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Should Banks' Stress Test Results be Disclosed? An Analysis of the Costs and Benefits

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Contents

1	Introduction	2
2	The Nature of Stress Tests and their Disclosure	7
3	The Benefits of Disclosure	11
3.1	Disclosure and market discipline	11
3.2	Disclosure and supervisory discipline	13
4	Problems with Disclosure	14
4.1	Impact of disclosure on risk sharing and the operation of the interbank market	17
4.2	Impact of disclosure on ex ante incentives of bank managers	20
4.3	Impact of disclosure on ex post actions of market partici- pants: Coordination failures and runs	29
4.4	Impact of disclosure on the ability of regulators to learn from the market	38
5	Policy Recommendations	43
6	Conclusion	48
	Acknowledgements	49
	References	51

Abstract

Stress tests have become an important component of the supervisory toolkit. However, the extent of disclosure of stress-test results remains controversial. We argue that while stress tests uncover unique information to outsiders — because banks operate in second-best environments with multiple imperfections — there are potential endogenous costs associated with such disclosure.

First, disclosure might interfere with the operation of the interbank market and the risk sharing provided in this market. Second, while disclosure might improve price efficiency and hence market discipline, it might also induce sub-optimal behavior in banks. Third, disclosure might induce *ex post* market externalities that lead to excessive and inefficient reaction to public news. Fourth, disclosure might also reduce traders' incentives to gather information, which reduces market discipline because it hampers the ability of supervisors to learn from market data for their regulatory actions.

Overall, we believe that disclosure of stress-test results is beneficial because it promotes financial stability. However, in promoting financial stability, such disclosures may exacerbate bank-specific inefficiencies. We provide some guidance on how such inefficiencies could be minimized.

1

Introduction

In the wake of the financial crisis, the Federal Reserve expects large, complex bank holding companies (BHCs) to hold sufficient capital to continue lending to support real economic activity even under adverse economic conditions. Stress testing is one tool that helps bank supervisors achieve that goal. The Dodd–Frank Wall Street Reform and Consumer Protection Act (DFA) requires the Federal Reserve to conduct an annual stress test of large BHCs and nonbank financial companies designated by the Financial Stability Oversight Council (FSOC) for Federal Reserve supervision to evaluate whether they have sufficient capital to absorb losses resulting from adverse economic conditions. (DFA, Section 1115(a)). The DFA also requires BHCs and other nonfinancial companies supervised by the Federal Reserve to conduct their own stress tests: for systemically important firms, these tests must be performed on a quarterly basis and for other firms—those with assets exceeding \$10 billion — they should be performed on a semi-annual

basis (DFA, Sections 1115(a), 1115(b)). The Federal Reserve adopted rules implementing these requirements in October 2012.¹

Interestingly, Congress left it to the regulatory agencies to specify the nature and design of these stress tests so that several important questions remain unanswered — and controversial. For example, should bank-specific stress-test results be publicly disclosed? If so, to what extent? Should the tests follow the traditional approach of focusing on the resilience of each bank individually or should they instead focus more on the resilience of the banking sector to a common macroeconomic shock?

Many proponents of disclosure of stress-test results have linked the severity of the recent financial crisis to bank opacity. They argue that many banks took on excessive risks that were not adequately disclosed so that such risks could not be properly priced by the market. Disclosure of stress-test results informs outsiders whether banks are sufficiently capitalized to absorb negative shocks, thereby enhancing *market discipline*. Such market discipline, in turn, would have prevented insiders from engaging in excessive *ex ante* risk taking behavior that may have contributed to the recent financial crisis. Greater transparency of a bank's risks would have also allowed banking regulators to better monitor the banks and allowed them to intervene early enough to take corrective actions by recapitalizing weak or insolvent banks. Unfortunately, by the time regulators intervened, it was too late as there was a widespread panic because the market could not distinguish a solvent bank from an insolvent bank and such panic brought the whole financial system to its knees. By disclosing stress test information, investors' confidence in the banking sector would be restored and such a boost in investor confidence would, in turn, positively influence the real economy. While the rationales for disclosing the results of these stress tests seem intuitive, some have argued that disclosing the results of these stress tests may actually have unintended consequences. For example, instead of providing market discipline, if stress tests are not properly

¹The Federal Reserve previously highlighted the use of stress tests as a means of assessing capital sufficiency under stress during the 2009 Supervisory Capital Assessment Program (SCAP) and the 2011 and 2012 Comprehensive Capital Analysis and Review (CCAR) stress test exercises.

designed, disclosure of their results may actually create more panic, thereby lowering confidence in the banking sector. A lower confidence in the banking sector may have more negative consequences on the real sector.²

In any debate regarding the desirability of disclosures, the objective of such disclosures must be specified. In the case of stress tests, these tests could serve either a microprudential and/or macroprudential objective. A microprudential goal implies that an individual bank has enough capital buffer to absorb potential losses, thereby ensuring its solvency. A macroprudential goal implies that the banking system as a whole has the ability to survive a systemic crisis, thereby promoting financial stability. In this monograph, we will argue that these two goals may not necessarily be compatible with each other — while stress-test results accompanied with appropriate disclosures could promote overall financial stability, they might simultaneously induce inefficiencies at the individual banks.

We will also argue that the benefits of disclosing stress-test results are clear: stress tests may uncover unique information about banks allowing both bank supervisors and market participants to exercise discipline on the bank's behavior. However, because banks operate in second-best environments that are prone to externalities, we argue that there are endogenous costs associated with such disclosures. We believe that a proper understanding of the sources of these costs would better inform the debate and guide regulators in both designing these tests and handling the disclosures. More precisely, we believe that — at least from a macroprudential financial stability perspective — the benefits of disclosing stress-test results are undeniable. Instead, our goal is to explain how, conditional on disclosure of these stress-test results, the costs associated with these tests could be minimized via the design of stress tests and the nature of the disclosure.

To better understand the sources of the endogenous costs, we will first review several theoretical frameworks for discussing the costs and

²This debate is described in the article “Lenders Stress over Test Results,” *Wall-Street Journal*; March 5, 2012. See <http://online.wsj.com/article/SB10001424052970204276304577261554100410414.html>.

benefits of greater disclosure. In the absence of a clear sense of the potential costs and benefits associated with greater disclosure, the knee jerk reaction is that more information is always better, since usually more information provides better market discipline. However, we will explain why the conventional wisdom that more disclosure leads to better market discipline need not hold for banks as they operate in *second-best* environments, i.e., environments with market and informational frictions. First, banks engage in risks that are notoriously opaque, hard to verify, and easily susceptible to asset substitution. Second, banks operate in environments that are prone to externalities. In such environments, there are endogenous costs to disclosure that supervisors must take into account in determining both the design of the tests and how to handle the disclosure of the results. In such environments, greater disclosure may actually sometimes impede welfare. The main insight of our monograph is that, when it comes to the disclosure of stress-test results, perhaps too much importance has been attached to how such disclosure would improve market discipline.³ If the goal of disclosure of stress tests' results is to improve market discipline, we will show that market discipline is a necessary but not sufficient condition for economic efficiency. Furthermore, in second-best environments, the incentives of all market participants need to be taken into account in understanding how and when disclosure would affect market discipline.

The remainder of the monograph is organized as follows. In Section 2, we review in detail the nature of stress tests, discussing the unique information they provide to outsiders. In Section 3, we review the conventional wisdom and explain how disclosure of stress tests could provide regulatory and market discipline and how such discipline may indeed have a positive impact on economic efficiency. Section 4, which is the main section of the monograph, reviews in detail possible costs of disclosure. We first explain in general why the conventional wisdom may not hold up well for banks. Then, we discuss four theories that highlight problems with disclosure and link them to the context of stress testing in the banking system. First, disclosure might harm

³We discuss later how the benefits of disclosure of stress-test results might be due to supervisory discipline in addition to market discipline.

the operation of the interbank market and the provision of risk sharing achieved in this market. Second, detailed ex-post disclosure might adversely affect the ex-ante incentives of bank managers and lead them to take myopic inefficient actions to pass the test. Third, greater disclosure might lead to inefficient ex-post reaction from market participants, who face a coordination problem (e.g., a run) and put excessive weight on public information rather than on their own private information. Fourth, the disclosure of stress-test information publicly might crowd out the private information in market prices and reduce the ability of regulators to learn from market prices. With the benefits of the insights gained from the discussions in Section 4, in Section 5 we explain that there is a non-trivial trade-off associated with disclosure of stress-test results. We believe that such disclosure serves an important purpose in promoting financial stability, in particular at the aggregate level. However, there are costs of detailed disclosure at the bank specific level. In order to minimize these costs, we provide several recommendations to regulators about how to handle the design and disclosure of stress tests results. Section 6 concludes.

2

The Nature of Stress Tests and their Disclosure

The Dodd–Frank Act requires the Federal Reserve to conduct an annual stress test of large BHCs and all nonbank financial companies designated by the FSOC for Federal Reserve supervision. The Federal Reserve adopted rules implementing these requirements in October 2012. Under the rules, 18 BHCs were part of the Dodd–Frank Act Supervisory Stress Tests this year (DFAST 2013).

