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Stress Tests to Promote Financial Stability: Assessing Progress and Looking to the Future

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Abstract

Stress testing, which has its roots in risk management, should be adapted to support financial stability monitoring and to incorporate the interconnections and dynamics of the financial system. Since the 2008 financial crisis, bank supervisors have honed their financial stability monitoring tools and significantly expanded the use of stress testing in the supervision of the largest financial institutions. This article describes areas in which further research could contribute to the development of best practices in stress testing and how bank supervisory stress tests can be made more useful for macroprudential supervision. We discuss both near-term and longer-term objectives.

I. Introduction

As stress testing has emerged as a key element of post-crisis financial supervision, it is worth taking a step back from the details of current implementations to consider broader trends and some fundamental topics that might benefit from additional research. Stress testing is not a new discipline for financial institutions and their regulators. In 1992, Congress required the Office of Federal Housing Enterprise Oversight to use stress tests as part of the regulatory capital framework for government-sponsored enterprises. However, the law had important weaknesses, for example, the legislation codified the inflexibility of the central stress scenario. Global bank regulators highlighted stress testing in 1996 as part of the first major amendment to the 1988 Basel capital framework. By 2001, stress testing was a well-established formal process in the International Monetary Fund's Financial Sector Assessment Program. However, prior to the U.S. financial crisis, stress tests were typically conducted internally by financial institutions on individual business lines. These tests were rarely comprehensive in terms of projecting stress outcomes for revenues, loss provisions, and trading losses on a firm-wide multi-period basis. Management often viewed them as compliance exercises.

In retrospect, banks' internal stress tests did not prepare financial institutions (or their regulators) for the 2008 financial crisis. Pre-crisis stress tests were not only limited in scope as described above, but also suffered from a failure of imagination. Few firms, if any, stress tested for a nationwide decline in housing prices, because such an event had not occurred since the 1930s. Regulators also considered a national

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housing bubble highly unlikely, if not impossible. Seeing beyond recent history, that is, not "fighting the last war," can be challenging.

Supervisory guidance was sparse about how to conduct stress tests and use them for managing risk and capital. As a result, there was no consistency in scenarios and metrics across firms, which made horizontal reviews across banks difficult for supervisors.[2] Although U.S. regulators examined banks' internal risk models, they lacked a model of their own for forecasting losses under stress. The S&L crisis of the 1980s is a cautionary tale of the need for horizontal reviews. In that episode, a broad-based, correlated exposure to interest-rate risk endangered an entire sector of the industry.

Recognition of the shortcomings of pre-crisis risk management has engendered a more rigorous approach among bank supervisors. Today's stress testing in the U.S., which could be termed "Version 2.0," differs from the pre-crisis efforts in the level of supervisory engagement and in the key role that the testing now plays in the supervisory assessment of bank management's capital planning and risk management ability and the firm's capital adequacy. On a substantive level, Version 2.0 also differs from pre-crisis efforts in the level of detail of the data collections, the scale and granularity of the models (including the severity of stress scenarios), and the level of disclosure of results.

Still, today's approach to stress testing remains essentially microprudential; it focuses on the resilience of individual banks to specific shocks, rather than on the broader and more complex macroprudential question of how stress might be transmitted among firms, across financial markets, and into the real economy.

This article outlines a research agenda and proposes some microprudential and macroprudential enhancements to supervisory stress tests. Part II discusses the main features that distinguish Version 2.0 from earlier efforts. Part III describes "Version 2.1"—changes that could enhance supervisors' ability to test the resilience of financial institutions under stress and thus increase the value of the current generation of stress tests for financial stability oversight. Part IV describes "Version 3.0," in which stress testing would incorporate systemic effects through the dynamics and complexities of contagion in financial crises—asset price cycles, margin calls, runs on funding, and asset fire sales—and the heightened data and modeling demands this would entail.

[2] Post-crisis, the Basel Committee on Banking Supervision (BCBS) identified weaknesses in firms' stress testing in four broad areas: (i) use of stress testing and integration in banks' risk governance; (ii) stress testing methodologies; (iii) scenario selection; and (iv) stress testing of specific risks and products. BCBS (2009).

