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The Corporate Finance Case for Deliberation-Oriented Stress Testing Regulation

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I. INTRODUCTION

In recent years, U.S. and European Union lawmakers and regulators have made stress testing of financial institutions to a central pillar of the financial regulatory regime.[1] Stress tests help financial institutions, as well as their regulators and other stakeholders, understand how an institution or system will respond to severe, yet plausible, stressed market conditions such as low economic output, high unemployment, stock market crashes, liquidity shortages, high default rates, and failures of large counterparties. The results of stress tests shed light on the tension points and weak links in portfolios and institutions that

* Associate Professor, Georgia State University College of Law. I thank the participants in the University of Connecticut Junior Scholars Workshop in Financial Services Law for putting me on the path that led to this Article.

1. *See* Patrick Jenkins & Brooke Masters, *Banks: Again Under Strain*, FIN. TIMES (July 7, 2011), *available at* http://www.ft.com/intl/cms/s/0/13e67092-a8c3-11e0-b877-00144feabdc0.html#axzz2wXZrsZHq ("Only since the financial crisis has stress-testing become a vital part of the regulatory arsenal."); Chester S. Spatt, *Regulatory Conflict: Market Integrity v. Financial Stability*, 71 U. PITT. L. REV. 625, 627 (2010) ("One of the most interesting innovations to emerge in the banking supervision model during the financial market crisis is the use of stress tests.").

could create extraordinary, but plausible, losses.[2] I have cautioned elsewhere that the potential of stress tests to foster a more stable financial system is higher if stress tests are conceptualized as multi-actor deliberations on how a firm might fail, rather than mere assurance, audit-like exercises that validate existing business practices and mathematical models.[3]

To date, however, assurance and audit norms have dominated stress testing practices and regulation.[4] The empirical fact of the industry's collective failure in recent decades to understand the causal channels through which its spectacular collapse would arise might be thought to be reason enough to re-orient stress testing regulation away from assurance and towards deliberation. But any normative argument in favor of deliberation-oriented stress testing (DOST) must consist of more than registering the failures of assurance-oriented stress testing (AOST).

Fortunately, the case for DOST is not limited to a critique of the track record of AOST. It is possible to make a positive case for DOST that is grounded in both basic corporate finance principles and organizational psychology-sociology. The organizational psychology-sociology argument posits that DOST might serve as a partial antidote to decisional pathologies that inhibit institutional learning at large organizations. These pathologies complicate institutions' efforts to understand the vulnerabilities that threaten to undermine their corporate objectives. To the extent that regulatory efforts to foster DOST successfully counteract those tendencies, these efforts *might* contribute to an incremental de-risking of financial institutions, and they *might* result in more reliable financial institutions and systems.[5]

2. *See generally* PHILIPPE JORION, FINANCIAL RISK MANAGER HANDBOOK 266–68 (3d ed. 2007).

3. *See* Robert Weber, *A Theory for Deliberation-Oriented Stress Testing Regulation*, 98 MINN. L. REV. 2236 (2014) [hereinafter Weber, *A Theory for Stress Testing*] (describing how policymakers should use stress testing as a tool of financial regulation). When using stress testing as an assurance tool, banks—or regulators in coordination with banks—assume a partial equilibrium model of the financial system; privilege static scenarios; draw from audit culture; rely on historical precedents in setting scenarios; examine test variables in isolation; require precise estimation; are motivated by compliance and verification concerns; and are mindful of how the relevant audience of the analysis will perceive it. By contrast, deliberation-oriented stress testing privileges dynamic scenarios; draws from business operations culture; relies on imagination; considers the interactivity of tested variables; remains open to uncertainty; and is motivated by governance concerns.

4. Some regulators have indicated their approval for greater emphasis on integrating stress test results into a more deliberative form of corporate governance. *See* BASEL COMM. ON BANKING SUPERVISION, PRINCIPLES FOR SOUND STRESS TESTING PRACTICES AND SUPERVISION 5 (2009) [hereinafter BCBS STRESS TESTING PRINCIPLES], *available at* http://www.bis.org/publ/bcbs155.pdf (concluding that, while bank managers view stress testing as an important risk management tool, stress tests should cover a greater number of severe scenarios).

5. To be clear, this theoretical prediction, which this Article aims to demonstrate, is a relatively modest one. It is largely silent with respect to trenchant microeconomic incentive problems that similarly inhibit institutional learning, such as the potential value destruction associated with managing for the benefit of short-term shareholders and the moral hazard engendered by ever-expanding government safety nets. *See* LYNN STOUT, THE SHAREHOLDER VALUE MYTH: HOW PUTTING SHAREHOLDERS FIRST HARMS INVESTORS, CORPORATIONS, AND THE PUBLIC 63–73 (2012) ("If stock prices do not always capture fundamental value, a conflict of interest exists between long-term investors who want directors to invest in the company's future, and short-term investors, especially activist hedge funds, who simply want to raise [the] share price today [by] cutting expenses, using cash reserves to repurchase shares, and selling assets or even the entire company[.]"); William W. Bratton & Michael L. Wachter, *The Case Against Shareholder Empowerment*, 158 U. PA. L. REV. 653, 696–705 (2010) (arguing that

The qualification here is necessary because it leaves unresolved a technical question concerning the mechanisms by which the firm's increased deliberation on stress will result in concrete changes in its business practices. This Article takes up this complementary question—which is in essence a corporate governance question concerning how financial firms make and act on decisions—by looking to basic corporate finance principles. It proceeds on the assumption that a successful DOST *regulatory* program will in fact result in an increased awareness on the part of executives, risk managers, and boards of directors of downside scenarios and the risks associated with prospective projects and investments. It is concerned, in other words, with what happens next.

When a financial institution shifts from an AOST orientation to a DOST orientation, its decision makers will have a heightened awareness of the riskiness of proposed projects. They will base their decisions on a different information set than they otherwise would have. This shift should in turn prompt two broad sets of responses by the institution's decision makers: (1) they will project lower future cash flows and investment returns for the project; and (2) they will discount those projected future cash flows with higher discount rates. In each case, these changes would lower the estimated present values of the prospective projects or investments. Thus, holding all else equal, a firm that ramps up its awareness of downside scenarios and potential failures should estimate lower project valuations for those projects or investments that are uncovered to be riskier than they would appear to the firm before it committed to a DOST program.

This final piece of this puzzle is to show how these estimated project valuations link up directly to the manner in which investment funds are allocated throughout the firm. According to the widely used "net present value rule" of capital budgeting, a firm should only invest in a project if it has a positive present value. The rule can be restated as requiring a proposed investment to have projected risk-adjusted returns in excess of the cost of the capital that would be required to invest in the project. On the margin, lower valuations should result in re-direction of capital away from those (newly appreciable) risky projects or investments that no longer yield positive net present values.

But the net present value rule is only one of many decisional tools that financial firms utilize when deciding how to allocate funds across businesses and projects. Large financial institutions that transact in fast-moving markets deploy a suite of decisional tools that provide information to decision makers concerning economic outcomes in an uncertain future. Focusing on DOST will flow through several of the more commonly used decisional

information asymmetries between shareholders and managers result in corporate underinvestment when managers seek to maximize stock prices due to pressures from short-term shareholders); Iman Anabtawi, *Some Skepticism About Increasing Shareholder Power*, 53 U.C.L.A. L. REV. 561, 579–83 (2006) (highlighting earnings management and greenmail as factors undermining firm valuation when managers seek to maximize short-term stock price); Simone M. Sepe, *Regulating Risk and Governance in Banks: A Contractarian Perspective*, 62 EMORY L.J. 327 (2012) (noting that safety nets attenuate debt holders' incentives to monitor risk, which in turn corrodes a central premise of the corporate governance infrastructure designed to prevent excessive risk-taking by banks); INT'L MONETARY FUND, GLOBAL FIN. STABILITY REPORT: MOVING FROM LIQUIDITY-TO GROWTH-DRIVEN MARKETS 107 n.9 (2014), *available at* http://www.imf.org/External/Pubs/FT/GFSR/2014/01/pdf/text.pdf ("Counting on the government's intervention in case of distress, [systemically important banks] may take on more risk than optimal even compared to other banks with similar balance sheets. Hence, while the expectation of government support lowers the expected loss given default of bond holders, the probability of default itself may increase and offset part of the reduction in the overall risk.").

tools and result in de-risking. Some of the more common tools are examined, including: value-at-risk techniques, expected shortfall metrics, performance evaluation tools such as risk-adjusted return on capital (RAROC), internal "economic capital" models, scenario analysis, decision tree analysis, and Monte Carlo modeling.

This Article proceeds as follows. To provide context, Part II summarizes the organizational psychology-sociology case for DOST. Part III explains how a DOST regulatory regime amounts to a public law intervention into corporate governance of financial institutions, and why that fits into a broader history of similar interventions. Part IV introduces discounted cash flow valuation and shows how DOST will effectuate a de-risking of project and investment selection through the net present value rule. Part V demonstrates how DOST will impact decision making through other information tools in ways that will result in de-risking. Part VI concludes.

II. A BRIEF SUMMARY OF THE ORGANIZATIONAL SOCIOLOGY AND PSYCHOLOGY CASES FOR DOST

This Article's main contribution to the scholarly literature on financial regulation is to explain *how* a DOST regulatory program, by fostering a heightened awareness of the possibility of failure or other downside scenarios, will in practice improve allocation of investment capital within the firm. The argument's validity depends on two premises: first, that DOST holds promise to promote the statutory objectives of financial regulators; and second, that regulatory initiatives to intervene into firm-level corporate governance so as to foster DOST have a credible chance of success. If either of these premises does not hold, then focus on the decision mechanics by which DOST affects firm investment policies is misplaced. This Part will summarize briefly why these premises are likely to hold.