In conducting the stress tests, the Federal Reserve considers different macroeconomic scenarios and examines the implications they would have on each individual BHC. In 2013, three scenarios were considered — baseline, adverse, and severely adverse. The results were published only for the severely adverse economic scenario.

To better understand how a scenario is developed for stress testing, it is useful to consider the inputs that went into the severely adverse scenario in the stress tests of 2013. The scenario includes trajectories for 26 variables: 14 variables that capture economic activity, asset prices, and interest rates in the U.S. economy and financial markets, plus three variables (real GDP growth, inflation, and the U.S./foreign currency exchange rate) in each of four countries or country blocks (the euro area, the United Kingdom, developing Asia, and Japan). This severely

adverse scenario is not meant to be a projection for the future, but rather a reflection of a very bad possible economic shock of the kind that was experienced in the recent financial and economic crisis. In this scenario, real GDP in the United States declines nearly 5 percent between the third quarter of 2012 and the end of 2013; the unemployment rate rises to 12 percent; the four-quarter percent change in the consumer price index (CPI) decelerates to 1 percent; equity prices fall more than 50 percent; equity market volatility index increases from 21 to 70; real estate prices decline by more than 20 percent; and the euro area, the United Kingdom, and Japan fall into recession, while developing Asia experiences below-trend growth.

For each BHC, the stress test examines the effect of the severely adverse economic shock on net income and losses, taking into account the exposures of the BHC and its business. In order to conduct this analysis, the Federal Reserve relies on input from the BHCs and on analytical models that determine the effect of the shock on the income and losses of the bank. Combining the results on income and losses with assumptions on capital distribution policy, the test generates the final output, which is the effect of the severely adverse shock on the bank's capital ratios based on different definitions of capital ratios. The four different ratios are the ratio of the common equity component of tier 1 capital to risk-weighted assets (the tier 1 common ratio), the ratio of tier 1 capital to risk-weighted assets (the tier 1 capital ratio), the ratio of total regulatory capital to risk-weighted assets (the total risk-based capital ratio), and the ratio of tier 1 capital to average assets (the tier 1 leverage ratio).

For purposes of the stress test, when any one of the bank's capital ratios is projected to drop below a certain threshold following the severely adverse economic shock, that bank is considered to have not "passed" the stress test. Such a bank is expected to limit capital distributions and/or raise more capital to be better prepared for adverse economic shocks. In general, banks differ from each other in the type of loans they make and the exposures of these loans to the assumed macroeconomic scenarios. Also, banks differ in their levels of capital buffers and how they maintain such buffers in light of planned

capital distributions. Hence, some banks may fail while others may pass depending on their different business models.

So what is new about stress tests? Examinations of large banks by regulators are not new. Large banks in the United States have been subject to continuous on-site examinations for many years, and these on-site examinations have always been a key input into a bank's CAMELS rating, which is a score between 1 and 5 used to classify a bank's overall condition. But, the newly required stress tests are different from traditional supervisory exams in several key dimensions.

First, because they focus on realized losses, traditional exams are typically backward looking. Stress tests are more forward looking because they project future losses. By anticipating future losses, regulators check whether banks are well capitalized today to absorb not only current losses but also future losses. Second, by projecting future losses under highly adverse scenarios, such tests provide information about left-tail risks. Stress tests, therefore, put relatively more weight on bad states of nature. Third, by applying a common set of scenarios to banks, these tests have the ability to provide more consistent supervisory standards across banks. The Federal Reserve is also attempting to provide systemic information by revealing how significant economic or financial shocks would affect the largest banks collectively as well as individually.

Finally, and most importantly for our context, unlike traditional supervisory exams whose results are kept confidential, DFA mandates public disclosure of bank stress-test results [see e.g., Prescott and Slivinski, 2009]. In the eyes of the Federal Reserve, an important part of the newly required stress tests is the disclosure of their results. The press release announcing the results states: "The Federal Reserve believes that disclosure of stress test results provides valuable information to market participants and the public, enhances transparency, and promotes market discipline." Indeed, the results of the most recent stress tests were disclosed publicly in March 2013. They provide very specific information on the ability of individual BHCs to absorb losses resulting from a severely adverse economic scenario. For each BHC, the four projected capital ratios under the severely adverse scenario

were disclosed publicly, alongside details on projected net income and projected loan losses by type of loan (First-lien mortgages, domestic; Junior liens and HELOCs, domestic; Commercial and industrial; Commercial real estate, domestic; Credit cards; Other consumer; Other loans).

As we mentioned in Section 1, it is the *disclosure* of stress test results that has drawn a lot of attention and controversy and the trade-off of such disclosure is the focus of our monograph. We will next review that tradeoff from the perspective of the economic theory literature. We will start with a discussion of the benefits of disclosure, which are quite well known and are therefore not so controversial. We then describe the disadvantages associated with public disclosure.

3

The Benefits of Disclosure

The idea that disclosure has benefits is not surprising. Going back to Blackwell's (1951) theorem, we know that for a single decision maker, her *ex ante* expected utility under information set X is weakly higher than under information set Y as long as information set X is finer than information set Y . Therefore, in the context of a single investor, more information about fundamentals is always desirable because it allows the investor to form more precise posteriors about fundamentals and hence take more desirable actions and achieve more desirable outcomes. In the language of policy makers, the disclosure of information produced by stress tests will improve market discipline by providing more precise information to market participants with which they can make more informed decisions concerning the financial institution in question. We start by discussing this idea in more detail. We then discuss an additional benefit of disclosure coming from better supervisory discipline.

3.1 Disclosure and market discipline

The view among many policy makers and academics is that more disclosure is socially desirable because it allows market participants to

impose market discipline earlier and more effectively. The intuition is straightforward: more disclosure allows market participants to have better insights into the risk exposures of a bank so that the bank's risks would be impounded in its market price. A higher price efficiency will then affect the resources flowing to the bank and thereby discipline a bank's insiders. For example, if the bank's activities are viewed as too risky so that the bank could become insolvent, such risks will be reflected in lower prices of the bank's debt and equity claims. This implies that the bank will be able to raise fewer funds, which will limit the damage imposed by the bank's actions. Moreover, anticipating this, the bank's insiders would be deterred from engaging in excessive risk taking. These are precisely some of the arguments made in favor of disclosing the results of banks' stress tests: public disclosure about a bank's financial condition enables market participants to make informed decisions about the bank and such informed decisions, in turn, discipline the bank's actions.

The US Savings and Loans (S&Ls) crisis of the 1980s is a case in point [see, for instance, Michael, 2004]. The crisis stemmed in part from the fact that the (variable) interest rates on the S&Ls' deposit liabilities rose above the (fixed) rates earned on their mortgage assets. However, S&Ls were not using market prices to value their mortgage assets. Rather, they used historical cost accounting that kept the assets at their original values. The use of historical cost accounting masked the problem by allowing an increase in interest rate to show up only gradually through negative annual net interest income. The insolvency of many S&Ls became clear eventually, but using market prices to value the mortgage assets would arguably have provided market discipline by highlighting the problem to outsiders much earlier, and the S&Ls problem could have been resolved at a lower fiscal cost. Similarly, the protracted problems faced by the Japanese banking system in the 1990s are also cited as a case where slow recognition of losses due to poor disclosure practices on the banks' balance sheet exacerbated the problems. Therefore, enhanced disclosures and market discipline are viewed as two sides of the same coin.

3.2 Disclosure and supervisory discipline

Aside from the usually emphasized role of disclosure in improving market discipline, another important benefit of stress-test disclosure — that perhaps did not receive as much attention in the debate — is the role of public disclosure on supervisory discipline. To understand this, suppose stress-test results did not reveal any new information about a bank's financial condition to market participants. We will argue that the mere act of disclosure could now impact the credibility of the tests and reputation of the supervisors. This is because, by disclosing stress-test results, regulators could be held accountable as their supervisory approach — whether in terms of how credible the tests are and/or what supervisory actions would be taken with regard to banks that fail the tests — would be subject to greater scrutiny and discussion by outsiders.

For example, a commitment to disclose stress-tests result improves depositors' trust in the banking system by alleviating concerns that regulators might privately forbear by concealing bad news from the market. Furthermore, by disclosing the stress tests' methodology as well as their results, the credibility of regulators could be enhanced in the eyes of the market. One might argue that the SCAP conducted by the Federal Reserve Bank in 2009 is an example that was successful in large part — not because of the informational content of the results *per se* — but rather because it held supervisors accountable for their actions by asking them to disclose ahead of time (1) what was needed for firms to pass the tests, (2) what firms that did not pass the test would be expected to do, and (3) what steps would supervisors take in connection with firms that did not pass the tests.¹ Conversely, it is widely believed that the first stress tests conducted on European banks in 2010 by the Committee of European Banking Supervisors (CEBS) in conjunction with the European Central Bank (ECB) lacked such credibility and did little to enhance the reputation of the supervisors.²

¹For more information about the SCAP exercise, see the Board's website at www.federalreserve.gov/bankinforeg/scap.htm.

²See Schuermann [2013] and <http://www.reuters.com/article/2010/07/23/banks-stresstest-idUSSGE66M07W20100723>.

4

Problems with Disclosure

Despite the view described in the previous section, disclosure of information is not a panacea. In fact, there are many disadvantages of greater disclosure that have been studied and analyzed in the academic literature. In this section, we will review them and discuss their relevance in the context of disclosure of bank stress-test results.

