

ALVAREZ & MARSAL READINGS IN QUANTITATIVE RISK MANAGEMENT

Stress Testing, Human Behavior and the Management of Capital
in the Post-Crisis World

Part One: Human Behavior in Financial Crises





STRESS TESTING, HUMAN BEHAVIOR AND THE MANAGEMENT OF CAPITAL IN THE POST-CRISIS WORLD

Bruce Stevenson | Managing Director | *Alvarez & Marsal*

INTRODUCTION

The U.S. banking industry has emerged from the most significant financial crisis in the past century. This crisis, coupled with the simultaneous Great Recession, had an impact on U.S. banks matched only by the Great Depression. For example, the U.S. banking industry as a whole had negative net income in 2009, a level of unprofitability not seen since 1934. The extraordinary losses incurred in this period prompted new laws and regulations designed to rebuild the strength of the banking system. U.S. banks now operate in a world defined by the capital that must be held in good times to permit survival in bad times.

The new focus on capital management places great emphasis on "stress testing" as a means of estimating capital needs during difficult periods. For example, the Dodd-Frank Act mandates that all banks of \$10 billion or more in assets conduct annual stress tests and formulate capital plans for each test (the so-called Dodd Frank Act Stress Tests [DFAST]). The Federal Reserve Bank (FRB) requires banks of \$50 billion or more in assets to participate in the separate Comprehensive Capital Analysis and Review program (CCAR). CCAR mandates capital plans for each of three scenarios of the U.S. macro-economy defined by the FRB and three different scenarios defined by each individual bank. The effectiveness of this stress testing is determined by assumptions made about the stress scenarios, the relationship of bank performance to the macro-economy stress impact on bank operations (including mathematical models thereof) and the behavior of markets and their participants in the stress scenarios.

In this paper and a subsequent future one, I examine what actually happens in periods of financial crises, specifically human behavior in periods of stress, and I suggest ways that bankers and regulators can make stress tests more sensitive to the impact of that behavior and its consequences for bank capital. The first paper emphasizes how stress-induced changes in people's attitudes toward risk significantly influence the value of risky assets, such as bonds and loans. In turn, bankers and other lenders change their willingness to underwrite and extend credit. As capital leaves the markets, economic contraction occurs, asset values fall and entities holding debt, such as banks, absorb losses proportionate to the degree of risk aversion and economic contraction.

The second paper examines the consequences of these dramatic swings in human behavior, including their impacts on banks. I observe that the structure of the stress scenarios and tests that make up CCAR and DFAST relies very heavily on descriptions of the macro-economy. In some cases, the human behavior implied in these scenarios does not align with how humans have behaved in past financial crises. Further, most regulatory stress tests rely on repetitive use of similar scenarios without recognizing that markets learn from past experience. Such repetition allows the markets to estimate both the probability and the outcomes of such scenarios, thereby allowing the scenarios to lose their shock value by becoming predictable.

I conclude that the current regulatory regime for stress testing over-emphasizes deterministic relationships between bank performance and changes in the macro-economy and under-emphasizes the role of dynamic human behavior on the capital markets and on the economy. Stress scenarios that explicitly anticipate the elevated levels of risk



aversion of investors, bankers and regulators, resulting from extreme circumstances not previously experienced, will better represent the conditions of stress for which capital planning is most relevant. Such scenarios imply a change to the regulatory regimes of stress tests and capital planning currently implemented by U.S. bank regulators.

WHAT ACTUALLY HAPPENS IN PERIODS OF STRESS?

The U.S. economy is never stable. Innovation, growth and contraction, creation and destruction are all part of the changes that take place. “Creative destruction” is the term applied to “the process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one” (Schumpeter, 1942). The financial markets that supply capital to the economy experience very similar patterns of growth and productive activity interspersed with contractions and, sometimes, shocks.

Human behavior changes with the ebb and flow in the economy, with some of the most pronounced changes in periods of economic and financial stress. In extreme stress, investors become very leery of risky assets and exhibit “flight to quality” (sale of risky assets and purchase of safe assets) (Chalmers et al., 2011). This flight from risk

is evident in the historical pattern of the VIX index of the Chicago Board of Trade (Figure 1). The VIX index measures the implied volatility of S&P 500 index options and the expected movement in percentage points (annualized) over the next 30 days. It is one measure of short-term volatility in equity markets and is often termed the “fear index.”