First, DOST holds promise to promote the statutory objectives of financial regulators. Psychologists have revealed tendencies for people to use mental shortcuts in ways that inhibit organizational learning about risk. These heuristics, which might not raise public policy concerns or motivate regulatory programs in other contexts, have significant negative social ramifications with respect to financial institutions in light of the utility-like roles that they play in the financial system.[6] Regulatory initiatives to promote DOST norms should be conceptualized as attempts to affect the information set that key corporate governance actors within financial institutions take into account when making decisions that bind the firm. Such initiatives amount to interventions into corporate governance to encourage financial institutions to make better—from the perspective of regulators—decisions about how to take on and balance risk against expected returns.

As a matter of corporate law, the board of directors has the responsibility to set a financial institution's corporate risk policy, as a necessary incident to its responsibility to manage or direct the institution's business affairs.[7] For firms of even modest operational

6. These roles include the transformation of savings into investment capital (particularly for small and medium businesses that lack access to securities markets), monetary policy transmission, and payment systems integrity. *See* ANAT ADMATI & MARTIN HELLWIG, THE BANKER'S NEW CLOTHES: WHAT'S WRONG WITH BANKING AND WHAT TO DO ABOUT IT 17–30 (2013) (describing financial utility functions of banks).

7. *See, e.g.*, 12 U.S.C. § 73 (2012) (requiring directors of nationally chartered banks to take an oath to "diligently and honestly administer the affairs" of the bank); DEL. CODE ANN. tit. 8, § 141(a) (2010) (requiring

complexity—a group that includes nearly all financial institutions—the board of directors inevitably delegates the responsibility to put that policy into action to an appointed management cohort.[8] But how do these managers generate the information set to take into account when putting the policy into action?

As an operational matter, today's banks establish risk management departments that are responsible for producing uncertainty- and risk-related information for managers to utilize when making decisions.[9] It is best to think of these risk management departments as the organizational sub-units that consider how future uncertainties impact firm objectives. They are information production centers that trade in uncertainty and risk in an effort "to find the best possible decision to make when faced with uncertainty."[10] They are, not surprisingly, also the operational setting where stress testing occurs.

A risk management department that adopts a DOST outlook[11]—whether on account of prodding from the board, management, or regulators—is likely to produce a different information set than it would if it retained the customary AOST outlook. The incremental information set that the DOST firm will produce will consist of information about stress and failure that an AOST firm would not produce. That information is the sort that financial institutions are unlikely to generate on their own, as demonstrated by the recent history of stress testing practices.[12]

In a 2005 study, the Bank for International Settlements found that some firms had difficulty selecting "big picture" hypothetical scenarios.[13] It also reported that the overwhelming majority of stress tests were being conducted on trading portfolios alone, and that stress testing of credit exposures and liquidity needs lagged behind.[14] The preponderant use of stress tests remained model validation.[15] A joint Federal Reserve Board (FRB) and Office of the Comptroller Currency (OCC) horizontal review of model

that a board of directors manage the business of a corporation); N.Y. BUS. CORP. L. § 701 (2014) ("[T]he business of a corporation shall be managed under the direction of its board of directors."); REV. MODEL BUS. CORP. ACT § 8.01(b) (2011) ("[T]he business and affairs of the corporation shall be managed by or under the direction, and subject to the oversight, of its board of directors.").

8. Stephen M. Bainbridge, *Director Primacy: The Means and Ends of Corporate Governance*, 97 NW. L. REV. 547, 566–67 (2003) (explaining how "branching hierarchy" of managers with board-delegated authority addresses problems of bounded rationality and imperfect agent monitoring).

9. To many financial economists, as well as risk managers and other financial professionals, risk and uncertainty are mutually exclusive terms. Risk connotes measurable certainty and uncertainty connotes the residual uncertainty that cannot be quantitatively measured. *See* FRANK H. KNIGHT, RISK, UNCERTAINTY, AND PROFIT 233 (1921) ("To preserve the distinction . . . between the measurable uncertainty and an unmeasurable one we may use the term 'risk' to designate the former and the term 'uncertainty' for the latter."); *cf.* Glyn A. Holton, *Defining Risk*, 6 FIN. ANALYSTS J. 19, 20 (2004), *available at* http://www.jstor.org/stable/4480615 ("According to common usage, risk entails both uncertainty and exposure—possible consequences. Knight's distinction addresses only the uncertainty.").

10. DAN BORGE, THE BOOK OF RISK 12 (2001). Borge labels this objective the "Holy Grail of risk management." *Id.*

11. Hereinafter, such a firm will be referred to as a "DOST firm."

12. *See* Weber, *A Theory for Stress Testing*, *supra* note 3, at 2268–73 (discussing the shortcomings of assurance-oriented stress testing).

13. *Id.* at 22.

14. *Id.* at 42.

15. *Id.*

validation practices at large banks found that bank practices were deficient even for that basic AOST function.[16] A 2009 Government Accountability Office report on risk management at U.S. banks singled out banks' failure to create a scenario for the hardly remote possibility of a severe downturn in the economy.[17]

In 2006, the FRB—the lead U.S. regulator for bank holding company groups—conducted its own investigation of bank stress testing practices. The FRB conducted the study to familiarize itself with the full range of stress testing practices in an effort to prepare supervisory guidance.[18] The study found that none of the banking groups had an integrated stress testing program that incorporated all major financial risks on an enterprise-wide basis.[19] Instead, banks were stress testing the impact of adverse events on individual products and business lines rather than on the institution as a whole. The tests did not take into consideration the dynamic interaction among risk factors or portfolio exposures.[20] Even more troubling, none of the investigated groups were regularly conducting worst-case scenario analysis involving insolvency scenarios. In light of this track record, bank supervisors have correctly assigned a portion of the blame for the most recent financial crisis to deficient stress testing—in other words, to the failure to generate and consider adequate information concerning the causal channels through which failure could occur.[21]

There are reasons to be optimistic that a DOST outlook would result in risk managers generating a different information set for use by the firm. DOST might counteract decisional pathologies—such as the disqualification heuristic, the outcome bias, the overconfidence bias, and the hindsight bias—that inhibit organizational learning. Our ability to update expectations in light of new information is frustrated by the *disqualification heuristic*, which describes our tendency to disqualify disconfirming information, highlight confirming information, and neglect information that contradicts prior convictions.[22] The disqualification heuristic is related to the so-called *overconfidence* bias, *hindsight* bias, and *outcome* bias. The overconfidence bias describes our tendency to have inflated subjective perceptions of our correctness.[23] The hindsight bias refers to our

16. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-09-499T, FINANCIAL REGULATION: REVIEW OF REGULATORS' OVERSIGHT OF RISK MANAGEMENT SYSTEMS AT A LIMITED NUMBER OF LARGE, COMPLEX FINANCIAL INSTITUTIONS 21 (2009), *available at* http://www.gao.gov/products/GAO-09-499T (reporting that the review revealed that banks "lacked requirements for model testing, clearly defined roles and responsibilities for testing, adequate detail for the scope or frequency of validation, and a specific process for correcting problems identified during validation").

17. *Id.* at 22.

18. *Id.* at 4.

19. *Id.*

20. *Id.* at 23.

21. *See* BASEL COMM. ON BANKING SUPERVISION, PRINCIPLES FOR ENHANCING CORPORATE GOVERNANCE 5 (2010), *available at* http://www.bis.org/publ/bcbs176.pdf.

22. *See* Lee Clarke, *The Disqualification Heuristic: When Do Organizations Misperceive Risk?*, 5 RES. IN SOC. PROBS. & PUB. POL'Y 289, 289 (1993) (using the Exxon oil spill to illustrate that "[o]rganizations and experts suffered from the disqualification heuristic, a mechanism that leads experts and decision makers to neglect information that contradicts conviction").

23. *See* Sarah Lichtenstein et al., *Calibration of Probabilities: The State of the Art to 1980*, *in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 306, 314 (Daniel Kahneman et al, eds., 1982) ("The most pervasive finding in recent research is that people are overconfident with general-knowledge items of moderate or extreme difficulty.").

tendency to overestimate the amount of information we thought relevant at the time we made a decision.[24] The outcome bias describes our tendency to evaluate events in ways that are anchored on observed outcomes.[25]

Together, these biases result in key corporate decision makers overlooking accumulating evidence of anomalies, overestimating the validity of their expectations, and struggling to distinguish narrowly avoided catastrophes from outright successes.[26] Nick Pidgeon and Barry Turner's "disaster incubation theory" formalizes these decisional pathologies and shortcuts into an organizational theory: weak signals of disaster are ignored during a latent phase of "disaster incubation" before pushing systems into disaster modes.[27] As a result, corporate decision makers do not usually experience failure and stress as *proximate* events. Research into the psychology of proximity has demonstrated that proximity is a decisive factor in determining how an event is processed: "[A]s proximity to calamity or success increases, the likelihood of strong reactions to the ultimate outcome increases, counterfactual dwelling on ways the outcome could have been altered increases, and behavioral changes are more likely to follow, especially with respect to potentially repeatable outcomes."[28]

Recently, psychologists have made further discoveries that people interpret near-miss events—that is, narrowly avoided catastrophes—not only as non-proximate, but also in ways that actually *lower*, rather than heighten, their perceptions of risk.[29] This troubling finding suggests the counter-intuitive result that narrowly avoiding catastrophe makes us less likely to perceive the risks associated with our activities and might even reduce our ability to engage in learning. These decisional pathologies are prevalent in the context of governance of financial firms and are among the most severe threats to financial stability because they inhibit managers' and board members' ability to understand risk.