II. Stress Testing 2.0: The Current Approach

The failure to anticipate the extraordinary events of 2007 and 2008 has led to a new approach to capital stress testing, first exemplified by the Supervisory Capital Assessment Program (SCAP) in 2009.[3] The SCAP subjected the 19 largest U.S. bank holding companies (BHCs) to a uniform stress test designed by regulators; companies that failed were required to raise new capital or accept relatively expensive government capital. The SCAP played a crucial role in turning around the financial crisis in the U.S. by subjecting domestic banks' portfolios to very stressful assumptions and requiring them to hold capital sufficient to survive them. The severity of the tests, together with a federal backstop, helped restore market confidence.

The SCAP evolved into the Comprehensive Capital Analysis and Review (CCAR) in 2011, now an annual process that, combined with Dodd-Frank Act stress testing (DFAST) requirements, has become a centerpiece of U.S. bank supervision. The three federal banking supervisors—the Federal Deposit Insurance Corporation (FDIC), the Federal Reserve, and the Office of the Comptroller of the Currency (OCC)—adopted rules imposing stress testing requirements in October 2012 that materially broadened the scope of capital stress testing of banking institutions beyond the 18 BHCs included in the most recent round of CCAR. For example, as a result of these new rules, most insured depository institutions with assets of more than $50 billion submitted stress test results to the OCC and the FDIC for the first time in 2013. Banks and BHCs with total assets of $10 to $50 billion will participate in an annual stress test beginning in 2014.[4]

Under CCAR, the Federal Reserve and BHCs themselves forecast balance sheets and quarterly net income over nine quarters under a baseline scenario and two supervisory stress scenarios: an adverse scenario and a severely adverse scenario. The stress tests estimate (1) credit losses on loans and securities on a quarterly basis over the forecast horizon, (2) the effects of a separate financial market shock on trading assets in the first quarter of the forecast horizon, and (3) the effects of credit losses and other changes on quarterly net income. DFAST stress test projections form the base for CCAR. The critical difference between CCAR and DFAST is in their treatment of dividend payments and other capital distribution plans.[5]

Three key features distinguish the substance of Version 2.0 stress tests from pre-crisis stress testing:

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[3] See Hirtle, Schuermann, and Stiroh (2009).

[4] Under DFAST, supervisors will not calculate stress test results for these firms; rather, banks will provide their own internal model results. Draft Federal Reserve rules also could require foreign banking organizations (FBOs) to create intermediate holding companies subject to capital (and liquidity) stress tests.

[5] In particular, DFAST evaluates capital adequacy under a supervisory assumption that BHCs hold constant their capital distributions. CCAR, by contrast, assesses whether the BHC in the severely adverse scenario could continue to take its planned capital actions under the firm's baseline plan without breaching ratios for regulatory capital and leverage, including a 5 percent post-stress Tier 1 common equity ratio. See also Hirtle (2012).

- *The scale and granularity of data collection*. For CCAR and DFAST, BHCs file the Federal Reserve's new FR Y-14 form, which collects different types of data on monthly, quarterly, and annual bases. The Y-14 includes extensive granular information, for example, loan-level data about mortgages and consumer credit. These data provide supervisors—and the BHCs themselves—with an unprecedented, comprehensive picture of the BHCs' portfolios. The OCC and the FDIC have established DFAST reporting templates for depository institutions to report their own projections of their balance sheets and revenues under the three scenarios. Although the filings are confidential, supervisors publish the instructions and blank forms, and the Federal Reserve releases high-level information, including loss amounts and rates by loan portfolio type, and estimated revenues under the severely adverse scenario.[6]

- *The scale and granularity of modeling*. Evaluating the balance-sheet impact of the severely adverse scenario under CCAR and DFAST requires detailed modeling for every category of banking activity based on detailed, portfolio-specific information. Developing these models has been a major undertaking for the participating institutions and the Federal Reserve. An important practical manifestation of this attention to modeling is the horizontal review of banks' risk management capacity under CCAR and DFAST. In reviewing internal capital planning processes, supervisors examine firms' holistic risk modeling capacities against a few common (supervisor-defined) scenarios. This peer-group analysis can reveal important deficiencies in the material risk models of individual banks or other parts of the broader capital planning process.

- *Disclosure*. The SCAP stress test helped reverse a deepening crisis by disclosing credible, institution-specific information about the resilience of banks to a further deterioration in economic conditions, back-stopped by public funds. The subsequent CCAR and DFAST stress tests have generated similar disclosures and have required that institutions with deficient capital under the severely adverse scenario or weaknesses in their capital planning to alter their capital distribution plans. Disclosure enhances market discipline as a tool for financial stability, strengthens the incentives for financial institutions to meet supervisory standards, and reinforces confidence in the functioning of the financial system by enhancing the credibility and transparency of the supervisory process.