When the VIX index is high, investors in the U.S. move from risky assets to assets perceived to be low-risk or risk-free. In this shift, which can be quite sudden, they seek to preserve the principal value of their investments (Brocato and Smith, 2012). As shown in Figure 1, the VIX increased during periods of market stress, such as the Asian and Russian financial crises of the late 1990’s that gave rise to the notorious failure of the Long-Term Capital Management (LTCM) hedge fund. More recently, the VIX index reached all-time highs in late 2008 with the failures of Bear Stearns and Lehman Brothers. Low values of the VIX index were linked with positive investor sentiment towards risky assets, most notably the 2004 to 2007 period of rapid appreciation in equities and real estate.

The shock of the Lehman failure is evident in the sharp spike of the VIX in late 2008. Coincident with this spike, prices of U.S. equities (as measured by the S&P 500 index) fell by 25 percent. In fact, the long-term negative correlation between the VIX Index and the equity markets is strong.

FIGURE 1
U.S. Equity Markets
CBOE Volatility Index on S&P 500 (VIX)
1990-2015

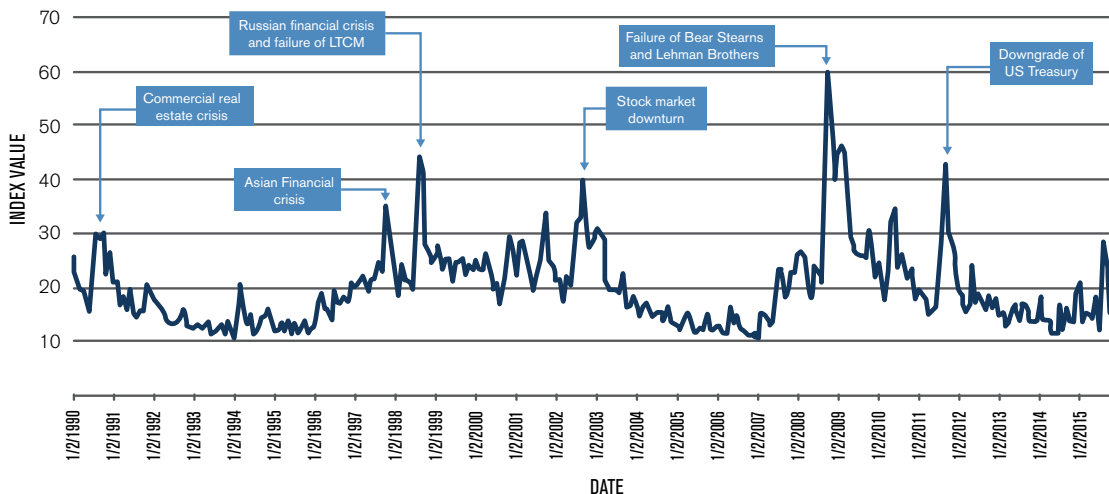
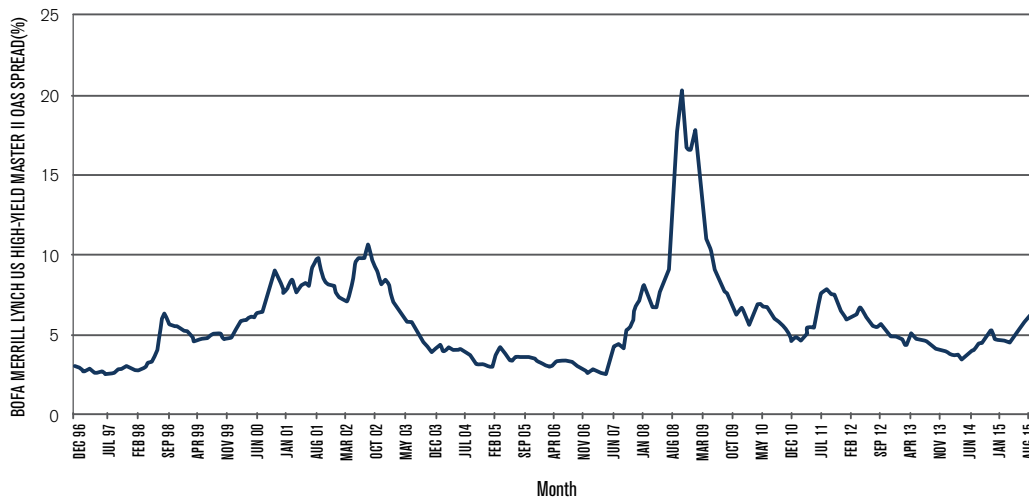