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24. *See* Baruch Fischhoff, *Hindsight ≠ Foresight: The Effect of Outcome Knowledge on Judgment Under Uncertainty*, 1 J. EXPERIMENTAL PSYCHOL.: HUM. PERCEPTION & PERFORMANCE 288, 297 (1975).

25. *See, e.g.*, Jonathan Baron & John C. Hershey, *Outcome Bias in Decision Evaluation*, 54 J. PERSONALITY & SOC. PSYCHOL. 569 (1988).

26. *See* KARL E. WEICK & KATHLEEN M. SUTCLIFFE, MANAGING THE UNEXPECTED: RESILIENT PERFORMANCE IN AN AGE OF UNCERTAINTY 26 (2007) (discussing the two problems that a biased search sets in motion: "you overlook accumulating evidence that events are not developing as you thought they would" and "you tend to overestimate the validity of your expectations").

27. *See* NICK PIDGEON & BARRY A. TURNER, MAN-MADE DISASTERS 71–84 (2d ed. 1997) (discussing the time sequence leading up to a disaster, and in particular "[t]he incubation period[, which] starts when the first discrepant event occurs unnoticed and . . . is brought to a conclusion by a precipitating incident which produces a transformation, revealing the latent structure of the events of the incubation period"). Other students of disasters and failures object that any systematic effort to discover weak signals of impending failure is bound to fail for complex systems, such as the financial system and its constitutive institutions and their portfolios. *See, e.g.*, CHARLES PERROW, NORMAL ACCIDENTS: LIVING WITH HIGH-RISK TECHNOLOGIES (2d ed. 1999) (arguing that system failures are inevitable, but also unpredictable, where system components are tightly coupled and exhibit interactive complexity); Robert F. Weber, *Structural Regulation as Antidote to Complexity Capture*, 49 AM. BUS. L.J. 643, 665–704 (2012) (explaining why the financial system is complex in light of, among other things, Perrow's normal accident theory).

28. Adam J. Hirsch & Gregory Mitchell, *Law and Proximity*, 2008 U. ILL. L. REV. 557, 570.

29. *See* Robin L. Dillon & Catherine H. Tinsley, *How Near-Misses Influence Decision Making Under Risk: A Missed Opportunity for Learning*, 54 MGMT. SCI. 1425, 1425 (2008) ("[I]t is harder for [organizations] to learn from 'near-misses' . . . because they evaluate such events as successes and thus feel safer about the situation.").

These results are worrisome from the perspective of risk management and stress testing. The tendency to normalize unexpected events—for example, localized pockets of increasing loan delinquency or market rumors of liquidity concerns—results from a failure to relate the event to a causal script involving the possibility of failure. It is easy to imagine how this plays out in the production of risk-related information within the firm: in the relative quiescence of present market conditions, market anomalies are normalized or, worse still, interpreted as signs of the robustness of the same quiescent conditions. This is a familiar story of how—despite the enormous resources devoted to developing the "sophisticated" risk management systems—clusters of weak signals of impending catastrophe became blind spots and went unheeded by risk managers, executives, directors, and regulators. These decisional pathologies together constitute a serious threat to the objectives of financial regulation[30] and justify a regulatory intervention, provided such an intervention stands a chance at success.

This Article's second premise is that regulatory initiatives to intervene into firm-level corporate governance to foster heightened focus on risk and failure do indeed have a credible chance of success. Using public regulatory power to institutionalize DOST norms presents unique challenges because the open-ended and indeterminate character of such efforts is a poor fit with the predominant conceptions of administrative law. It is easy to understand why regulators have so far opted for an AOST approach. It is much easier to implement a regulatory regime based on verifying and validating decisions taken by corporate firms. A basic precept of corporate law in any capitalist economy is that boards and their delegated executives decide how to invest the firm's capital and assume risk. A regulatory effort to encourage stress testing as deliberation amounts to an attempt by public authorities to affect the means by which those decisions are made, making it an awkward fit for traditional administrative law.

In other work, I have proposed a three-part framework to guide efforts to implement a regulatory regime that encourages such uses of stress tests.[31] This proposed three-part framework consists of: (1) conceiving of regulatory efforts to promote DOST as *management-based regulation* that acts on corporate planning processes rather than on corporate actions or outputs; (2) encouraging *quantitative skepticism* within bank risk management departments; and (3) seeking to embed corporate governance principles shared by so-called *high-reliability organizations*—such as nuclear power plants, air traffic control systems, and wildfire fighting crews—that remain committed to resilient performance and zero tolerance for failure even in conditions of uncertainty and volatility.[32] Such a regulatory approach would amount to committing public regulatory resources to an effort to alter the internal decisional infrastructure within which a bank investigates and considers action in light of the possibility of failure. If successful, DOST could emerge as an antidote to the decisional pathologies described above that will ensure that corporate decision makers have access to a wider information set concerning the possibility of failure and catastrophe.

30. This failure, it should be noted, is different from the familiar microeconomic incentive-related explanations about financial crises. *See supra* note 5.

31. *See* Weber, *A Theory for Stress Testing*, *supra* note 3, at 2301–24 (illustrating the three principles guiding the "use of regulation to institutionalize deliberation-oriented stress testing").

32. *Id.*

III. REGULATORY INTERVENTIONS INTO CORPORATE GOVERNANCE ARE ALREADY COMMONPLACE

The prospect of public administrators meddling with how corporate financial institutions generate, consider, and act on information might appear at first blush to run afoul of basic notions concerning how the law allocates discretion over corporate affairs. These concerns are misplaced because public law interventions into the corporate governance of financial firms are commonplace and consistent with both corporate law and administrative law.

Managers of financial institutions must undertake a basic valuation exercise when deciding how much leverage to use in making an investment, or how to invest in a business line or portfolio of loans or securities. Project valuation therefore affects how financial institutions *decide* to allocate capital and take on risk. And financial institutions fail or succeed based on those decisions. As a result, project valuation also impacts the financial regulatory agencies' ability to promote their twin statutory objectives: i.e., safety and soundness of individual institutions and the systemic stability of the financial system as a whole. It is therefore surprising that the organizational settings—or, in other words, the corporate governance systems within which managers exercise their discretion in performing these valuation tasks—have attracted relatively little academic attention from scholars of corporate finance and financial regulation.

Legal scholars have not focused on this concern because the basic precepts of corporate law direct them elsewhere. As a matter of legally imposed fiduciary responsibilities, corporate business decisions are left to the discretion of a corporation's board of directors, which is empowered to delegate operational duties to employee managers.[33] Thus, stockholders cannot mount a judicial challenge to the board of directors' actions, even in connection with disputes over matters that directly impact the stockholder's expected returns, such as dividend policy. Instead, stockholders' ability to affect risk policy in most cases is limited to electing new directors or simply expressing their views by selling shares.[34] Other affected stakeholders—such as employees, localities, voluntary creditors, tort claimants, and counterparties—are even less empowered to challenge the board or management's exercise of discretion over corporate affairs. Nevertheless, the state's regulatory authority is bounded only by state and federal constitutional law and, to the extent that the power is wielded by an administrative agency, the agency's enabling statute. This is where administrative law and corporate law intersect.

Congress, state legislators, and state and federal financial regulators routinely intervene in the corporate governance of financial institutions. The most important example of these interventions is the solvency supervision of financial institutions. In the U.S. banking context, regulators refer to these responsibilities as "safety and soundness" regulation.[35] The linchpin of safety-and-soundness regulation is the capital adequacy

33. *See* DEL. CODE ANN. tit. 8, §§ 141(a), 142(a) (2012) (establishing that the business and affairs of every corporation are managed the board of directors, which may delegate powers to officers).

34. Of course, the duty of loyalty also protects stockholders' interests where directors or managers are engaging in self-dealing at the stockholders' expense.

35. The theoretical justifications for this supervisory role are twofold. First, the government, whether through formal guarantee programs such as banking deposit insurance and state insurance guaranty funds or

regime. The main purpose of the capital adequacy regime is to ensure there is an adequate loss-absorbing buffer of capital to permit the firm to operate reliably, even in cases of unexpected losses.

Less well-known is that the regime also amounts in practical effect to a state intervention into the corporate governance systems of banks that are otherwise the exclusive province of bank boards. In other words, public administrative law intervenes where corporate law provides for no intervention authority on the part of private stakeholders. Specifically, the regime is often said to impose a "risk tax" on banks in the form of an equity cushion. To take a simple example, if a bank with $100 in assets is subject to a requirement that it maintains a 10% capital ratio, then it must maintain a minimum $10 of equity capitalization. This equity capitalization, which at the most basic level means the bank must not let its liabilities exceed 90% of its assets, is referred to in the banking sector as "capital."[36] In this example, the bank would have $90 in liabilities and $10 in capital.

If the bank wishes to acquire another $10 of assets, it cannot raise $10 in debt or deposits (both liabilities) to do so, because that would result in a capital ratio below 10%—specifically, the ratio would be 9.09% (i.e., $10 of capital ÷ $110 of total assets = 0.0909). Instead, the bank must either: (a) retain—that is, not distribute to stockholders—at least $1[37] of earnings over time; or (b) raise at least $1 by selling stock.[38] In the former case, stockholders suffer from reduced dividend payments; and in the latter case, stockholders suffer from having their proportionate share of the bank's common stock diluted as new shares are issued. In either case, the stockholders, as owners of the firm, internalize to some extent the cost to the government—in the form of increased systemic instability and heightened expectations of recourse to deposit insurance—that increasing assets without

through informal political realities of bailout expectations, is a contingent creditor of the financial sector. In this way, safety-and-soundness supervision is the public analogue of private "regulation" that counterparty creditors impose contractually. Second, because the political costs of a breakdown in the financial system—including most prominently the payments system, the monetary transmission mechanism, and the savings transformation function—are unacceptable in a democratic society, the state has a de facto obligation to ensure the integrity of the financial system. *See* Adam J. Levitin, *In Defense of Bailouts*, 99 GEO. L.J. 435, 446–51 (2011) (defining systemic risk in political terms as "the risk of socially unbearable macroeconomic consequences of microeconomic failures").

