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All errors are our own.

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EXECUTIVE SUMMARY

Since the conference version of this report in February 2011, bank stress tests have been almost continuously in the news. In the United States, the Dodd-Frank Act mandates annual stress tests for key institutions. In early 2011, the Federal Reserve conducted the first test under the Act on major banks, and is currently conducting the second test, the results of which will be announced in early 2012. Europe completed a stress test in July 2011 that ignored many principles of this report. Like the prior European tests in 2010, the 2011 version is now deemed to have failed, so that yet another European stress test exercise is contemplated.

We offer a framework for evaluating these exercises. The starting point is to contrast micro- and macro-prudential principles for stress tests.

Microprudential stress tests emphasize the traditional role of bank capital as a buffer against loss, shielding the deposit insurance agency. The focus is on resolving insolvent banks and on "prompt corrective action" to protect taxpayers. The Basel capital ratio is key. The U.S. savings and loan crisis of the early 1980s is the motivating event.

Macroprudential stress tests focus on whether the banking system as a whole has the balance sheet capacity to support the economy. A central goal is averting runs on systemic banks by wholesale creditors that lead to a contraction of credit and damage to the broader economy. To avoid aggregate deleveraging in periods of distress, remedies focus on raising new capital measured in total dollars (or euros), rather than on merely satisfying capital ratios.

We argue for the macroprudential approach and propose five principles.

First, banks have to be sufficiently solvent to avert runs. The "run point" of a systemic bank often entails significantly higher capital than the bare solvency point.

Second, even solvent banks may be required to refrain from depleting capital if the system as a whole does not meet the higher macroprudential criteria. For shareholders, one dollar inside the bank should be worth more than one dollar in dividends. But, in any case, supervisors should consider more than just private benefits and costs. Had U.S. supervisors suspended dividends in the summer of 2007, $80 billion of capital could have been retained in the 19 banks that were subject to the 2009 Supervisory Capital Assessment Program. That sum is roughly half of the public recapitalization funds that these banks received.

Third, the remedy to undercapitalization should be stated in dollar (or euro) amounts, not capital ratios. The objective is to maintain the balance sheet capacity of the banking system as a whole. That capacity depends on the level of equity in the system. After a shock, targeting the ratio of equity to assets invites banks to meet the goal by shedding assets and exacerbating the credit crunch.

Fourth, stress scenarios should consider both sides of the balance sheet, and explicitly consider fire sales, runs by wholesale creditors, common exposures and credit crunch risks.

Fifth, liquidity rules, in addition to capital requirements, should be part of the overall framework of macroprudential oversight.

By means of an illustrative example, this paper highlights the need for a macroprudential approach, and explains why the potential economic costs are much higher when banks are systemic. We then provide a diagnostic framework using bank equity and CDS prices (and correlations between them) that can help in the formulation of corrective measures.

We also review a range of empirical evidence regarding large intermediaries in the light of our framework. Taken together, this evidence suggests that the financial systems in both the United States and Europe remained stressed even in early 2011, well after the crisis peaked:

First, based on the level of CDS prices, the default risk of U.S. intermediaries at the onset of the 2009 stress tests was perceived to be much higher than before the crisis. After the U.S. stress test, CDS prices fell substantially, but remained elevated as of early 2011 compared to highly rated nonfinancial companies. European banks also faced elevated CDS prices at the time of the 2010 stress test, and only a few institutions have experienced significant declines, indicating that perceived default risk was persistently high.

Second, the correlations between equity returns of intermediaries remained higher after the stress tests than they were in 2006, prior to the crisis. Even banks with less elevated CDS prices show equity returns that are *positively* correlated with their competitors bearing higher CDS prices. Thus, bad news for one bank is bad news for all. This persistent pattern suggests that, even in early 2011, there were virtually no institutions seen as capable of absorbing weaker organizations in a fire sale. Otherwise, bad news for weaker firms might be viewed as good news for potential saviors.

Third, the correlations between equity returns and banks' own-CDS prices remained negative for almost all of the institutions. A substantial negative correlation is to be expected if an institution is thinly capitalized because news that raises the value of its equity will lower the default risk on debt. For well-capitalized firms, however, this correlation should be weak or non-existent.

Finally, the macroprudential perspective also provides important lessons for the 2011 Europe financial crisis. The bulk of the report analyzes the state of conditions in the runup to early 2011. This analysis anticipated the failure of the July 2011 European tests. We have added an epilogue that updates the empirical work to cover the developments in Europe through 2011. We continue to argue that the troubles in Europe will persist until the European banks are capitalized to the degree that they can withstand losses on their sovereign bond holdings without triggering a run or a widespread deleveraging that undermines the supply of credit.

1. Introduction

The Dodd-Frank Wall Street Reform and Consumer Protection Act (hereafter, "Dodd-Frank") requires the Board of Governors of the Federal Reserve to undertake stress tests annually. The tests must cover bank holding companies (BHCs) and nonbank financial firms supervised by the Board (Dodd-Frank Sec. 165 (i) (1)), and can be extended to include other financial institutions at the Board's discretion. The Board is obliged to assess "whether such companies have the capital, on a total consolidated basis, necessary to absorb losses as a result of adverse economic conditions." The Board also "may develop and apply such other analytic techniques as are necessary to identify, measure and monitor risks to the financial stability of the United States." Beyond these statements, however, the Dodd-Frank Act does not define how these tests are to be conducted.

It is now clear that the purpose and parameters of these stress tests are subject to different, contradictory interpretations. An excellent example of the potential tension and confusion is the Federal Reserve's instructions to the 19 largest BHCs regarding the tests that were carried out in early 2011. The Federal Reserve (2010) writes that "the purpose of this supervisory letter is to re-emphasize the Federal Reserve's expectations concerning the processes Supervisory Capital Assessment Program (SCAP) BHCs should have in place to ensure that they hold adequate capital under adverse conditions to maintain ready access to funding, continue to serve as credit intermediaries, and continue operations."

On the one hand, requiring intermediaries to have adequate capital to maintain funding access and to continue to operate reflects the usual microprudential concerns and motivations for regulating banks. We elaborate on this vision below, but a simple description is that—because banks have their deposits guaranteed—they must accept certain restrictions and regulations to limit the costs of these guarantees to taxpayers. This perspective has driven U.S. bank regulation since the introduction of deposit insurance in the 1930s.

In contrast to this microprudential motivation, requiring intermediaries to have the capital needed to continue to serve as providers of credit implies a broader set of macroprudential concerns. An intermediary may pose no threat to the taxpayer because of potential default on its guaranteed deposits, but may not be adequately capitalized to maintain (or expand) its lending. Moreover, macroprudential capital adequacy is a system-wide phenomenon: An intermediary that appears adequately capitalized *in isolation* may still be subject to regulatory constraints on capital distributions if the system as a whole has a capital shortfall that threatens financial stability.

This macroprudential standard is new and not reflected in existing bank supervisory practices, although it has been a subject of academic and policy interest for years. The macroprudential perspective, also elaborated below, seeks to control "the social costs associated with excessive balance-sheet shrinkage on the part of multiple financial institutions hit with a common shock" (Hanson, Kashyap and Stein, 2011).

This report explores and highlights the potential tensions in the design and conduct of stress tests that arise from the differences between the micro- and macroprudential motivations for financial supervision and regulation. We do not focus on the design of stress scenarios or on the specification of particular numerical targets for different financial indicators. These considerations are important. Indeed, the logic of our approach suggests that the 2010 European stress tests had serious flaws on these dimensions

that we describe below.[1] But the center of our attention is more conceptual and attempts instead to fundamentally shift the thinking about the purpose and goals of stress tests.

Accordingly, we start in Section 2 by defining five key dimensions of a stress test and comparing how micro- and macro-prudential stress tests differ on these dimensions. The comparison shows that the standards embodied in both the Basel regulations and the parameters of the 2010 Federal Reserve tests are decidedly microprudential. Hence, if future tests are to form part of a macroprudential toolkit, they will have to be amended.

In Section 3, we provide a series of illustrative examples to highlight the issues that arise once macroprudential concerns come to the fore. These examples are organized according to (a) the condition of the financial system at the time and (b) the number of systemically important intermediaries. We believe a classification scheme such as this would help guide regulatory decisions by a macroprudential supervisor.

In Section 4, we review three stress tests that were conducted at different points in the past 15 years in Europe, Japan, and the United States. Each of these tests was conducted in the midst of a systemic banking crisis. Comparing the outcomes allows us to assess the predictions from the examples shown in Section 3. Our main conclusion from this analysis is that the existing record helps us to identify the elements of stress tests that are necessary for restoring or securing financial stability. This evidence is particularly important given the continued uncertainty about the condition of European intermediaries, and the pending tests to be conducted in both Europe and the United States.

At the same time, there are many design issues that are *not* informed by the past tests. Our concluding section of the paper reviews these open questions. In addition, a new epilogue covers stress test developments in 2011 that occurred after the conference draft was completed.

2. Micro- and Macroprudential Rationales for Stress Tests

2.1. Microprudential Rationale

Since the 1930s, the starting point for bank regulation in the United States has been to offset distortions associated with deposit insurance. The fear that under-capitalized banks will use insured deposits to gamble on "heads I win, tails the taxpayers lose" strategies has been a central concern. For example, based on this consideration, the FDIC Improvement Act (FDICIA) of 1991—enacted in the wake of the savings and loan crisis—focused bank closure policy on "prompt corrective action" (shutting banks before the value of equity is zero) and "least cost resolution" (selling assets or the bank as a going concern to recover as much as possible). FDICIA included many guidelines on how much capital banks should hold and restrictions on various activities as capital was depleted. FDICIA also constrained the discretion of regulators in allowing weak banks to operate and prescribed the circumstances and timing for closing impaired institutions.

1 Regrettably, the same problems were present in 2011 European tests that were conducted after the conference version of the report circulated.

The Basel Committee on Bank Supervision's (henceforth the Basel Committee) guidance on dealing with weak banks similarly emphasizes prompt resolution (Basel Committee, 2002, p. 30-31): "Weak banks should be rehabilitated or resolved quickly and banking assets from failed institutions should be returned to the market promptly, in order to minimise the eventual costs to depositors and creditors."

These microprudential objectives and framework suggest a role for a particular type of stress test. Exhibit 2.1 describes the five main features of a microprudential test. First, the purpose of the test would be to reveal the current value of assets in order to put in place sufficient capital as a buffer against loss (creating "greater loss absorbency" in the language of Basel III).

Second, the goal of accurate asset pricing provides a clear view on the scope of the test. Fundamentally, the test aims to assess the capital adequacy of each intermediary being studied. The reason to consider multiple intermediaries together is to help improve asset valuation through horizontal comparisons across intermediaries. Because the assets of intermediaries are by their very nature opaque (given the imperfect information that individual lenders, let alone their supervisors, have about borrowers), a comparison of how multiple intermediaries are valuing similar assets is likely to be helpful. Yet, it is logically possible to examine only a single entity at a time.

Exhibit 2.1. Elements of Microprudential Stress Tests	
Purpose:	The goal is to value bank assets correctly and determine that adequate loss-bearing capacity is in place to protect taxpayers from having to bail out insured deposits.
Scope:	Analyze one bank at a time, or use data from multiple banks to overcome imperfect information about the value of individual bank assets.
Liability Considerations:	Count the amount of insured deposits and the amount of junior debt and equity. The required loss absorbency is calculated as a ratio relative to asset risk.
Asset Considerations:	Credit risk of different assets determines enterprise risk, so loss absorbency of liabilities is tied to asset composition. A capital ratio therefore naturally emerges as a basis for supervision.
Output:	Develop guidance about whether to close a bank and when to sell its assets to maximize taxpayer recovery.

Third, the test dictates a lens through which the liability side of the intermediary's balance sheet should be viewed. Insured deposits are deemed important because they represent the taxpayer's exposure in the event of problems at the bank. The amount of equity and other debt that are junior to insured deposits also is important. These junior claims matter because they can in principle be written down to absorb losses before the taxpayer would be asked to make a contribution to honor deposit contracts.

By implication, this framework ignores the maturity structure of uninsured liabilities and the liquidity of the assets to be sold should rollover of liabilities become too costly. In particular, the percentage of wholesale funding that can flee quickly has not historically been considered.[2] The problem of a bank run was judged to be controlled once deposit insurance was in place and no special attention was given to the problems created by a run on the part of uninsured depositors.

In the wake of the recent crisis, the Basel committee recognized this issue and proposed that banks should have a net stable funding ratio (NSFR) calculated by looking at the percentage of short-term funding to total funding. The idea behind the NSFR is that a bank should have adequate long-term funding so that it could operate even if some short-term funding was not renewed. This idea has been incorporated into the Basel III framework for further evaluation, but no early implementation is contemplated. Moreover, the NSFR would be a time-invariant construct that is the same for all banks.

Fourth, the microprudential perspective also gives guidelines about how to view an intermediary's assets. The basic belief is that assets matter because of the credit risk that they pose. Falling asset values cause losses for intermediaries that must be controlled. As a result, the required level of loss absorbency of an intermediary's liabilities should be determined by the credit risk of the intermediary's assets. The riskier its assets, the more equity and junior debt an intermediary needs to be deemed safe. Consequently, the *ratio* of assets versus loss-absorbing liabilities emerges as the critical metric in a microprudential stress test.

Finally, when an intermediary is impaired, the least-cost resolution rule under FDICIA dictates that regulators sell it, or parts of it, to recover as much as possible. Thus, the output of the stress test guides regulators about when to close an intermediary so that it can be shut down before taxpayers incur losses. Each intermediary's problems and resolution are viewed in isolation, so there is no need to coordinate asset sales across intermediaries.

We believe this is a fair characterization of the microprudential philosophy and the practice of bank supervision prior to the global financial crisis of 2007-2009. It also seems fair to say policymakers had not contemplated a circumstance in which a breakdown of capital markets would thwart equity issuance by financial institutions. Yet, the opaqueness of intermediary assets in this kind of crisis scenario suggests that investors would naturally worry about adverse selection, whereby the financial institutions with the worst assets would be the ones seeking funds. Leery investors might therefore become reluctant to buy equity in this kind of environment (Myers and Majluf, 1984). If regulators did want intermediaries to issue new equity, removing the discretion to do so would be a logical policy. If all financial institutions were compelled to raise capital, investors would have less need to worry that intermediaries are doing so because of the private information they have about their own assets.

Arguably, prior to the global financial crisis that began in 2007, most banking crises in the advanced economies were instances when prompt corrective action (and hence the microprudential approach) was the correct approach. One survey (Basel Committee, 2004) looks at eight advanced-economy banking crises up to 2004 [Switzerland (1991–1996), Spain (1978–1983), United Kingdom (1991–1992), Norway (1988–1993), Sweden (1991–1994), Japan (1994–2002) and the United States (1991–1992)]. Most involved the bursting of a property bubble, and the intermediaries were resolved by forcing them into the arms of larger rivals.

2 Chapter 2 of the IMF's Global Financial Stability Report (2010) emphasizes the role of wholesale funding as a source of systemic liquidity risk that needs to be regulated.

The Swiss banking crisis of 1991–96 came in the aftermath of the property boom of the 1980s. Small regional banks (whose assets were concentrated in property-related lending) were most affected. From 1991, nearly half of the 200 regional banks were taken over by larger rivals, especially the three (later two) large Swiss banking groups. However, the regional banking crisis in Switzerland was resolved without government funding (Basel Committee, 2004, page 47).

The U.K. "small banks crisis" in the early 1990s was similar to the Swiss banking crisis. Over 100 small banks in the United Kingdom (specialising in lending to particular geographical regions, industrial sectors or ethnic/religious groups) were heavily exposed to property lending. Most were allowed to fail without intervention by the regulator (Bank of England at the time), although National Mortgage Bank (NMB) received temporary liquidity support.

Given both the historical experience with crises in advanced countries and the economic logic requiring prompt corrective action, the microprudential approach seems like a reasonable framework for bank supervision in the face of modest financial shocks.

2.2. Macroprudential Rationale

The macroprudential rationale rests on the idea that an economy must maintain the capacity of its banking sector (and intermediary sector as a whole) to channel credit from savers to borrowers in support of real economic activity. The main fear is that individual intermediaries, when hit with a common shock, will scramble for survival by shrinking their assets to preserve their capital ratio. In doing so, however, they will reduce credit availability throughout the economy, and this aggregate outcome may trigger an unstable spiral of balance sheet shrinkage that weakens the economy and begets further balance sheet shrinkage.[3] For such an adverse feedback scenario to be a valid concern, the familiar Modigliani-Miller capital structure irrelevance propositions must fail. At a minimum, it must be the case that borrowers incur costs to find new lenders when an existing lender reduces credit.

The macroprudential risks are more severe if the scrambling by some impaired financial institutions increases the problems for other financial institutions. We believe this to be the case for several reasons. First, financial intermediaries invariably have many short-term liabilities. Consequently, if their creditors refuse to roll over funding, they will be forced to sell assets to cover redemptions. If the natural buyers of these assets are other financial institutions that are also impaired, efforts to sell assets trigger a fire sale that depresses prices.[4] In this case, the fire sale limits the ability of all financial institutions to sell assets.

Fire sales also cause another closely related problem. If an institution is financing itself through repurchase agreements, then fluctuations in the perceived value of the institution's collateral can thwart rollover and lead to the equivalent of a bank run.[5] Even if the institution does not intend to sell its assets, the assets' value as collateral falls in a fire sale. If the haircut on the assets rises, the institution must

3 See Greenlaw, Hatzius, Kashyap, and Shin (2008) for a model showing how capital impairment at leveraged financial intermediaries can lead to a magnified contraction in credit availability, Hirtle, Schuermann and Stiroh (2009) argue that the U.S. stress test included the macroprudential goal of facilitating aggregate lending.

4 See Shleifer and Vishny (2011) for an excellent survey of fire sale causes and consequences.

5 See Gorton and Metrick (2010) for evidence that the market for repurchase agreements experienced a run in the crisis of 2007-09.

either come up with additional funding or sell the assets. Additional sales create the possibility for a liquidity spiral (Brunnermeier and Pedersen, 2009) in which falling prices depress collateral values and prompt forced selling that leads to even lower prices.

Third, existing bank regulation evaluates bank solvency based on the ratio of bank capital to its (risk-weighted) assets. This approach implies that a bank faced with credit losses can satisfy its regulatory requirements either by raising new equity or by reducing the riskiness of assets. A bank that is in trouble may find it difficult to raise new equity because of the aforementioned adverse selection problem: Who can be confident in the claims of an intermediary—following its announcement of large losses—that the worst is over and the investment opportunity of a lifetime beckons? Therefore, it is likely to be easier for an individual intermediary to reduce its risky asset holdings to restore compliance with its regulatory requirements. We will refer to this reduction of risky assets relative to equity as deleveraging.