Note that one common argument against disclosure is that it generates proprietary costs for the firm, whose information is being disclosed, arising from information leakage to competing firms [see e.g., Dye, 1986; Darrrough and Stoughton, 1990; Gigler, 1994]. This is indeed an important force that affects the private incentives of firms to disclose, but we will mostly ignore it here since it does not alter the social tradeoff that the government should care about when designing disclosure policy. That is, if disclosure triggers proprietary costs that damage the cash flows of the disclosing firm, such disclosures enhance the cash flows of competing firms, so the *social* costs to such disclosure could be small or even non-existent. Thus, a regulator, concerned with social welfare and overall economic efficiency, is unlikely to be swayed by proprietary cost arguments.

In order to understand at a basic level why the provision of more information to the marketplace can harm overall efficiency, we need to understand what might break down in the simple logic of Blackwell's [1951] famous result. This result hinges upon two important assumptions. First, the investor is playing against nature where the fundamentals are exogenous. Second, there is a *single* decision maker, i.e., there are no strategic interactions among different investors. Indeed, if any one of these assumptions is relaxed, it is not immediate that a finer information set is always preferable.

Specifically, it seems clear that the following statements fail to hold for banks:

1. The behavior of a bank's insiders is relatively insensitive to changes in the bank's disclosure environment.
2. Banks operate in relatively frictionless environments.
3. The stakeholders of banks care more about fundamentals than the behavior of other stakeholders.

Consider the first statement. It is clear that banks are run by insiders with incentive schemes that induce them to respond to changes in their disclosure environment. Over the years, bank managers have been increasingly exposed to the use of price-sensitive incentive schemes and price-sensitive risk-management schemes, and so disclosure of the information that they have, by affecting the public information and the market prices, would clearly affect their incentives on project selection and risk taking. This implies that the cash flows of banks are not exogenous as in the traditional Blackwell environment, but respond to the disclosure regime, and so disclosure may not be optimal; it may lead bank managers to make suboptimal decisions.

Consider the second statement. It is clear that banks operate in second-best environments with *multiple* imperfections. They are subject to shocks that cannot be perfectly insured. Banks' insiders and even bank regulators do not have all the information about financial shocks and are trying to gauge additional information from the market. In the presence of such imperfections, disclosure might sometimes hurt more than it helps. As the theory of second best suggests, removing

one friction might hurt the overall outcome when multiple frictions are present.

Consider the third statement. It is clear that banks operate in an environment where their investors impose strong externalities on each other. The fundamental role of banks is maturity transformation: banks typically finance their long term loans with short-term deposits. This asset–liability mismatch, in turn, makes banks fragile so that the depositors are not a homogenous group who just care about the bank’s fundamentals. Instead, such fragility implies that depositors care both about the bank’s financial condition *and* the behavior of other depositors. This is the source of runs that are a major threat for banks and financial institutions. Then, disclosure of information might lead to an undesirable outcome in the coordination problem faced by the bank’s investors.

Overall, one might argue that what makes banks or financial institutions special compared to non-financial institutions is that, taken together, the above statements are potentially less descriptive of a bank’s environment relative to that of other firms. Therefore, using Blackwell’s theorem that more disclosure is desirable because it improves market discipline is not so obvious. Below, we explain why — in the presence of multiple market imperfections — stress-test disclosure may result in endogenous costs that hamper the benefits of greater disclosure. More precisely, we will explain that such tests — if not properly designed—may actually destabilize prices, thereby reducing market discipline and hence economic efficiency. We will also illustrate that *even if* more disclosure to the capital market improved price efficiency and hence enhanced market discipline — and therefore financial stability — such market discipline need not necessarily improve economic efficiency. We want to emphasize that the preceding statement does not imply that disclosure of stress-test results is not desirable. Rather, if these tests are to become part of the standard regulatory toolkit, then it is important for regulators to be clear about the goals and objectives of such disclosures. For example, we will argue that the cost–benefit trade-off will be different if supervisors have a micro-prudential goal rather than a macro-prudential goal. This, in turn, implies that the degree of transparency and therefore the nature of the disclosures need

not be the same if the goal is disciplining individual banks versus promoting overall financial stability.

We will review the costs of disclosure from the point of view of four different types of theories. First, we will discuss the potential negative effect that greater disclosure has on the operations of the interbank market and the risk sharing that banks achieve in this market. Second, we will discuss the negative implications that disclosure may have for the actions of bank managers. Third, we will discuss the destabilizing effect that disclosure may have and how it might lead to undesirable runs. Fourth, we will discuss how greater disclosure of information might crowd out the private information processed and generated by financial markets.

4.1 Impact of disclosure on risk sharing and the operation of the interbank market

One of the most fundamental concerns about disclosure in the economics literature was brought up by Hirshleifer [1971] and is widely known as the “Hirshleifer Effect.” According to the Hirshleifer effect, greater disclosure might decrease welfare as it reduces risk sharing opportunities for economic agents. Suppose that risk averse economic agents are exposed to idiosyncratic shocks that these agents would like to insure against. If the realization of shocks is unknown in the marketplace, these agents may engage in risk-sharing contracts, such that resources will flow from parties that had a good realization to parties that had a bad realization upon the realization of the shocks. Such risk-sharing improves welfare from an ex-ante point of view. However, early disclosure of the realization of the shocks will reduce risk sharing opportunities. Once it is known that an agent suffered a bad realization, it will no longer be possible to insure against it. Therefore, from an ex-ante perspective the welfare of all agents is reduced due to the loss of risk sharing opportunities.

This concern might be very relevant in the context of the banking industry. A large literature [e.g., Allen and Gale, 2000] studies risk-sharing arrangements among banks in the interbank market. If

banks are exposed to random liquidity shocks, they will create arrangements among themselves or with outside markets to insure against such shocks. In Allen and Gale [2000], banks hold deposits in each other, which they can withdraw in case they face high withdrawal demands from their depositors. If depositors' liquidity shocks are not strongly positively correlated across banks, then this allows banks to share the risks of high liquidity shocks. Banks in need of liquidity withdraw deposits from banks that have a lower need for such liquidity. This allows banks to improve expected welfare for their depositors by reducing the probability of a run and/or holding fewer reserves and so enhancing the return on their portfolios.

One can then easily see how greater disclosure can interfere with the operation of the interbank market in the Allen and Gale [2000] framework via the Hirshleifer effect. Suppose that more information about the state of each individual bank and its ability to withstand future shocks is publicly disclosed following the results of stress-test conducted by the government. Then, the ability of banks to engage in risk-sharing arrangements among themselves will be limited, as they cannot insure against a shock, the realization of which has already become known. This implies that ex-ante welfare for depositors is reduced.

While the Hirshleifer effect suggests that disclosure is unambiguously bad, the reality of the banking sector and the interbank markets is more complicated. In particular, as was clear during the recent financial crisis, when aggregate conditions seem bleak, the lack of disclosure might lead to a breakdown in financial activity. In the context of risk sharing and insurance, if the aggregate state of the financial sector is perceived to be weak, banks would not be able to insure themselves against undesirable outcomes [see, e.g., Leitner, 2005]. In this case, some disclosure on certain banks might be necessary to enable some risk sharing and its welfare improving effects. The question is how much disclosure is desirable and what form should it take. In a recent paper, Goldstein and Leitner [2013] study a model to analyze these forces and provide guidance for optimal disclosure policy in light of these forces.

We will provide a brief description of this model. Suppose that a bank's assets take the value of $\tilde{\theta} + \tilde{\varepsilon}$, where $\tilde{\theta}$ and $\tilde{\varepsilon}$ are random

independent variables. We can think of $\tilde{\theta}$ as the fundamentals of the bank, and $\tilde{\varepsilon}$ as additional noise that has mean of 0. Suppose that the realization of $\tilde{\theta}$ of each bank becomes known to the regulator in the process of conducting a stress test. In the base case, suppose that this realization is not known to the bank or to other market participants. The paper also considers the more complicated case where the bank knows its own fundamentals. The realization of $\tilde{\varepsilon}$ of an individual bank is not known to anyone in the economy.

In order to introduce a motive for risk sharing, the paper assumes that banks suffer a discrete loss if the value of their assets falls below 1. For example, denote the final value of a bank's assets as z , and say that the payoff to the bank's claimholders will be $z + r$ if $z \geq 1$ and z if $z < 1$, where $r > 0$. This is a simple way to capture different real-world scenarios. For example, if the bank's assets are worth more than 1, then an investment opportunity that increases the overall value of the bank is available. Alternatively, if the value of the assets falls below a certain threshold, then the bank suffers a loss due to a run. The basic idea is that there is some damage to the bank if the value of its assets falls below a certain threshold.

Suppose that the mean of $\tilde{\theta}$ in the banking sector is greater than 1, but some banks will have a realization of $\tilde{\theta}$ below 1. Suppose that no information about the realizations of $\tilde{\theta}$ for individual banks is being disclosed or is known in the market. Then, risk sharing arrangements will emerge among banks, such that they will all end up with assets that are worth more than 1, and none of them will suffer the loss of r . This can happen, for example, as banks trade claims that replace their risky asset with a fixed value above 1. This is possible because the average asset value across banks is above 1. In this case, it is clear that disclosure of the realizations of bank specific realizations of $\tilde{\theta}$ by the government is damaging, as it will cause banks with realizations below 1 to be excluded from the market for risk-sharing, and so risk-sharing opportunities will be reduced and ex-ante welfare will decrease. This phenomenon is precisely the Hirshleifer effect.