We should not assume, however, that a framework that has worked well for the past four years will suffice going forward. Rules for CCAR and DFAST focus U.S. supervisory stress testing on the capital implications of credit stress on individual institutions under a very limited set of adverse scenarios. These stress tests also

[6] Board of Governors (2013a).

lack important potential second-round impacts, such as idiosyncratic increases in banks' funding costs related to deterioration in their capital adequacy or declines in liquidity—for example, if funding run-offs force banks to delever.

Financial stability monitoring, as described by the OFR and others, highlights the tendency for risks to build within the financial system over time.[7] For example, during booms, easy leverage and liquidity can breed market excesses, which are not considered in stress testing under CCAR and DFAST. When market confidence turns, asset prices can rapidly readjust, leading to withdrawals of key funding sources for financial institutions, margin calls that force firms to sell assets, and asset fire sales when similarly challenged banks rush to sell at the same time, creating further downward pressure on prices. With these systemic issues in mind, financial stability monitoring now is turning attention toward leverage, liquidity, and interconnections among financial institutions.

Public disclosure of supervisory stress tests can provide important new information to market participants, subject of course to the need to protect confidential supervisory information. Investors, creditors, and counterparties of individual financial institutions have an obvious interest in evaluating their resilience under stress, but their ability to run their own stress tests is limited by the information that is publicly available in financial statements and regulatory filings. Disclosure can improve the ability of institutions to assess their own vulnerability in the broader context of market-wide stresses.[8] Risk managers at firms, for example, could better understand the size and materiality of their firm's risk relative to others within the industry. This insight could help them assess implications for liquidity, funding, and revenue. Similarly, public disclosure of comprehensive stress testing could be a two-way street, with market participants providing the regulators with informed critiques of the stress testing models and processes.

Incorporating these types of enhancements to supervisory stress testing presents challenges, but in the long run would further enhance confidence in supervisory stress test results and promote financial stability. The following sections discuss in more detail some ways stress tests can be improved and how the next generation of tests may be able to model crisis dynamics more explicitly.[9]

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[7] See OFR (2012), Adrian, Covitz, and Liang (2013), and Greenlaw and others (2012).

[8] Gick and Pausch (2012), Goldstein and Sapra (2012).

[9] Some foreign regulators have begun to develop models that incorporate these effects. For example, the Bank of Canada's Macro-Financial Risk Assessment Framework includes solvency, liquidity, and network effects (Gauthier, He, and Souissi (2010)). The Dutch National Bank's macro stress-testing model stresses banks' market and funding liquidity risks (Van den End (2012)). The Bank of England's RAMSI model (Aikman and others (2009)) and the European Banking Authority's stress tests also include simulations of funding cost increases under stress.

III. Version 2.1: Enhancing the Current Framework

The Version 2.1 research agenda that we describe in this section aims to enhance the existing stress-testing framework. This version focuses on research toward objectives that can be implemented in the near term. It is important to acknowledge that the CCAR and DFAST process may not be able to address all the issues raised here. Rather, bank supervisors might need to supplement CCAR and DFAST with additional supervisory analytics to probe a broader range of scenarios and consider important liquidity and network effects.

Scenario Design, Multiple Scenarios, and Reverse Stress Testing

Scenario design is the first challenge in developing a supervisory stress test. U.S. supervisory stress tests focus on national macroeconomic variables (the SCAP, for example, shocked U.S. GDP, national unemployment, and national home prices), an approach that will become more problematic as agencies add mid-size companies with more regionally concentrated portfolios to the U.S. stress testing regime. International macroeconomic variables are not a salient component in current stress tests, which could limit their comparability with stress test results from foreign banks. In the absence of these variables, supervisors must ensure that banks' extrapolation of variables not specified in the scenarios are, nonetheless, consistent.

Additionally, current supervisory scenarios are stated in terms of macroeconomic factors. However, some experts argue that it is shocks to the financial system that cause economic downturns, rather than the other way around.[10] Scenarios that ignore the details of financial-sector transmission channels will tend to miss vulnerabilities such as crowded trades, asymmetric information, excessive leverage, liquidity shortages, and interconnectedness. While banks attempt to map macroeconomic scenarios to their portfolios, additional scenarios might be better defined using variables that affect the banks' balance sheets more directly. Further work is needed on techniques for defining such "finance-specific" scenarios, because these are likely to be important in actual stress episodes.