FIGURE 2
High Yield Spreads
Spread of High-Yield Bonds Over Treasuries
1997-2015



As investors flee risky assets in times of stress, they fly to assets of perceived safety, such as gold and Treasury bonds, as well as cash and money market funds, to preserve the principal value of their investments (Brocato and Smith, 2012; Caballero and Kurlat, 2009; Blengini, 2010; Chalmers et al., 2011). In severe stress, the flight to safety causes the prices of the low-risk assets to rise and, for low-risk fixed income assets, yields to fall. For example, in November 2008, the price of the 10-year Treasury rose to 106 and the price of the 30-year T-bond rose to nearly 118, with resulting bond yields well below the rate of consumer inflation (i.e., negative risk-adjusted returns).

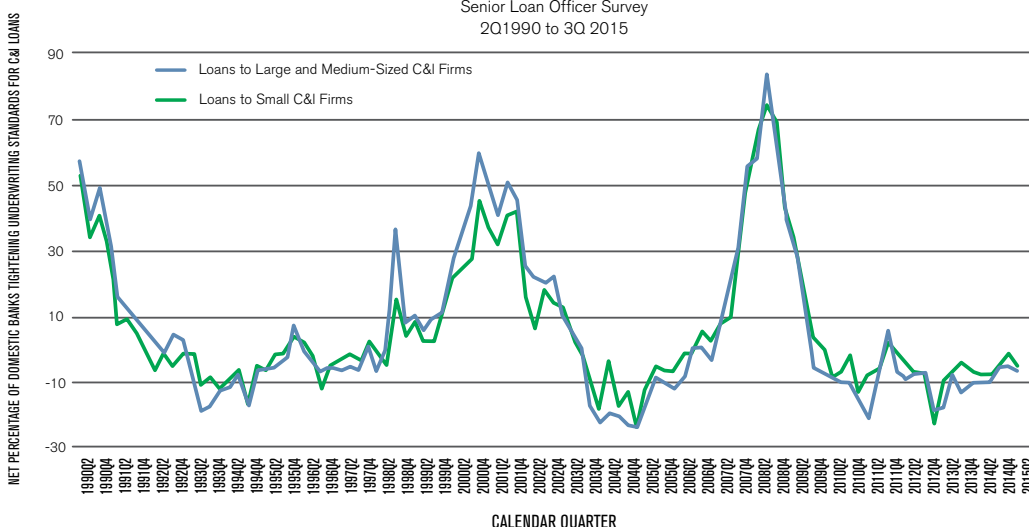
This aversion to risk in times of stress or crisis is clearly evident in the U.S. corporate bond market. For example, the spread between BB-rated corporate bonds and U.S. Treasuries, reflected in the BofA

Merrill Lynch High-Yield Master II OAS Spread, is highly sensitive to market stress (Figure 2). During the financial crisis, this spread spiked dramatically as high-yield investors actively sold non-investment grade bonds, driving down the price and driving up the yield.

Chalmers et al. (2011) also demonstrate that sophisticated investors shift to increasingly safe assets in anticipation of worsening market and economic conditions. Conversely, allocations to riskier assets increase when conditions are expected to improve.

We also see this shift in risk aversion within banks during stress. Figure 3 shows the temporal pattern of tightening and loosening of underwriting standards for commercial and industrial loans at U.S. commercial banks, revealing a pronounced cycle of loose

FIGURE 3
Federal Reserve Bank
Senior Loan Officer Survey
2Q1990 to 3Q 2015



underwriting (values close to zero or even negative) followed by sharp spikes of very rapid and intense tightening of those criteria. Since it is individuals within banks that actually change the loan underwriting standards, this cycle reflects the waxing and waning of those individuals' attitudes towards credit risk. When senior loan officers perceive credit risk to be low, they relax these standards and when, suddenly, they see that risk increasing, they tighten those standards (see Stevenson, 2014).

In the most extreme stresses and shocks, even the viability of the banks can be doubted, as was the case following the failure of Bear Stearns and Lehman Brothers in 2008. In the bank market, the key measure of investor sentiment is the TED spread or the difference between the 90-day London Inter-bank Offer Rate (LIBOR) and the 90-day Treasury bill (T-bill) (see Figure 4). Given that the T-bill rate is the riskless rate of return and LIBOR is the rate that banks charge one another for short-term inter-bank lending, the TED spread is a measure of the risk banks perceive in one another.