One way to delever is to refuse to roll over expiring loans. Most loan contracts (or lines of commitment) have a maturity of less than a year. In part, this short tenor is due to additional bank regulation that deems short-term lending to be safer than longer-term lending, so that the required level of equity that must be held for commitments of less than one year is much lower than for longer-term commitments. The short maturity of loans means that over the course of a few quarters an individual bank can quickly reduce its risky assets. The other way to delever is to sell assets. In this case, the buyer of the assets will presumably not make loans that it otherwise would have made, or not buy other assets.

Deleveraging by an individual institution is usually inconsequential if the overall economy is strong. In a strong economy, new lenders quickly replace old lenders and there are many potential buyers of assets. But in a weak economy, where many financial institutions are distressed, the attempt by a large number of intermediaries to delever may backfire as asset prices plunge in the fire sale. This "paradox of deleveraging" means that a common shock can lead to a credit crunch for some borrowers.

A credit crunch, defined as a case where a borrower of a given quality faces reduced credit availability, can reduce aggregate economic activity. The spillover occurs when one borrower that is hit by a credit crunch reduces purchases from another borrower, or lays off its workers, who then cut their consumption, so the initial reduction in credit has a second-round effect. The second-round effect makes other borrowers less creditworthy. They may default on their borrowing or may just cut their own spending. Either way, another possible cycle can emerge that involves adverse feedback between financial and economic conditions.

Mitigating the damage from fire sales, credit crunches and defaults is a central goal of macroprudential regulation. A macroprudential stress test naturally serves as one part of the macroprudential toolkit.[6] Its purpose is to limit both the likelihood of system-wide fire sales, credit crunches, or defaults, and to reduce their costs should they occur. The other four elements of a macroprudential stress test, shown in Exhibit 2.2, also differ markedly from the elements of a microprudential test.

6 See Kashyap, Berner and Goodhart (2011) and Goodhart, Kashyap, Tsomocos and Vardoulakis (2012) for additional tools that would complement stress tests.

Exhibit 2.2. Elements of Macroprudential Stress Tests	
Purpose:	The goal is to limit the likelihood and costs of aggregate fire sales, credit crunches and systemic defaults.
Scope:	The test examines the entire financial system. Any entity that contributes to fire sales, whose default has follow-on effects, or which can exacerbate a credit crunch should be included.
Liability Considerations:	Because a run can lead to a credit crunch or fire sale, the scale of wholesale funding that is run-prone is paramount. Capital adequacy depends on the health of the overall financial system.
Asset Considerations:	The test indicates whether the financial system is vulnerable to deleveraging that might amplify adverse shocks.
Output:	Develop guidance about whether to close a bank and when to sell its assets to maximize taxpayer recovery

First, the scope of the test naturally encompasses the entire financial system. Rather than merely sorting weak and strong intermediaries, the test must assess the overall capacity of the financial system to avoid deleveraging and fire sales. The contribution of institutions to aggregate conditions is paramount. Superficially, this consideration might suggest a focus exclusively on large institutions, but smaller institutions that have correlated risks or risk management strategies also could pose a risk due to their "common exposure."[7] In addition to this cross-sectional dimension, contributions to systemic risk likely will be time-varying, partly due to the tendency of intermediaries to increase risk-taking during cyclical expansions. Finally, the financial system's penchant for instability will depend on a range of market practices—such as trading arrangements that affect the opaqueness of counterparty risks—that may compel even well-capitalized firms to delever in a synchronized fashion.

Our focus in this report is on financial institutions and their balance sheet capacity. But the macroprudential perspective logically also implies that funding-market meltdowns, such as we saw in the collapse of the asset-backed commercial paper market or the run on repurchase agreements and MMMFs, would be important. We do not propose that stress tests have to look into every corner of the financial system. But if a particular market is thought to be fragile, financial institutions that are exposed to it would need to be sufficiently stronger to offset the risk for that market to collapse.

Second, the assessment of the liability side of an institution's balance sheet will focus on its susceptibility to a run. In the recent crisis, we saw that many institutions whose accounting ratios suggested that they were adequately (or even well) capitalized lost access to wholesale funding. As funding liquidity dried up, intermediaries were forced to sell assets or to dramatically reduce credit extensions. Thus, fire-sale risk depends importantly on the proportion of wholesale funding that might trigger a run.

7 During the crisis of 2007-2009, the run on money market mutual funds (MMMFs) was a key example of a systemic disruption arising from the common exposure to rollover risk of many, small intermediaries. The U.S. Government perceived this disruption sufficiently threatening to warrant a blanket government guarantee of MMMF liabilities.

The link between run risk and credit withdrawal implies that when an institution becomes impaired, one policy goal should be to head off aggregate deleveraging. In turn, this goal gives rise to two corollaries. First, attention should be focused on raising new equity, which would both limit the likelihood of a run and allow intermediaries to continue extending credit without selling assets. Paying attention to the level of equity relative to level of assets *prior to the onset of trouble* is fundamentally different from comparing equity relative to the *current* size of the balance sheet once a crisis has begun. The former benchmark suggests that a weak institution will be required to offset losses by raising equity on a dollar-for-dollar basis, so that an equity shortfall should be stated in dollar terms. The latter benchmark permits asset shrinkage as a valid way to comply with regulation.

The other corollary is that the required level of capital for a given institution may depend on the condition of the entire financial system. Even if an organization satisfies a microprudential standard of capital adequacy without deleveraging, the macroprudential standard of adequacy will be determined by the abundance and distribution of capital in *the financial system as a whole*. For example, if other institutions are weak, stronger institutions might need to become even stronger to preserve system-wide balance sheet capacity. Well-capitalized firms would then be in a position to take over the lending of the constrained firms or to buy assets without becoming paralyzed.

Third, the credit risk of an institution's assets is not the only asset characteristic relevant for a macroprudential assessment. If assets that intermediaries might wish to sell would contribute to a fire sale, they pose a systemic risk. Thus, assets that are illiquid and cannot be sold in times of system-wide distress can pose a threat to financial stability.[8]

As a consequence, asset risks depend in part on the aggregate positions of all financial institutions. Crowded trades or similar lending positions can cause correlated losses that trigger systemic risks. Such forms of common exposure provide another motivation for horizontal comparisons in macroprudential stress tests, which should be designed to highlight sources of vulnerability in the financial system as a whole.

Practically, these considerations provide specific guidance about how a stress test might be conducted. These tests typically start by specifying macroeconomic developments that can be translated into asset losses. The asset losses are then translated into requirements for the amount of capital (and perhaps junior debt) that financial institutions must hold.

The motivation for macroprudential supervision suggests that the macroeconomic scenarios specified in the stress tests should be those with system-wide consequences. System-wide consequences could include a run by wholesale creditors or highly correlated asset losses. The resulting loss estimates need to be assessed to determine if they are big enough to trigger system-wide deleveraging. In turn, capital adequacy must be judged by whether capital is sufficient to prevent system-wide deleveraging. The mere solvency of institutions is insufficient if they do not have enough lending capacity to support economic growth. Well-capitalized intermediaries must be strong enough to expand their balance sheets as demanded in a growing economy. This imperative naturally implies that capital shortfalls should be stated in dollar terms (based on the initial size of financial institution balance sheets), not in terms of capital ratios (which could be achieved through balance sheet shrinkage).

8 The U.K. Financial Services Authority emphasized such liquidity risks—and the possible contagion arising from them—in its proposals for improving bank stress tests (FSA, 2008).

2.3. Characterizing the 2011 Federal Reserve Stress Tests

The largest intermediaries in the United States were required to provide the Federal Reserve in January 2011 with a "comprehensive capital plan [which] should incorporate a stress testing framework that considers a range and variety of economic, financial market and operational events and outcomes, including very severe ones, to estimate potential capital needs" (Federal Reserve, 2010). The instructions to the intermediaries in this supervisory document provide almost all of the guidance necessary to determine the extent of the micro- and macroprudential aspects of the tests.

By its design, the test focused on capital shortfalls of individual institutions and thus had a microprudential purpose. This purpose is most evident in the statement that "post-stress capital estimates (inclusive of any proposed capital distributions) will be evaluated relative to regulatory minimums and a tier 1 common to risk-weighted assets supervisory reference level of 5 percent."[9] The test design did not allow for feedback from the system-wide outlook to affect the requirements for individual intermediaries. Instead, the goal was to verify the loss-bearing capacity of individual entities.

The Federal Reserve applied the test to the 19 major intermediaries that participated in the original SCAP. While these intermediaries account for nearly 70% percent of U.S. banking assets, and thus cover most of the banking system, the tests did not cover systemically important non-banks or smaller banking institutions. Thus, they could not gauge fire-sale risks.

With regard to liability structure, the document focused on the composition of each intermediary's capital base. More specifically, the intermediaries reported "the composition of the firm's regulatory capital base, including key contractual terms of the capital instruments and any management plans to retire, refinance, or replace the instruments over the planning horizon." Wholesale funding was not explored systematically. A firm could have chosen to examine the systemic risks arising from wholesale funding as part of its own stress test if it deems this risk to be material to its business model. But the stress test did not explicitly seek to integrate such data across intermediaries in order to gauge the system-wide consequences of a run on wholesale funding.

The test focused on *credit* losses from different macroeconomic scenarios. The scenarios made no explicit mention of asset *liquidity* risks. Again, an individual institution could have chosen to consider this as part of a stress scenario, but the test design provided no scope for judging whether the collective actions of the intermediaries in response to a liquidity shortfall might trigger a fire sale.[10]

Overall, the framework of the 2011 Federal Reserve stress tests was decidedly microprudential. It is unclear how the resulting data could have been credibly used to determine whether these financial institutions collectively would be able to "continue to serve as credit intermediaries." Ultimately, the regulators' key decisions on whether the tested banks were strong enough to pay dividends were made on an individual bank-by-bank basis, with no direct account of the ramifications of these payouts for the strength of the financial system as a whole.

9 Subsequently, the document indicates that the banks will also need to shows plans for meeting the additional capital levels mandated by Basel III.

10 As noted in the epilogue, the 2012 U.S. tests appear to have the same issue.

We do not mean to suggest that reaching a determination on the overall intermediation capacity of the financial system would be easy; indeed, there are many open questions about how to do so. We take up some of these questions in section 5 that draws broad lessons from this sample of stress tests. For now, we turn to an extended example that helps inform our thinking about the challenges in managing system-wide deleveraging.

3. An Illustrative Example

To clarify some of the challenges in controlling deleveraging risk, we provide an extended example of the supervisory decisions that must be confronted. Our starting point is a single, deposit-funded intermediary whose balance sheet is illustrated in Exhibit 3.1. We may think of such an intermediary as being small relative to the economy as a whole. The banks involved during the U.S. savings and loan crisis, or the small regional banks involved in the Swiss regional crisis or the U.K. small-bank crisis would be examples. Such banks would be considered non-systemic, so that the main issue with them is the fiscal costs involved when assets deteriorate and depositors (and hence the deposit insurance fund) face losses.

Figure 3.1 Stylized Bank Balance Sheet

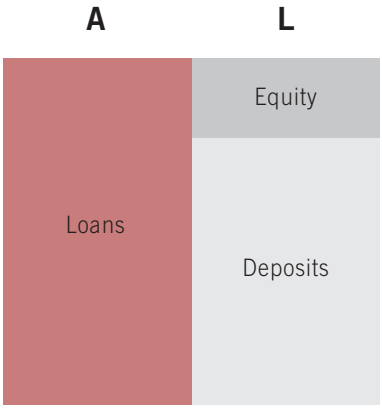
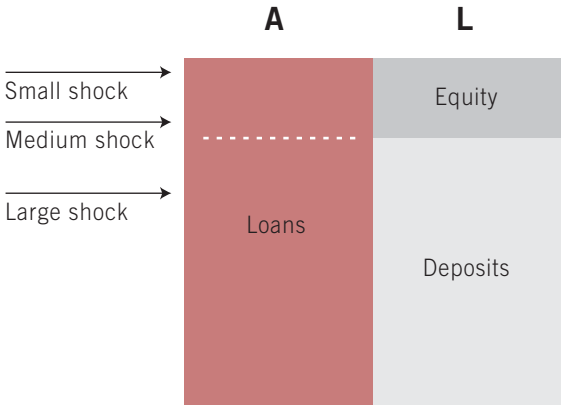


Figure 3.2 Three Types of Shocks



We then consider three sizes of shocks to the asset quality of the intermediary—small, medium and large. Large shocks are enough to wipe out the equity value of the intermediary and push the going-concern value of the assets below the face value of debt. Medium shocks and small shocks deplete the equity value of the intermediary but are not large enough to wipe out the value of equity altogether. The three shocks are illustrated in Exhibit 3.2.

From a microprudential perspective, there is no qualitative difference between small and medium shocks. Equity serves the microprudential role as a buffer against losses for depositors. The only difference between the two is quantitative: how much equity is depleted due to the shock.

Figure 3.3 Outcomes with Non-Systemic Banks

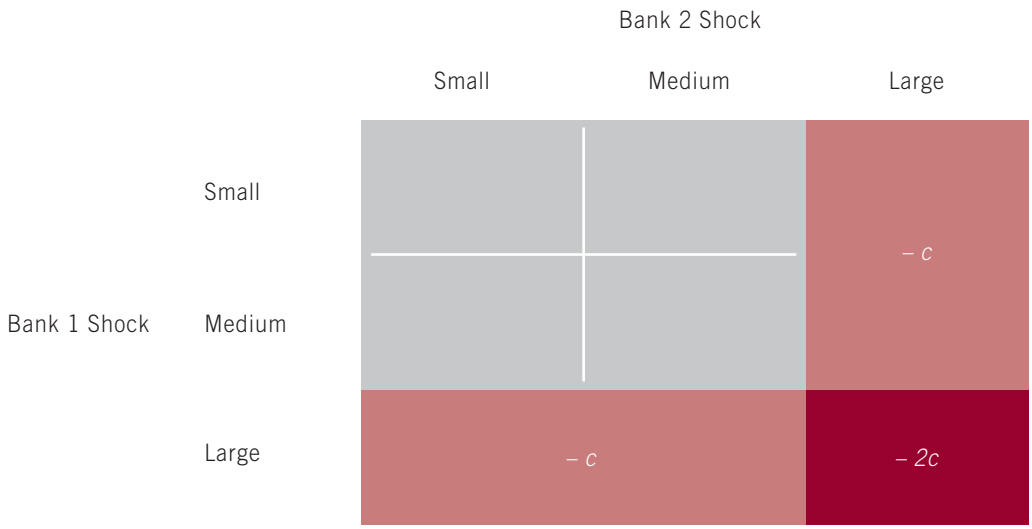
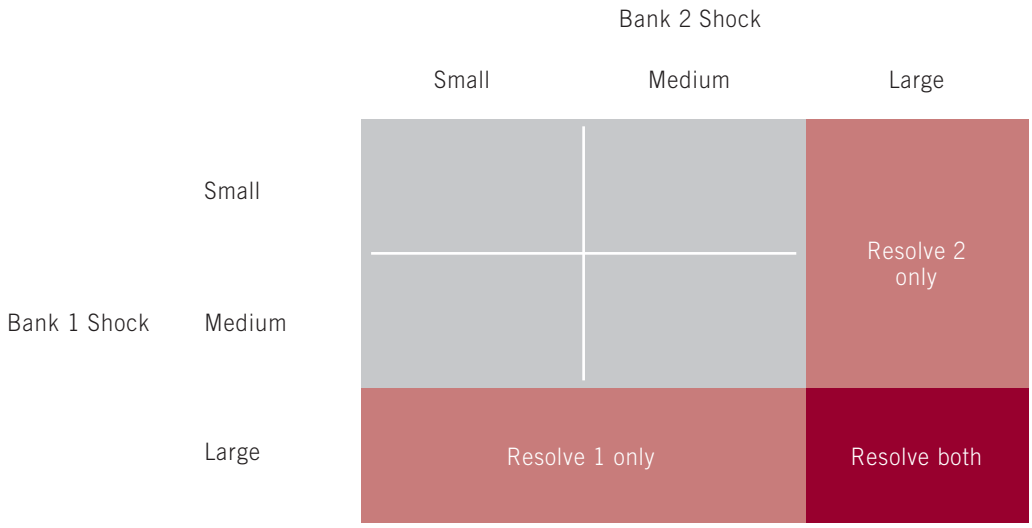


Figure 3.4 Resolution of Non-Systemic Banks



Suppose that the fiscal cost of resolution after a large shock is given by c. We may interpret this cost as the cost borne by the deposit insurance fund in taking over the intermediary and then selling it as a going concern. A microprudential stress test (either on the intermediary or system-wide) would focus on the informational need to get a better signal of asset values. The purpose would be to learn about the fiscal costs of resolution.

3.1. A World with Two Non-systemic Intermediaries

Suppose now that there are two non-systemic intermediaries in the financial sector. To calculate the total fiscal cost of resolution, one would first ascertain whether one or both intermediaries receive the large asset shock. Exhibit 3.3 illustrates. If both intermediaries receive the shock, then the fiscal cost is $2c$. If only one receives it, the cost is c. The underlying assumption is that these intermediaries are small enough that the cost to the economy as a whole arising from loss of their lending capacity is small.