36. *See* ADMATI & HELLWIG, *supra* note 6, at 6.

37. If the bank retains $1 of earnings and funds the remaining $9 of the $10 balance sheet expansion with deposits or other debt, it will have $11 of capital (because the $1 of retained earnings will be added to the existing $10 of the bank's capital) and $110 of total assets, resulting in a 10% capital ratio (i.e., $11 of capital ÷ $110 of total assets). In funding the $10 balance sheet expansion, the bank could rely to a greater extent on retained earnings, which would result in a higher capital ratio. For instance, if the bank retained $5 of earnings and raised $5 in the deposit market, it would have a capital ratio of 13.6% (i.e., $15 of capital ÷ $110 of total assets).

38. For purposes of capital accounting, issuing common stock is the equivalent of retaining earnings; in each case, the bank increases its capital. Applying the same logic from the retained earnings example in the preceding footnote, the bank could raise greater amounts of equity capital (i.e., common stock) as part of a mixed debt-equity fundraising effort to fund the balance sheet expansion. For instance, if the bank sold $5 of common stock and raised $5 in the deposit market, it would similarly have a capital ratio of 13.6% (i.e., $15 of capital ÷ $110 of total assets). Of course, the bank could also decide to fund the equity portion of the balance sheet expansion by mixing stock issuance and earnings retention.

increasing capital loss buffers necessarily entails.[39] Hence, the use of the phrase "risk tax" to describe this effect of capital adequacy regulation.[40] By way of the risk tax effect, the capital adequacy regime intrudes, albeit indirectly, into the paradigmatic domains of board and managerial discretion: dividend policy and capital structure decisions. Other examples of regulatory intervention into corporate governance in furtherance of supervisory mandates include review of compensation policies[41] and risk management practices.[42]

Stress testing regulation should be conceptualized as a further intrusion into the corporate governance of financial institutions. As a historical matter, then, regulatory intervention into corporate decision-making has constituted a feature of financial regulation for decades.[43] But, as noted above, practical and theoretical consideration of the organizational settings within which these core corporate decisions are made lags behind the development of corporate decision-making practices. This Article contributes to the catch-up effort to explain why these regulatory interventions, which are already features of the regulatory regime, make sense. In particular, it describes how stress testing regulation will likely affect corporate decisions by changing the ways firms value projects and process risk-related information.

39. *See* WILLIAM A. KLEIN & JOHN C. COFFEE, JR., BUSINESS ORGANIZATION AND FINANCE: LEGAL AND ECONOMIC PRINCIPLES 343–46 (2007) (discussing how increased leverage heightens the probability of default). Another way of stating this proposition is that increased leverage entails higher expected costs to the government. Asset growth without corresponding growth in capital necessarily leads to increased *leverage* because a lower proportion of the bank's assets are funded with equity capital.

40. Another way in which capital adequacy regimes impose risk taxes is through the system of risk weights. Technically speaking, the above textual description describes a *leverage* ratio rather than a *capital* ratio. The capital ratio functions the same way, but expresses the relationship between capital and "risk-weighted assets," a quantity determined by applying risk weight multipliers to the assets. Thus, for example, a 35% risk weight applies to residential mortgage loans and a 75% risk weight applies to commercial mortgage loans. As a result, the acquisition of a portfolio of commercial mortgages will increase risk-weighted assets (i.e., the ratio denominator) by more than an acquisition of residential mortgages of identical size, and therefore require the bank to maintain a larger capital cushion to ensure compliance with the minimum capital ratio requirement. There is a higher "risk tax" associated with commercial mortgages than with residential mortgages, reflecting a perception that residential mortgages are less risky than commercial mortgages. The risk tax is therefore calibrated to the perceived riskiness of the asset.

41. *See, e.g.*, Guidance on Sound Incentive Compensation Policies, 74 Fed. Reg. 36,395 (June 25, 2010) (promulgating guidelines "designed to help ensure that incentive compensation policies at banking organizations do not encourage excessive risk-taking").

42. *See* Robert F. Weber, *An Alternative Story of the Law and Regulation of Risk Management*, 15 U. PA. J. BUS. L. 1005, 1031–58 (2013) (chronicling the emergence of risk management as a focus of bank supervision).

43. The Basel Committee's first multilateral capital adequacy agreement regime, known as "Basel I," was published in 1988, although U.S. banking regulators had imposed generally applicable capital requirements before then. *See* Robert F. Weber, *New Governance, Financial Regulation, and Challenges to Legitimacy: The Example of the Internal Models Approach to Capital Adequacy Regulation*, 62 ADMIN. L. REV. 783, 799–804 (2010) (providing a brief history of the regulation of bank capital adequacy in the United States before Basel I, and the impact and formation of the Basel Committee).

IV. STARTING WITH THE BASICS: HOW DOST WILL IMPACT CORPORATE DECISION-MAKING THROUGH THE NET PRESENT VALUE RULE

This Part will introduce discounted cash flow valuation and the net present value rule. These are the foundational informational tools that businesses use in deciding how to commit funds to projects and investments. Because DOST will alter the risk-related information set that financial institutions take into account when conducting discounted cash flow valuation and using the net present value rule, it should affect decision outcomes in predictable ways. In particular, it should cause firms to reject projects and investments that the new risk information reveals to have negative net present values.

According to the widely used "net present value rule"[44] of financial management, corporate managers should invest capital in projects that have a positive net present value.[45] When considering alternative projects, the net present value rule directs financial managers to select the project with the highest net present value for the firm. This task requires financial managers to *value* the projects.

Business school corporate finance textbooks start with an introduction to basic valuation principles: the present value of an asset or project—often referred to as its "discounted present value" (DPV)—is the sum of its expected net cash flows discounted to present value.[46] The following equation reflects this relationship:

$$DPV = \sum_{t=0}^{N} \frac{FV_t}{(1+i)^t}$$

44. *See* ASWATH DAMODARAN, INVESTMENT VALUATION: TOOLS AND TECHNIQUES FOR DETERMINING THE VALUE OF ANY ASSET 871 (3d ed. 2012) ("One of the foundations of investment analysis in traditional corporate finance is the net present value rule."); John R. Graham & Campbell R. Harvey, *The Theory and Practice of Corporate Finance: Evidence from the Field*, 61 J. FIN. ECON. 187, 197–98 (2001) ("Most [survey] respondents select net present value and internal rate of return as their most frequently used capital budgeting techniques . . . ."). The internal rate of return method to which Graham and Harvey refer also requires predictions of future cash flows and the fixing of appropriate discount rates to estimate the opportunity cost of capital. *See* RICHARD A. BREALEY ET AL., PRINCIPLES OF CORPORATE FINANCE 103 (10th ed. 2011) ("The IRR Rule is a close relative of NPV and, when used properly, it will give the same answer."); *id*. at 109 ("The internal rate of return rule is to accept an investment project if the opportunity cost of capital is less than the internal rate of return.").

45. *See* R. CHARLES MOYER ET AL., CONTEMPORARY FINANCIAL MANAGEMENT 179 (12th ed. 2012); WILLIAM W. BRATTON, CORPORATE FINANCE: CASES AND MATERIALS 49–50 (7th ed. 2012) (stating that under the net present value rule, an investment is acceptable if "the present value of the estimated returns equals or exceeds the cash outlay required to finance it").

46. *See, e.g.*, DAMODARAN, *supra* note 44, at 11 ("[D]iscounted cash flow (DCF) valuation . . . relates the value of an asset to the present value (PV) of expected future cash flows on that asset . . . . While discounted cash flow valuation is only one of the three ways of approaching valuation . . . it is the foundation on which all other valuation approaches are built."); BREALEY ET AL., *supra* note 44, at 22–24. Discounted cash flow methods of valuation have been the dominant methodology for half a century. *See, e.g.*, David B. Hertz, *Risk Analysis in Capital Investment*, 42 HARV. BUS. REV. 95, 95 (1964) ("The controversy and furor that once came out in the business press over the most appropriate way of calculating these values [of capital investments] has largely been resolved in favor of the discounted cash flow method as a reasonable means of measuring the rate of return that can be expected in the future from an investment made today.").

where:

DPV = the discounted present value of the future cash flows
FV_t = the predicted future net cash flows in period *t*
i = the discount rate (or interest rate)
t = the time in years before a given future cash flows occur
N = the time in years before the last projected future cash flow

To value a proposed investment, a financial manager projects the investment's future net cash flows over a given time horizon [FV_t].[47] These projected cash flows become the numerator in the above equation. For instance, if an Investment A is a U.S. government bond—the proverbial risk-free asset, notwithstanding recent deterioration in sovereign credit ratings[48]—the projected cash flow is the principal repayment of $1000 per bond upon maturity.[49] On the other hand, if the financial manager projects that an Investment B will yield a $0 profit 33% of the time, a $1000 profit 33% of the time, and a $2000 profit 33% of the time, the expected cash flows are still $1000. But the dispersion of possible outcomes is much wider. That is, in addition to the possible $1000 return, Investment B could also either pay off handsomely with a cash flow of $2000, or it could fail dismally with a cash flow of zero dollars.