Figure 4 reveals that late 2007 and especially 2008 were periods in which LIBOR expanded significantly as banks became uncertain whether they would be repaid by the other banks to which they were lending. This so-called "counterparty default risk" grew, or at least the perception of it grew, and banks charged increased rates for this perceived increase in risk. Simultaneously, the Federal Reserve injected large amounts of liquidity into the U.S. economy, effectively depressing yields on Treasury securities and widening the TED spread.

Figure 4 also reveals that the TED spread widened after the stock market crash on October 20, 1987 and after the implosion of Long-Term Capital Management in 1998.

Comparison of Figures 1 through 4 quickly reveals the convergence of cycles in the VIX Index, the TED Spread, the spread of high-yield bonds and the tightening of loan underwriting standards. In times of crisis, investors (including banks) become highly averse to risk and they sell risky assets depressing their prices (and, for high-yield bonds, increasing their risk-adjusted yields). Under extreme duress, banks become leery of one another, causing the TED spread to spike.

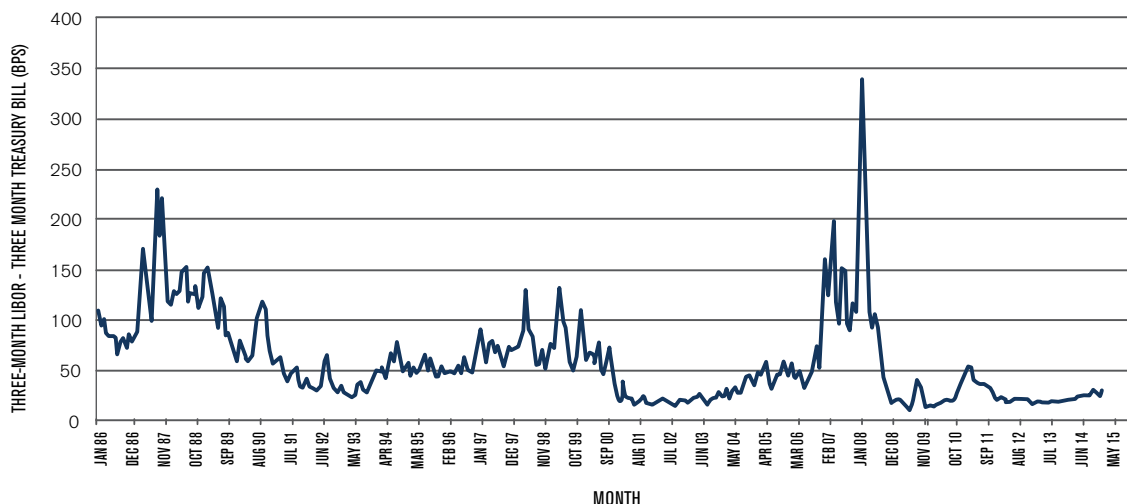
An important consequence of the flight from risky assets to low-risk assets is a convergence of markets. Long-term correlations between assets and between asset classes often change significantly as investors leave equities and move into fixed income and gold (Bloom et al., 2010). In fact, during severe stress, correlations between investment assets converge on extreme values by moving from low values close to zero in "normalized" markets to values that approach either -1.0 or +1.0. Inter-asset correlations are variables, known to change with shifts in the U.S. economy (Williams et al., 2010).

The fact that inter-asset correlations are not constant has major implications for bankers and risk managers. Major changes in correlations are driven by changes in investor behavior that themselves are driven by market events.

For example, correlations between equity markets increase toward +1.0 and correlations between equity markets and high-grade fixed-income markets, positive in quiescent periods, go sharply negative during stress as investors flee stocks for low default bonds. The spike in prices for Treasury bonds in late 2008 is an example.

I address this point in more detail in Part Two of this paper.

FIGURE 4
Global Banking Markets
TED Spread
1986-2015





KNIGHTIAN UNCERTAINTY

Some have argued that these behaviors are irrational, particularly those behaviors that lead to investors accepting negative real returns. Investors should always seek positive risk- and inflation-adjusted returns.