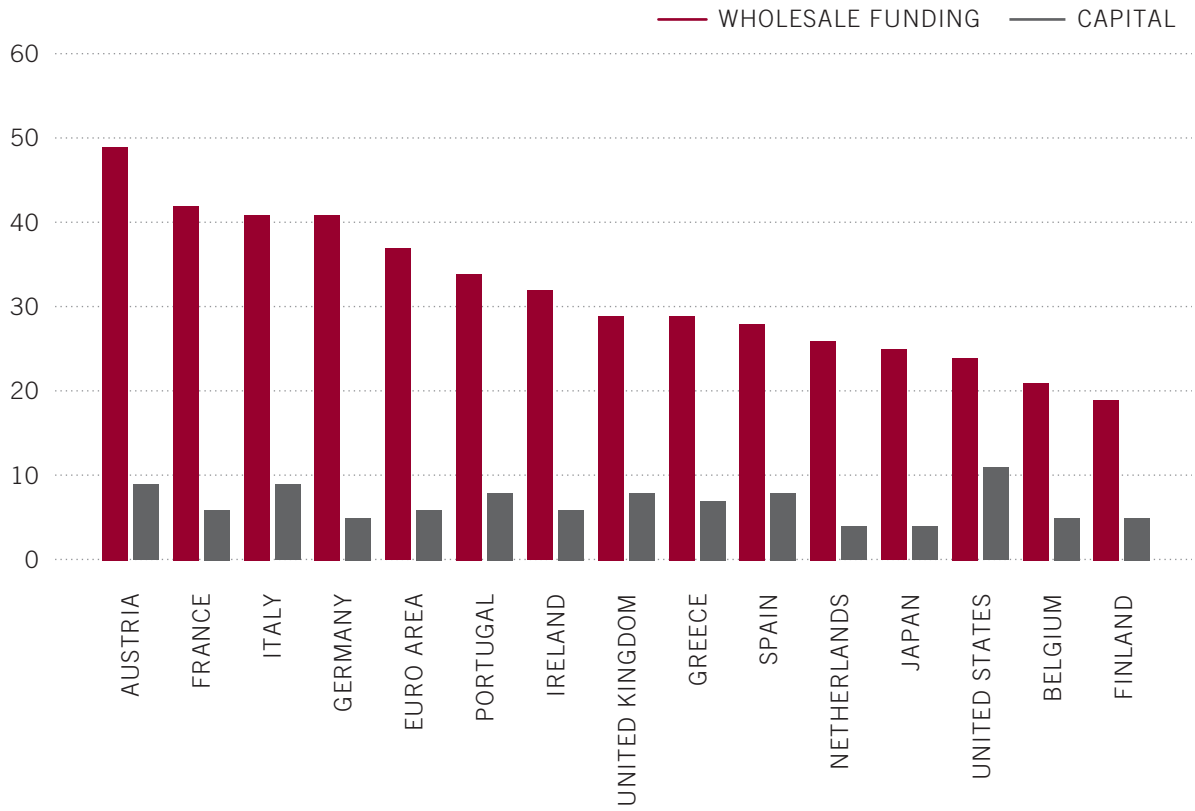
The supervision decision is correspondingly simple. If either intermediary receives the large shock that wipes out its equity, then the policy reaction is to resolve the intermediary according to the least-cost principle and prompt corrective action rule. Exhibit 3.4 illustrates. The Basel Committee document (BCBS, 2002) outlines the menu, inspired by the experience of the U.S. savings and loan crisis.

3.2. A World with Two Systemic Intermediaries

Now, suppose instead that the intermediaries involved are large and systemic. Many intermediaries involved in the U.S. and European stress tests would fall into this category.

Large systemic intermediaries have liabilities other than retail deposits. In particular, they also depend on wholesale funding, such as commercial paper and repurchase agreements, which may disappear quickly. Exhibit 3.5 reports mid-2010 data from the International Monetary Fund on the ratio of wholesale funding to total liabilities in advanced countries. For comparison, analogous ratios for capital are also shown. Clearly, the reliance on wholesale funding is important in all these countries.

Figure 3.5 Wholesale Funding and Capital Across Countries, June 2010



Source: IMF, Global Financial Stability Report, October 2010. For the purposes of this example, we postpone the deeper question of why wholesale funding is so pervasive and take the balance sheet structure as given in Exhibit 3.6 below. In addition, we assume that the wholesale creditors are sophisticated, uninsured creditors who react sensitively to overall financial market conditions and to the condition of the debtor intermediary in deciding whether or not to roll over their short-term funding.

Figure 3.6 Bank with Wholesale Funding

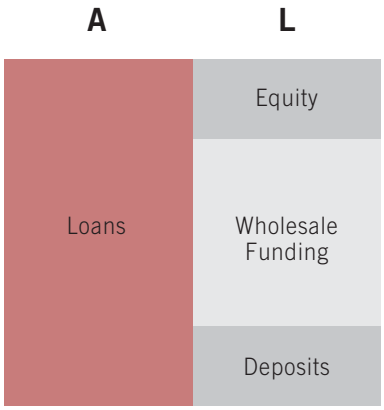
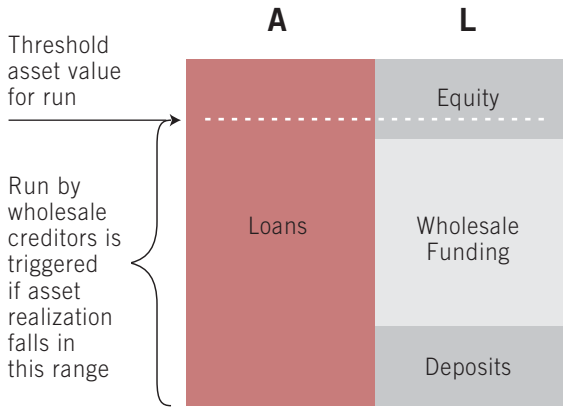


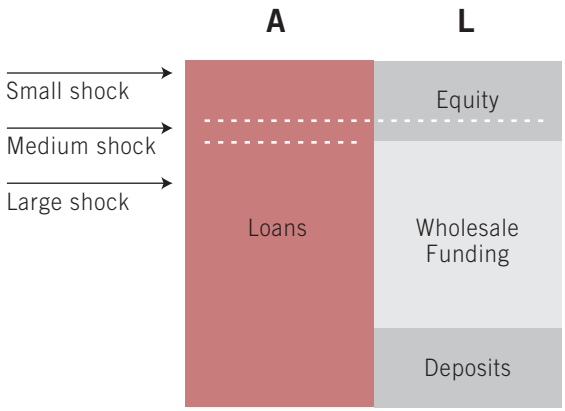
Figure 3.7 Threshold Value for Run



A classic theme in the banking literature is the possibility of "self-fulfilling" runs, where creditors who believe that other creditors will run have a compelling reason to participate in the run. The mutually reinforcing nature of the run decision can lead to the run outcome for the bank (Diamond and Dybvig, 1983). In practice, self-fulfilling runs of this sort do not happen out of the blue. Normally, runs are triggered by a bank's deteriorating fundamentals. Historically, bank runs have occurred around the peak of an economic cycle when the economy starts losing steam (Gorton, 1988). In the recent crisis, the runs on Bear Stearns and Lehman Brothers occurred when fundamentals had deteriorated to such an extent that questions arose about the soundness of these institutions.

It is also possible to show theoretically that when creditors face the question of rolling over their short-term debt and receive slightly noisy signals regarding the financial condition of the intermediary, they may decide to run if the signaled value falls below some threshold level (see Morris and Shin, 2004 and 2008; Goldstein and Pauzner, 2005). The threshold value that determines if a run is triggered will normally be consistent with the solvency of the intermediary. The reasoning is as follows: If the intermediary is insolvent in the sense that the value of its assets falls below the notional value of debt, then some creditors will face losses. Fearing such losses, the nimble, sophisticated and uninsured creditors will have the most incentive to run. Indeed, they have very little to gain by *not* running, and everything to lose. The tradeoff is tilted towards their running even if the intermediary is in the solvent region, but sufficiently close to insolvency that the possibility of *others* running becomes a significant concern. Consequently, theory predicts that a run will be triggered below a threshold point in the solvent region for the intermediary. Exhibit 3.7 illustrates such a "run point"—the threshold value for asset realization below which a run by wholesale creditors is triggered. The exact location of the run point depends on (among other things) the degree of wholesale funding and the illiquidity of the assets (see Morris and Shin, 2008).

FIGURE 3.8 MEDIUM-SIZED SHOCKS TRIGGER RUNS



When there is a possibility of a run, the danger facing the intermediary comes not only from the asset side of the balance sheet, but also from the liability side, and the possibility that the wholesale creditors will run from the intermediary.

Suppose that the three shocks introduced earlier have the following features. The large shock, as before, is enough to wipe out the equity of the intermediary, and the assets of the intermediary fall below the face value of liabilities.

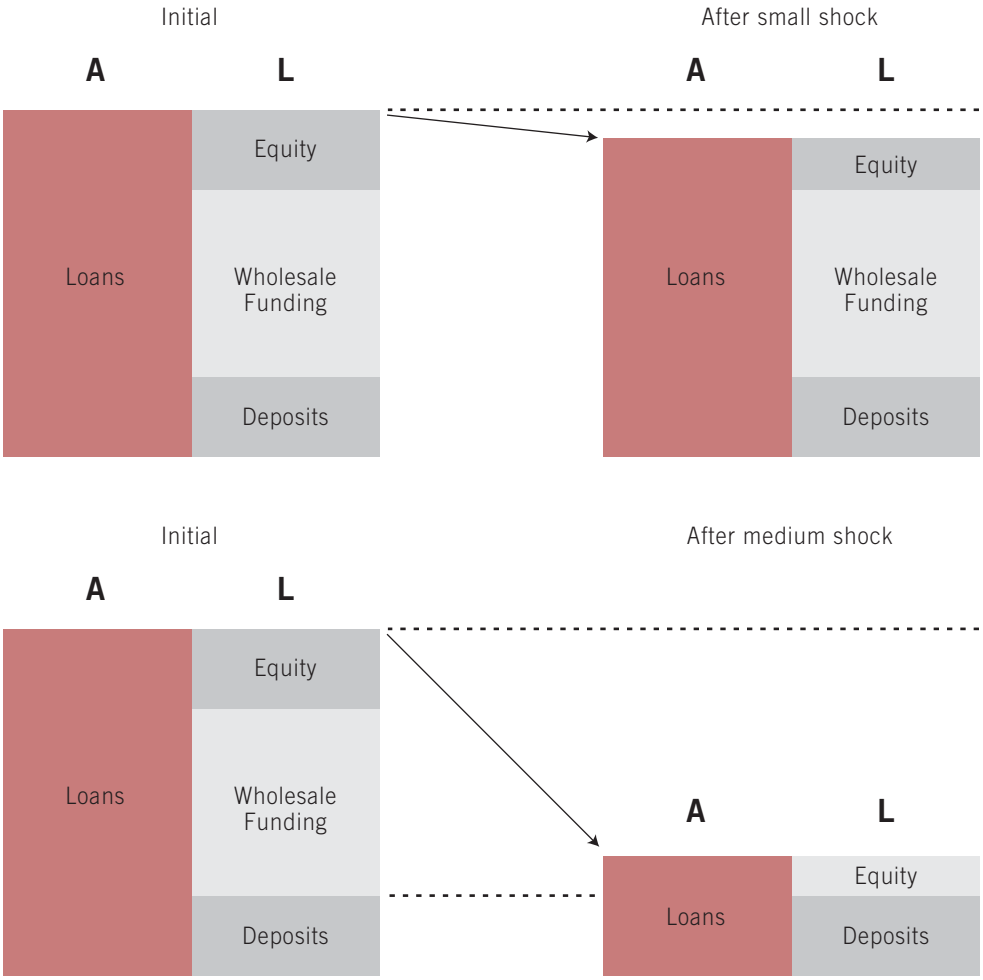
The medium and small shocks are not large enough to wipe out the equity of the intermediary by themselves. However, the medium shock diminishes the asset value of the intermediary below the threshold value for the run by creditors. This "run point" is indicated by the dashed line in Exhibit 3.8. By assumption, the small shock leaves the value of the intermediary's assets above the threshold value for the run. In contrast to the fully deposit-funded bank examined above, the medium-sized shock has a far-reaching effect on the systemic intermediary, due to the run by its wholesale creditors. Exhibit 3.9 contrasts the impact of the medium-sized shock relative to the small shock.

In Exhibit 3.9, the small shock leaves the intermediary largely unscathed. However, the medium shock triggers a run by the wholesale creditors, which (in the absence of outside support from, say, the central bank) must be met by shedding assets.[11]

The run by wholesale creditors means that assets must be sold at possibly distressed prices so that much of the equity of the intermediary is dissipated. The resulting balance sheet of the intermediary reflects the contraction of the balance sheet as a whole, where the wholesale liabilities have run and only the deposits and a thin layer of equity remain. The assets have been dissipated in the fire sale. For the large shock, the outcome also would reflect the cost c of the asset value deterioration, and would result in the intermediary being under water by the amount c in addition to the deleveraging.

11 In this example, we ignore the fact that wholesale creditors are frequently financial intermediaries themselves, so that there are chains of intermediation relationships. A full-fledged framework with interlinkages results in more severe runs (Shin, 2010, ch. 6).

Figure 3.9 Consequences of Small and Medium-Sized Shocks



The main economic cost of the run is the reduction in lending to the economy. The severe contraction of the balance sheet of an intermediary undergoing a run lowers the capacity of the financial sector to channel credit.

To pursue this analysis, we denote by W the amount of wholesale funding used by an individual intermediary, and denote by E the depletion in the equity value of the individual intermediary that results from the distressed asset sales which accompany the deleveraging in the aftermath of the medium shock. Thus, the shrinkage in the size of the intermediary's balance sheet is $W+E$. This quantity is also the amount by which the intermediary's lending shrinks.

Figure 3.10 Economic Costs of Distress of Systemic Banks

		Bank 2 Shock		
		Small	Medium	Large
Bank 1 Shock	Small		$-(W+E)$	$-(W+E)-\delta$
	Medium	$-(W+E)$	$-2(W+E)$	$-2(W+E)-\delta$
	Large	$-(W+E)-\delta$	$-2(W+E)-\delta$	$-2(W+E+\delta)$

If the intermediary has been subject to a large shock that pushes its asset value below the solvency boundary, there will be additional costs arising from the greater shrinkage of the balance sheet, as well as the fiscal cost to the deposit insurer. We denote by δ the additional social cost associated with the large shock to an intermediary, beyond the social cost associated with a medium shock.

Exhibit 3.10 above illustrates the social cost from the reduction in lending capacity for the economy together with the fiscal cost to taxpayers resulting from the combination of the three types of shocks to an individual intermediary. We see that the economic costs are larger than the mere fiscal costs arising from the microprudential banking resolution problem.

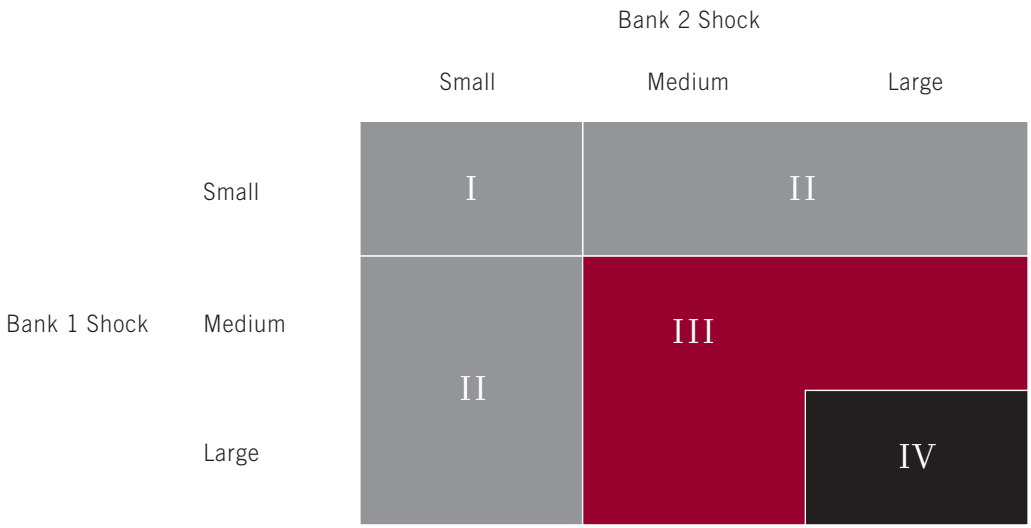
3.3. A Taxonomy with Systemic Intermediaries

To the extent that the economic costs are more far-reaching when there are systemically important intermediaries, the public policy questions also demand a system-wide perspective. The public policy imperative is to preserve the balance sheet capacity of the financial system as far as possible. If a relatively stronger intermediary has the capacity to take over (or acquire the assets of) a weaker intermediary that is vulnerable to a run, then the lending capacity of the financial system could be protected from the threat of deleveraging by the impaired intermediary.

Within our two-intermediary example, let us illustrate the issues by means of the following simplifying assumption. When an intermediary receives a small shock, we suppose that its equity position is still large enough that it can absorb a struggling rival that has received a medium or large shock. However, when an intermediary receives a medium shock, its asset value barely covers its liabilities and it does not have the capacity to take over another intermediary.

We can then distinguish four possible cases in the financial system, labeled from Case I to Case IV. The taxonomy of the four cases is illustrated in Exhibit 3.11 below.

Figure 3.11 Taxonomy of Four Cases for the Banking Sector



Case I ("All Solvent") obtains when all institutions are well capitalized and face neither runs nor insolvency. Case I is illustrated as the top left hand cell in Exhibit 3.11. In Case I, we would expect that the CDS rates for both intermediaries would be low because of the lack of default risk and the stability of wholesale liabilities. By the time of the stress tests in Europe and the United States, this condition had clearly failed for most (if not all) large intermediaries, so we will not dwell on this possibility.

Case II ("Solvent firms can rescue impaired") obtains when some—but not all—institutions are poorly capitalized and at risk of a run or insolvency. The relatively stronger intermediaries have sufficient equity to acquire the assets of (or to absorb) a weaker institution. In terms of observable market indicators, the strong intermediaries enjoy low CDS rates that are relatively insensitive to economic news affecting their stock prices. More distinctively, Case II implies that bad news for the weak institutions may be good news for the strong intermediaries, since the strong firms will be able to acquire the weak ones or absorb their assets in a fire sale. Because of this countervailing effect of shocks, common movements in equity prices are not large. Indeed, equity prices of the healthiest institutions may be *negatively* correlated with those of the weakest institutions. In Exhibit 3.11 above, Case II is illustrated by the light shaded area in the top right and the bottom left cells.

Case III ("Solvent firms cannot rescue impaired") also involves the coexistence of some solvent and some weak intermediaries. However, in Case III, even the relatively stronger intermediaries have insufficient capital to acquire the assets of (or take over) the weak institutions. One market indicator of this case would be high levels of CDS prices for all institutions, although some intermediaries may have somewhat lower CDS levels than the rest. In addition, equity prices would display a significant degree of common movement across institutions as shocks to the economy have powerful effects on the viability of the weak institutions. Perhaps most important, there would be no countervailing response for the equity price movements of weak institutions because the solvent institutions do not stand to gain from the demise of the impaired intermediaries. Case III is illustrated in Exhibit 3.11 by the chevron-shaped group of cells in the middle of the grid.

Finally, Case IV ("All insolvent") depicts a more extreme degree of chronic under-capitalization in the financial sector. All intermediaries are insolvent on a mark-to-market basis. Their traded equity prices merely reflect the option value of the uncertain outcomes of the asset values, together possibly with the value of a potential bailout of the financial sector. CDS levels are highly elevated for all institutions and there is substantial co-movement in both CDS returns and equity returns. Importantly, because all intermediaries are undercapitalized, good news that lowers the estimated default risk is also passed into equity prices, so equity returns and CDS returns of individual institutions should all be negatively correlated. Case IV is indicated in Exhibit 3.11 by the dark-shaded cell in the bottom right hand corner.

To summarize, our taxonomy above suggests that there are four possible states of the financial system. Using a combination of CDS prices, the co-movement in CDS and equity returns, and the relative movement of individual institutions' CDS and equity returns, one could attempt to diagnose the state the financial system at any moment in time.