Finance professionals refer to the dispersion of such possible cash flows around the expected cash flow as an investment's *risk*.[50] All else equal, the more widely distributed the potential outcomes are, the riskier the investment is. Investors are risk averse, which means that they prefer to assume less risk for a given expected return. To take account for risk aversion, the "riskier" expected cash flows for Investment B should have a lower present value than the "less risky" expected cash flows for Investment A—even though the expected cash flows themselves are identical. In the finance parlance, it is said that the cash flows must be *discounted* at a higher rate.[51] The equation's denominator [$(1+i)^t$] performs this discounting function, where *i* is the discount rate and *t* is the number of periods over

47. The financial manager is interested in the net cash flows because it would be inappropriate to count the cash flow revenues without counting the cash flow expenses that went into producing those revenues.

48. *See* Mohamed El-Erian, *Downgrade of US Debt Rating Heralds a New Era*, FIN. TIMES, Aug. 8, 2011, at 9 (noting, in the immediate aftermath of the decision by Standard and Poor's to downgrade U.S. Treasury securities, that "[n]ot so long ago, it was deemed unthinkable that America could lose its AAA" and that "'risk free' and 'US Treasuries' were interchangeable terms").

49. U.S. government bonds, as well as nearly all corporate bonds and debentures, are usually denominated in units of $1000 in principal amount. *See* W. STEVE ALBRECHT ET AL., FINANCIAL ACCOUNTING: CONCEPTS AND APPLICATIONS 465 (11th ed. 2011) ("The principal, or face value, of each bond is usually $1,000"). This example assumes the bond is near maturity and that no future interest payments are expected; otherwise, the financial manager would need to take account of the amount of the interest payment in the valuation exercise.

50. For a critique of the overuse of this usage of the term "risk," see Weber, *supra* note 42, at 1010–11 ("Even when the causal environment cannot be expressed probabilistically, it may still allow for prudential and precautionary efforts to minimize risk or counterfactual simulations to explore the impact of events.").

51. *See* DAMODARAN, *supra* note 44, at 12 ("The discount rate will be a function of the riskiness of the estimated cash flows, with higher rates for riskier assets and lower rates for safer projects."). The discount rate represents the time value of money and a risk premium that compensates the investor for the incremental risk it assumes. *See* JOHN D. STOWE ET AL., EQUITY ASSET VALUATION 47 (2007) (providing data sets on the historical equity risk premia relative to bonds and bills from 1900 to 2007, for select countries).

which the cash flows must be discounted. In setting an appropriate discount rate, a financial manager approximates the *opportunity cost of capital* for the investment—a measure of the expected rate of return on an equivalently risky asset or project.[52]

To determine an appropriate discount rate for an investment or project, financial managers usually rely on a capital asset pricing model.[53] Because their investors can diversify away idiosyncratic risks that impact particular projects in particular ways, firms generally use discount rates that incorporate consideration of market risk alone.[54] Market risk, denoted by "beta" (β), is an expression of the degree of dispersion (or "volatility") of actual returns around expected returns of the investment or project relative to the dispersion of actual returns of the market or economy as a whole. Thus, if Asset Portfolio XYZ has a beta of 2.0, it will on average return 4% when the relevant market- or economy-wide benchmark[55] returns 2%. And, it will on average return negative 4% when the benchmark returns negative 2%. The capital asset pricing model uses beta to calculate the discount rate. The financial manager multiplies the incremental expected return on the market-wide benchmark by beta[56] and adds the risk-free rate of return as shown in the below equation:

52. *See* PETER MOLES ET AL., CORPORATE FINANCE 383 (2011) ("The discount rate is the rate of return required by investors for investments with similar risk, which is the project's opportunity cost of capital."); BREALEY ET AL., *supra* note 44, at 23 ("The rate of return *r* [that performs the discounting function] is called the *discount rate*, *hurdle rate*, or *opportunity cost of capital*. It is an opportunity cost because it is the return that is foregone by investing in the project rather than investing in financial markets.").

53. The empirical support for the capital asset pricing model described below has been equivocal. *See* John Y. Campbell, *Asset Pricing at the Millennium*, 55 J. FIN. 1515, 1515 (2000). Some financial managers prefer to use arbitrage pricing theory (which avoids the difficulty of coming up with a proxy for market-wide returns by looking to "factor betas," or the sensitivity of the asset to specified economic factors driving asset returns) or a modified capital asset pricing model (which "corrects for the [base model's] failure to predict market capitalization rates for small firm stocks and stocks with a high ratio of book value to market value"). BRATTON, *supra* note 45, at 135–36; *see also* BREALEY ET AL., *supra* note 44, at 196–203 (surveying empirical research into capital asset pricing model and discussing alternatives). For present purposes, it suffices to note that each of these approaches requires the financial manager to compare a proposed project to other assets for which data concerning market risk are available.

54. The statement "the discount rate should only take into account market risk and should never take into account idiosyncratic, firm-specific risks" might, at first glance, appear to have counter-intuitive implications. Consider, for instance, a firm-specific risk such as the possibility that managers of a firm's most profitable division leave the firm to start their own fund. When this firm's financial manager learns of the possible exit, he or she will deem the firm's expected cash flows to be riskier in the sense that the distribution of possible outcomes now must include the possibility of lower profit numbers for the exiting division. But the discount rate to be applied to the firm's cash flows is constant because the incremental risk is idiosyncratic and firm-specific. And yet, it is obvious that the firm is "riskier"—using the layperson's definition—and it should be worth less on account of the exit. The seeming incongruity is resolved by incorporating consideration of the increased idiosyncratic risk of the personnel exit into the *cash flow projections* rather than the discount rate. *See* BREALEY ET AL., *supra* note 44, at 224–25 (explaining that diversifiable risks should never affect discount rates and should instead impact cash flow forecasts alone); *cf. also* DAMODARAN, *supra* note 44, at 894 (noting that "the riskiness of an asset" can be "encapsulated" in either a higher discount rate or in lower cash flow projections).

55. The benchmark might be a forward contract pegged to a diversified composite of portfolios within the relevant asset class. To take the obvious example of individual stocks, the average returns of a stock are compared to the average returns of exchange-wide stock indexes, such as the S&P 500.

56. By multiplying beta by the incremental return on the market-wide benchmark rather than the total return on the market-wide benchmark, the capital asset pricing model incorporates consideration of the sensitivity to market risk alone instead of also considering changes in the risk-free rate, which are unrelated to market risk.

$$i_p = \beta(r_m - r_{rf}) + r_{rf}$$

where:

i_p = the project's discount rate (or interest rate)
β = the project's beta
r_m = the return on the market-wide benchmark
r_{rf} = the risk-free rate of interest

Thus, for example, if an asset has a beta of 2.5, the return on the market-wide benchmark is 6.5%, and the risk-free rate is 4.5%, then the appropriate discount rate would be 9.5%.[57]

But how do financial managers determine the appropriate beta for a project? In the words of Professor Bill Bratton of the University of Pennsylvania, "[a]scertaining a project beta can be a complicated business."[58] Some projects have historical data concerning their returns; others do not. If historical data are available, the financial manager can compute a beta by looking to how those returns vary with the market benchmark and set the discount rate accordingly. Where, as with many proposed projects, no historical data are available, the financial manager will search for *comparable* assets for which historical data are available.[59] This analogical inquiry amounts to asking the question "which assets exhibit the degree of market risk that we expect this project to exhibit?"

Still other times, the financial manager will be unable to identify any comparable assets. In those cases, the financial manager must exercise professional judgment in constructing a discount rate from whole cloth. As a general matter, the market risk for a given project will usually be a function of the project's operating leverage,[60] the project's dependence on the business cycle,[61] and the project's sensitivity to trends in interest rates generally.[62] These latter two factors are most relevant in the context of the investments and projects undertaken by financial institutions. Therefore, the financial manager will compare the expected earnings cyclicality and interest rate sensitivity of the project or investment to those of other assets for which data are available. Again, the task is analogical.

57. This result obtains because: 2.5*(6.5% – 4.5%) + 4.5% = 9.5%.

58. BRATTON, *supra* note 45, at 134.

59. *See* BREALEY ET AL., *supra* note 44, at 221–22 (explaining how firms set discount rates for projects by looking at betas for comparable assets). Even if the financial managers are confident that they have located a "pure play" comparable asset that is exposed to the same market risk as the project or investment they are valuing, adjustments might be required to take into account the different capital structure of the comparable company. *See* BRATTON, *supra* note 45, at 134 (referring to this process as "delevering").

60. Operating leverage refers to the proportion of fixed costs to variable costs. A project or investment has high operating leverage if it has high fixed costs relative to variable costs. BREALEY ET AL., *supra* note 44, at 222.

61. Economists refer to this criterion as "cyclicality," which can be defined technically, in the case of a project, as the relationship between the project's earnings and the aggregate earnings on all real assets. *See id.* (explaining that cyclical firms are "firms whose revenues and earnings are strongly dependent on the state of the business cycle" and "tend to be high-beta firms").

62. *See id.* at 224.