However, this argument does not distinguish between uncertainty and risk, which are different concepts (Keynes, 1921; Knight, 1921; Sarin and Wakker, 1998). Risk applies to future circumstances in which the outcome is unknown but for which the probabilities can be estimated accurately (Knight, 1921). "Knightian Uncertainty" refers to situations in which neither the outcomes nor their probabilities are known. In fact, as Caballero (2009) points out, each market participant can know his own local world but understanding all the possible linkages among those local worlds, especially during rare crises when the linkages become critical, is too complex. The change in paradigms resulting from the rare, crisis-related linkages triggers the massive Knightian Uncertainty.

Investors faced with Knightian Uncertainty focus on the extreme adverse outcomes even though such outcomes are unquantifiable. In extreme market stress, such as the financial crisis, investors realize their expectations about risk are invalid, transforming probabilistic outcomes into uncertainty. Under such circumstances, investors rid their portfolios of everything but the safest investments, such as U.S. Treasury bonds, leading to the well-documented flight-to-safety. Additionally, there is theoretical evidence that volatility may occur

as investors seek to determine prices for assets in a market that no longer conforms to pre-crisis, equilibrium conditions (Keynes, 1936; Epstein and Wang, 1994).

In these periods of extreme stress, markets for risky assets become illiquid and investors demand high premiums to purchase them. A core feature of panics caused by Knightian Uncertainty is that market participants behave as if the likelihood of a catastrophe is much higher than it actually is (at least in the absence of the panic itself) (Caballero and Kurlat, 2009).

DISASTER MYOPIA AND DISASTER MAGNIFICATION

Knightian Uncertainty is closely related to the concepts of "disaster myopia" and "disaster magnification" (Herring and Wachter, 2002). Disaster myopia describes excessive optimism in financial markets in which all outcomes are assumed to be benign. Investors and other market participants dismiss low-probability, high-magnitude events since they are typically outside of their own individual experience. Bankers project future losses to be low since they were low in the last (most recent) period. Premiums for risk fall as over-optimism about economic growth increases, excess capital (in the sense of Stevenson, 2010) flows into credit markets, and credit officers become overly optimistic and relax underwriting standards (Stevenson, 2014; Caprio and Honahan, 2009). The operative phrase is "this time it's different."

Disaster magnification characterizes excessive pessimism in which the worst possible outcome is foreseen over the horizon. Risk is perceived to be greater than it actually is, as measured objectively and, as a consequence, premiums for risk rise. Losses are assumed to be worse than their long-run averages. According to Caprio and Honahan (2009), the weak fundamentals of extreme credit expansions became evident to market participants and the process reverses. For example, falling real estate prices reveal the weak recoverability of property-related loans and erode the value of collateral. Asset sales by depressed borrowers seeking liquidity drive down the prices of other securities and the resulting economic disruption undermines the solvency of borrowers in unrelated sectors. The operative phrase is “the sky is falling.”