However, the Hirshleifer effect is less obvious if the mean of $\tilde{\theta}$ in the banking sector is below 1, a case that may correspond to the bleak

conditions in the recent crisis. In this case, without any disclosure, the market for risk sharing will not get started, as on average the market cannot support avoiding the loss of r . Here, disclosure of stress-test results that reveal the realizations of $\tilde{\theta}$ across banks can improve welfare. But, again, due to the Hirshleifer effect, full disclosure — i.e., disclosure of the realizations of $\tilde{\theta}$ for all banks — will not be desirable, since then all banks with realizations below 1 will be excluded. In fact, the paper shows that optimal disclosure will be to separate banks into two groups. One group will have an average $\tilde{\theta}$ of exactly 1 (and so will contain banks with realizations above 1 and banks with realizations below 1) and will benefit from risk sharing, avoiding the loss of r . The other group will have an average $\tilde{\theta}$ below 1 and will not enjoy risk sharing, so that banks in this group might lose r (depending on the realization of the bank-specific $\tilde{\varepsilon}$). Essentially, optimal disclosure is just enough to restart the risk sharing market, but not higher than that so that risk sharing opportunities start being diminished. This is in the spirit of the Bayesian Persuasion  solution proposed by Kamenica and Gentzkow [2011].

The paper goes on to describe in more detail which banks will be in which group, and what happens when banks also know their fundamentals (in this case adverse selection emerges and more disclosure is needed to incentivize very good banks to participate). But, the main point is hopefully clear from the above discussion. In good times, disclosure is undesirable due to the Hirshleifer effect. But, in bad times, some disclosure is necessary to get the market for risk sharing started. However, full disclosure is not desirable. Rather, partial disclosure will help banks of different strengths to pool together to allow for risk sharing opportunities.

4.2 Impact of disclosure on ex ante incentives of bank managers

A leading rationale for disclosure of stress-test results is that it provides better market discipline [e.g., Tarullo, 2010, Bernanke, 2013]. In this section, we will explain why market discipline is not necessarily a panacea for economic efficiency. More disclosure may indeed improve

market discipline, but such market discipline may harm *ex ante* incentives. To illustrate this, we will draw upon recent work by Gigler et al. (hereafter GKS_V) who study the following issue: how frequently should publicly traded firms be required to disclose the results of their operations to the capital market? This is an important policy issue that accounting standard setters must grapple with.

In the United States the frequency of mandatory reporting has risen from annual reporting to semi-annual reporting to quarterly reporting, with this last change occurring in 1970. With the current regulatory environment calling for greater accountability and higher transparency of financial information, it is likely there will be pressure on firms to disclose the results of their operations even more frequently. The arguments for more frequent disclosure are identical to those made regarding the disclosure of bank stress-test results: more timely information would increase price efficiency and hence enhance market discipline. Market discipline, in turn, implies economic efficiency because it leads to efficient resource allocation. The main insight of GKS_V is that, in a second-best environment with multiple imperfections, these arguments are incomplete.

Our objective is to illustrate the main arguments in the GKS_V paper while keeping the technical details to a bare minimum.¹ Bank insiders choose to invest in either a short-term loan portfolio or a long-term loan portfolio. Each portfolio (hereafter project) generates stochastic cash flows over two periods. The short-term project differs from the long-term project in two ways:

1. The short term (long term) project generates higher (lower) stochastic cash flows in the first period but lower (higher) stochastic cash flows in the second period.
2. But, the long-term project has a higher net present value (NPV) than the short-term project.

Condition (2) implies that the bank's insiders should choose the long-term project to maximize economic efficiency. Condition (1)

¹While the GKS_V model applies to any firm facing price pressure, we will apply the insights of that model to a bank.

implies that relative to the long-term project, the only attraction of the short-term project is that it generates stochastically bigger cash flows in the first period.

The bank's shareholders are one of two types: either long-term investors who sell in future periods or short-term investors who sell in early periods. The proportion (or, equivalently, the probability) of short-term investors is assumed common knowledge and is parameterized by α which captures the degree of impatience of the investors. The larger α is, the greater the degree of price pressure and therefore market discipline that insiders face. To capture this feature, assume that, *ex ante*, i.e., in period 0, before an investor knows his type, the bank's insiders (equivalently, the firm's current shareholders) choose their investment strategy, i.e., invest in either the short-term project or the long-term project to maximize:

$$\alpha E_0(\tilde{P}_1) + (1 - \alpha) E_0(\tilde{P}_2) \quad (4.1)$$

where P_1 and P_2 , respectively, denote the period 1 and period 2 equilibrium market prices of the firm, and $E_0(\cdot)$ denotes the expectations operator conditional on period 0 information of insiders. Note that the objective function captured by (4.1) implies that there are no conflicts of interest between insiders and their current shareholders, no managerial career concerns, and therefore no incentive issues that would generate a demand for compensation contracts. Instead — in order to focus exclusively on the role of transparency and market discipline — the conflict of interest is solely between the firm's insiders (current shareholders) and outsiders (the capital market). Therefore, the objective function captures the feature that, in choosing between the short term versus the long-term project, banks' insiders face price pressure or market discipline from the capital market.

In a fully informed world, i.e., a world with no informational frictions between insiders and outsiders, prices play their proper role of fully reflecting all future cash flows of the firm so that:

$$P_1 = E_1(\tilde{P}_2)$$

Using the law of iterated expectations, $E_0(\tilde{P}_1) = E_0[E_1(\tilde{P}_2)]$ so that the objective function of insiders collapses to:

$$E_0(\tilde{P}_i), i \in \{1, 2\}$$

which does not depend on α , the degree of impatience of the investors. Stated differently — regardless of the extent of price pressure — insiders choose the long term project because it maximizes the expected value of the bank. Note that, in a world of no frictions, market discipline works perfectly because prices are playing their proper role of fully reflecting all future cash flows. Therefore, the cost of any myopic behavior is fully internalized by the firm’s current shareholders—they cannot possibly gain by choosing the short-term project to produce attractive short-term cash flows at the expense of long-term cash flows.

GKSV then consider the following second-best environment with two informational frictions:

1. There is information asymmetry between insiders and outsiders about the profitability of the underlying projects. A bank’s insiders have superior information about the profitability of the projects but because of the conflict of interest between insiders and the capital market, they cannot credibly disclose this information to outsiders. Instead, they have strong incentives to overstate the profitability of the project to the market as it would result in higher stock prices. Note that information about profitability is usually soft and therefore, *ex post*, non-verifiable so that there are no explicit mechanisms such as legal liability that could discipline such overstatement.
2. Even though outsiders may observe the cash flows from the projects, they cannot discern whether the cash flows are generated from the short-term project or from the long-term project. Note that once again, direct disclosure of the nature of the project to outsiders is simply not feasible not only because such projects are very hard to describe but also because the cash flows are stochastic, direct disclosures are also difficult to verify *ex post*.

Given these two frictions, it is natural to ask whether standard setters could possibly alleviate the information asymmetry between insiders and outsiders — via more mandatory disclosure. GKSJ study two disclosure regimes: a frequent disclosure regime where operating cash flows are disclosed every period, i.e., in periods 1 and 2 and an infrequent disclosure regime in which all operating cash flows are not disclosed until the end of period 2. There is therefore strictly more information in the frequent disclosure regime in the sense that outsiders observe the operating cash flows of the firm in period 1. Disclosing the operating cash flows of the project every period would seem desirable because such cash flows would be reflected earlier, rather than later, in the stock price. As we saw above, more informed prices could, in turn, induce the manager to choose the project that maximizes the expected total cash flows, i.e., the long-term project. However, GKSJ show that in a second-best environment with strategic interactions this intuition is, at best, incomplete.

More precisely, GKSJ derive the following results:

- a. If the bank's decision is treated as exogenous, i.e., taking the project choice as given, then more frequent disclosure indeed improves price efficiency and therefore market discipline.
- b. However, if the bank's decision is endogenous, while more frequent disclosure does indeed improve price efficiency, such price efficiency does not necessarily imply economic efficiency long — insiders may be induced to choose the short-term project rather than the long-term project.

Result (a) is consistent with Blackwell's theorem that more information is always desirable. By treating the bank's decision as exogenous, more disclosure improves price efficiency. Because the firm's decision is exogenous, by definition, price efficiency is equivalent to economic efficiency.

However, Result (b) implies that, when insiders behave strategically to maximize their payoffs, price efficiency does not necessarily translate into economic efficiency. When *both* project choice and project profitability are unobservable, then the market's inference problem becomes

more subtle. Disclosure of operating cash flows every period as in the frequent disclosure regime would now be used by the market to form inferences about *both* the project choice and the project profitability. GKSJ show that the market conjectures the bank's project choice and uses disclosure of operating cash flows to form inferences about the project's profitability. In the frequent disclosure regime, GKSJ show that the period 1 market price, P_1 , is strictly increasing in period 1 operating cash flows and the period 2 market price, P_2 , is strictly increasing in the period 2 operating cash flows. Since the short-term project produces stochastically higher cash flows in period 1, insiders now face a non-trivial trade-off when choosing between the short and long-term project. The larger the degree of impatience of the investors, i.e., the larger α is, the more likely it is that insiders choose the short-term project. However, in the infrequent disclosure regime, insiders always choose the long-term project.