The computational math of project valuation—summing discounted cash flow projections—is straightforward. However, the intellectual tasks for the financial manager are difficult because: (1) projecting future cash flows relies on predictions of contingent events (i.e., profit and loss data) in an uncertain future; and (2) setting an appropriate discount rate relies on the drawing of intrinsically imprecise analogies between those uncertain cash flows and cash flows from risk-equivalent projects. The nature of these projections and analogies depends in part on the imaginative capabilities of risk management personnel. To the extent that DOST expands the information set (by causing it to encompass further loss and risk possibilities) on which risk management personnel base their decisions, it will be expected to lower project valuations. First, it should result in lower projected cash flows for some projects. Second, it should raise discount rates for some projects. The discount rate point is twofold. On the one hand, it will increase discount rates for those projects that are revealed to have greater market risk—i.e., those projects that are more sensitive to the performance of the economy. On the other hand—and this point is under-appreciated—the proposed projects themselves might contribute to system-wide market risk, requiring upward adjustments to discount rates not only for the *proposed* projects but for *all* ongoing and proposed projects. In light of these effects, DOST should bias the net present value calculations downward, resulting in an incremental de-risking and de-leveraging of firms.[63]

V. OTHER APPLICATIONS: VALUE-AT-RISK, EXPECTED SHORTFALL, PERFORMANCE EVALUATION METRICS, ECONOMIC CAPITAL, DECISION TREE ANALYSIS

The net present value rule is the predominant capital allocation tool across all industries. But financial institutions have developed other decisional tools to drive corporate decisions about how to allocate capital, including "value-at-risk," "expected shortfall," performance evaluation metrics such as "risk-adjusted return on capital" (RAROC), "economic capital" metrics, scenario analysis, decision tree analysis, and Monte Carlo modeling. These devices are private sector decisional tools, not legal-regulatory devices. But to the extent that regulatory efforts succeed in fostering private sector DOST norms—what in other work I have referred to as a more mindful decisional infrastructure—these devices will be the decisional levers that affect business decisions and capital allocation throughout the firm and, ultimately, throughout much of the economy. Just as with the net present value rule, the embedment of DOST norms should result in more conservative decision outcomes with respect to each of these decision-making tools.

63. At first blush, it might appear that DOST introduces a pessimism bias in the information set. However, it light of the decisional pathologies summarized above, it is better to conceive of DOST as correcting a persistent optimism bias. *Supra* Part II.

A. Value-at-Risk

Value-at-risk models can be thought of as the basic building blocks of risk measurement.[64] Risk managers express value-at-risk as *the maximum expected loss* a firm will face *within a specified probability level* (known as the "confidence level") *over a particular time period* (known as the "time horizon").[65] The value-at-risk model allows risk managers to make the following statement: "We are *X* percent certain that we will not lose more than *V* dollars in the next *N* days."[66]

The most common variant of value-at-risk methodology, by far, is historical simulation,[67] which consists of a computational phase and an interpretive-planning phase. In the computational phase, the firm takes its current assets and liabilities and revalues them on the basis of daily historical values for relevant risk factors (e.g., interest rates, exchange rates) and prices over a predetermined look-back period, most typically 500 days.[68] This is essentially a counterfactual exercise: "assuming we had this portfolio yesterday, and the day before yesterday, and so forth, what would our net profit-loss position have been?"[69] When the firm has valued its assets and liabilities over the relevant time horizons comprising the look-back period, it ranks the net profit-loss outcomes from worst to best.[70]

64. JORION, *supra* note 2, at 283; BANK FOR INT'L SETTLEMENTS, COMM. ON THE GLOBAL FIN. SYS., STRESS TESTING AT MAJOR FINANCIAL INSTITUTIONS: SURVEY RESULTS AND PRACTICE 3 (2005).

65. MICHEL CROUHY ET AL., RISK MANAGEMENT 187–88 (2001); KEVIN DOWD, BEYOND VALUE AT RISK: THE NEW SCIENCE OF RISK MANAGEMENT 39 (1998). The risk is measured according to the confidence interval. In layman's terms, the term "value-at-risk" is a misnomer: A risk management text frames value-at-risk techniques in terms of the questions they answer as follows: "[Value-at-risk] is not the answer to the simple question: How much can I lose on my portfolio over a given time period? The answer to this question is "everything," or almost the entire value of the portfolio! . . . Instead, [value-at-risk] offers a probability statement about the potential change in the value of a portfolio resulting from a change in market factors, over a specified period of time. [Value-at-risk] is the answer to the following question . . . : What is the maximum loss over a given time period such that there is a low probability, say a 1 percent probability, that the actual loss over the given period will be larger?" CROUHY, *supra*, at 187.

66. JOHN C. HULL, RISK MANAGEMENT AND FINANCIAL INSTITUTIONS 196 (2007).

67. *See* Christophe Pérignon & Daniel R. Smith, *The Level and Quality of Value-at-Risk Disclosure by Commercial Banks*, 34 J. BANKING & FIN. 362, 367–70 (2010) (finding that 73% of large international banks that disclose their value-at-risk methodologies, a group that itself comprises 65% of all such banks, use historical simulation methods).

68. *See* JAMES T. GLEASON, RISK: THE NEW MANAGEMENT IMPERATIVE IN FINANCE 187 (2000) ("In a nutshell, you run your daily . . . [profit and loss] process over and over again, using the history of past daily market price moves."). For assets traded on markets, risk managers can simply plug in the appropriate historical prices. For untraded assets, risk managers must construct a pricing model that specifies how the identified risk factors affect the asset's value.

69. PHILIPPE JORION, VALUE AT RISK: THE NEW BENCHMARK FOR MANAGING FINANCIAL RISK 263 (3d ed. 2007) (observing that historical value-at-risk methods do not "represent an actual portfolio but rather reconstruct the history of a hypothetical portfolio using the current position"). If the time horizon is longer—say, ten days—then risk managers make appropriate adjustments. Specifically, they typically assume that the value-at-risk estimate for a time horizon consisting of *N* days is equal to the product of the one-day value-at-risk estimate times $\sqrt{N}$. *See* HULL, *supra* note 66, at 203; LINDA ALLEN ET AL., UNDERSTANDING MARKET, CREDIT, AND OPERATIONAL RISK: THE VALUE AT RISK APPROACH 7 (2004) (referring to this method as the "square root rule").

70. Robert T. Miller, *Oversight Liability for Risk-Management Failures at Financial Firms*, 84 S. CAL. L. REV. 47, 63 (2010).

In the interpretive-planning phase, risk managers decide on the applicable confidence level. If the confidence level is, say, 5%, they will look to the fifth percentile of outcomes—thus, if the look-back period is 500 days then the fifth percentile would be the 25th worst net profit-loss outcome. The difference between current market values of the portfolio and this fifth percentile is then interpreted as the "value" that is "at risk" over the next day. A higher confidence level will result in a higher value-at-risk number—e.g., if the confidence level is 99% instead of 95% then the value at risk will be the difference between current market values and the *fifth* worst net profit-loss outcome.

It is easy to see how DOST would impact the design of a value-at-risk model. Risk managers use their discretion to set the look-back period, the time horizon, and the confidence interval.[71] Increasing the look-back period allows risk managers to incorporate a wider set of past data, and lessons to be learned from it, into the value-at-risk model. Increasing the time horizon will bias the value-at-risk calculations upward, increasing its conservatism. By increasing the confidence interval, risk managers will similarly arrive at higher value-at-risk calculations. These calculations would then be reported to and considered by other risk constituencies within the firm, who would take these newly conservative information sets and establish policies accordingly.

B. Expected Shortfall

The Basel Committee on Banking Supervision published a consultative paper in May 2012 in which it indicated its intention to encourage banks to move beyond value-at-risk to so-called "expected shortfall" risk metrics.[72] As discussed above, value-at-risk metrics are silent with respect to the likelihood and magnitude of losses outside of the confidence level—e.g., what is likely to occur in the most extreme one percent of loss cases? Expected shortfall estimates, by contrast, take into account not only likelihood of losses (like value-at-risk), but also the magnitude of possible loss outcomes.[73] From a statistical perspective, expected shortfall explores the "tails" of the value-at-risk loss distributions.[74] In terms of prevalence of usage, it has yet to supplant value-at-risk as the predominant risk measurement technique, but some financial institutions have come to more fully rely on expected shortfall metrics.[75]

71. Executive-level input is required to set the confidence interval.

72. BASEL COMM. ON BANKING SUPERVISION, FUNDAMENTAL REVIEW OF THE TRADING BOOK 20 (2012), *available at* http://www.bis.org/publ/bcbs219.pdf. The Basel Committee explained its overture to expected shortfall in terms of the shortcomings of value-at-risk: "[T]he current framework's reliance on [value-at-risk] as a quantitative risk metric stems largely from historical precedent and common industry practice. This has been reinforced over time by the requirement to use [value-at-risk] for regulatory capital purposes. However, a number of weaknesses have been identified with [value-at-risk], including its inability to capture 'tail risk'. The Committee therefore believes it is necessary to consider alternative risk metrics that may overcome these weaknesses." *Id.*

73. *Id.*

74. The tails of a loss distribution are populated by low-likelihood, high-magnitude losses.

75. BASEL COMM. ON BANKING SUPERVISION, MESSAGES FROM THE ACADEMIC LITERATURE ON RISK MEASUREMENT FOR THE TRADING BOOK 2 (Working Paper No. 19, 2011), *available at* http://www.bis.org/publ/bcbs_wp19.pdf; *see also id*. at 17 (referring to expected shortfall's "potentially growing importance in the future"); *id*. at 20 (noting that expected shortfall "is now preferred to [value-at-risk] by an increasing number of risk managers in the industry").

Formally, expected shortfall is defined as the average of all value-at-risk risk measurements for the quantile of the loss distribution above the confidence level.[76] For instance, to again adopt the example of a 99% value-at-risk confidence level, expected shortfall would express the average of the loss outcomes that populate the 1% loss outcomes in the distribution. In remedying the "missing tail" problem that besets basic value-at-risk techniques, expected shortfall introduces another problem in the form of data insufficiency. Advocates for more robust usage of expected shortfall hail advances in computational simulation methods that, in their view, "have advanced to a point that expected shortfall is a viable risk management option for financial institutions."[77]

Just as with value-at-risk, DOST will impact expected shortfall calculations. Most directly, expected shortfall will be an increasing function of the confidence level. That is, when risk managers set higher confidence levels for purposes of their value-at-risk calculations, they will necessarily obtain higher expected shortfall calculations. Consequently, firms will make decisions after taking into account larger risk measurements, with predicted conservative results. Furthermore, in constructing the model on which the simulations populating the tail of the distribution will be based, DOST will increase the likelihood that risk managers incorporate extreme, non-linear loss scenarios uncovered during stress tests.