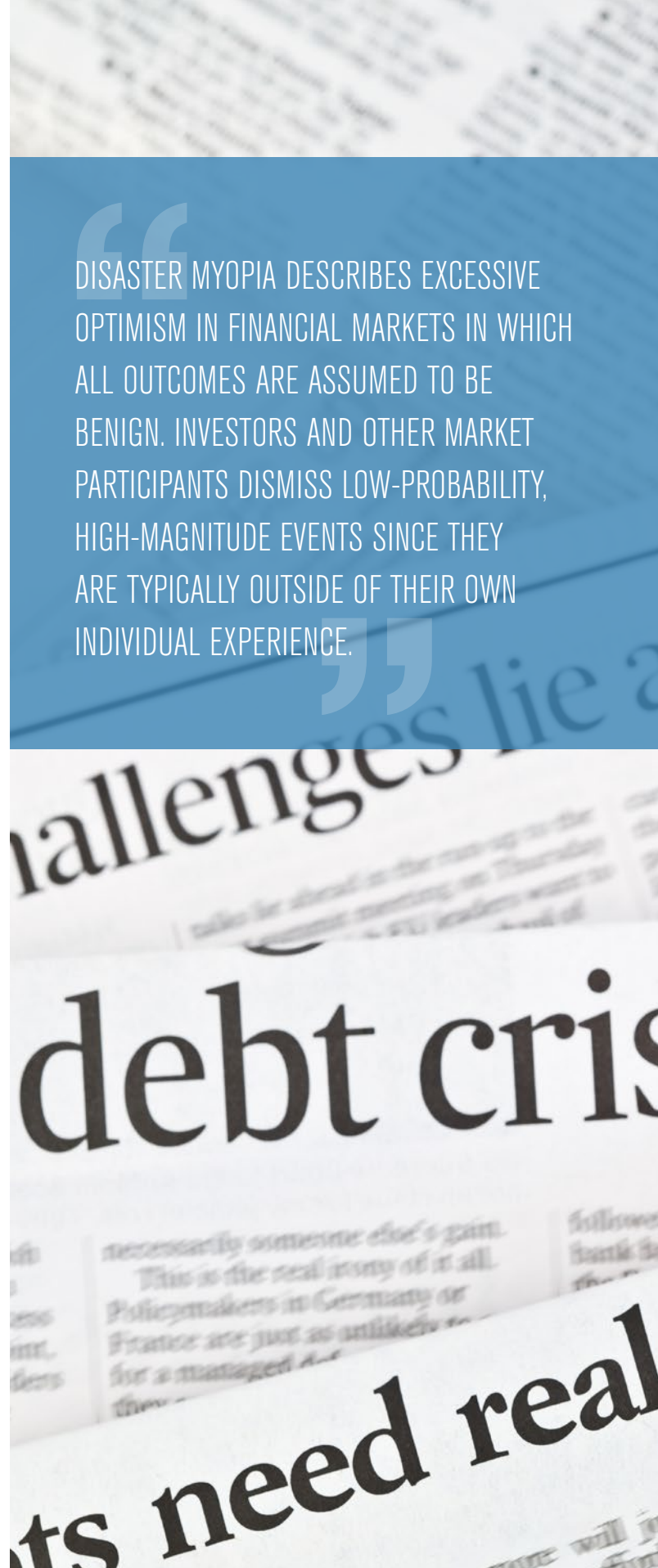
The tipping point of disaster myopia changing to disaster magnification typically is a negative surprise that is large, adverse, new and confusing (Caballero and Kurlat, 2009). Importantly, surprises that can trigger crises are not simply bad outcomes that are within the frames of reference of market participants (i.e., events with quantifiable probabilities from historical distributions) (Caballero and Kurlat, 2009). Rather, they are unforeseen changes in the market and economic environment itself, a shock. Such events trigger sharp rises in perceived uncertainty and a shift from managing quantifiable risk to estimating unquantifiable (Knightian) uncertainty, something that neither people nor institutions do well. Market participants rarely respond negatively to events that are familiar.

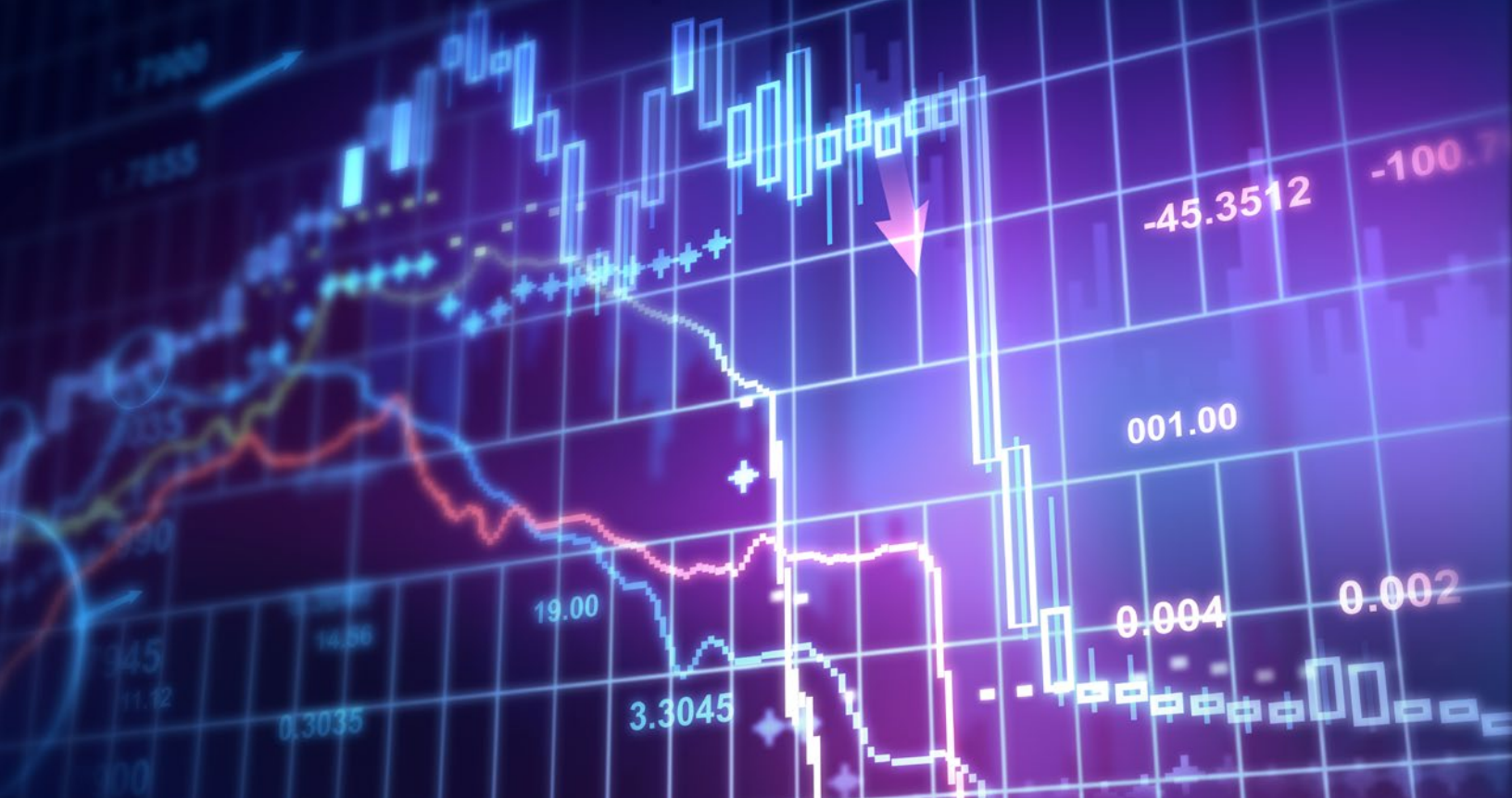
Caballero and Kurlat (2009) also observe that, for these negative surprises to become financial crises, two other factors must be present: (1) excessive concentration of aggregate risk in highly leveraged (systematically important) financial institutions and (2) response of relevant financial authorities that is too slow in addressing the consequences of the negative surprise coupled with excessive risk concentration.