A stress test can alter the state of the system by mandating change for some or all of the intermediaries. For instance, upon the completion of a stress test, intermediaries may be required to raise capital, alter their asset composition by holding more liquid assets, and (over time) adjust their reliance on wholesale funding. Depending on the extent of these requirements, the state of the financial system may become different from that which prevailed before the test. The resulting condition of the system can again be gauged using the same set of financial market criteria that were used before the test.

The mandates that follow a test would differ depending on whether the test has a microprudential or macroprudential focus. In a microprudential test, only weak intermediaries would be required to raise new capital and adjust the structure of their other funding. Also, solvent institutions would not be restricted from depleting capital, say by paying dividends or repurchasing shares. In contrast, a macroprudential test might compel even solvent institutions to stay well-capitalized by, for instance, continuing to ban dividend payments even for those banks that are solvent from a microprudential perspective.

As a practical matter, the difference in focus between micro- and macroprudential regimes will be most pronounced if the financial system is best characterized by Case III. For macroprudential purposes, the differences between this case and the one where all intermediaries are insolvent (Case IV) are minor. Indeed, even distinguishing these scenarios is challenging, because the overall system is fragile in both instances and likely to be incapable of supporting an economic recovery until more capital flows into the system. For microprudential purposes, the firms that have their actions restricted and are instructed to raise capital will depend critically on whether the individual firm is clearly insolvent or not.

A second practical difference relates to the regulatory guidance that firms receive. An early suspension of dividends for the entire industry would be one example of a macroprudential precautionary measure. The directive that financial institutions raise some given dollar amounts of capital (such as the official instructions that followed the 2009 U.S. stress test) would be another. A microprudential framework would not contemplate either of these options.

Finally, the example highlights three key patterns that we explore in the next sections. First, the macroprudential threshold for the amount of capital needed to prevent deleveraging *exceeds* the microprudential solvency threshold. There is some theoretical basis for calculating the additional capital necessary to prevent runs in simple cases using global game techniques (Morris and Shin, 2008).

For more realistic cases, any theoretical estimate will need careful validation based on empirical evidence from market prices, where they exist. Theoretical models also will need to take account of possible "announcement effects" of a stress test that alter the information environment between public and private information.

Second, in order for a stress test to alleviate concerns that deleveraging is imminent, the test must either produce a credible private capital-raising program or be accompanied with an adequate government backstop to make sure that wholesale creditors see no risk of suffering losses. The government backstop could involve direct guarantees for wholesale funding or could come via capital injections. For instance, in the illustrative example examined above, Case III would be particularly amenable to new capital raising by intermediaries. Recall that in Case III the relatively stronger intermediaries are solvent but not sufficiently well-capitalized to absorb a weaker rival. If the relatively stronger intermediaries were to strengthen their capital position, either by raising additional capital or by suspending dividends for the requisite period, they would be in a better position to bolster the balance sheet capacity of the system as a whole.

Third, assessment of the systemwide impact of a stress test can be deduced by comparing CDS and equity prices for strong and weak intermediaries before and after the test. As the two-intermediary example showed, the presence of strong intermediaries that stand to benefit from buying (the assets of) weaker institutions at a fire sale price can lead to inverse movements in CDS or equity prices for the target versus those for the acquirer. In contrast, if two weak intermediaries are compared, then their CDS and equity prices would be expected to move in tandem.

4. Empirical Evidence on Past Stress Tests in Europe, Japan, and the United States

In this section, we seek to evaluate the typology introduced in the last section. We begin by reviewing basic summary statistics that inform us about average conditions for a broad sample of European and U.S. intermediaries before and after the stress tests. We then turn to intermediary-level data on key market conditions that help distinguish the four cases presented by our classification scheme.

While our four-case taxonomy provides a convenient way to organize our thinking, any real-world application naturally includes many shades of gray. For example, the taxonomy presumes one-off shocks that determine the final outcome, whereas in the real world the financial system will experience repeated shocks and continuing uncertainties.

Perhaps more important, the taxonomy ignores common movements in market risk premiums that influence all asset prices. Thus, a rigorous method for inferring in which cell of the taxonomy the economy finds itself would require distinguishing common shocks from specific ones — a difficult task that we do not undertake. Nor can we use the standard empirical crutch of finding a control group unaffected by a shock because, by their nature, systemic shocks affect the entire financial sector.

Thus, in what follows, we view the results as being suggestive of the categories (I through IV) in which the financial system is situated before and after a stress test, but acknowledge that the analysis is not definitive. Given the special nature of each episode, this imperfect assessment may be all that is possible.

With this proviso, we now turn to an empirical assessment of recent stress tests. In the body of the report we show the evidence through 2010, while the epilogue updates the analysis to include 2011 developments.

4.1 Aggregate Evidence

Exhibits 4.1 and 4.2 below compare the average behavior of equity and CDS prices for major U.S. and European intermediaries in the three-month windows before and after their respective 2009 and 2010 stress tests.[12] In the United States, the leading regulators announced the stress tests on February 10, 2009. In Europe, on December 2, 2009, the ECOFIN called on the Committee of European Bank Supervisors (CEBS) to conduct semi-annual stress tests on key intermediaries. The results of these stress tests were revealed on May 7, 2009 in the United States and on July 23, 2010 in Europe. Our CDS samples include six large bank holding companies in the United States (which accounted for more than half of commercial bank assets and deposits as of September 2010) and 26 large European intermediaries based in 10 countries. The equity samples include 19 large U.S. intermediaries and 50 European ones.

Exhibit 4.1a. CDS Spread Summary Statistics: United States and Europe (bp)

	United States			Europe		
	Before	After	Change	Before	After	Change
Average	300	190	-110	175	158	-17
Median	272	161	-110	145	120	-25
Max	692	469	-223	516	628	112
Min	113	58	-55	65	45	-20
Std. Dev.	52	32	-20	22	14	-9

Exhibit 4.1b. CDS Spread Summary Statistics: Other European Groupings (bp)

	Europe ex Ireland			Europe ex Ireland & Spain		
	Before	After	Change	Before	After	Change
Average	166	144	-22	136	118	-18
Median	143	119	-24	133	112	-21
Max	473	355	-118	257	233	-24
Min	65	45	-20	65	45	-20
Std. Dev.	19	11	-8	16	9	-7

Source: Authors' calculations based on data from Bloomberg.

Note: The samples include 6 large US intermediaries and 26 European intermediaries with CDS outstanding. Greece and Portugal do not have any institutions with CDS.

12 Note that the row labeled standard deviation in each exhibit shows the average of the time-series standard deviations for each firm in the respective samples.

Several stylized facts emerge from these summary statistics, all of which suggest that the U.S. stress tests went farther than the European tests in healing the financial system. As a precursor, note that global financial crisis conditions were much worse in early 2009 when the U.S. tests were implemented than in mid-2010 when the European tests were conducted. Also, macroeconomic factors other than the stress tests influenced financial sector health. Unfortunately, it is not possible to create a control group to account for these influences because of the systemic nature of the financial disturbances: By definition, no part of the financial world can be assumed immune to systemic disruption. Consequently, in the "before-and-after" comparisons that follow, we make no claim that the stress tests are responsible for all observed differences. A further implication of this caveat is that we do not claim that average pre-test conditions were equivalent in the two regions and make no effort to compare the levels of CDS prices between them.

The first observation from our summary statistics is that there were many weak institutions during both pre-test windows, as reflected in elevated CDS prices. Consequently, we can dismiss Case I in our typology, because at least some banks were not perceived as healthy.

Second, mean and median CDS prices declined in both regions after the stress test, but the decline was substantially larger in the United States, suggesting that the perceived risk of default had fallen more (Exhibit 4.1a). At a disaggregated level, each intermediary in the U.S. sample experienced a decline of its average CDS price that (except in one case) was statistically significant at a 10% confidence level.

In contrast, of the 25 European banks, three experienced a rise in CDS price, while only six experienced a statistically significant drop.

Third, the range of U.S. CDS prices shifted markedly lower, while the range of European CDS prices actually widened (Exhibit 4.1a). Excluding Irish and Spanish banks, the range of European CDS prices also shifted lower, but only modestly so (Exhibit 4.1b). Again, it appears that, in contrast to the experience in Europe, the U.S. stress test was associated with a substantial reduction of default risk even for those institutions perceived as most threatened. In contrast, in light of apparent country effects, the widening of the CDS range in Europe appears to be linked to doubts about national promises (implicit or explicit) to recapitalize weak banks.

Fourth, in the aftermath of the stress tests, the average equity price of the U.S. sample was 42% above the pre-crisis window, compared to a rise of only 5% in Europe (Exhibit 4.2a). Again, the equity increase was observed across the U.S. sample and statistically significant in all but one instance. The bottom end of the range showed the largest improvement, suggesting that the U.S. stress test lowered fears of insolvency or nationalization, allowing for a return to equity capital-raising. In Europe the market reactions were much more varied. Fifteen of the 50 banks saw their share prices rise significantly, while two showed statistically significant declines. Overall, the range of equity prices in Europe shifted lower, not higher (Exhibits 4.2a and 4.2b). That shift was most acute in those euro-area countries that experienced the largest widening of their government yield spreads over Germany (namely, Greece, Ireland, Portugal and Spain).

Exhibit 4.2a. Equity Price Summary Statistics: United States and Europe (Based on Equity Prices Indexed to 100 on Stress Test Announcement Date)						
	United States			Europe		
	Before	After	Change	Before	After	Change
Average	73	99	27	98	102	4
Median	75	96	20	97	102	5
Max	138	187	49	248	143	-104
Min	19	65	46	63	44	-19
Std. Dev.	15	8	-7	8	6	-2

Exhibit 4.2b. Equity Price Summary Statistics: Other European Groupings (Based on Equity Prices Indexed to 100 on Stress Test Announcement Date)						
	Europe ex Ireland			Europe ex Ireland, Greece, Portugal & Spain		
	Before	After	Change	Before	After	Change
Average	97	103	6	98	104	6
Median	97	103	6	98	104	6
Max	148	143	-5	145	130	-15
Min	63	71	8	76	86	10
Std. Dev.	7	6	-1	7	5	-2

Source: Authors' calculations based on data from FactSet.
Note: The samples include 19 large US intermediaries and 50 European intermediaries that are publicly traded.

Perhaps the simplest way to summarize the aggregate differences in the effectiveness of the two tests is to look at patterns of equity issuance that accompanied the tests. Using either a micro- or macroprudential approach, a stress test is effective only if impaired intermediaries emerge as substantially better capitalized—presumably because they have gone to the equity market to raise new funds. Exhibit 4.3 below lists the capital raisings by the 19 U.S. SCAP banks and by 50 large European banks in the three-month windows before and after the respective announcements of the stress test results.

Importantly, in the months leading up to the tests, intermediaries in both regions were not issuing equity. Afterwards, a stark difference emerges. U.S. intermediaries raised over $50 billion in the month after the stress test results were announced. Moreover, no U.S. intermediary made use of the complicated backstop program that the U.S. Treasury had prepared for firms unable to meet their capital targets.[13]

13 While the backstop was not utilized, Hirtle, Schuermann and Stiroh (2009) note that it provided confidence in the capital-replenishment process following the U.S. stress test.

In Europe, only one large institution, Deutsche Bank, raised new equity. This response can be interpreted in three ways. The most sanguine version is that the stress test revealed all intermediaries to be adequately capitalized and in no need of funds. However, this conclusion would be akin to a declaration that the prevailing state of the world is our Case I. The elevated levels of CDS prices and, in some cases, substantial further CDS price increases make this rosy scenario interpretation implausible.

Exhibit 4.3. Intermediary common equity issuance: Before and after the stress test (Billions of Dollars, except as indicated)

Before					
United States			Europe		
Date	Firm	Amount	Date	Firm	Amount
04/14/2009	GS	$5.75	NA	None	0
After					
United States			Europe		
Date	Firm	Amount	Date	Firm	Amount
05/08/2009	MS	$4.57	10/06/2010	DBK	€10.18
05/08/2009	WFC	8.63			
05/11/2009	BK	1.39			
05/11/2009	COF	1.55			
05/11/2009	USB	2.76			
05/12/2009	BBT	1.73			
05/18/2009	STT	2.30			
05/19/2009	BAC	13.46			
05/20/2009	RF	1.84			
05/27/2009	PNC	0.62			
06/01/2009	STI	1.61			
06/02/2009	JPM	5.76			
06/02/2009	KEY	1.00			
06/02/2009	MS	2.36			
06/04/2009	FITB	1.00			
Total		$50.57	Total		$14.04

Source: Bloomberg.

Note: The periods before and after the stress tests represent three month windows. The totals are shown in U.S. dollars (using exchange rates on the date of issuance).

A second (modestly less sanguine) interpretation is that the European governments had provided sufficient guarantees of support so that the intermediaries, however impaired, could continue to operate without the risk of a run. In this case, private equity issuance would be unnecessary, at least initially. Our reading of the Japanese experience earlier in the decade suggests that this kind of strategy is possible, if the government's commitment is credible and followed up with specific actions to address under-capitalization of the financial system (Exhibit 4.4).

Exhibit 4.4. Case Study on Resona Bank and the Japanese Stress Tests of 2003

When Heizo Takenaka became the Minister of Financial Affairs in September 2002, he proposed a broad plan to stabilize the financial system. The stress tests which formed part of the plan played an important role in that process (see Hoshi and Kashyap 2010, 2011 for details).

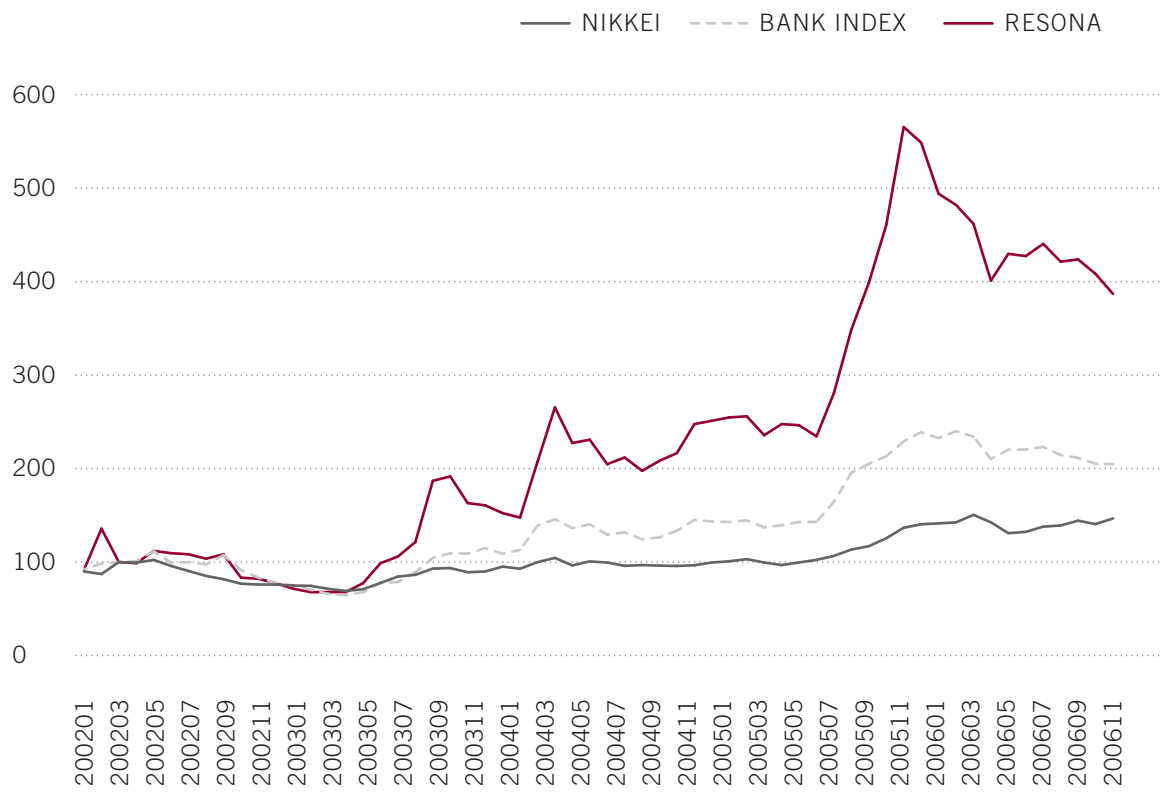
Takenaka's plan included a commitment to use public funds to recapitalize weak banks. Over time, it also narrowed the scope for banks to avoid recognition of the losses on their balance sheet. In exchange for public funds, banks would be subject to business improvement orders that mandated various management decisions, including the possible replacement of senior executives. The most critical application of this principle occurred in May 2003, when the Government of Japan intervened to prop up Resona Bank, then the sixth largest Japanese bank.[14]

Resona was deemed to be undercapitalized based on its March regulatory filing. The bank was given ¥1.96 trillion of government funding and ordered to file a plan to rehabilitate itself with the Financial Services Agency (FSA), which it did in June 2003. Most of the Board of Directors, including the Chairman, was replaced. As part of the commitment to acknowledge balance sheet deterioration, a new auditor was hired to take a fresh look at the bank's financial condition.

When the new bank leadership received the auditor's report, it discovered that the June 2003 plan had understated the size of losses embedded in the balance sheet. The under-reporting was so large that all of the government equity already had been lost by September 2003. Despite this setback, investors took this news in stride.

The figure shows the level of the Nikkei 225 stock index, the Tokyo Stock Price index for banks, and the share price for Resona, each normalized to be 100 in March 2002. All three measures hit their trough in April 2003 and began rising after the Resona rescue. The gains for the bank index and the Nikkei continued through the year even as Resona's bad news was revealed. Later in 2003, the FSA nationalized Ashikaga Bank, a weak regional bank that—like Resona—had under-reported losses. The lack of contagion in the equity market reflected increasing confidence that policymakers could and would distinguish impaired institutions from others.

14 Additional details on the next two paragraphs can be found in Hoshi and Kashyap (2005).



The Resona case holds two valuable lessons. First, the turning point came once the government demonstrated a commitment to address the problems in the bank and had sufficient resources to keep it afloat. Second, the insufficiency of the first capital injection was not fatal. Over the course of 2003, the government took a series of steps that earned the credibility that its previous plans had lacked. Accordingly, whenever regulators opt for a large bailout, they should anticipate that it will take time for the impaired institutions to recover, so that the credibility and durability of the commitment (and, accordingly, the size of the package) are both of central import.

The third possible explanation of the different results in the U.S. and Europe, which seems most likely to us, is that the tests in Europe failed to change the problems facing the banks. The limited change in the average and median levels of the CDS and equity prices in Europe certainly point in this direction. Nevertheless, to justify this conclusion we need further evidence.