C. Risk-Based Business Performance Evaluation Tools

Large financial institutions have developed internal decisional tools by which to evaluate unit performance. Risk-adjusted performance measurement tools allow managers and boards to compare the profitability of portfolios or business units with different sources of risk and different capital requirements.[78] They can assist these decision makers in determining whether to enter or exit a particular business, or in estimating the potential value that would be created if extra resources were allocated to existing or new business lines.[79] In so doing, risk managers are able to distinguish between, say, a unit with net equity capitalization of $1000—that is to say, it might have $10,000 of assets and $9000 of liabilities, leaving $1000 in stockholders' equity—that produces $100 of profit by taking very risky bets, and a unit with the same equity capitalization that produces $100 of profit by making very conservative investments. Bearing in mind the basic valuation principle that risky cash flows have lower present values than less risky cash flows, the latter business unit is more economically profitable. A simple comparison of the units' respective

76. *Id.* at 21 (noting that, where α represents the confidence level, "[expected shortfall] is then the expected loss conditional on this loss belonging to the 100(1-α) percent worst losses").

77. *Id.*

78. *See* CHRISTOPHER L. CULP, THE RISK MANAGEMENT PROCESS: BUSINESS STRATEGY AND TACTICS 469 (2001) (noting that performance evaluation tools are "of limited use unless [they] can be linked to decisions about whether business units deserve allocations of scarce economic capital"); Michel Crouhy et al., *Measuring Risk-Adjusted Performance*, 2 J. RISK 5, 5–6 (1999), *available at* http://www.risk.net/digital_assets/4870/v2n1a1.pdf (explaining that the purpose of risk-based capital allocation systems "is to provide a uniform measure of performance that management can use to compare the economic profitability of businesses with different sources of risk and different capital requirements").

79. Robert M. Mark & William V. Bishop, *The Flexibility of RAROC*, TERADATA MAGAZINE 1, 1–2 (Mar. 2007), *available at* http://apps.teradata.com//tdmo/v07n01/pdf/AR5210.pdf.

performances based on return on capital, or return on equity, will not account for this important difference.[80]

One basic building block for these tools is risk-adjusted return on capital, or "RAROC." RAROC, most typically utilized on a granular, asset-specific or portfolio-specific basis, allows financial firms to compare the expected return on an investment to the capital the firm expects to have at risk in the investment.[81] Formally, an investment's RAROC is the net economic income of an investment divided by the capital at risk in the investment.[82] Financial firms use RAROC to compare investment performance ex post or proposed projects ex ante. They also use RAROC as a rule of thumb by which to evaluate proposed projects by comparing project RAROC projections to the firm's hurdle rate,[83] which represents its opportunity cost of capital.[84]

Projecting the net economic income from the investment involves the familiar exercise of projecting cash flows—just as with project valuation.[85] However, determining the capital at risk in the investment requires a significant degree of managerial discretion.[86] Where the relevant risk is market risk, the capital at risk is frequently determined by using

80. *See* BREALEY ET AL., *supra* note 44, at 711–13 (explaining return on capital, return on equity, and return on assets in terms of risk-neutral accounting book value entries alone). When used in the financial context "return on capital" refers to "return on equity." *See* ADMATI & HELLWIG, *supra* note 6, at 98 (explaining that "[i]n the world of banking and banking regulation . . . *capital* refers to equity"). This Article, and the RAROC literature, adopt the customary financial usage.

81. Miller, *supra* note 70, at 84. In principle, RAROC permits granular comparisons even at the individual asset level. *See* Andrew Kuritzkes & Til Schuermann, *What We Can Know, Don't Know, and Can't Know About Bank Risk: A View from the Trenches*, *in* THE KNOWN, THE UNKNOWN, AND THE UNKNOWABLE IN FINANCIAL RISK MANAGEMENT: MEASUREMENT AND THEORY ADVANCING PRACTICE 103, 115 (Francis X. Diebold et al., eds. 2010) (discussing that quantitative applications like RAROC support decision-making down to the level of individual loans).

82. CULP, *supra* note 78, at 464.

83. *See id.* at 470 (explaining that the "comparison of RAROC to a hurdle rate enables a firm to determine whether a business is viable and thus entitled to new capital"). For projects with risk-adjusted returns in excess of the hurdle rate, the so-called internal rate of return rule provides that the project should be undertaken. *See* JOHN R. GRAHAM & SCOTT B. SMART, INTRODUCTION TO CORPORATE FINANCE ABRIDGED EDITION 254 (3d ed. 2011) (explaining that "the hurdle rate represents the firm's minimum acceptable return for a given project, so the *IRR decision rule is to invest if the projects IRR exceeds the hurdle rate; otherwise reject the project*").

84. RAROC and net present value project valuation methods both take into account the riskiness of projected returns, the former through the risk-adjustment to returns and the latter through the discounting function. Increased risk leads to decreased net present value and RAROC for projects, and vice versa. *See* Crouhy et al., *supra* note 78, at 19 ("RAROC is an increasing function of net present value. Suppose the net present value decreases. This implies that the numerator in RAROC decreases and the denominator increases, and hence RAROC decreases."). In this respect, RAROC can be said to work towards the same purpose as the net present value rule. *Cf.* Miller, *supra* note 70, at 74 ("Because different borrowers present different credit risks, financial firms in the business of lending money would like to be able to compare loans controlling for the credit risk of the borrowers. There are many ways this can be done. For example, the firm could revalue the loans, applying higher discount rates to more risky loans and lower discount rates to less risky loans, thus lowering the expected returns for riskier loans and obtaining risk-adjusted rates of return for the loans. Another way of accomplishing the same result is to adjust the capital the firm must deploy to make the investment.").

85. *See supra* Part IV (explaining the computational math of project valuation).

86. Miller, *supra* note 70, at 76 ("Computing a loan's RAROC, however, involves significant business judgments. [C]omputing the numerator is the easy part. Computing the denominator—the capital at risk—is the hard part.").

value-at-risk techniques.[87] For credit risk, the capital at risk is gauged by reference to credit spreads of publicly traded bonds of comparable default risk.[88] In each case, risk managers must ask themselves how much of the capital is properly considered to be *at risk*. This question is approached from the statistical perspective of confidence intervals. We have already seen how value-at-risk utilizes confidence intervals. Similarly, risk managers determine capital at risk on account of credit risk by looking at a specified confidence level of comparable credit risk spreads. For example, a more conservative bank might calculate capital at risk by looking to the 99.5% most extreme spread, whereas a less conservative bank might look to the 95% most extreme spread. Moreover, in the case of credit risk, risk managers must exercise further judgment in selecting the comparable assets to use as proxies for the credit risk. The incremental DOST information set would impact each of these intellectual exercises, biasing the risk-adjusted returns downwards.

D. Economic Capital and Internal Capital Adequacy Tools

Legal scholars, often experts in public administrative law, understandably focus on legal-regulatory minimum capital requirements. But financial institutions themselves also have developed internal corporate governance procedures—typically referred to as "economic capital," "allocated capital," or "risk capital" programs—designed (1) to ensure that they have enough capital to absorb unexpected losses and (2) to enable cross-unit business performance comparisons on a more aggregate basis than other tools like RAROC.[89] These corporate governance procedures are usually linked to stress testing programs, so any regulatory intervention that affects the conduct of internal stress testing programs will inevitably impact the internal economic capital programs. Any additional capital required to support existing businesses pursuant to a firm's internal economic capital program will either result in the firm re-considering the viability of that business or channeling capital away from other risk-accreting activities. In the former case, the firm de-risks by pulling the plug on or scaling back existing businesses on account of their riskiness. In the latter case, the firm de-risks by channeling capital away from other businesses or retaining (rather than re-investing) earnings, bolstering loss-absorbing stockholders' equity on the right-hand side of the balance sheet in the process.

All large banking groups have economic capital programs in place. For example, Citigroup, Inc. (Citi) "calculates and allocates risk capital across the company in order to consistently measure risk taking across business activities, and to assess risk-reward relationships."[90] To Citi, "[r]isk capital is defined as the amount of capital required to absorb potential unexpected economic losses resulting *from extremely severe events* over a one-year time period."[91] Morgan Stanley created a system it refers to as its "Required Capital Framework," a "risk-based use-of-capital measure, which is compared with [Morgan Stanley's] regulatory capital to help ensure [it] maintains an amount of going

87. Crouhy et al., *supra* note 78, at 6.

88. Miller, *supra* note 70, at 76–77.

89. *See, e.g.*, Bank of Am. Corp., Annual Report (Form 10-K) 36 (Feb. 25, 2014) (explaining Bank of America's use of "allocated capital" metric to distribute capital across firm units).