To understand why insiders may choose the short-term project, it is important to understand how the capital market prices the bank given its disclosure. Because the bank's project choice is not observable, prices do not reflect the firm's *actual* choice of its project but rather the market's conjecture. However, in period 0, insiders can now influence the distribution of the market prices via their choice of the project. Because the short-term project produces stochastically higher cash flows in period 1, in the frequent disclosure regime, greater market discipline pressures insiders to act sub-optimally by choosing the short-term project rather than the long-term project. Unlike the case when the bank's project is observable, insiders can now benefit by producing short term attractive cash flows at the expense of long-term cash flows. Insiders respond to the richer disclosure environment by investing in the sub-optimal project that reduces economic efficiency. If there is no information in period 1, as in the infrequent disclosure regime, insiders are not prone to market pressure in period 1 — they therefore choose the efficient long-term project as it maximizes the expected period 2 market price.

It is important to note that, relative to the infrequent disclosure regime, prices are more efficient in the frequent disclosure regime because prices impound more firm specific information, i.e.,

the operating cash flows in period 1, earlier. The GKS_V study thus highlights the importance of distinguishing “price efficiency” from “economic efficiency.” The distinction between price efficiency and real efficiency has been discussed at length in the recent survey by Bond et al. [2012], and the GKS_V result is related to their general discussion. The study illustrates that the view that price efficiency is equivalent to economic efficiency holds very well in relatively frictionless environments where there is potentially only one source of information asymmetry between insiders and outsiders. For example, in the GKS_V model, if project choice were observable but project profitability were unobservable, then more frequent disclosure would improve *both* price efficiency and economic efficiency. However, in the presence of multiple imperfections such as unobservable project choice and unobservable profitability, insiders may be induced to choose the short-term project to improve the perception in the market in the short term about the firm’s profitability, and this would reduce economic efficiency.

This point is similar to the one made by Stein [1989]. In Stein [1989], a manager who cares about short-term prices is tempted to reduce long-term profitability and inflate short-term profitability to increase short-term price. Of course, the market is rational and understands the manager’s choice in equilibrium. Still, given the conjecture of the market about the manager’s action, the manager is better off taking the short-term action, such that the market does not conclude that profitability is lower than it really is. The same thing happens in GKS_V; the manager is tempted to take an inefficient myopic action, considering its effect on the short-term price. This leads to reduction in real efficiency. The contribution of GKS_V is to link this point to the disclosure requirements — which are the focus of this survey — and show that less disclosure could actually provide better incentives for investment, and hence improve overall efficiency.

Recent studies provide evidence for the theoretical prediction of GKS_V that more public disclosure could lead to sub-optimal decisions, even though such disclosures are viewed to be *ex post* efficient. Bhojraj and Libby [2005] manipulated reporting frequency and price pressure in a laboratory experiment, with experienced financial managers from publicly traded corporations, and empirically demonstrated that

corporate managers become myopic when faced with intense price pressure and greater disclosure frequency. These results were obtained in the absence of any agency frictions and even when managers had the opportunity to make voluntary disclosures. Cheng et al. [2010] provide empirical evidence that firms that frequently issue quarterly earnings guidance behave myopically, where myopic behavior is defined as sacrificing long-term growth for the purpose of meeting short-term goals. They find that dedicated guiders invest significantly less in research and development (R&D) than occasional guiders. They also find that, in comparison to occasional guiders, dedicated guiders meet or beat analyst consensus earnings forecasts more frequently and they both manage expectations downward and cut R&D expenditures to achieve this goal. However, they find that dedicated guiders' long-term earnings growth rates are significantly lower than those of occasional guiders. Overall, their results are consistent with dedicated guiders engaging in myopic R&D investment behavior and meeting short-term earnings targets with possible adverse effects for long-term earnings growth.

The implications of the above discussion are particularly relevant for the debate on whether stress-test results for individual banks should be disclosed to the public. While disclosure of stress-test results may indeed enhance market discipline, in the sense that the market prices the risks of the bank more efficiently, it is not at all obvious that higher price efficiency translates into higher economic efficiency. Bank managers may respond myopically trying to inflate short-term performance at the expense of long-term efficiency. Regulators need to be mindful of this problem. Banks clearly operate in second-best environments in which the risks that they undertake are opaque, hard to verify, and susceptible to asset substitution. Therefore, banks may choose sub-optimal portfolios that allow them to pass the stress tests but that reduce the long-term value of the bank. Individual banks could also engage in window dressing behavior to pass the test by engaging in inefficient asset sales. Over time, this behavior could become more pernicious: as banks become familiar with the supervisory stress test model, banks would find it even easier to "pass" the stress tests. An appropriate analogy here would be that of an instructor who administers a test to gauge how well her students have mastered the subject matter. Suppose the

instructor makes the sample questions available to the students and the sample questions are not qualitatively different from those on the actual exam. Then, there is the danger that students might pass the exam not necessarily because of their mastery of the subject matter but perhaps because they have all studied *to* the test. Similarly, as stress tests become a standard feature of the regulatory toolkit, so that all banks strive to pass the stress tests, banks would rely more and more on the supervisory model. Such behavior, in turn, lowers the benefit of banks developing and maintaining independent risk models. The danger of all banks using the same narrow model to pass the tests could plant the seeds for the next banking crisis [Schuermann, 2013].

If the purpose of disclosing stress-test results is to improve market discipline, we have several recommendations. First, the full specification of supervisory models should not be disclosed to the banks so that banks are less likely to “study to the test.” It is important that banks should get a good understanding of the basic elements of the supervisory models so that banks and the market are confident that the models are empirically validated and sound, but the information provided to them should be limited so they cannot manipulate their performance so that they pass the test but sacrifice long-term efficiency.

Second, if bank-specific test results must be disclosed, such disclosures should be enhanced with detailed disclosures of the risk exposures of each bank by asset class, by country, and by maturity bucket. The market can then evaluate the stress-test results *together* with the underlying risk exposures to get a better understanding of the extent to which the bank has been engaging in sub-optimal behavior for the purpose of passing the stress test. However, if the bank’s portfolios are opaque so that its risk exposures are difficult to credibly disclose, market discipline may be harmful because it may induce banks to window dress their performance by engaging in such sub-optimal behavior. More precisely, banks may be induced to engage in *ex ante* risks that make the bank appear healthy in the eyes of the market but that reduce its long term value.

Third, supervisors should weigh the trade-off between disclosure of individual banks’ stress-test results versus disclosure of aggregate results. The above concern about potential sub-optimal actions by

banks' insiders is especially relevant when banks' individual results are disclosed, but not so much when only aggregate results are disclosed. This is because if only aggregate results are disclosed, then banks cannot affect them as much by changing their own risk choices. Hence, to reduce the incentives of individual banks to pass the test by engaging in sub-optimal behavior, supervisors may want to consider disclosing only aggregate results. Disclosing aggregate results across banks can still provide macroprudential information. Admittedly, this solution is not ideal because the avoidance of disclosure of individual bank's results will reduce the microprudential role of disclosure. We revisit these issues later when we discuss our policy recommendations.

Note that disclosing aggregate results will also overcome another problem that has been raised in connection to disclosure of bank supervisory information: banks will be reluctant to share information with regulators if they know that such information will be publicly disclosed. This issue is discussed in detail in Prescott [2008]. In a way, this is another mechanism by which greater disclosure has an adverse effect on the ex-ante incentives of bank managers, which might make disclosure of bank specific information undesirable. Indeed, thinking about the design of stress tests described in Section 2, one can see that the government relies on banks' own information in the process, and so has to think about the incentives for banks to provide this information.

4.3 Impact of disclosure on ex post actions of market participants: Coordination failures and runs

We argued above how disclosure of stress-test results might still be efficient *ex post* but not necessarily be efficient *ex ante*. However, there are concerns that even the *ex post* reaction to disclosure of stress-test results will not be efficient. In such cases, disclosure could actually make market discipline inefficient. In the preceding section, we discussed environments in which all market participants behaved as "a single investor" in the sense that all market participants only cared about fundamentals so that the role of disclosure was to reduce fundamental uncertainty. Therefore, more disclosure increased price efficiency and

hence market discipline. However, there are environments in which market participants have not only fundamental concerns but also strategic concerns. In such strategic environments — when the reaction to disclosure is coming from multiple market participants — such market participants could exert externalities on each other and fail to coordinate their reactions in an efficient way. This would, in turn, imply an *excessive* reaction to disclosure — thereby damaging the efficiency of market reaction. In the context of banks, this implies that when market participants do not only care about how well capitalized or solvent a bank is (fundamental concern) but also worry about what other market participants believe about the bank’s financial condition (strategic concern), disclosure of stress tests could impair market discipline.