4.2 Evidence on Individual Institutions

We now turn to examining intermediary-level European and U.S. CDS and equity data to identify whether the pre-stress-test state of the world corresponded to cases II, III, or IV. In addition, we ask what these data say about how that state changed in the aftermath of the stress test. In what follows, we take as given that the rosy scenario (Case I) does not obtain, so that the operative issue is the mix between healthy, weak and insolvent intermediaries.[15]

Our intermediate cases, II and III, differ on whether the clearly solvent banks are strong enough to rescue the banks that are close to insolvency. Either way, the clearly solvent institutions should have relatively low CDS prices. In case II, the strong banks are so well capitalized that they could manage to absorb a distressed institution or its assets at a fire-sale price. In this scenario, bad news for the weak firm would be good news for the strong institution, so equity prices for the two would be negatively correlated. This negative correlation would limit the observed co-movement in equity prices. In addition, the abundance of capital for the clearly solvent institutions would mean that their CDS prices should barely move. In turn, the correlation between their own CDS prices and own equity prices would be low, as would the correlation between their CDS prices and those of the weaker intermediaries.

In Case III, even the solvent banks are weak, so their CDS prices are more sensitive to news. This sensitivity will mean that their own CDS and equity prices will be negatively correlated, and that the CDS and equity prices of all banks will display substantial positive correlations. Case IV presents a more extreme version of Case III, with severely depressed equity prices reflecting the forbearance (and expected bailout) that keeps insolvent firms afloat.

What do we observe in the pre-test three-month window? In the United States, the intermediary with the lowest average CDS price (JP Morgan) still averaged 165 basis points, far above the highest average CDS price for intermediaries in this sample that prevailed in 2006—when average CDS prices for the same set of institutions ranged between 10 and 25 basis points (Exhibit 4.5a). Remarkably, the standard deviation for the CDS prices for that earlier period was less than three basis points. So the theoretical benchmark that we proposed for Cases I or II, whereby CDS prices are very low and insensitive to economic developments, does seem to hold in the period *before* the financial crisis began.

Within the European sample, several intermediaries exhibited lower pre-test CDS prices than in the U.S. sample, but all these prices also were still far above their 2006 levels, when CDS prices for this set of institutions averaged between 5 and 15 basis points (Exhibit 4.5b). The volatility of the individual prices was also very low in that pre-crisis interval, with the standard deviations all being less than 2 basis points. Thus, only a few years ago, European intermediaries also were perceived to have virtually no default risk.

15 This assumption appears robust. For example, using a different empirical approach, Demirguc-Kunt et al. (2010) show that the stock returns of large intermediaries that had been insensitive to accounting measures of capital prior to the crisis became sensitive during the financial crisis, consistent with undercapitalization.

Exhibit 4.5a. CDS Prices of U.S. Intermediaries								
	2006			Before			After	Final 12 Weeks of 2011
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
JPM	17	2.5	165	26.7	97	18.8	151	11.3
WFC	10	2.1	225	46.7	130	22.3	150	12.2
GS	23	2.7	258	34.5	142	23.7	328	41.2
BAC	12	2.6	281	57.7	186	35.9	394	39.1
MS	22	2.2	360	36.1	211	39.1	415	54.8
C	11	2.3	507	109.3	370	51.2	261	28.0

Exhibit 4.5b. CDS Prices of European Intermediaries								
	2006			Before			After	Final 12 Weeks of 2011
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
HSBC (UK)	8	1.5	92	11.2	71	4.2	149	11.2
ING (NE)	6	1.1	117	13.0	110	9.0	216	23.5
DBK (DE)	13	1.4	144	20.2	102	8.1	212	34.2
AIB (IE)	8	0.7	391	96.8	503	85.5	NA	NA
BNP (FR)	7	0.7	117	13.7	95	8.8	270	39.9
ACA (FR)	7	0.7	158	25.3	125	9.7	273.4	43.1

NA Not applicable (AIB CDS were required to pay out after a credit event in June 2011).
Source: Authors' calculations based on data from Bloomberg.

From this perspective, CDS prices in the pre-test windows displayed heightened concerns about default risk for all of the intermediaries in both samples. However, in several cases these risks may not have been viewed as acute. For example, one U.S. intermediary and all but one of the European intermediaries showed average CDS prices below 200 basis points in the pre-test period. Assuming a recovery rate of 80%, a one-year CDS price of 200 basis points is consistent with a default probability of 10%.[16]

16 The default probability is the CDS spread divided by (one *minus* the recovery rate). At a recovery rate of 50%, the default probability would be 4%, while at a recovery rate of 90%, the default probability would be 20%.

Other evidence helps us determine whether these intermediaries with relatively lower default risk were seen as able or not able to absorb weaker intermediaries (consistent with Cases II or III, respectively). Exhibit 4.6 shows the average pair-wise correlation of weekly equity returns for institutions from Exhibit 4.5. The average pair-wise correlation is a convenient, intuitive way to summarize the degree of co-movement between the returns. In the U.S. sample, average correlations were high in the 12 weeks before the stress test and dropped somewhat afterwards. The final row in the first panel of the exhibit shows the same statistics for the year 2006. Relative to this baseline period, correlations in the United States remained elevated after the stress test.

The second panel shows that the same basic pattern holds in Europe. The average correlation was extremely high in the 12 weeks before the stress test, and dropped somewhat after the stress test, but remained higher than during the baseline 2006 period.

Exhibit 4.6. Average Pair-wise Correlations for Weekly Stock Returns in European and U.S. Banks—

USA	Avg. Pair-Wise Correlation	Std. Error
12 Weeks prior to Announcement	0.809	0.036
12 Weeks after Announcement	0.643	0.059
All 2006	0.521	0.031

EUROPE	Avg. Pair-Wise correlation	Std. Error
12 Weeks prior to Announcement	0.845	0.024
12 Weeks after Announcement	0.708	0.051
All 2006	0.569	0.028

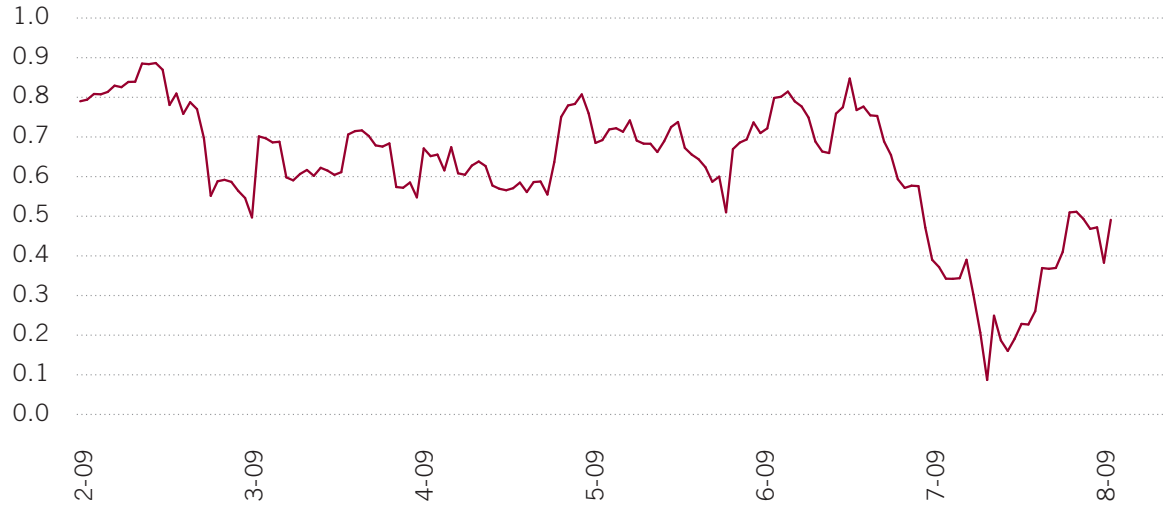
Source: Authors' calculations based on data from FactSet.

A more direct check of whether investors perceived any of the intermediaries to be strong enough to benefit from the demise of a weaker institution is to examine the high-frequency correlations between specific intermediaries. In Europe, rolling 20-day correlations of equity prices of the intermediary with the lowest CDS spread (HSBC) and the intermediary with the highest spread (AIB) occasionally show a negative correlation (see Exhibit 4.7a). This pattern suggests that investors perceived some capability of a healthy institution to benefit from acquiring a weaker one at a fire-sale price. However, such a negative correlation appears to be the exception in both regions. In the United States, equity prices of the intermediary with the lowest CDS price (JP Morgan) show a positive 20-day rolling correlation with other intermediaries throughout the pre-test sample, although the correlation with Citigroup (the intermediary with the highest CDS price) does plunge a couple of months after the stress test was completed (see Exhibit 4.7b).

Figure 4.7a. Twenty Day Rolling Correlations of Equity Returns for Allied Irish Banks and HSBC before and after the Stress Test

Source: Authors' Calculations based on data from FactSet.

Figure 4.7b. Twenty Day Rolling Correlations of Equity Returns for Citigroup and JP Morgan Chase before and after the Stress Test



Source: Authors' Calculations based on data from FactSet.

Finally, Exhibit 4.8 casts further doubt on the possibility of takeovers by healthy banks, suggesting that the financial systems in both Europe and the United States were either facing Case III or, possibly, Case IV. In both regions, the pre-test relationship between the CDS and equity returns of individual intermediaries displays a sizable negative correlation (Exhibit 4.8a and 4.8b).

Figure 4.8a. United States: 2006, Pre- and Post-test Correlations of Equity and CDS Returns

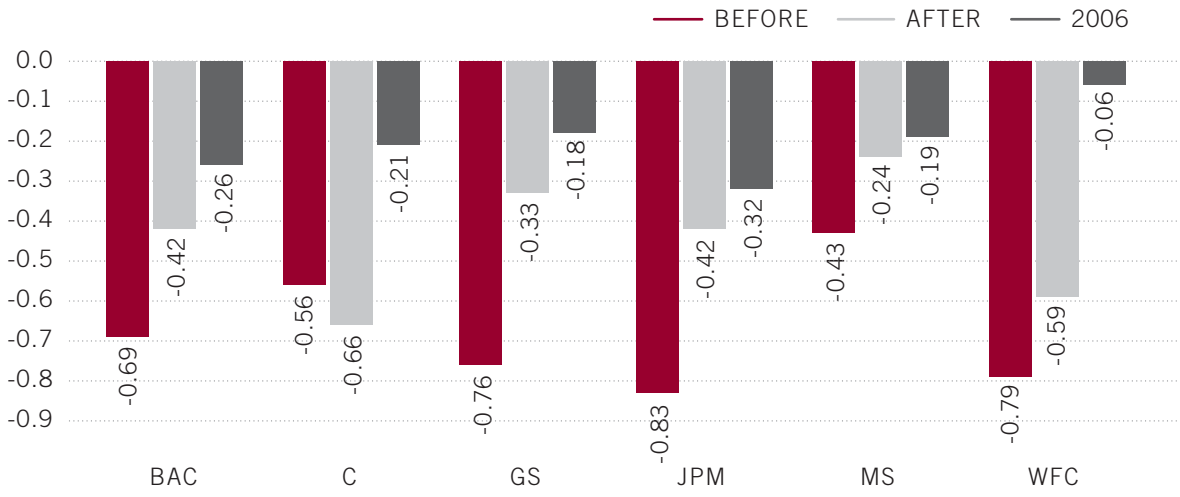
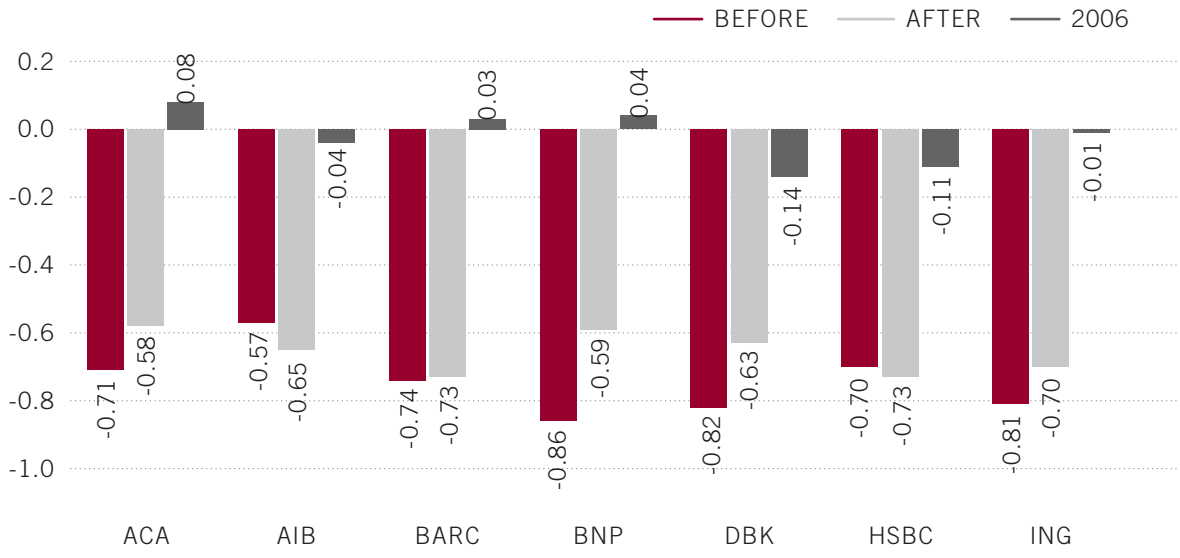


Figure 4.8b. Europe: 2006, Pre- and Post-test Correlations of Equity and CDS Returns



Source: Authors' calculations based on data from Bloomberg and FactSet.

This negative correlation is large even for the intermediary with the lowest CDS price, while a well-capitalized firm presumably would show little correlation since its "distance to default" would be large. In contrast, in 2006, the correlations in the United States (while still negative) were notably smaller. In Europe, the 2006 correlations generally were close to zero.

In the appendix, Exhibits A-1 and A-2 show time series graphs of the weekly CDS and equity returns for all 13 of the banks in these exhibits for the three-month windows before and after the stress tests. The graphs show that the strong negative correlations are due neither to outliers, nor to the outsized influence of brief disturbances. Throughout the pre-test windows, the equity and CDS returns move in opposite directions for each of these institutions.

If both financial systems were in Case III or IV prior to the stress tests, did the tests alter those conditions? The evidence suggests that the U.S. system moved closer to Case II, while the European system was little changed. Exhibit 4.5 highlights the large decline of CDS prices in the United States after the test. Similarly, the correlations between equity and CDS prices of these U.S. intermediaries generally became less negative following the stress test, suggesting that the perceived distance to default had increased.

Yet, CDS prices in the U.S. post-test window lingered far above the levels witnessed in 2006. Moreover, the correlation of equity returns was still positive even for the U.S. institutions ranked strongest (JP Morgan) and weakest (Citigroup) by CDS levels. This positive correlation contrasts to what one might expect if the stronger bank were viewed as the potential beneficiary of a fire sale. At that time, the market prices of Citigroup instruments still displayed characteristics of an impaired institution: The Citigroup CDS price averaged 370 basis points, while its equity price averaged more than 90% below its peak 2006 level, the largest drop among the U.S. sample of intermediaries.

Overall, while the perceived health of the U.S. institutions improved substantially after the stress tests, investors still viewed them with much greater concern than in the years prior to the crisis. More importantly in terms of our typology, no U.S. intermediary was seen as safely in a position to absorb the weakest of these institutions, based on its own capital had that become necessary. Thus, despite the benefits of the stress test, it is far from clear that by mid-2009 the U.S. financial system was closer to Case II than Case III. As we discuss in the conclusions, the difference between the two categories is of keen importance for macroprudential regulatory policy choices.

The picture in Europe is even less sanguine. CDS prices for HSBC and Deutsche Bank dropped substantially, while HSBC's share price climbed. Nevertheless, all of the European intermediaries continued to show strong negative correlations between their own CDS and equity prices. Combined with the earlier findings, we conclude that the European stress tests failed to alter the state of the financial system.

5. Some Lessons

Adopting a macroprudential perspective on stress tests requires a new supervisory mindset. Bare solvency of a bank is not enough. Instead, the objective is to ensure as far as possible that the financial sector as a whole can play its role of channeling funding from savers to borrowers. This approach implies that the structure of the canonical stress test needs to be redesigned in at least five important dimensions.

First, intermediaries have to be *sufficiently solvent* so that they are viable in the face of many shocks, not merely those associated with credit risk. Both sides of the balance sheet must be considered. In particular, the amount of wholesale funding (from the liabilities side) and the size of the liquid asset holdings of the bank (from the asset side) should be factored into the setting of target capital levels.

Second, even solvent banks may be required to refrain from depleting capital, say by paying dividends or repurchasing shares.[17] To the extent that accumulated equity capital of a relatively stronger bank will enhance its capacity to acquire weaker rivals at fire sale prices, the shareholders of the strong bank would stand to benefit in the long run from capital conservation. In this sense, a dollar (or euro) held *inside* the bank would be worth more than one dollar (or euro) outside the bank from the point of view of shareholders.

If the managers of a bank were to argue that such decisions should be left to its board, the reasonable supervisory response would be that intermediaries and the financial system are special, in that the system's soundness has more than just private costs and benefits. The special role of banks is why they are regulated in the first place, and why taxpayers were asked to pay to prop up the system in the crisis. A ban on dividends would rest on an extension of this logic, not on the possible benefits to the healthy intermediary's shareholders.

Rosengren (2010) has estimated that approximately $80 billion of bank capital could have been retained in the 19 banks that underwent the U.S. stress tests (SCAP), had dividend payments been suspended promptly at the beginning of the financial crisis in the summer of 2007.[18] The sum paid out in dividends ($80 billion) is roughly half of the public capital injection into the SCAP banks through the U.S. government's Capital Purchase Program (CPP).

Third, when capital shortfalls are detected in macroprudential tests, supervisors should mandate dollar amounts for capital additions, rather than focusing on the restoration of capital ratios. The objective is to maintain the balance sheet capacity of the banking system as a whole, rather than inducing banks to meet capital ratios by shedding assets and exacerbating the degradation of financial intermediation.

17 In sharp contrast to this principle, European banks subject to the 2010 stress test were allowed to pay out over 28 billion euros to their shareholders that year, despite the shortfall of capital in the banking system.

18 See also Acharya et al. (2010) for a detailed breakdown of dividend payouts and capital raising by U.S. and European banks during the crisis years.

Fourth, stress scenarios should focus on shocks that involve fire sales, runs by wholesale creditors and credit crunch risks.[19] Scenarios with high correlations to these outcomes should be central to stress tests. Consequently, scenarios should be selected to take account of common exposures (through repurchase arrangements, reliance on money market mutual funds, via crowded trades or correlated credit risks, the holding of thinly traded assets) and the linkages to financial utilities (e.g., clearinghouses and exchanges).[20]

Fifth, liquidity rules, in addition to capital requirements, would be part of the overall framework of macroprudential oversight.