90. Citigroup, Inc., Annual Report (Form 10-K) 74 (Mar. 3, 2014).

91. *Id.* (emphasis added).

concern capital after absorbing potential losses *from extreme stress events* . . . ."[92] The Goldman Sachs Group, Inc. also structures its internal capital adequacy system around stress testing, and explicitly addresses liquidity stress testing:

> Our stress testing process incorporates an internal capital adequacy assessment with the objective of ensuring that the firm is appropriately capitalized relative to the risks in our business. As part of our assessment, we project sources and uses of capital given a range of business environments, including stressed conditions. Our stress scenarios incorporate our internally designed stress tests and those required under [applicable regulatory stress testing programs] and are designed to capture our specific vulnerabilities and risks and to analyze whether the firm holds an appropriate amount of capital. Our goal is to hold sufficient capital to ensure we remain adequately capitalized after experiencing a severe stress event. Our assessment of capital adequacy is viewed in tandem with our assessment of liquidity adequacy and is integrated into the overall risk management structure, governance and policy framework of the firm.[93]

Wells Fargo & Company clarifies in its annual report that the need to maintain economic capital programs independent from regulatory minimum capital requirements results from the fact that other stakeholders and third parties—such as capital markets investors and rating agencies—have different objectives than regulators.[94] These disclosures demonstrate that by altering the firm's stress testing systems, a DOST orientation will directly impact the results of economic capital programs.

E. Scenario Analysis, Decision Tree Analysis, and Monte Carlo Simulations

Scenario analysis, decision tree analysis, and Monte Carlo simulation techniques are decisional tools that allow financial managers to take account of the future contingencies that inevitably affect future cash flows. For any given future date, the net present value rule requires the financial manager to fix a single cash flow estimate. Typically, the financial manager will sensibly select the cash flow projection that is, in the manager's estimation, more likely to occur than any other cash flow.[95] Given the single-cash-flow constraint, such an approach makes sense. However, the constraint itself limits the net present value rule's reliability inasmuch as it fails to capture how other less likely, but hardly remote, possible outcomes would affect the project or investment's valuation. In the words of

92. Morgan Stanley, Annual Report (Form 10-K) 107 (Feb. 25, 2014) (emphasis added).

93. Goldman Sachs Group, Inc., Annual Report (Form 10-K) 83 (Feb. 27, 2014).

94. *See* Wells Fargo & Co., Annual Report 2013 99 (2014), *available at* https://www08.wellsfargomedia.com/downloads/pdf/invest_relations/2013-annual-report.pdf ("Our capital adequacy assessment process contemplates a wide range of risks that the Company is exposed to and also takes into consideration our performance under a variety of stressed economic conditions, as well as regulatory expectations and guidance, rating agency viewpoints and the view of capital markets participants.").

95. *See* DAMODARAN, *supra* note 44, at 894 (noting that probability-weighted averaging of cash flows across large numbers of scenarios is "seldom used, simply because it requires far more information to compile" and that managers prefer to use the projected "cash flows under the most likely scenario"); Hertz, *supra* note 46, at 97 (describing the use of the "single best possible forecast" as the "Achilles heel" of capital investment valuation).

former McKinsey consultant David Hertz, himself famous for pioneering Monte Carlo methods in capital budgeting, "the sophisticated businessman knows that behind these precise calculations are data which are not that precise."[96] These other tools provide information to corporate managers about the value of the project of investment under each outcome or under at least a subset of outcomes.[97]

When used for corporate planning purposes, scenario analysis involves computing the value of the proposed project or investment under a number of different scenarios, varying the assumptions about macroeconomic and project-specific variables such as the state of the economy, responses of competitors, and regulatory outcomes.[98] The financial manager will then estimate the future cash flows under each of the chosen scenarios and, if possible, present an expected valuation across all scenarios.[99] The expected outcomes under particular scenarios can be disaggregated, permitting comparison of cash flow outcomes among different scenarios. DOST should expand the suite of downside scenarios financial managers take into consideration, thereby resulting in a wider range of possible outcomes than would otherwise be considered.[100]

For projects or investments with scenarios that will depend on discrete, sequential events, financial managers can also use decision tree analysis. Decision tree analysis provides a "flexible and powerful approach for dealing with risk that occurs in phases, with decisions in each phase depending upon outcomes in the previous one."[101] It is a disciplined way of decomposing a sequence of future events on which the valuation of a proposed project or investment will ultimately depend. An example of a project for which decision tree analysis might prove helpful is a proposed insurance policy that mortgage brokers would offer to homebuyers. Assuming the product required advance regulatory approval by the Consumer Financial Protection Bureau (CFPB), the outcome of investment in researching and marketing the policy will only bear fruit if the CFPB approves. Otherwise, those expenditures will not yield any return. Furthermore, even if the product secures CFPB approval, consumers must accept it. This represents another possible event node—that is, a point where outcome might vary based on how the uncertain event unfolds

96. Hertz, *supra* note 46, at 96.

97. See *id*. at 96–97 (noting that a decision-maker needs to know more than the expected rate of return because there is a high level of uncertainty about the variables entered into the calculation for rate of return and thus, the rate of return does "not tell the whole story").

98. *See* DAMODARAN, *supra* note 44, at 895. The reason it is necessary to qualify this statement as applying only to corporate planning scenario analysis is that risk managers also use scenario analysis. When used by risk managers, scenario analysis itself is a stress testing technique. *See* Weber, *A Theory for Stress Testing*, *supra* note 3, at 2261–63. The distinction between scenario analysis used for corporate planning purposes and scenario analysis used for risk management purposes is not airtight, particularly in the cases of financial institutions that encourage participation by risk management personnel in strategic decision-making. *See generally* Anette Mikes, *Risk Management and Calculative Cultures*, 20 MGMT. ACCT. RESEARCH 18 (2009) (noting that risk management departments characterized by what Mikes calls "quantitative skepticism" are more likely to participate in strategic decision making).

99. DAMODARAN, *supra* note 44, at 896. Scenario analysis will only yield an expected value across all scenarios in the event the scenario probabilities sum to one. *Id.*

100. To say the project or investment projects a wider range of possible outcomes is simply another way of saying it is riskier. *See id.* at 896; *supra* Part IV (discussing how risk relates to the dispersion of possible outcomes).

101. DAMODARAN, *supra* note 44, at 905.

in practice—on a decision tree. Once all the event nodes are identified and probabilities are assigned to all the contingent outcomes, the decision tree is "folded back" onto itself, a process referring to the computation of expected values working backward through the tree.[102] The process culminates in an expected value for the investment today.[103] Just as with scenario analysis, DOST will affect the conduct of decision tree analysis. In particular, it should result in more finely defined event nodes, especially as new potential pitfalls in projects are identified. It should also result in higher probabilities assigned to downside cases at event nodes, thereby affecting the folding back of the tree and, as a result, the project valuation itself.

Monte Carlo simulations allow financial managers to value projects or investments as to which risk cannot be decomposed, as presumed by scenario analysis and decision tree analysis, into discrete analytical packets.[104] This variant of risk can be called "continuous risk" to denote how possible values for the variables on which project valuation will depend are distributed continuously and do not consist of a discrete number of identifiable outcomes. To illustrate, compare the binary risk of the CFPB approval process to the continuous risk of product sales volume growth once the product achieves regulatory approval and market acceptance. The former is an example of a discrete risk and the latter is an example of a continuous risk, because future sales volume growth cannot be modeled by reference to a discrete series of outcomes and could take the form of any number of outcomes. New York University finance professor Aswath Damodaran describes Monte Carlo simulation as follows:

> In its classic form, distributions of values are estimated for each parameter in the valuation (growth, market share, operating margin, beta, etc.). In each simulation, we draw one outcome from each distribution to generate a unique set of cash flows and value. Across a large number of simulations, we can derive a distribution for the value of investment that will reflect the underlying uncertainty we face in estimating the inputs to the valuation.[105]

The financial manager uses computers to run thousands of simulations using randomized values of the relevant parameters. Thus, Monte Carlo techniques use probability distributions for the parameters that impact the project's valuation to produce a probability distribution for the project valuation.[106] Since simulations require financial managers to input probability distributions for the relevant parameters, they work best for projects that are affected primarily by parameters for which there is substantial historical

102. *See id.* at 901 (explaining that the last step in decision tree analysis is folding back the tree, "where the expected values are computed working backward through the tree").

103. *Id.*

104. Risk management departments also use Monte Carlo methods in connection with value-at-risk information systems. *See* Pérignon & Smith *supra* note 67, at 372, fig. 4 (2010) (describing the various value-at-risk calculation methods). The diversity of contexts in which Monte Carlo techniques are used underscores again how many of these informational techniques are used by both business line managers and risk managers. *Cf. supra* note 98 and accompanying text (making similar point with respect to how scenario analysis is used).

105. DAMODARAN, *supra* note 44, at 908.

106. *See* DIMITRIS N. CHORAFAS, RISK MANAGEMENT TECHNOLOGY IN FINANCIAL SERVICES: RISK CONTROL, STRESS TESTING, MODELS, AND IT SYSTEMS AND STRUCTURES 147 (2007).

or cross-sectional data.[107] Here too, DOST will affect project and investment valuations. Specifically, it should encourage the use of more conservative distributions.

VI. CONCLUSION

The collective failure of the financial sector to deliberate actively on the channels through which failure and catastrophe might emerge is well documented. It is less well understood that much of this failure might result from decisional pathologies that afflict even those managers and board members who are committed to reliable performance. A regulatory program to promote DOST might provide a possible organizational antidote to these problems, but, as with any attempt to alter corporate decisions, the proposal must bear in mind the organizational mechanics of decision-making within the regulated firms. An examination of those decision-making mechanics for financial institutions reveals promising results. DOST should alter the information set that firm managers take into account when deciding whether to adopt projects or investments. In particular, the change should reflect a pessimism bias that will alter decision outcomes under the net present value and several other more specialized decisional tools in regular use by financial institutions.

107. DAMODARAN, *supra* note 44, at 920. Cross-sectional data reflect differences in a parameter across existing investments that are similar to the investment being analyzed. *Id.* at 909.