As the surprise turns risk into uncertainty, the natural response of people, and leveraged institutions, is to withdraw into assets perceived to be riskless. A panic can trigger “fire” sales of risky assets that aggravate the impact of financial leverage and cause enormous damage to balance sheets and credit markets.

The events of the financial crisis are illuminating. During mid-2007, investors in securitizations of home mortgages began to realize that losses on the AAA-rated tranches of these securitizations were possible. At that time, it was not clear that such losses could impact banks and the broader financial markets. For example, low spreads on the AAA-rated tranches suggested that financial markets considered the resulting shock to housing-related assets, and its magnitude, to be unlikely.

“DISASTER MYOPIA DESCRIBES EXCESSIVE OPTIMISM IN FINANCIAL MARKETS IN WHICH ALL OUTCOMES ARE ASSUMED TO BE BENIGN. INVESTORS AND OTHER MARKET PARTICIPANTS DISMISS LOW-PROBABILITY, HIGH-MAGNITUDE EVENTS SINCE THEY ARE TYPICALLY OUTSIDE OF THEIR OWN INDIVIDUAL EXPERIENCE.”





However, as the losses adversely impacted banks creating and issuing new securitizations (e.g., new deals got stuck), suddenly and unexpectedly, the soundness of the financial system became questioned. The disruption of financial markets that resulted from this shock (the failures of Bear Stearns and Lehman Brothers and the run on money markets) was a true surprise, unexpected even after large losses from housing assets became a concrete possibility.

CONCLUSIONS

Financial markets are inherently dynamic. With economic growth, lenders and other investors in risky assets, such as equities and loans, typically earn positive risk-adjusted returns. However, periodic downturns put stress into the financial system and, rarely, such stresses become crises. These crises typically make risk-adjusted returns on risky assets negative as investors sell such assets and purchase Treasuries and other assets perceived to be of low risk.

Human beings participating in the financial markets are also dynamic and their individual and collective behaviors play key roles in shaping the dynamism of the markets. Such behavior can appear to be erratic and irrational with over-optimism leading to myopia about predictable, but low-probability, adverse events. Once such rare events occur, however, humans can overreact, magnifying the perception of adverse outcomes into “disasters” with adverse outcomes seen as more likely than their true probabilities, the so-called disaster magnification.

