with the value of the house. Remember that the value of the house may be a leveraged bet on the economy. For employment and, therefore, home prices there is a bigger difference between a change in GDP from 0 percent growth to -1 percent growth than there is from 1 percent growth to 0 percent growth. This means that the losses on the loan can accelerate as the economy gets worse. In a crisis, these losses can be highly non-linear. A bank can go from no losses to moderate losses to extreme losses. This is why many banks found their loan-loss forecasts falling off a cliff as the housing crisis worsened in early 2008. As the economy moved past critical levels, defaults skyrocketed, housing price depreciation accelerated and loan portfolios collapsed.

These types of losses are common in financial portfolios. While equity portfolios are linear, option portfolios are highly non-linear and credit portfolios are nothing more than out-of-the-money options, which don't render a loss because their strike price is away from the underlying security's price. The accelerating losses in our housing scenario are fundamentally the same as a short gamma position in an option, where exposure becomes larger as the price of the underlying asset decreases. The only linear instruments that banks hold in significant amounts are government bonds and those are only linear because banks default long before their home countries' default. This is Taleb's<sup>1</sup> notion of fragility in a portfolio. It can appear to be robust under reasonably large moves, but beyond a certain point the losses can accelerate. An anti-fragile portfolio is one that has decelerating losses in the tail. This is not about convexity or gamma in the traditional sense as these are concerned with risk in current market conditions; it is about negative convexity in the tails.

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<sup>1</sup> / [http://www.riosmauricio.com/wp-content/uploads/2013/05/Taleb\\_Antifragile.pdf](http://www.riosmauricio.com/wp-content/uploads/2013/05/Taleb_Antifragile.pdf)

We can capture non-linear effects by taking our original stress test and create two additional tests on top of it. Let's assume that the stress is a 20 percent fall in housing prices. Then our two new stresses will be a 21 percent and a 22 percent decline. If the difference between the 22 percent and 21 percent stress scenario is larger than the difference between the 21 percent and 20 percent stress scenario then we know that it is insufficient to describe the risk in the bank's portfolio. This is because losses are accelerating after the stress event.

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## from stress testing back to risk appetite

In the end a stress test tells us what we can lose in a very specific scenario. A well designed stress test can also tell you if you have risk hidden in the tails. In order to be useful there needs to be a continuous feedback loop between stress testing and stories. Risk appetite is all about being able to say what you think will happen to your portfolio in a bad event. Since no stress test is perfect, actual exposures need to be set a good deal below the level of failure, but failure should always be an option. Nobody who invests in a BB rated company expects the same level of safety as they do in an AAA rated company. They do expect a commensurate increase in returns. Good stress testing lets the risk takers explain to the true risk owners what their downside is in simple language. Imagine how much easier it would have been for banks to manage through 2008 or the Eurozone crisis if they had thought about a collapse in advance rather than simply stating that these events were outside the tail of their risk measurements

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Adam Litke is the Head of Enterprise Risk Services for Bloomberg. He is responsible for developing Bloomberg's strategy around risk models and software. Prior to this Adam was the head of Market Risk for the Securities and Investment Group of Wells Fargo and head of Market Risk for Wachovia where he managed market risk activities including quantitative risk management, counterparty risk modeling and direct management of market risk. Before that Adam worked for Barclays Bank, PLC as the head of Market Risk in the Americas and head of Market Risk for Global Financing. Adam also served as the Global Head of Market Risk for Swiss Re Financial Products, and spent several years in various management roles with BNP Paribas.

Adam is a trustee of the Georgia State University Risk Management Foundation and is a former advisory board member for the GSU masters program in mathematical risk management. He is also a past chairman of the Market Risk Program Committee for the New York Chapter of PRMIA.