Increasing the number of scenarios would also improve stress tests. Current U.S. stress tests typically employ just two stress scenarios. There are two important drawbacks to running a limited number of supervisory stress scenarios. First, running fewer stress scenarios makes it more likely that the scenarios could be inadequate, either because a problematic scenario was missed, or a selected scenario did not represent a stress, given the institution's exposures. CCAR and DFAST attempt to address this shortcoming by having firms formulate additional scenarios tailored to their own business models. However, this discretion introduces a danger that firms may "pull their punches" in scenario design. Research is needed regarding optimal scenario design for firms (as opposed to supervisors), because they have more intimate knowledge of their own

[10] Borio, Drehmann, and Tsatsaronis (2012).

portfolios and more flexibility in how they can implement tests. As the universe of institutions covered by U.S. stress testing becomes larger and more heterogeneous, the use of a few scenarios will become an increasing concern. Second, if supervisors rely on a small and fixed set of scenarios, banks are likely to learn to anticipate the features of a scenario, curtailing the effectiveness of the tests. As the process matures and becomes more predictable, it runs the risk of "teaching to the test," in the sense that financial institutions will learn to shape their activities to exploit weaknesses in scenario design.

Reverse stress tests offer an alternative. While traditional stress tests map a scenario to an outcome, reverse stress tests specify the outcome—a capital shock of a given severity, for example—and look for scenarios that produce that outcome. A reverse stress test is portfolio-specific and, by construction, highlights the most relevant scenarios. It also helps address the concern that generic (forward) stress tests may miss the idiosyncratic vulnerabilities of individual firms. Reverse stress testing can be extended to sample broadly from the space of possible outcomes for the various risk factors specified by CCAR and DFAST by using Monte Carlo or other probabilistic sampling methods, thereby potentially illuminating risks that are not apparent even from a thoughtfully specified scenario set. Improved techniques to facilitate an extensive search of the space of potential scenarios and related restrictions on risk exposures are worthy research topics.

The related problems of designing scenarios and developing reverse stress tests are current focuses of research. Basel guidance has repeatedly asserted that stress scenarios should be severe and plausible; they should also be coherent, meaning that risk factors must move together in realistic ways.[11] As a simple example, Schuermann (2013) notes that not all currencies can depreciate at the same time. Other coherence rules are more nuanced. Glasserman, Kang, and Kang (2013) suggest an empirical method for coherent modeling of extreme events. Flood and Korenko (2013) and Breuer and others (2009) restrict attention to elliptically distributed risk factors, where linear correlation measures dominate consistency considerations. These frameworks are useful steps, but, to the extent such models are based on historical estimations, they are subject to the criticism that the relationships among various factors tend to change abruptly during crises. Resolution plans developed by large financial institutions may provide valuable sources of forward-looking information for scenario selection.

Coarse and Granular Stress Tests

Another way to reduce the cost and complexity of running multiple scenarios would be to evaluate some scenarios more carefully than others. Supervisors would evaluate most scenarios at a high level, taking a more granular approach only to those scenarios that they believe are relatively likely or could pose the greatest risk

[11] BCBS (2009), p. 2.

to the financial system. An unexpected outcome in a coarse test could be explored with more granular data as needed. Such an approach would require a methodology for aggregating a portfolio to key factor exposures as opposed to relying on loan-level models. Moreover, a key element of both the SCAP and CCAR has been the public disclosure of certain key results. In this context, setting a "granularity threshold," below which fine-grained results remain confidential, might provide supervisors with useful flexibility in implementation.

Alignment with Internal Risk Management

Basel II imposed a "use test" on models that banks develop for measuring regulatory capital: they should be the same models banks use for their internal risk management. This principle enhances the credibility of risk models and aligns internal risk management with regulatory objectives. When a regulatory stress test becomes a binding constraint on capital, this alignment becomes more difficult to achieve, particularly if the bank and the regulator attach different importance to different scenarios or evaluate the stress impact differently. Although the CCAR and DFAST processes require that banks also report their own scenarios, the regulators' severely adverse scenario may not align with a bank's own view of the greatest risks it faces, and a bank's evaluation of losses in a given scenario may not match losses under regulatory models. This mismatch could present an obstacle to bank risk management if the bank must take the regulatory view of risk. Overcoming this obstacle requires balancing the benefits of transparency in regulatory models against the risk of gaming that could arise if banks have complete information about regulatory models.