However, if the circumstances are both unfamiliar and adverse in the extreme, market participants can see these circumstances not as risky but as uncertain, meaning they can estimate neither the outcome nor its probability. This Knightian Uncertainty prompts extreme responses from investors, including an apparently irrational “flight to safety,” which have significant implications for banks and other institutional investors. We will investigate these impacts in the second installment of this paper.

REFERENCES

- Blengini, I. 2010. Portfolio decisions and flight to safety. Unpublished working paper.
- Bloom, D., P. Mackel, S. Williams, M. McDonald, R. Lynch, D. Fenn, and M. Austin. 2010. "Risk on – Risk off" – how a paradigm is born. HSBC Global Research Currency Weekly: 1-15.
- Brocato, J. and K. L. Smith. 2012. Sudden equity price decline and the flight-to-safety phenomenon: additional evidence using daily data. *Journal of Economics and Finance* 36: 712-727.
- Cabellero, R. J. 2009. Sudden financial arrest. Paper presented at the 10th Jacques Polak Annual Research Conference, International Monetary Fund, November.
- Caballero, R. J. and P. Kurlat. 2009. The "surprising" origin and nature of financial crises: a macroeconomic policy proposal. Prepared for the Jackson Hole Symposium on Financial Stability and Macroeconomic Policy, August.
- Caprio, G., Jr. and P. Honahan. 2009. Banking crises. In: *The Oxford Handbook of Banking*, Oxford University Press.
- Chalmers, J., A. Kaul, and B. Philips. 2011. The wisdom of crowds: Mutual Fund Investors' Aggregate Asset Allocation Decisions. Unpublished working paper.
- Epstein, L. G. and T. Wang. 1994. Intertemporal asset pricing under Knightian uncertainty. *Econometrica* 62(2): 283-322.
- Herring, R. and S. Wachter, 2002. Bubbles in real estate markets. Zell/Lurie Real Estate Center, Working Paper #402: 1-15.
- Keynes, J. M. 1921. *A Treatise on Probability*. London: Macmillan. Second edition (1948).
- Keynes, J. M. 1936. *The General Theory of Employment Interest and Money*. London: Macmillan.
- Knight, F. H. 1921. *Risk, Uncertainty, and Profit*. New York: Houghton Mifflin.
- Rosenberg, J.V. and T. Schuermann. 2004. A general approach to risk management with skewed, fat-tailed risks. Federal Reserve Bank of New York Staff Reports, no. 185. 58 pp.
- Sarin, R. and P. P. Wakker. 1998. Revealed likelihood and Knightian uncertainty. *J. Risk and Uncertainty* 16: 223-250.
- Schumpeter, J. A. 1942. *Capital, Socialism, and Democracy*. London: Routledge.
- Stevenson, B. G. 2014. The excess capital hypothesis and cyclical changes in loan underwriting. *RMA Journal*: 48-55.
- Stevenson, B. G. 2010. Credit crises: The excess capital hypothesis. *Bank Accounting and Finance*, October-November: 39-51.
- Williams, S., D. Fenn, M. McDonald, D. Bloom, and P. Mackel. 2010. "Risk on – risk off": the full story. HSBC Global Research, Currency Quant Special: 1-37.



Bruce Stevenson is a Managing Director with A&M in New York, with more than 27 years of experience in applying quantitative technology to challenges within the financial services industry. He has a unique blend of experience developing analytical solutions within banks and as a financial services consultant.

An industry thought-leader, Mr. Stevenson has published nearly 20 papers on risk management, portfolio management and quantitative analytics in lending and risk management journals.

Bruce G. Stevenson

Managing Director
Alvarez & Marsal
Financial Industry Advisory Services, LLC
600 Madison Avenue
New York, New York 10022
1-212-328-8595 (Office)
1-917-565-2593 (Mobile)



Companies, investors and government entities around the world turn to Alvarez & Marsal (A&M) when conventional approaches are not enough to activate change and achieve results.

Privately-held since 1983, A&M is a leading global professional services firm that delivers performance improvement, turnaround management and business advisory services to organizations seeking to transform operations, catapult growth and accelerate results through decisive action. Our senior professionals are experienced operators, world-class consultants and industry veterans who draw upon the firm's restructuring heritage to help leaders turn change into a strategic business asset, manage risk and unlock value at every stage.

LEADERSHIP.
PROBLEM SOLVING.
VALUE CREATION.

Follow us on:



For more information, visit www.alvarezandmarsal.com.