A formal analysis of these ideas appears in a paper by Morris and Shin [2002]. In the model presented in their paper, there are many small market participants, each one making a decision on an action. The action taken by market participant i is denoted as a_i . The average action by market participants is denoted as \bar{a} and the economic fundamentals by θ . Market participant i chooses his action with two things in mind. First, he wants the action to be as suitable as possible to the fundamentals θ . This is captured in the model by the assumption that he wants his action to be as close as possible to the economic fundamentals θ . Second, he wants his action to be compatible with the actions taken by other market participants. This is captured in the model by the assumption that he wants his action to be as close as possible to the average action \bar{a} . Then, the action taken by market participant i is given by the following decision rule:

$$a_i = (1 - r)E_i(\theta) + rE_i(\bar{a}). \quad (4.2)$$

where r takes values between 0 and 1. It captures the weight that market participants put on having their actions close to those of other market participants. The term $E_i(\theta)$ captures the expected level of the fundamentals θ given all the information available to market participant i when he makes the decision. The term $E_i(\bar{a})$ captures the expected level of the average action \bar{a} given all the information available

to market participant i when he makes the decision. A crucial element for the mechanism discussed here is that market participants make their decisions under *incomplete information*. In particular, each market participant has access to some private information about the fundamentals θ and also to public information about θ . The public information comes partly as a result of the disclosure by a regulator such as the government.

The situation described in the above setting is often referred to in the economics literature as a “beauty contest” following Keynes [1936]. Keynes argued that stock market investing and other related settings look like a beauty contest in the sense that people act not only according to what they think the “right” action is — i.e., the one that is justified by fundamentals — but also according to what they think other people think about which action is the right action. As a result, as in the above expression, they end up making a decision based on two components: the expected level of the economic fundamentals and the expectation of what other people will do.

This setting may describe well the decisions made by market participants following disclosure of stress-test results concerning the strength of a particular bank. The ability of the bank to keep operating depends not only on the economic fundamentals it is facing, but also on the willingness of creditors and other counterparties to extend credit, loosen collateral requirements, reduce interest rates, etc. Just like in a bank-run model [e.g., Diamond and Dybvig, 1983], for the bank to survive, it is sometimes not enough that the fundamentals are adequate, but it is important that creditors/depositors have confidence in the bank and keep their money there. If some market participants lose confidence and “run”, others want to do so as well, because the run by some creditors destabilizes the bank, making it in the best interest of others to run as well. As a result, every market participant that needs to make a decision concerning its relationships with the bank — i.e., whether to rollover the debt, extend more credit, loosen collateral requirements — will make a decision, just like in the decision rule described above, based on what he thinks the economic fundamentals of the bank are, *and* based on what he thinks other creditors and counterparties are going to do. A creditor will be “tough” with the bank if he expects other

creditors to be tough as well. This is similar to the “beauty contest” setting described by Keynes.

As Morris and Shin [2002] show in their paper, a setting like this leads each market participant to put more weight on public information than what is justified by the precision/quality of this information. This is because the public information provides indication, not only about the level of economic fundamentals, but also about what other market participants know, and as a result, about what they are going to do. Since every market participant puts direct weight on the actions of other market participants in his objective function, he ends up increasing the weight put on public information and reducing the weight put on private information, as the latter provides information only about the economic fundamentals of the bank whereas the former also provides information about what other market participants will do.

Formally, denoting the precision of public information as α and that of private information as β (and assuming normal distributions of the signals around the realization of the fundamentals θ), the weight that a market participant puts on his private signal ends up being

$$\kappa \equiv \frac{\beta(1-r)}{\beta(1-r) + \alpha},$$

and that on his public signal, $1 - \kappa$. We can see that when there is no beauty-contest motive, i.e., when $r = 0$, the weight that is put on the private signal is the appropriate one based on the precision of the two signals, that is, the ratio between the precision of the private signal and the sum of precision of the two signals. But, as the beauty-contest motive appears and increases, i.e., r increases above 0, then the weight on the private signal decreases and that on the public signal increases, consistent with the discussion above.

This framework illustrates well the trade-off associated with disclosure of stress-test results. The usual argument is that disclosure is good because it enables greater market discipline. That is, when more information about the economic fundamentals of the bank is available, market participants can make more informed decisions, and reduce (increase) the capital available to a weak (strong) bank. This,

in turn, improves economic efficiency by transferring capital to institutions that can make more adequate use of it. This point is captured by the fact that the action of market participants is directly affected by their assessment of the fundamentals. When the supervisor discloses the information it has gathered during the stress test, this information improves the precision with which market participants know the economic fundamentals, and enables them to make a more informed decision. This represents a benefit of disclosure.

On the other hand, there is a negative effect of disclosure, captured by the fact that the action of market participants is directly affected by their assessment of the actions of others. When the supervisor discloses its information, market participants will put excessive weight on this information due to the beauty-contest motive, which implies that public information gets more weight because it is observed publicly. Then, they will reduce the weight they put on their own private information, implying that valuable information does not get to have proper impact on market participants' actions. This is the precise sense in which there is over-reaction to the public information. Indeed, in the above equation, we see that the weight on the private information decreases by more than is warranted due to precision alone. Assuming that from the point of view of the social planner (such as a central bank) the only thing that matters is the extent to which market participants' actions are consistent with fundamentals,² this over-reaction to public news reduces the efficiency of their actions. Hence, while disclosure provides market discipline, it might provide *too much discipline*, causing market participants to act too much on the basis of public information and too little on the basis of private information.

Recent empirical evidence provides support for this amplified role of public information in a related context. Hertzberg et al. [2011] study a natural experiment based on the expansion of the Public Credit Registry in Argentina in 1998. The role of the registry is to aggregate information about borrowers and to make it available to potential

²This is probably true in the situation discussed in this paper because there is no social benefit from having market participants act like each other, perhaps only a social cost, due to the destabilizing aspect of this.

lenders. The information includes assessments by current lenders of the creditworthiness of the borrower. Prior to 1998, the registry only provided information about “large” borrowers, i.e., a borrower whose total debt was above \$200,000. This is because the Public Credit Registry felt that the cost of gathering and distributing information for a large number of small borrowers was too high. In 1998, following the adoption of CD-ROMs, the need for the threshold was eliminated, leading to the disclosure of information about 540,000 borrowers, for which credit assessments were previously only known privately. The reform was announced in April 1998 and implemented in July of that year. Hertzberg et al. study the change in lenders’ behavior after the announcement of the new policy. Consider a lender who had negative information about a borrower, for whom the information was not initially disclosed (since the borrower owed less than \$200,000 in total). From the point of view of this lender, no new information has arrived. The only difference is that the lender realizes that the information will become available publicly. The authors show that for these borrowers, the amount of credit has decreased after the announcement. This is supposedly because the lenders realized that making this information public will make other lenders reduce credit. Hence, they essentially put more weight on the information only because of the fact that it was about to become public.

The implication coming out of this theoretical analysis and the empirical support it received in the literature is clear: disclosure is a mixed blessing. On the one hand, it improves market discipline by providing more information on the basis of which market participants can act. On the other hand — because of the beauty-contest aspect — which is typical of financial settings, such market discipline is based too strongly on the public information and not strongly enough on private information available to market participants. Disclosure of more information by the government crowds out their use of other sources of information, which might reduce the efficiency of the market discipline. Analytically, the result that comes out of such models is that disclosure is beneficial only when the quality/precision of the information being disclosed is sufficiently high.

As a result, the government should be mindful of the fact that even if the information being disclosed is not biased, it may still be harmful when it is not precise enough. Due to externalities among market participants, the weight being put on the disclosed information is excessively high, not adjusting enough to the fact that its precision is low. Hence, information should be disclosed only when there is enough confidence about its precision. In practice, this implies that information should be disclosed after multiple checks and examinations, and hence not very frequently. The above discussion also provides some guidance about the nature of stress-test disclosures: one possibility would be for supervisors to release aggregate results of their tests across banks of similar risk exposures without disclosing bank-specific results. For example, supervisors could release sufficient information about loss rates by major asset class across all banks. Aggregating the results would eliminate idiosyncratic noise and measurement errors across individual banks and reduce the destabilizing effects of the information. But as we argue later when we discuss some policy recommendations, this would come at the cost of not achieving the full benefit of market discipline at the individual bank level.

Another important point to note is that not all banks may be equal in this regard. Being cautious about disclosure and making sure that only very precise information is being disclosed is important only for banks, for whom the beauty contest forces are relatively strong. These are banks whose creditors face strong strategic complementarities (i.e., their motive to act like each other is particularly strong) and are more likely to fall into a coordination failure. Based on the literature (see, Chen et al. [2010] for an empirical implementation in the context of complementarities in mutual funds), this is likely to be the case in the following situations:

- The bank faces a severe maturity mismatch, having short-term liabilities and long-term assets. In this case, the bank is more prone to be subject to a run, and creditors are more strongly affected by what they think other creditors are likely to do.
- The bank's assets are more illiquid. In this case, the bank faces large discounts when selling assets to pay to creditors, and this

implies that creditors impose a stronger externality on other creditors.

- The bank's base of creditors is less concentrated, being characterized by many small creditors rather than by a few large creditors. In this case, creditors are less likely to internalize the externalities, making a coordination failure more likely.