Modeling Liquidity Jointly with Solvency

CCAR and DFAST are solely capital stress tests. Although the Federal Reserve has recently conducted horizontal liquidity reviews of large BHCs, these reviews were not integrated with CCAR and DFAST. A number of important channels of interaction exist between a bank's solvency and its liquidity, and U.S. bank supervisors could consider integrating them into current stress tests. For example, given a decline in capital adequacy, a bank could experience an increase in its cost of funding that affects its profitability, and, under supervisory stress tests, earnings are an important buffer against credit losses.

More problematically, banks under stress can lose access to funding, requiring asset sales. Such effects are not currently captured in U.S. supervisory stress tests, which consider only credit losses on banks' available for sale (AFS) securities and do not require firms to assume that funding strains could force them to liquidate AFS securities.[12] As a result, for most firms, estimates of realized losses on their AFS securities portfolio have had a limited impact on capital in their 2013 supervisory stress test results, even under severely adverse

[12] Board of Governors (2013b).

scenarios. Liquidity conditions in a real stress event would probably prove less benign.[13] Other potential liquidity-solvency channels include loan pipeline back-ups, commitment drawdowns, derivatives collateralization requirements based on the bank's own credit rating, and ratings-based triggers for deposit withdrawals.

IV. Version 3.0: The Next Generation

The next generation of stress tests will go beyond exploring the effects of a stress on the balance sheets of individual financial institutions to ask: Then what? What are second-round effects of one bank's stress on other banks? What impacts does a stress event have on other parts of the financial system? How do those events, in turn, alter the behavior of a bank? These questions demand a rethinking of the approach to stress testing to capture interconnections and the internal workings of the financial system. The following issues are key for this Version 3.0 to address.

Feedback Dynamics and Contagion

Currently, stress tests implicitly assume that banks are atomistic. That is, there is no mechanism to deal with the fact that some banks are large enough for one bank's response to a shock to affect the market and other banks. A static representation may help supervisors understand the vulnerabilities of banks with opaque balance sheets and simple correlated exposures, but other tasks, such as exploring the broader vulnerability to crises, require a specification of system dynamics and behavior. Aside from the danger that one bank may be large enough for its stress response to feed back into the markets, the possibility of similar exposures shared across firms—all the firms on the "same side of the boat"—brings attention to the secondary and possibly system-wide ramifications of stress scenarios. The potential for contagion in our highly interrelated financial system would only exacerbate the aggregate effect.

Two prominent paths for this dynamic are fire sales and funding runs. A fire sale occurs when a market shock pushes leveraged asset managers such as hedge funds to their margin limits, inducing forced sales. These sales further depress prices in an already weakened market, leading other funds to hit their margin limits, thus adding fuel to the fire. The fire sale can also spread to other markets as portfolio managers under pressure liquidate their positions more broadly.[14]

A funding run can be triggered by an erosion of creditworthiness. Lenders or other counterparties withdraw from lending to a firm that is perceived to be under pressure, forcing the firm to deleverage its balance sheet.

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[13] With respect to market risk, at present only banks' trading assets are subject to shocks. However, this shock persists for only one quarter in the U.S. supervisory scenarios and also is assumed to materialize and begin to recede prior to banks' realization of loss on their loan portfolio.

[14] Fire sale and run dynamics are discussed in OFR (2012), pp. 56-57. For further background, see Brunnermeier (2009) and Shleifer and Vishny (2011).

For example, a bank could deleverage by liquidating inventory from its market-making desks and reducing its willingness to fund its customers. The weakness in a bank may begin as a mere perception, but become increasingly real as events unfold. Funding runs can cause fire sales in asset markets as firms deleverage to reduce their exposure, creating the feedback dynamic described above.