The Financial Stability Oversight Council (FSOC) in the United States and the European Systemic Risk Board (ESRB) will need to make the necessary change in mindset to override the deeply entrenched rules that are underpinned by microprudential perspectives.

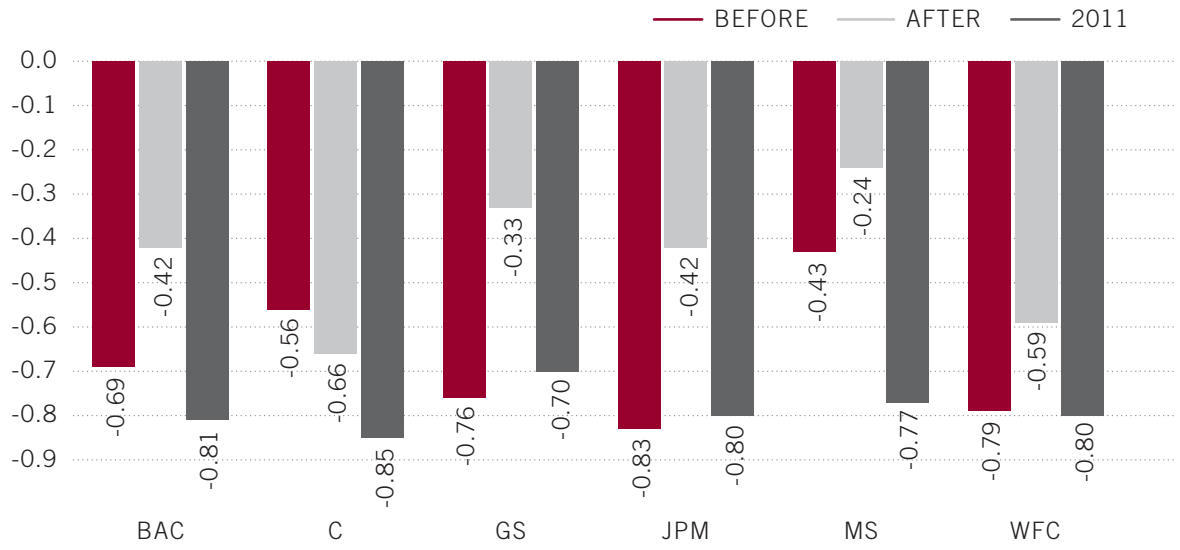
One way to see the force of these implications for the United States today is to examine updated correlations between the CDS and equity returns of large institutions. The green bars in Exhibit 5.1a show the correlations between CDS and equity returns for U.S. intermediaries over the final 12 weeks of 2011; for ease of comparison, we include the pre- and post-stress test levels from Exhibit 4.8a.

In every instance, the correlations are similar to or more negative than the correlations *prior* to the 2009 stress tests. In level terms, end-2011 CDS prices actually exceeded pre-test averages for three of the six institutions, and were very elevated compared to 2006 levels in every instance (Figure 4.5a). Thus, the improvement for most of these firms is far less obvious than press reports might suggest. Importantly, a similar comparison of CDS-equity correlations for European banks (Figure 5.1b) upholds the widely-held concerns that are reflected in their elevated CDS prices (Figure 4.5b).

19 See Alfaro and Drehmann (2009) for evidence that, in past stress tests, scenarios based on historical data have not been sufficiently severe. Haldane (2009) attributes this pattern in part to "disaster myopia."

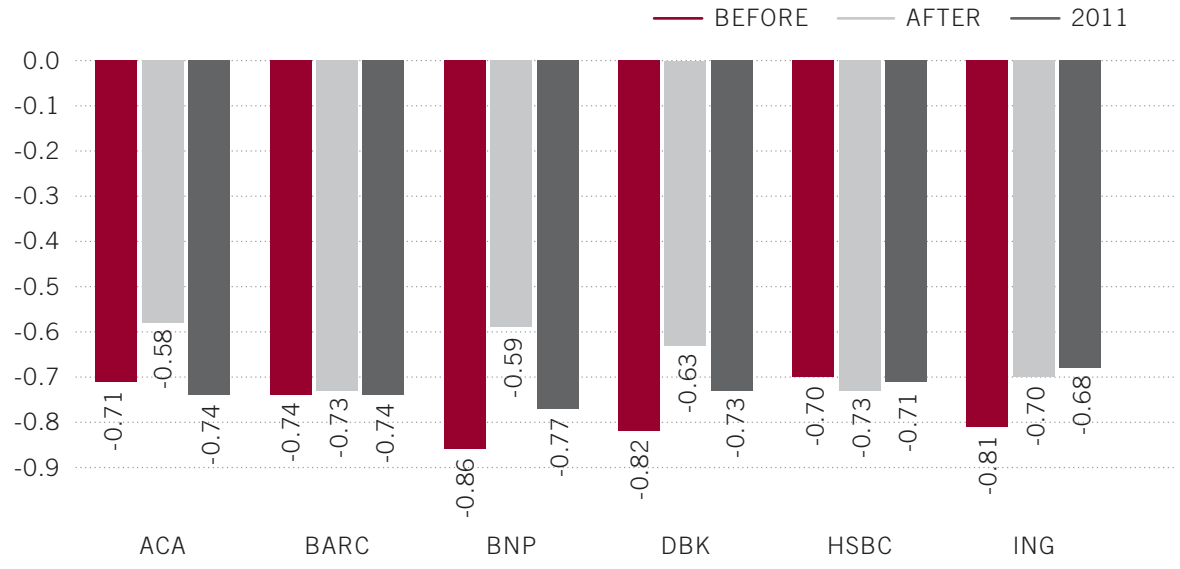
20 Haldane (2009) highlights the failure of stress tests prior to the crisis to account for such "network externalities."

Figure 5.1a. United States: End 2011, Pre- and Post-test Correlations of Equity and CDS Returns



Source: Authors' calculations based on data from Bloomberg and FactSet.

Figure 5.1b. Europe: End 2011, Pre- and Post-test Correlations of Equity and CDS Returns



Source: Authors' calculations based on data from Bloomberg and FactSet.

One possible counterargument may be that CDS levels reflect increased risk premiums throughout the financial system, rather than the fundamentals of the intermediaries concerned. However, this argument cuts both ways, because higher risk premiums in the financial system also could indicate a greater threat of runs by wholesale creditors. Importantly, the Federal Reserve did not make explicit use of such evidence (from market CDS and equity prices) in its decisions to permit capital disbursement by some intermediaries following the 2010 stress tests. It also did not appeal, as it might have, to the need for a sizable counter-cyclical capital buffer as envisioned under the Basel III guidelines.[21] Similarly, in its 2011 stress test analyses, the European Banking Authority continued to anticipate sizable capital disbursement by a number of fragile banks even under its severe stress scenario.[22]

Yet, even if the financial system in the United States can sustain a slow healing process, authorities will be faced with periodic questions on whether to restrain capital depletion by some intermediaries for the benefit of the system as a whole. The macroprudential logic suggests that such restraints may be justified even for solvent institutions. To be sure, there will be political pushback from the intermediaries involved, so that implementing such policy measures will be controversial. This prospect suggests that supervisors need to speak publicly about this issue to prepare investors and public opinion for a potential showdown.

The macroprudential perspective also gives some important lessons for Europe's current predicament. In early 2011, Andrea Enria, speaking as nominee to head the European Banking Authority in his testimony before the European Parliament, acknowledged that "we need to do a stronger, more credible and reliable exercise."[23] Yet, as explained in the epilogue to this report, the subsequent 2011 tests failed this goal.

The role of banks in the euro-area crisis is nothing short of fundamental. The sovereign funding problems that became the focus of global markets in 2011 cannot be separated from the weak positions of most European banks. For example, Figure 5.2 updates data presented in the conference version of the report on funding arrangements of European banks. Already in 2010, the ECB's liquidity support in rolling over the periphery's banking sector liabilities had become critical in several smaller countries, where wholesale funding had dried up. As 2011 proceeded, the withdrawal of wholesale funds also became a problem for banks in Italy and France, and they too turned to the ECB for substantial support.

In Europe, banks are large creditors to sovereigns.[24] Distress in the financial sector could easily tip the banking system into the familiar downward spiral of recoiling from risky positions, spiking CDS spreads, further deleveraging, and so on. Any sovereign debt restructuring in Europe directly impairs the banks. So any discussion of alleviating sovereign debt burdens must include plans to keep the banks operating; otherwise a run will ensue immediately and the financial system will freeze up and stop intermediating.

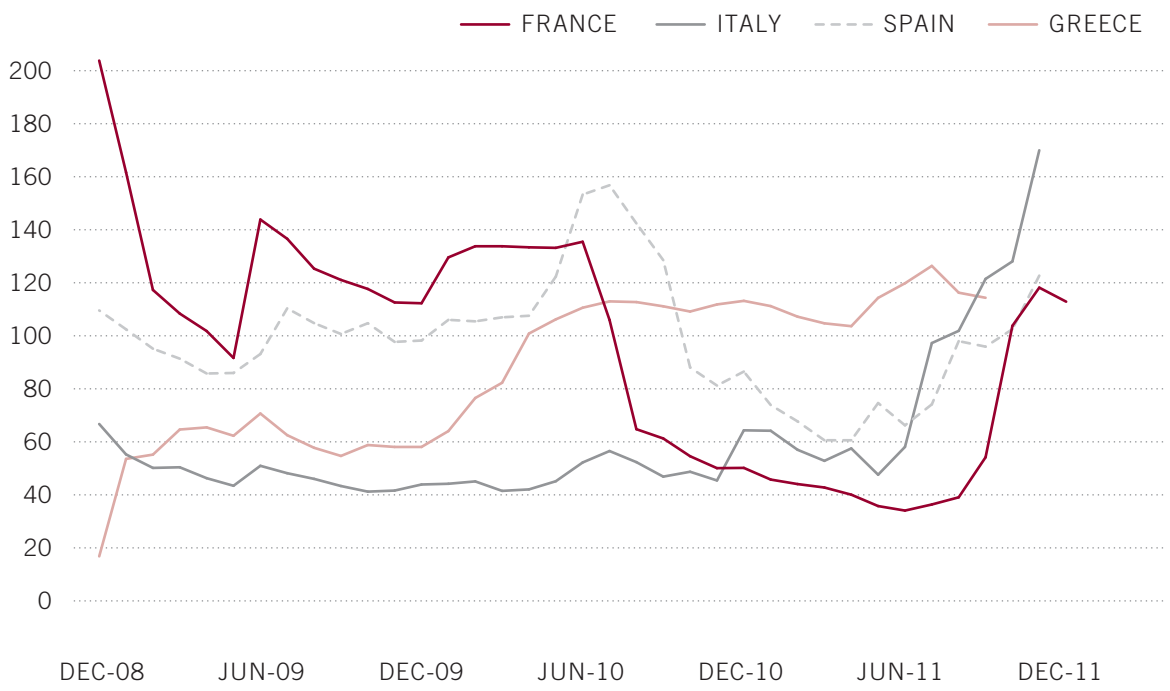
21 Admittedly, the current Basel proposal calls for implementation of the buffer during periods of excess private credit growth. Thus, it would not appear to be applicable in the present situation. Moreover, the proposal gives rise to cross-border competitiveness issues because it is subject to the discretion of national authorities.

22 See http://www.eba.europa.eu/EU-wide-stress-testing/2011/2011-EU-wide-stress-test-results.aspx for a bank by bank breakdown of expected payouts. For example, the three largest French banks were all assumed to continue paying dividends.

23 "EU bank stress-tests must be tougher," *Financial Times*, February 1, 2011.

24 Blundell-Wignall and Slovik (2010) emphasize that European bank exposure to sovereigns is primarily through their banking books, while the European stress test focused on the modest exposure through their trading books. This was partially addressed in the 2011 tests.

Figure 5.2. European Central Bank Lending to Euro Area Monetary Financial Institutions (Billions of euros)



Sources: National central banks.

The preferred approach would be to mandate a private recapitalization to a level that leaves the banks clearly solvent after the sovereign losses. But the credibility of a plan of this sort would depend on a backstop to recapitalize any banks that fail to raise the requisite funds. Unfortunately, the policy choice in the 2011 European stress tests was to state all capital deficits in terms of the ratio of assets to equity (rather than in billions of euros).

This decision has created two problems. First, it invited the banks to shrink assets to comply with the tests. Second, by allowing them to shrink to the level that their current capital can support, the banks also were encouraged to hedge their way out of trouble. But such hedging (e.g., buying CDS on sovereigns or other banks) increases CDS prices and raises funding costs for others. Whatever their motives, hedging actions of leveraged intermediaries have an impact that is identical to the financial actions of the nefarious speculators whom politicians are fond of blaming for the crisis.

The preferred path would be to repair directly the balance sheet capacity of the banking sector. For this purpose, banks would have to raise more capital quickly. Regulators could assist the process by restricting capital depletion, including dividend payments. They also would need to demonstrate the availability of a public backstopping mechanism large enough to achieve the recapitalization if private resources are unavailable. The aim of recapitalization would be to ensure that the banks are no longer vulnerable to runs by wholesale creditors. This goal means much higher capital, especially for those banks that have large wholesale liabilities. Europe's financial instability will not end until these challenges have been met.

Epilogue

The first version of this paper was written for the February 2011 meeting of the U.S. Monetary Policy Forum. Accordingly, its focus was naturally on the U.S. banking sector, although the crisis in Europe was attracting rising concern. As we write this epilogue at the end of 2011, we have the benefit of hindsight in analyzing the subsequent intensification of the crisis in Europe. In many ways, the crisis in Europe has been a live laboratory for the themes discussed in our paper. Unfortunately, the experience of 2011 shows little evidence that European regulators applied macroprudential principles in implementing new stress tests or drawing conclusions from their results.

On July 15, 2011, the European Banking Authority (EBA) published its second stress test of 90 EU banks from 21 countries.[25] The stated objective was to assess their resilience against an "adverse but plausible scenario," such as the deterioration from the baseline forecast of GDP, unemployment and house prices. For GDP, the scenario was a 4% deviation from baseline. The scenario also included some modest sovereign stress, with haircuts applied to sovereign and bank exposures in the trading book and increased provisions for these exposures in the banking book. The basic philosophy underlying the tests remained *microprudential* in nature, with the focus on assessing the solvency of individual intermediaries in the face of shocks to the asset side. The possibility of a sharp deterioration of funding conditions entailed by runs on the European banking system as a whole was not considered.

In its July 15 report, the EBA announced that only eight banks fell below the threshold 5% core tier 1 ratio of capital to risk-weighted assets, with a total capital shortfall of 2.5 billion euros. A further 16 banks had a core tier 1 ratio of between 5% and 6%. With hindsight, the reported shortfall of only 2.5 billion euros appears so low as to lack credulity. Even Dexia, which failed in a run less than three months later, received a clean bill of health with a supposed core tier 1 ratio of 10.4%, comfortably above the 5% threshold.

Notably, the EBA announced the results of the stress test in the same week when the sovereign crisis in Italy turned sharply worse, with yields on Italian government debt bonds having surged on Monday, July 10. Consequently, market developments already made the modest sovereign haircuts applied in the stress test scenarios seem anachronistic, immediately undermining the credibility of the results on bank capital positions.

Yet, the greater failure of Europe's 2011 test may be in its lack of attention to bank funding issues. The focus on bank liabilities in stress tests that emerges from macroprudential principles should have had particular resonance in Europe, given the elevated reliance on wholesale funding of the European banking sector. Exhibit E1, which plots the cross-border assets and liabilities of Eurozone banks since 1990, highlights how much this reliance has increased over time.[26]

Cross-border bank lending in euros grew very sharply in the middle years of the previous decade. This period coincided with the property booms in Ireland and Spain and with the expansion of European bank operations in central and Eastern Europe. More research is needed to answer why European banks were induced to expand so rapidly, but one hypothesis is that the introduction of the euro eliminated currency mismatch on banks' balance sheets, so that banks were able to draw deposits from surplus countries in

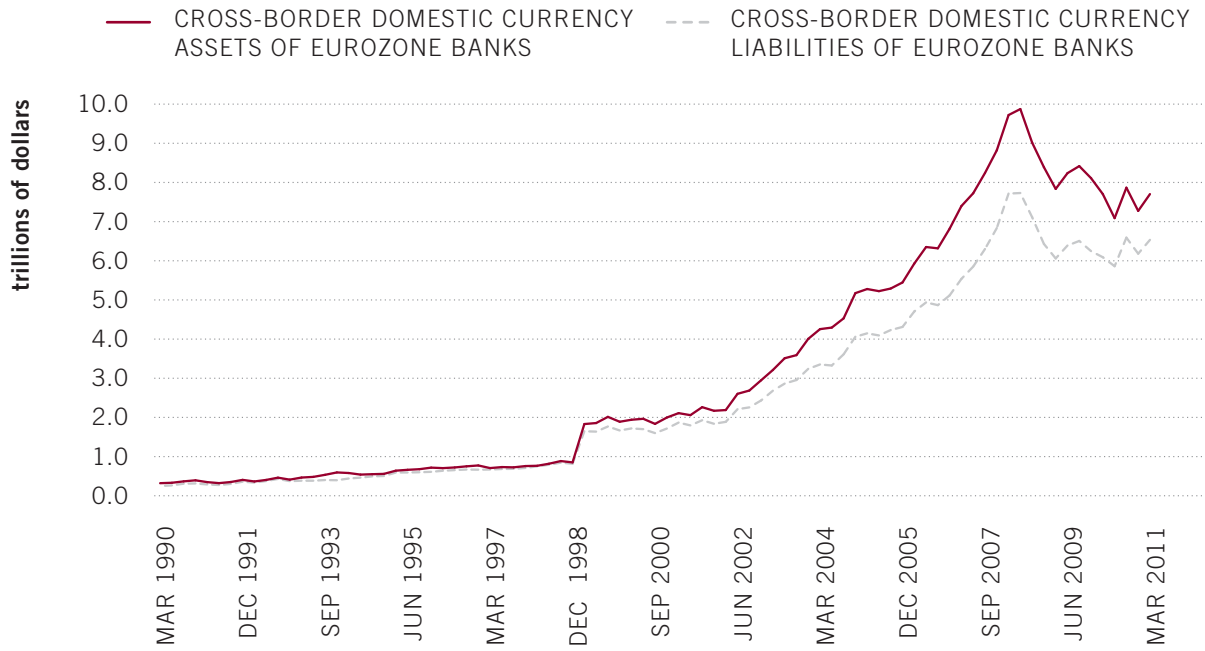
25 http://stress-test.eba.europa.eu/pdf/EBA_ST_2011_Summary_Report_v6.pdf

26 The mechanical jump in the two series at the start of 1999 reflects the reclassification of lending and borrowing as being in domestic currency (i.e. euros) when monetary union began.

their expansion. Notably, this period also was characterized by rising exposure of euro-area banks to the debt of other euro-area sovereigns, a portfolio shift encouraged by regulators who permitted banks to assign a zero risk weight to this debt. Similarly, the ECB also accepted such collateral without any haircut, adding to banks' perceived asset liquidity.