Indeed, studying redemptions by investors from open-end mutual funds, Chen et al. [2010] have shown empirically that funds that have less liquid assets and are held by a less concentrated base of shareholders experience a stronger sensitivity of outflows to bad performance. This implies that the response of investors to public news (bad past performance) is amplified for these funds due to the fact that their investors are subject to stronger strategic complementarities and coordination failures.

It is important to note that the Morris and Shin's [2002] paper has a special structure, in which investors have a beauty-contest motive, wishing to act like each other — running on a bank if others do so — but the social planner only cares about whether actions are suitable to fundamentals — running on the bank when the bank is managed inefficiently. The literature that followed Morris and Shin [2002] has shown that their results about the excessive and inefficient reliance on public information might be reversed in other settings [see Angeletos and Pavan, 2007]. For example, one could think of a case where homogeneity across agents is socially, but not individually, desirable. In this case, the social planner (government) would like to encourage agents to act similarly by disclosing more information publicly even if it is not very precise. Bolton et al. [2013] describe a model in this spirit in the context of organizational design. In their model, it is desirable for the organization that agents will act similarly to each other, yet this is not in agents' self interest. Hence, there is a role here for increased public communication to induce coordination. Similarly, different conclusions will arise if we consider strategic substitutes instead of strategic complementarities. So, when thinking about optimal disclosure policy, it is important to think about the situation at hand and understand

the details specific to the situation. The reason we focused on the Morris–Shin framework here is that, as stated earlier, we believe that it is the most relevant for the case discussed in this paper: disclosure of stress-test results for financial institutions. Indeed, when it comes to a financial institution, there is the possibility of a coordination failure — agents wish to run when others do — but this is not what the social planner wants — he wants agents to act based on fundamentals.

Finally, a recent interesting paper by Bouvard et al. [2013] presents another model to analyze optimal disclosure by a regulator in the face of a possible coordination failure. In their paper, runs on financial institutions are a result of an inefficient coordination failure. If creditors are uninformed about the fundamentals of individual banks, they run based on the prior they have concerning the state of the financial system as a whole. Then, they will run in bad times (when the prior is low) and not run in good times (when the prior is high). If the regulator discloses information about bank-specific fundamentals, then runs on individual banks will occur depending on their specific fundamentals. This implies that disclosing information in good times will generate some runs, while disclosing information in bad times will prevent some runs. The implication is that disclosure is desirable in bad times but not in good times. This is a similar conclusion to the one in Goldstein and Leitner [2013], but based on completely different considerations. Similar to the theme discussed in this subsection, the paper says that ex-post reaction to the information disclosed might be inefficient due to coordination failures. They argue that the inefficiency resulting from disclosure occurs in good times — when without disclosure runs would not occur — but not in bad times — when runs occur without disclosure. Interestingly, they show that if the regulator is better informed than creditors about the overall state of the financial system (in addition to being better informed about individual banks) then disclosure of bank-specific results might be perceived as a bad signal about the financial system as a whole, and so regulators might inefficiently refrain from disclosing in bad times.

4.4 Impact of disclosure on the ability of regulators to learn from the market

An important input into bank supervision by the government is the information gathered from market prices of bank securities. The attraction in using market information for bank supervision is best summarized by the following quote from Gary Stern — the former President of the Federal Reserve Bank of Minneapolis:

“Market data are generated by a very large number of participants.

Market participants have their funds at risk of loss. A monetary incentive provides a perspective on risk taking that is difficult to replicate in a supervisory context.

Unlike accounting-based measures, market data are generated on a nearly continuous basis and to a considerable extent anticipates future performance and conditions.

Raw market prices are nearly free to supervisors. This characteristic seems particularly important given that supervisory resources are limited and are diminishing in comparison to the complexity of large banking organizations.”³

As Gary Stern argues, the attraction in using market data is that it aggregates information from many different market participants and so it contains pieces of information and opinions that regulators would otherwise have hard time reaching. This idea goes back to Hayek [1945], who argued strongly for the importance of market information. The information aggregated into market prices of bank securities is not the traditional inside information that is featured in models of financial markets. Rather, these are the results of analysis by many market participants based on their experiences with the bank and their assessment of the bank’s prospects. It is very likely that such information can prove to be useful for regulators, who are far from being fully informed about

³See: <http://www.minneapolisfed.org/pubs/region/01-09/stern.cfm>.

the state of the bank. Another benefit of using market information is that it is produced by traders, who have the best incentive to produce and trade on information; this is after all the source of their monetary profits. In addition, market information is produced continuously and is constantly updated. Regulators can look at it over time and across different securities and so obtain different angles on the question they are trying to learn about. Of course, the information is forward looking, unlike accounting variables which are typically based on historic numbers, and so it is more relevant for the decisions that regulators need to make.

Indeed, existing research establishes that government actions are affected by market prices: Feldman and Schmidt [2003], Krainer and Lopez [2004], and Furlong and Williams [2006] empirically document that bank supervisors make substantial use of market information.⁴ Moreover, numerous policy proposals call for governments to make even more use of market prices, particularly in the realm of bank supervision [see, e.g., Evanoff and Wall, 2004, Herring, 2004]. Such policy proposals are increasingly prominent in the wake of the recent economic crisis and the perceived failure of financial regulation prior to it.⁵

However, several papers — e.g., Bond et al. [2010], Goldstein et al. [2011], and Bond and Goldstein [2013] — show theoretically that the informational content of market prices should not be taken as given, and that the use of market information by the government and the disclosure of government information to the market might adversely affect the ability of the government to learn from market prices. Hence, when the government discloses information about stress-test results to the market, it should be mindful of the fact that this might reduce

⁴The usefulness of market prices has been established empirically in other contexts, showing that managers learn from the prices of their own securities when making investment decisions, see Luo [2005], Chen et al. [2007], and Bakke and Whited [2010].

⁵For example, Hart and Zingales [2011] propose a mechanism, by which the government will perform a stress test on banks whose market price deteriorates below a certain level, in order to evaluate whether there is a need for intervention. Other recent proposals say that banks should issue contingent capital (i.e., debt that converts to equity) with market-based conversion triggers [see Flannery, 2009, McDonald, 2013].

the incentives of traders in the market to produce information and trade on information that they have, which will make market prices less informative and harm the ability of the government to use this important input in its supervision policy.

Consider the model of Bond and Goldstein [2013]. In their model, the government takes an action that affects the value of a financial institution. The government may inject cash to the financial institution or tax it, depending on its objective function and the state of the world. For example, if the government thinks that the failure of a financial institution is imminent and that this will have strong negative implications for the rest of the financial system, then it may attempt to bail it out or inject capital to make the failure less likely. The problem is that the government does not have all the information about the state of the financial institution or the extent to which it exerts externalities on the financial system. The government ends up making a decision based on its own information, part of it may be collected in the process of conducting stress tests, and based on the information it can glean from the financial market where a security of the financial institution is traded.

Indeed, there is ample anecdotal evidence that governments in the recent crisis have been influenced by market prices when making intervention decisions in financial institutions. For example, consider the following quote from the Report of the Office of the Special Inspector General for the Troubled Asset Relief Program (January 2011) concerning the injection of capital to Citigroup. It shows clearly how this decision was informed by the development of the stock price of Citigroup:

“Citigroup would lose \$27.68 billion in 2008, and by Nov 19, 2008, its stock price had dropped precipitously . . . The company’s survival was in doubt . . . On Nov 23, 2008, Treasury, FRB, and FDIC announced a package of transactions intended to reduce the risk of Citigroup failing and, in turn, dragging down the financial system with it . . . the government said that it would provide guarantees in connection with a Citigroup asset pool of up to \$306 billion . . . also promised Citigroup an additional \$20 billion in TARP funds”

So, if the government is trying to learn from the market, then the fact it is releasing more information to the market might be harmful. In order to understand the tradeoff associated with disclosure in this context, it is important to understand how security prices in financial markets get to reflect information about the fundamentals of the financial institution. The process by which this happens has been studied in a large literature on financial markets pioneered by Grossman and Stiglitz [1980]. Importantly, for information to get aggregated and reflected in market prices, speculators must have the incentive to produce information and trade on the information. There are two forces that affect this incentive. The first one is the information importance effect. Speculators will trade more aggressively on their information, producing more informative prices, when their signal contains more information that is not already in the price. The second one is the residual risk effect. Speculators will trade more aggressively on their information, producing more informative prices, when they are exposed to less residual risk.

In general, it is shown that when the government discloses information of its own (e.g., the results of stress tests), it affects these two forces in a way that leads to opposite effects on the incentives of speculators to trade and on price informativeness. First, when more information is available publicly, traders lose some of their informational advantage, and so produce less information and trade less aggressively. This leads market prices to be less informative. Second, when more information is available publicly, traders bear less exposure to risk when they trade in financial markets, and so have an incentive to produce more information and trade more aggressively.

The practical implication coming out of this discussion, which is developed by Bond and Goldstein [2013], is that disclosure might be harmful to the government as it causes speculators to trade less on their own information and so weakens the ability of the government to learn from the price. Essentially, the information disclosed by the government crowds out private information from the market. This occurs when the information importance effect is stronger than the residual risk effect, which is the case when the government discloses information on something that speculators are themselves informed about and trade

on. But, disclosure will be undoubtedly beneficial when the supervisor discloses information about issues that traders in financial markets have no informational advantage on. Then, only the residual risk effect exists and the government benefits from traders' increased motive to trade.