Firms' Reactions to Stresses

A multi-period model should incorporate the reactions of banks and other institutions to a stress event, something that is rarely done in the standard approach to stress testing. The behavior of portfolio managers, CEOs, regulators and policymakers may shift in response to a major financial event, as exemplified by firms' deleveraging in the wake of the 2008 shocks. This behavior fundamentally altered the aggregate risk picture, while policymakers simultaneously reduced short-term interest rates and engaged in large-scale asset purchases. Current (i.e., Version 2.0) stress tests posit scenarios that follow a path of the stressors over time, but typically without modeling or tracking the path-dependent, multistep decision processes that will inevitably describe the actual behavior of market participants. The question of specifying reaction functions is a complicated problem, and it deserves deeper research. One possible approach could be to obtain information from banks' contingent funding plans about their likely reaction functions.

Complicating the reactions to a stress is the fact that the stress occurs in a world of heterogeneous institutions that vary in their business models, risk postures, and risk factor exposures. A threat that dooms one institution might be innocuous to another. A particular shock may affect some institutions only indirectly, for example by threatening their funding. Another institution with greater exposure might shrink its balance sheet, while a less exposed firm could begin to act preemptively by hoarding assets.

Shifting Landscape

Historical analysis can provide insights into fire-sale dynamics and funding runs, but it cannot help us calibrate for risks in the present. These events are infrequent, so the sample to draw from is small, compounded by the fact that institutions and their interconnections, positions and leverage change over time. For example, the largest investment banks in the U.S. prior to 2008 have all been assumed by, or converted into, regulated bank holding companies. Although historical relationships may be reasonable for value-at-risk models, which assume that future variations in market factors will be drawn from the same distribution as the recent past, this implicit presumption of a slowly evolving data-generating process obviously will not work when we are dealing with a non-typical and extreme set of stresses. It is also important to recognize that risk exposures can migrate, even if the institutional structure does not change from the status quo. During the 2000s, there was a significant shift of credit risk into securitization vehicles as banks responded to the incentives created by Basel II. Stress testing should be applied more broadly than simply to large BHCs, to avoid pushing risks away from supervisory scrutiny.

Agent-based Modeling

Version 3.0 of stress testing takes into account institutional interactions, feedback effects, reactions to stresses, and the ever-changing financial environment. This new version can cope with feedback and contagion, be calibrated for the current market environment, and treat each of the entities as different from the rest.

One promising framework for this approach is agent-based modeling.[15] The potential for agent-based models for stress testing is suggested by their application in other fields, such as evaluating contagion in epidemiology, congestion vulnerability in traffic flows, and crowd behavior in building evacuations.

Agent-based models follow the dynamics of agents, assessing their reaction to events—period by period—and updating system variables accordingly. An agent-based model of the financial system might include the major banks, broker-dealers, suppliers of funding, and asset managers as agents, and include the supply and demand in the funding and asset markets as variables. An agent-based model incorporates heterogeneity as well as idiosyncratic and perhaps less-than-optimal rules for how financial institutions operate.

Conclusion

Stress testing for internal risk management is now an essential part of the bank supervision toolkit. Bank supervisors can also use stress tests to probe the financial system for weaknesses, emerging risks, common exposures, and interconnections. Stress tests can help reveal data gaps for further supervisory investigation and assess the risk management capabilities of individual firms. Of course, the task must be undertaken with the understanding that the exercise is based on trying to evaluate future events. The next crisis will likely differ from the last, and contagion effects in crises are complex and difficult to evaluate before they occur. For these reasons, we argue that the next generation of stress tests should include second-order effects across firms and markets, and should expand to include the impact upon funding and liquidity.

Although much has been learned during the post-crisis process of implementing new bank supervisory stress-testing capabilities, we have identified important questions that would benefit from research and policy analysis.[16] We advocate an exploration of this research agenda, as well as a broader move toward implementation of more dynamic, network-focused modeling embodied in stress testing Version 3.0. Our discussion has focused on supervisory stress tests for banks and bank holding companies. But some of the most prominent failures in the recent crisis, those of Lehman Brothers, Bear Stearns, AIG, the Reserve Primary Fund, and Fannie Mae and Freddie Mac, occurred outside the scrutiny of bank regulators. We do not yet fully understand how to design equally challenging scenarios for diverse types of financial institutions,

[15] Bookstaber (2012).

[16] See also Acharya, Engle, and Pierret (2013), Flannery (2012), and Pritsker (2012).

but one source for exploring these risk dimensions is the accumulated institutional expertise within financial firms. Non-bank regulators might survey experts in industry to hone in on issues of particular concern. They might also perform meta-analyses of risk reports from a cross section of firms to identify common risk factors that these institutions consider significant.

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