Yet, compared to other dimensions of economic integration within the eurozone, cross-border mergers in the European banking sector remained the exception rather than the rule. In this way, an asymmetry developed on euro-area banks' balance sheets, where the introduction of the euro meant that "money" (i.e. bank liabilities) was free-flowing across borders, but the asset side (aside from sovereign and bank exposures) remained fixed and local. As bubbles were local but money was fluid, the euro-area banking system was vulnerable to massive runs once banks started deleveraging. The sharp deterioration in the European financial crisis can be seen as a reflection of the runs discussed in the body of our paper.

Exhibit E1. Cross-border domestic currency lending and borrowing by eurozone banks



Source: BIS Locational Banking Statistics, Table 5A

The publication of the September 2011 edition of the IMF's *Global Financial Stability Report* (GFSR) provided some impetus for the euro-area banking system debate.[27] Chapter 1 of the September GFSR identifies potential "spillovers" to the banking sector from the crisis, as reflected in the price discounts on euro-area sovereign debt. The terminology of "spillovers" reflected a carefully designed compromise between the IMF staff and European IMF Board members, who objected to terminology that implied capital shortfalls. The reluctance to acknowledge the aggregate capital shortfalls may partly reflect the

27 http://www.imf.org/External/Pubs/FT/GFSR/2011/02/index.htm

entrenched microprudential mindset when considering bank stress tests. It also probably reflects the lack of a public backstop mechanism credibly large enough to recapitalize the banks in the absence of private funds. Absent such a mechanism, public announcement of a large capital shortfall merely encourages a further run.

Unsurprisingly, events in Europe continued to deteriorate over the autumn, as the need for greater capital raising by the banking sector gained increased recognition. The December 8 announcement of the European Banking Authority—updating the results of the earlier stress test—was one outcome of the EU summit resolution of October 26. [28] In particular, the EBA shifted the objective of the earlier exercise, aiming now "to strengthen [banks'] capital positions by building up an exceptional and temporary capital buffer against sovereign debt exposures to reflect market prices as at the end of September." The report states explicitly that "these buffers are explicitly not designed to cover losses in sovereigns but to provide a reassurance to markets about the banks' ability to withstand a range of shocks and still maintain adequate capital."

The EBA's new estimate of required capital required rose to 114.7 billion euros, up from just 2.5 billion euros in the July 15 report. Nevertheless, the EBA calculation still falls well short of the 200-billion-euro "spillover" figure that appeared in the IMF's September 2011 GFSR. In addition, European regulators continued to leave the door open to widespread deleveraging because, in contrast to macroprudential principles, they specified the capital *ratios* that banks should achieve rather than the equity amounts that each bank should raise.

Over the same time period, evidence of a widening bank run in the euro area continued to mount. One source of evidence is the surge in claims by the Bundesbank on the eurosystem (more than 460 billion euros at the end of 2011) that reflects in part the cumulative flight of deposits from other euro-area countries to German banks. Another is the explicit run by U.S. prime money market funds that have slashed their exposure to European (particularly French) banks by roughly $175 billion dollars since May (see Fitch, 2011), eventually compelling the ECB to lend in size *in U.S. dollars* to euro-area banks. Finally, press reports have highlighted the extraordinary dependence of some (particularly Italian) banks on the ECB's late-2011 record provision of nearly 500 billion euros of three-year funds. Taken together, the evidence shows a widening circle of euro-area banks that cannot obtain adequate funding in private markets.

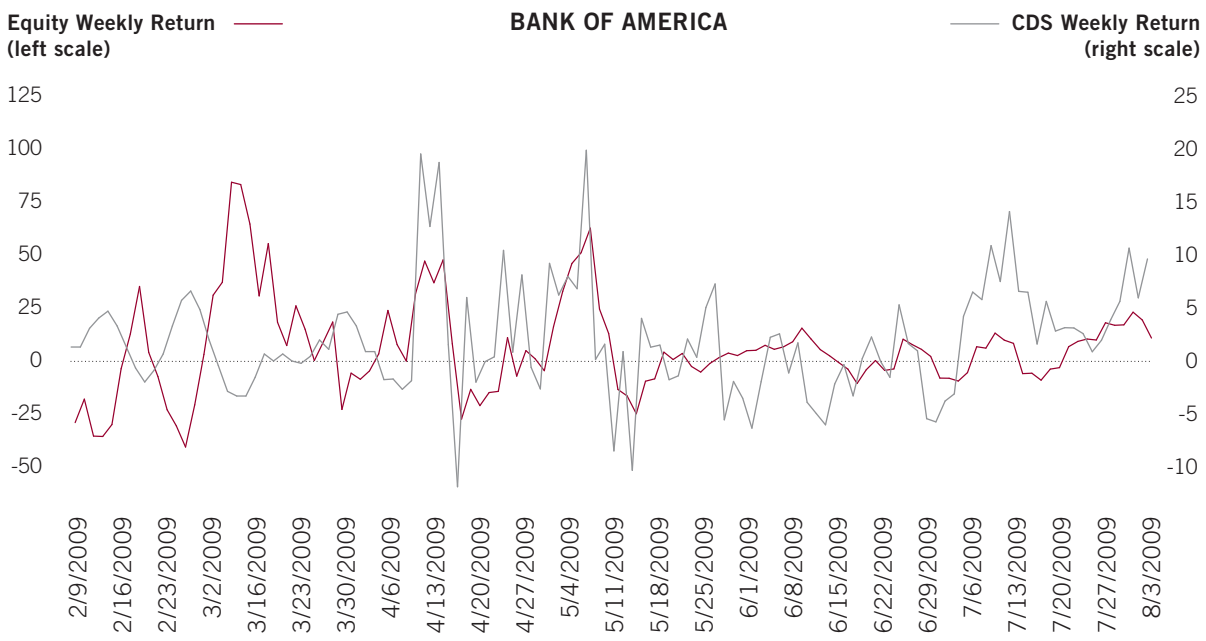
In many ways, the crisis in the euro area bears the hallmarks of a classic "twin crisis" that combines a banking crisis with an asset price plunge that amplifies banking distress. In the emerging market twin crises of the 1990s, the banking crisis was intertwined with a currency crisis. In the euro-area crisis of 2011, the twin crisis combines a banking crisis and a sovereign debt crisis with vicious feedback effects: the mark-to-market amplification of sovereign distress worsens the banking capital shortfall, while the latter intensifies pressure on sovereigns through credit restraint and resulting economic decline. Rising doubts about the sustainability of the euro area in its current form only add to these stresses.

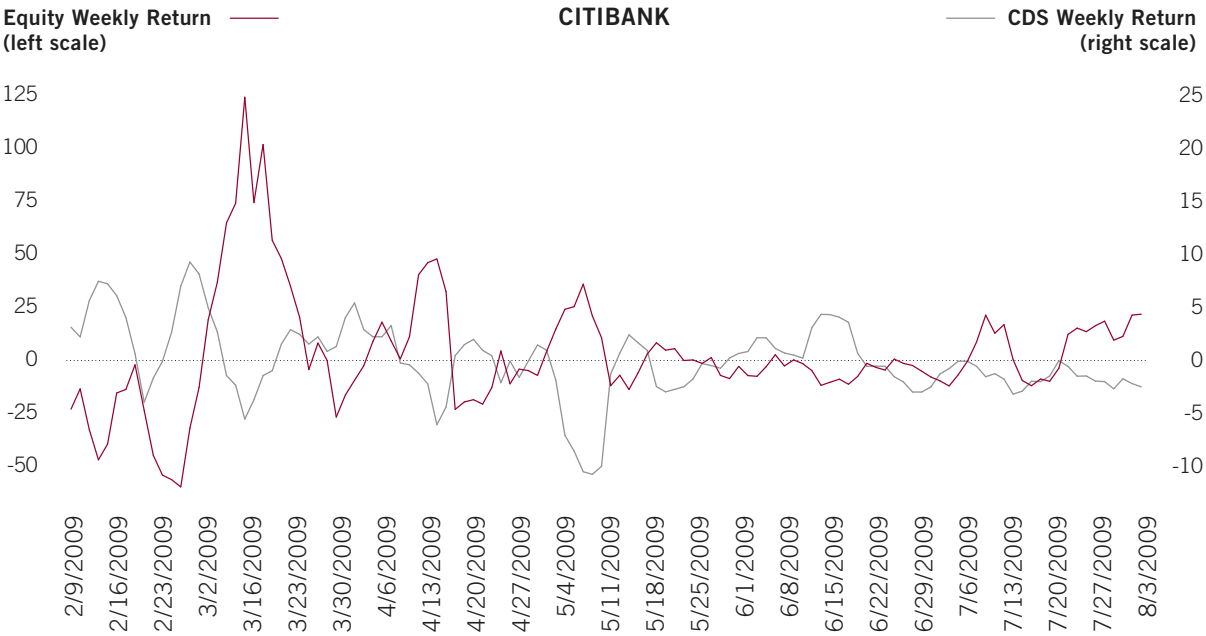
Events in the euro area are evolving rapidly as we write this epilogue. Yet, the principles of macroprudential stress tests outlined in the report seem as relevant as ever. The focus on the nature and vulnerability of bank liabilities is an especially important principle. An earlier adoption of this principle by European policymakers would have favored a more effective crisis response.

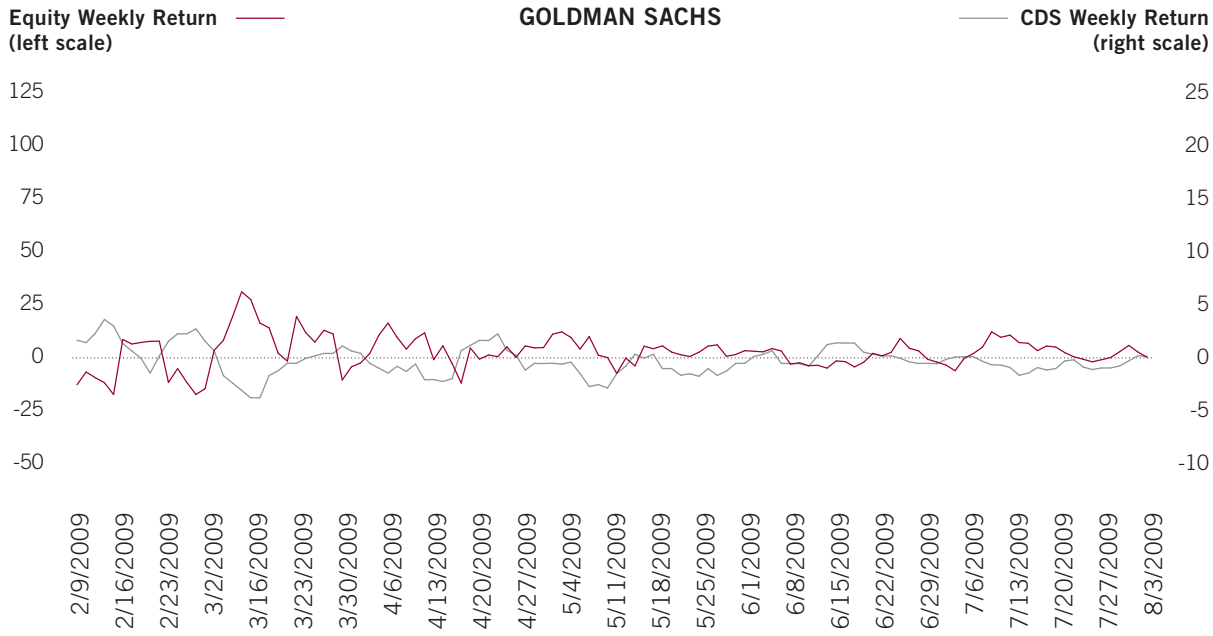
28 http://www.eba.europa.eu/News--Communications/Year/2011/The-EBA-publishes-Recommendation-and-final-results.aspx

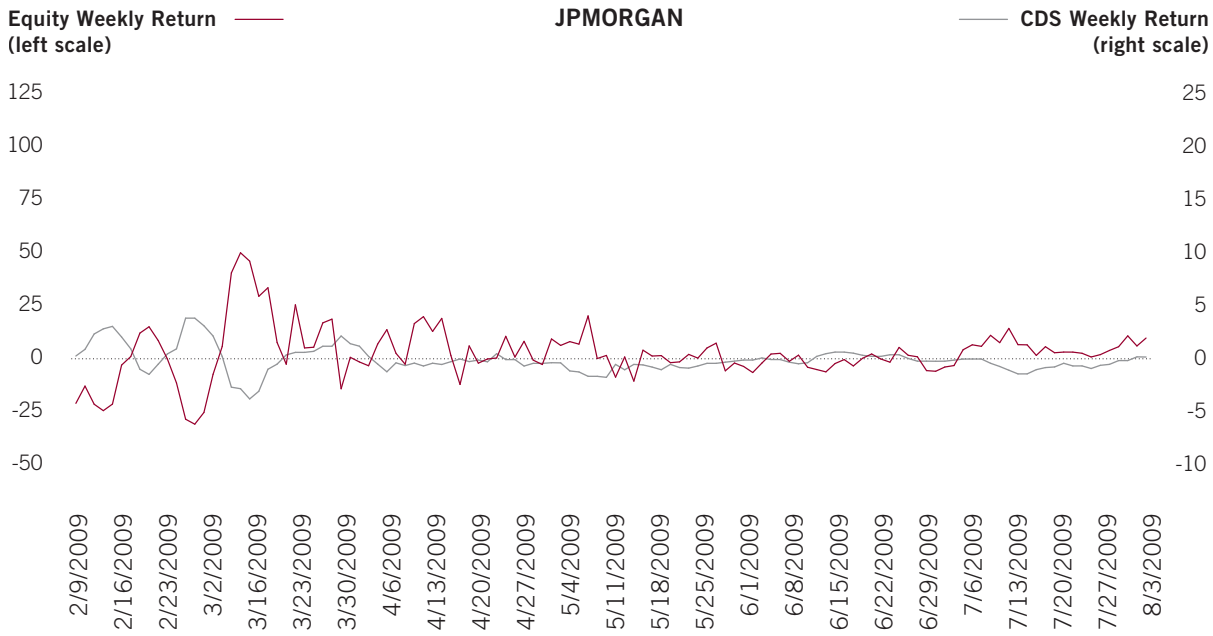
Appendix

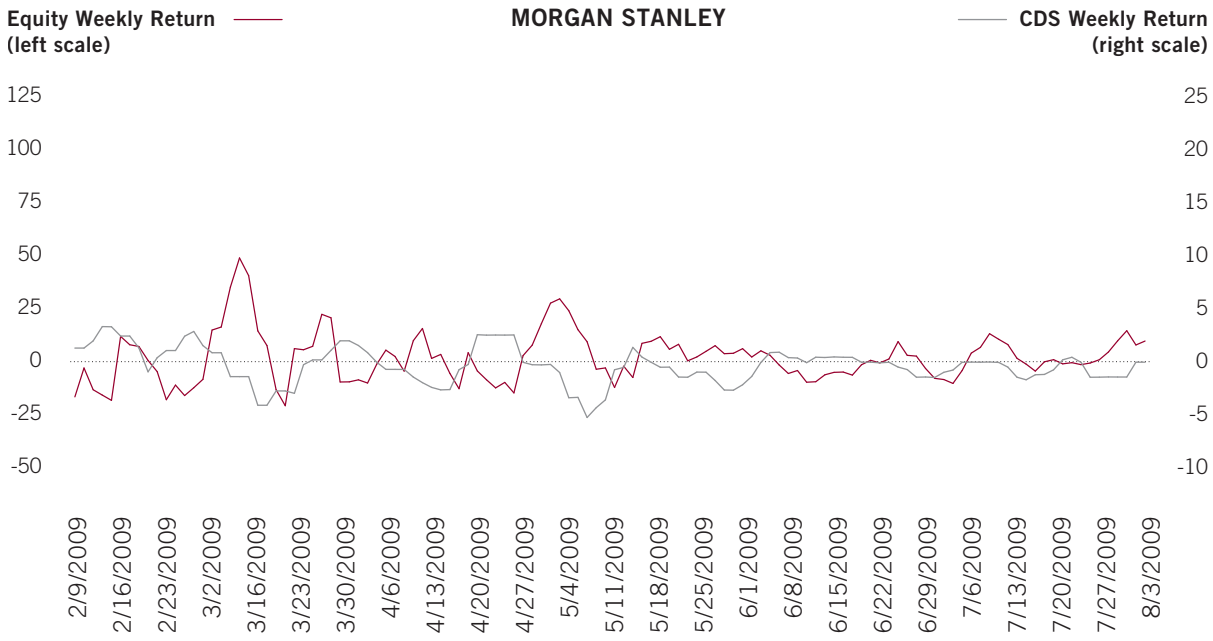
Exhibit A1. Weekly CDS and Equity Returns for U.S. Banks