More generally, disclosure of supervisory information — collected in the process of stress tests — might harm rather than promote market discipline. If market discipline is partly achieved via trading of bank securities in financial markets, which aggregates market participants' views into market prices, then disclosure of supervisory information might hamper this process by reducing market participants' incentives to trade on their information and views. Hence, disclosure is surely beneficial only to the extent that it is about parameters that are unlikely to be known to market participants and that the supervisor is unlikely to want to learn from market participants.

Here again, disclosing only aggregate information of stress-test results may alleviate the problem of drowning out price signals. This is because the supervisor is less likely to be at an informational disadvantage compared to market participants about systemic risk, such as the state of the banking system as a whole. Hence, disclosing such information to the market is less likely to reduce the ability of the supervisor to learn from the market. We will discuss this point more in the next section.

5

Policy Recommendations

Unlike traditional supervisory exams, we have argued how stress testing of banks potentially uncovers unique information that was simply not available prior to SCAP in 2009. According to conventional wisdom, this is a powerful argument for disclosing the results of these stress tests: this disclosure will complement more conventional capital and leverage ratios thereby allowing market participants to make informed decisions concerning banks' financial condition. Moreover, knowing that the market reaction will be better informed due to the disclosure of the results of stress tests, banks may become more prudent in their risk-taking behavior. In that sense, disclosure of stress-test results may enhance market discipline. Our objective in this monograph has been to challenge this conventional wisdom. We have argued that (1) banks engage in risks that are notoriously opaque, hard to verify, easily susceptible to asset substitution and (2) banks operate in environments that are prone to externalities. In such environments, there are endogenous costs to disclosure that supervisors must take into account in determining both the design of the tests and how to handle the disclosure of the results.

Throughout the monograph, we make various types of recommendations about how disclosure of these stress tests should be handled in order to minimize the above costs. We have argued for disclosure of aggregate results across banks instead of bank-specific results. This will enable risk sharing activities in the interbank market, reduce the incentives of bank managers to take undesirable myopic actions, minimize the damage from causing panic by disclosing noisy information publicly, and maintain the ability of the government to learn from the market the information it likely wants to learn. If the goal of the tests is macroprudential stability, then disclosing aggregate information is not a problem as it promotes this goal.

But, if bank-specific results must be disclosed for the sake of promoting microprudential stability of individual banks, then policymakers should be mindful of the potential downsides and take measures to limit them. For example, results should be accompanied with detailed disclosure of risk exposures such as loss rates by asset class, etc. We have also argued against supervisors disclosing the full specification of their models to banks. Finally, if bad news is disclosed, it is imperative that supervisors disclose the corrective actions to remedy the bad news and such corrective actions should be credible. We next summarize the four main endogenous costs of stress tests' disclosure discussed in this monograph and offer some recommendations about how to alleviate each one of them.

- Disclosing the results of stress tests might adversely affect the operation of the interbank market and the ability of financial institutions to trade claims to achieve insurance and risk sharing. This might reduce the welfare provided by financial institutions to the depositors and creditors who invest in them.

Recommendation: In order to preserve risk sharing opportunities within the financial system, it is important to disclose only partial information, such that banks of different qualities and strengths are pooled together. If times are good, no disclosure is necessary, and all banks can be pooled together. But, if times are bad, some bad banks have to be separated from others so that the market for

risk sharing can get started. Then, some disclosure is necessary. The amount of disclosure will be the minimum required to start the risk-sharing market without separating banks too much in a way that will unnecessarily harm risk sharing opportunities. Hence, there is a rating system that pools banks together into similar rates. We have discussed the features of this optimal rating system.

- Disclosing the results of stress tests might adversely affect the incentives within financial institutions, encouraging them to hold suboptimal loan portfolios in order to pass the stress tests but that may not be beneficial in the long term. More importantly, over time, as stress testing becomes routine more banks would mimic the supervisory model instead of developing their own independent internal models. This model monoculture may add endogenous risk to the financial system.

Recommendation: If regulators do not disclose the results of individual banks, but only aggregated results, then the incentive to window-dress banks' portfolios for the purpose of passing the stress test will be significantly reduced. Again, if the goal is to promote financial stability, then this is a viable solution. However, this solution may not provide enough market discipline for individual banks especially in times of financial crisis when confidence in the banking sector is low [see Schuermann, 2013]. A possible compromise is that stress-test results be accompanied by a detailed description of the risk exposures of the individual banks. The market can then “do its own math” and evaluate the stress-test results together with the underlying risk exposures to get better understanding of the potential for existence of sub-optimal risk choices or window-dressing. We have also argued against disclosing the full specification of the supervisory model to the banks. This would prevent banks from just preparing to pass the test and allow them to develop their own independent models and risk management tools that improve long-term efficiency.

- Disclosing the results of stress tests might lead to over-reaction by market participants *ex post* due to the fact that they exert externalities on each other and want to act like each other and hence put excessive weight on public information. This, for example, might lead to a run on a financial institution following a negative stress-test assessment.

Recommendation: One potential solution is to only disclose aggregated results so market participants do not attach excessive weight to specific loss numbers of individual banks, which might be very noisy. Aggregating can significantly reduce the noise and prevent the destabilizing effect of making information public. Again, if the goal is to promote financial stability, this is a good solution. However, to provide some market discipline, individual bank results should be disclosed. In this case, it is important that disclosure is made only when results are as precise and reliable as possible. This is particularly important for financial institutions that are exposed to panic because they have short-term liabilities, illiquid assets, and a dispersed base of investors. Moreover, if bad news is disclosed, it is important to disclose it with a description of the corrective actions that are about to be taken, so that panic is not triggered. This would enhance the credibility of the test as well as that of the supervisor as was done for SCAP (2009). For example, if a bank is found to be solvent but also to suffer from risk of illiquidity, then it should be provided with access to borrowing to mitigate the illiquidity problem. Finally, from the point of view of coordination failure, there is room for disclosure in bad times (when at least some runs will be prevented), but not in good times (not to trigger unnecessary runs).

- Disclosure of stress-test results might deter financial-market speculators from trading on their views and information on financial markets and hamper the ability of the supervisor to learn from market data for its regulatory actions.

Recommendation: The supervisor may want to minimize disclosure of information on issues on which market participants are well

informed. Disclosing such information might hamper the incentives of market participants to trade on their information and interfere with the ability of the supervisor to use the information from the market such as price signals in its regulatory actions. Again, disclosing aggregate information, on which the supervisor is less likely to be at an informational disadvantage relative to market participants, can reduce the severity of this cost of disclosure without drowning out the information from price signals. There is also no damage in disclosing information about the regulator's preferences or policy goals, since the regulator is not trying to learn about them from the market. This will reduce uncertainty for market participants and allow them to trade more freely on the information they have enabling more learning by policymakers.

6

Conclusion

Supervisory stress tests can be beneficial because — unlike traditional supervisory tests — they provide unique information about the banking sector to outsiders. Constantly thinking of adverse economic shocks and examining whether the large financial institutions have sufficient capital to endure such shocks is a very useful exercise to prevent the negative spillovers from financial institutions' losses in bad times to the rest of the economy via contagion across financial institutions and the reduction in loans to the real economy. This is an important lesson from the crisis of 2008 and an important part of the regulatory framework going forward.

An important part of stress tests is the disclosure of their results to the public. We believe that, from a macroprudential perspective, disclosure of stress-test results can be beneficial because they promote financial stability. Even from a microprudential perspective, disclosure can be quite useful in providing market discipline for individual banks and helping with the accountability of regulators who need to make decisions about these banks. However, we believe that perhaps too much

importance has been attached to the beneficial role of market discipline without accounting for the underlying mechanisms. Our objective in this monograph was to highlight those mechanisms. Our main takeaway is that in promoting financial stability, disclosure of stress-test results may exacerbate bank-specific inefficiencies. Importantly, as stress tests become routine, supervisors need to be mindful of potential disadvantages of detailed disclosure of the results at the bank-specific level. For example, they need to understand that banks will develop an incentive to pass the tests rather than engage in prudent risk-taking behavior. They also need to consider adverse implications of disclosure on market operations: the reduction in risk sharing opportunities in the interbank market, potential panics among bank creditors and other bank counterparties, and reduction in information aggregation and processing in the market. We provide some guidance on how such inefficiencies could be minimized.

Besides the disclosure of stress test results, there are many other issues that need to be addressed and improved in the design and implementation of stress tests. One major difficulty is in the fact that stress tests only consider three scenarios (focusing on the most adverse one). These scenarios are heavily influenced by past events, but as we know, future events can take a whole different form; there is room to analyze many more scenarios than just the three that are examined currently. Considering many scenarios that could emerge from recent economic developments would improve the ability of the tests to identify weak spots in the financial system. Then, the information will become more precise and some of the problems with disclosure discussed in this monograph will be reduced. Another difficulty is related to the ability to capture systemic risks and general-equilibrium effects in the current framework. As we saw in the recent crisis, problems are aggravated by equilibrium forces, as the shocks to some institutions might bring down other institutions. Developing a framework that captures the combined effects on all banks, taking into account their relations with each other and with the rest of the economy, is a major challenge that academics and policymakers need to address in the years to come.

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