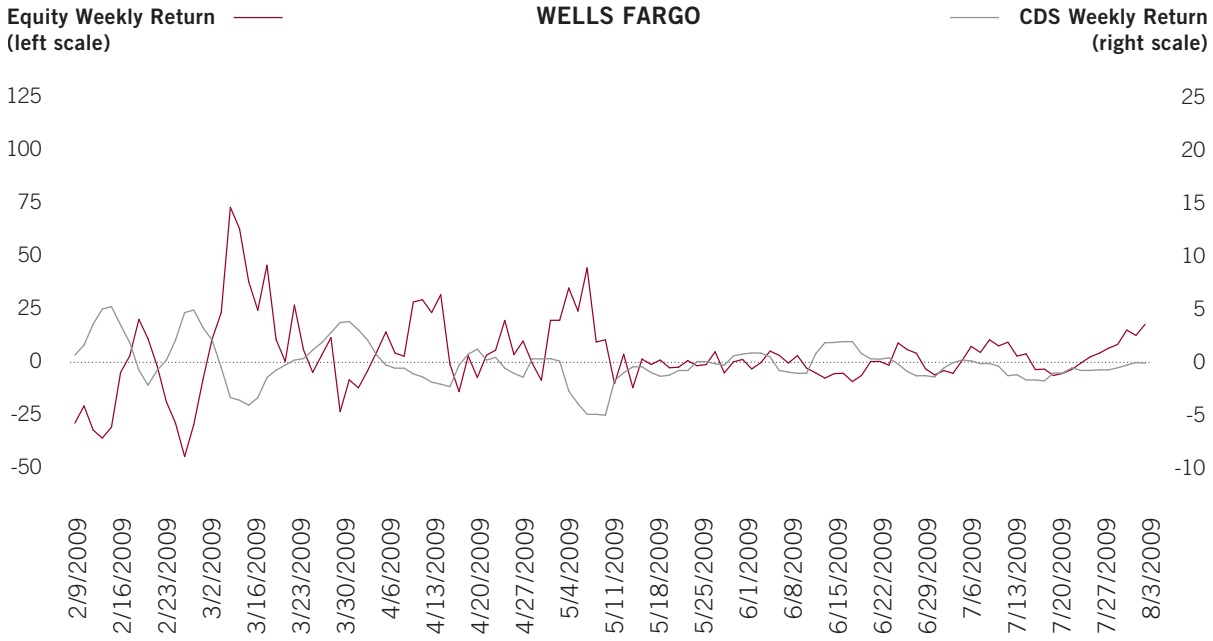





GOLDMAN SACHS
Equity Weekly Return (left scale)
CDS Weekly Return (right scale)
125
100
75
50
25
0
-25
-50
25
20
15
10
5
0
-5
-10
2/9/2009
2/16/2009
2/23/2009
3/2/2009
3/16/2009
3/23/2009
3/30/2009
4/6/2009
4/13/2009
4/20/2009
4/27/2009
5/4/2009
5/11/2009
5/18/2009
5/25/2009
6/1/2009
6/8/2009
6/15/2009
6/22/2009
6/29/2009
7/6/2009
7/13/2009
7/20/2009
7/27/2009
8/3/2009

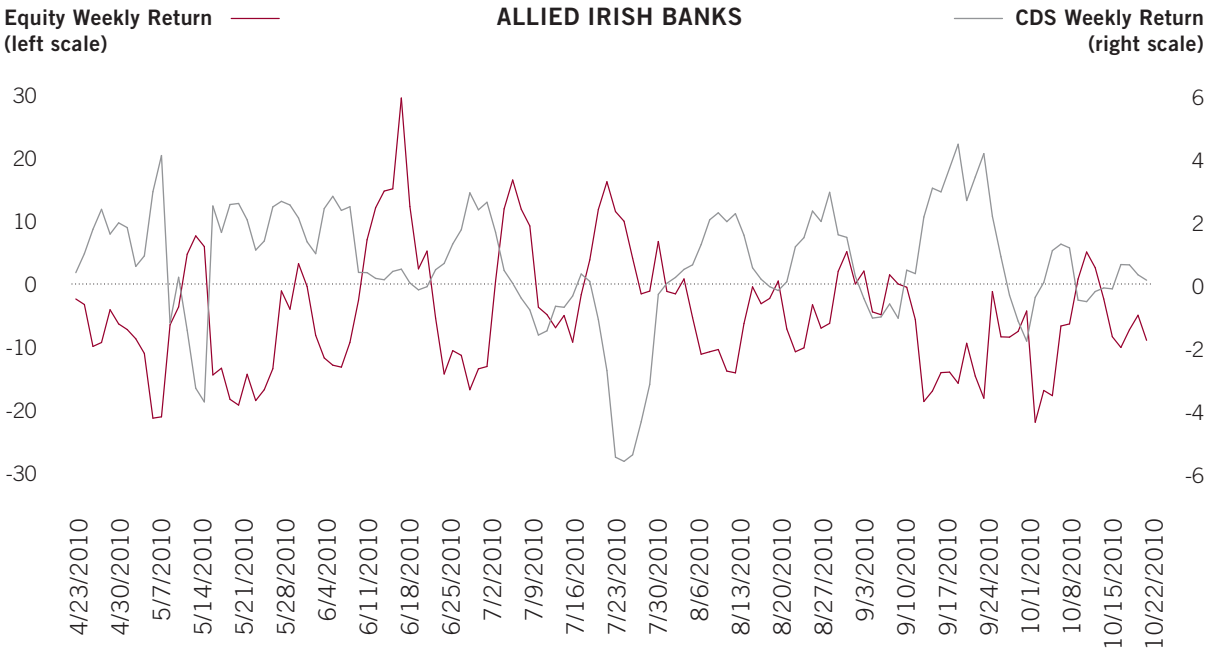

JPMORGAN
Equity Weekly Return (left scale)
CDS Weekly Return (right scale)
125
100
75
50
25
0
-25
-50
25
20
15
10
5
0
-5
-10
2/9/2009
2/16/2009
2/23/2009
3/2/2009
3/16/2009
3/23/2009
3/30/2009
4/6/2009
4/13/2009
4/20/2009
4/27/2009
5/4/2009
5/11/2009
5/18/2009
5/25/2009
6/1/2009
6/8/2009
6/15/2009
6/22/2009
6/29/2009
7/6/2009
7/13/2009
7/20/2009
7/27/2009
8/3/2009

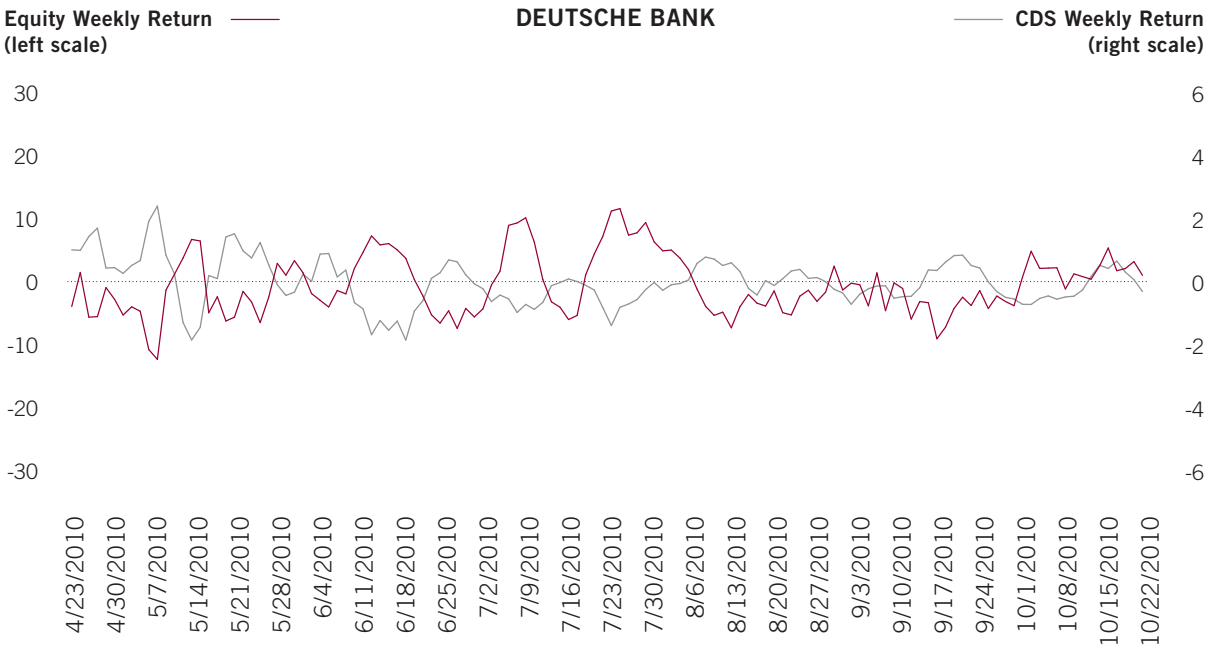


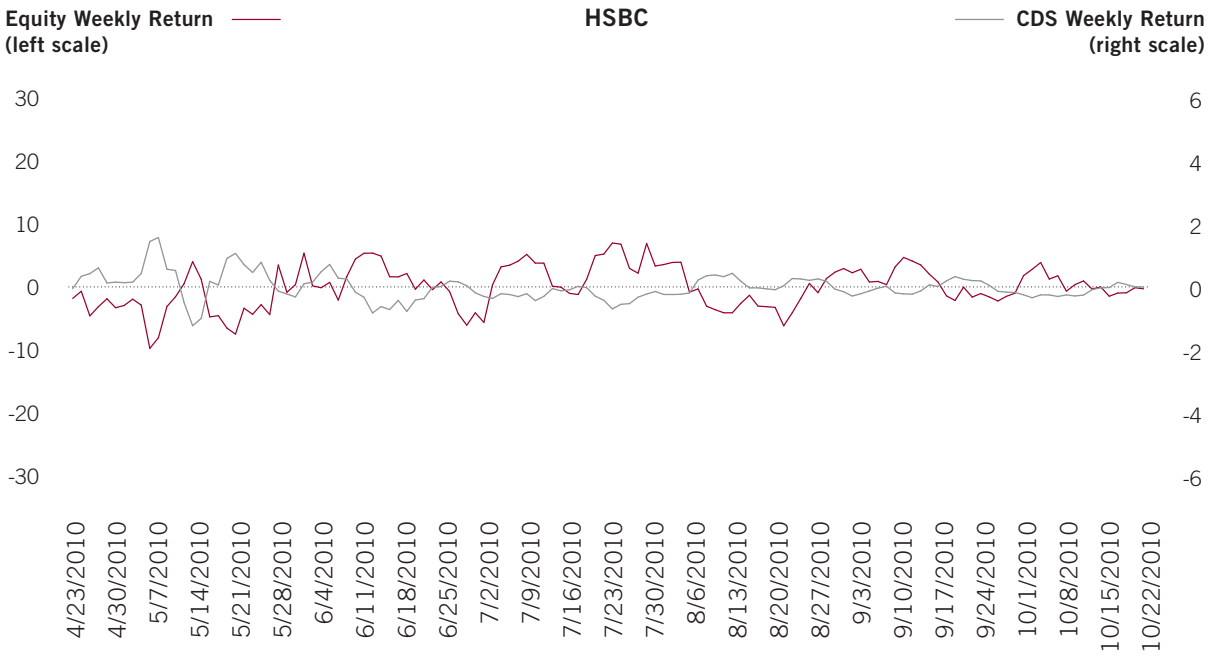


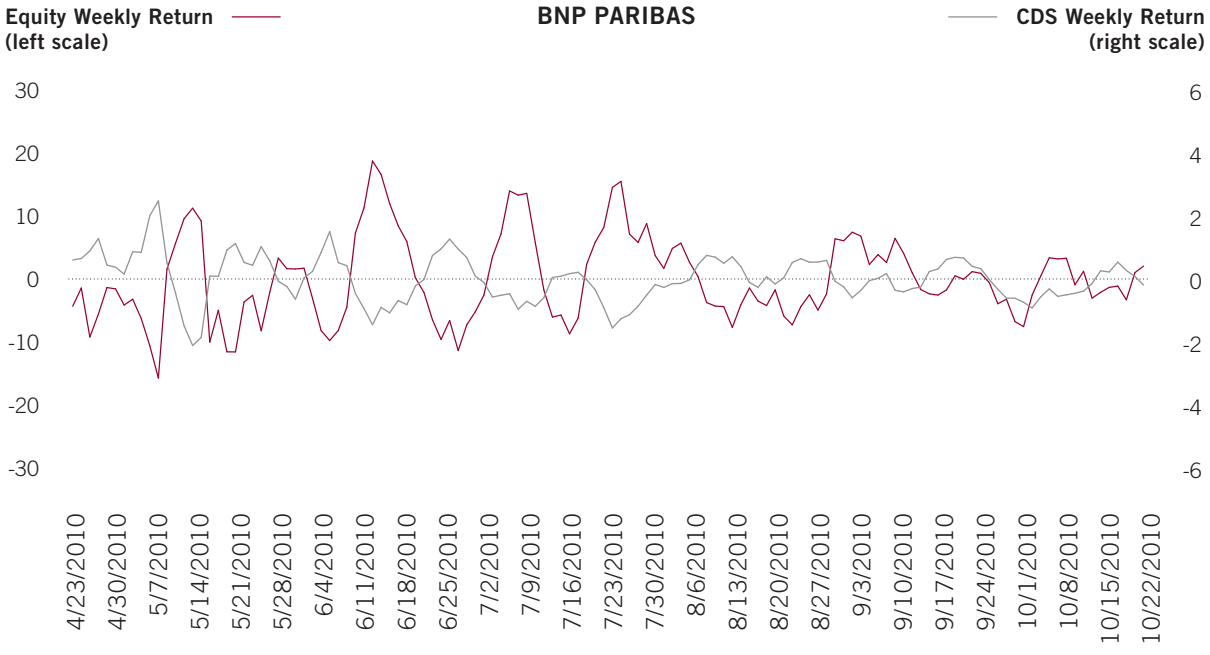
Source: Authors' calculations based on data from Bloomberg and FactSet.

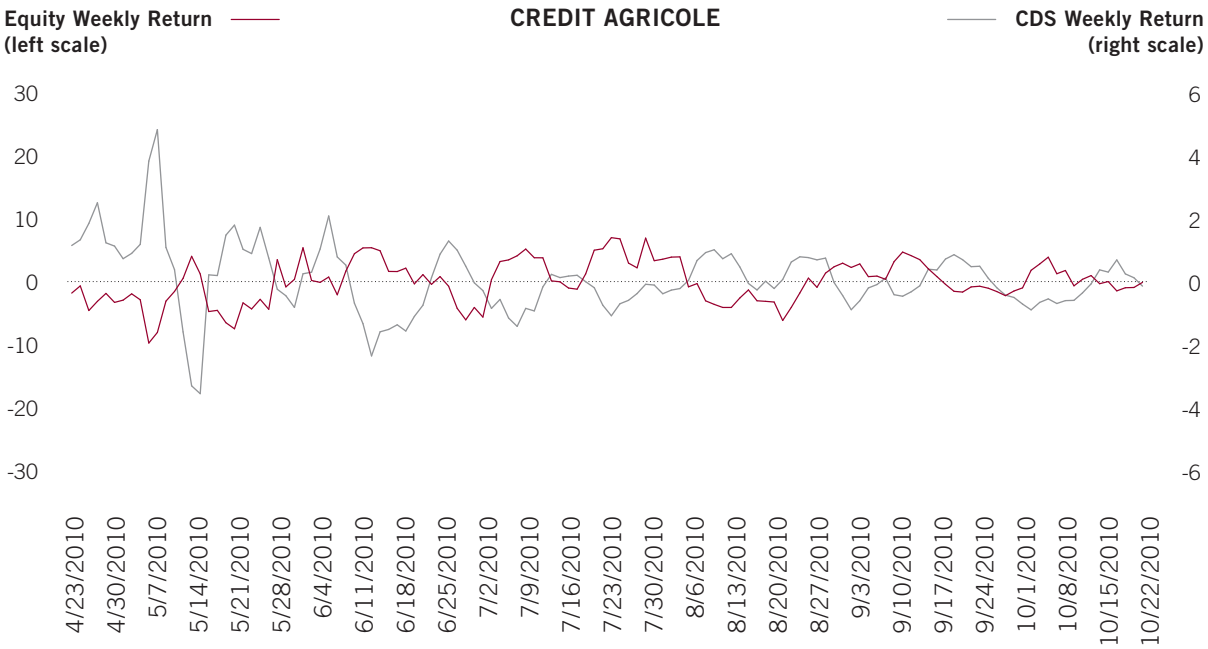
Exhibit A2. Weekly CDS and Equity Returns for European Banks

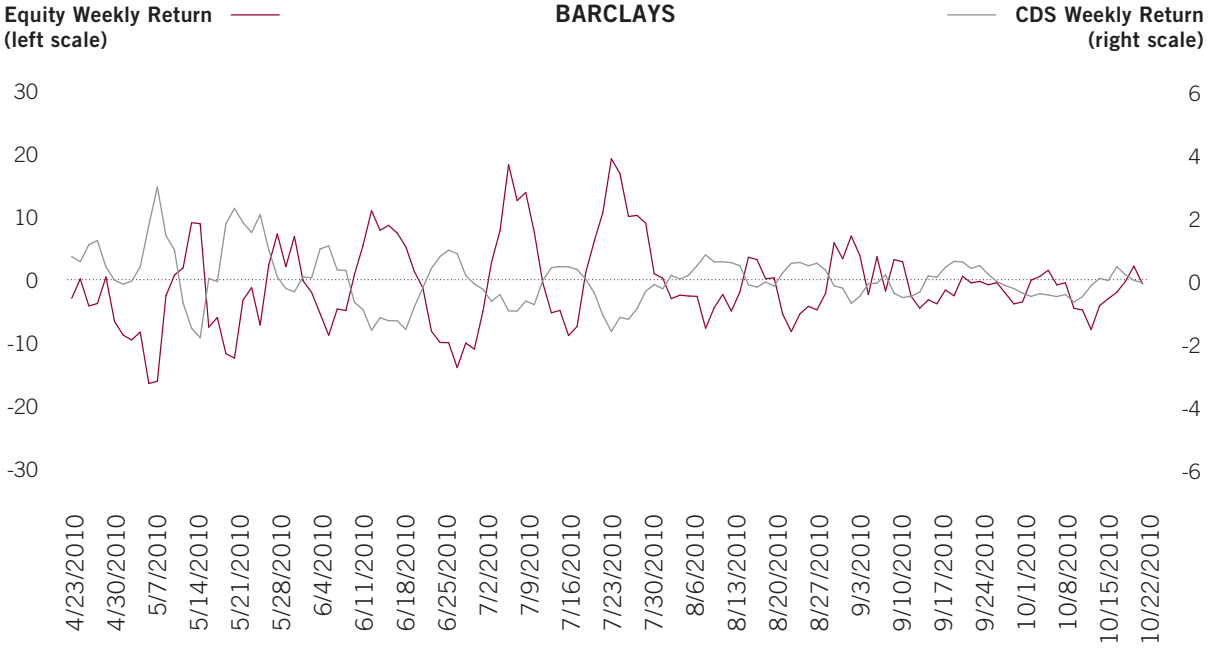





Equity Weekly Return
(left scale)
HSBC
CDS Weekly Return
(right scale)
30
20
10
0
-10
-20
-30
6
4
2
0
-2
-4
-6
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
8/13/2010
8/20/2010
8/27/2010
9/3/2010
9/10/2010
9/17/2010
9/24/2010
10/1/2010
10/8/2010
10/15/2010
10/22/2010


Equity Weekly Return
(left scale)
BNP PARIBAS
CDS Weekly Return
(right scale)
30
20
10
0
-10
-20
-30
6
4
2
0
-2
-4
-6
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
8/13/2010
8/20/2010
8/27/2010
9/3/2010
9/10/2010
9/17/2010
9/24/2010
10/1/2010
10/8/2010
10/15/2010
10/22/2010





Source: Authors' calculations based on data from Bloomberg and FactSet.

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