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Market Discipline, Public Disclosure and Financial Stability

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1 Introduction

Inadequate disclosure by commercial banks has been cited as a contributing factor to the financial crisis. Banks did not report enough information about the assets they were holding or the risks that they were exposed to, and inadequate disclosure meant that investors were less able to judge risks to a bank's solvency than bank insiders, such as managers. Investors did not demand sufficient disclosure prior to the crisis. Possible reasons for this include risk illusion, or expectations that governments would be willing and able to bail out failing banks.

Increased uncertainty aversion during a time of systemic stress led to investors withdrawing funding from the most opaque banks. The lack of transparency is likely to have intensified the crisis – for example, by leading to much higher funding costs, even for relatively healthy banks. Increased disclosure can help to alleviate the problem of asymmetric information between banks, who have good information about their own financial resilience, and investors that provide funding to banks, who have less information.

Better disclosure can be beneficial to financial stability in non-crisis times, too. With good information, debt investors are able to price risk more accurately and, if the incentives are right, this can act as a disciplining force on banks. As debt investors become aware of the risks that banks are taking, they are less likely to provide funding to banks that are not providing an attractive trade-off between risks and returns. This can affect the risk-taking decisions of bank managers. This market discipline mechanism empowers investors to ensure that managers are acting in their interests, and reduces the likelihood that a bank takes risks that its investors are not aware of. Therefore publishing better information may reduce the probability of future financial crises, as it can make sudden changes in investor sentiment less likely.

E. Haven et al. (eds.), *The Handbook of Post Crisis Financial Modeling*

Public disclosure reduces information asymmetries between insiders (managers of banks) and outsiders (investors), and so means greater certainty for investors in their ability to forecast the performance of banks' debt and equity. In a perfectly functioning market, investors would demand that managers of banks disclose information about risks in order to allow those investors to correctly price the banks' liabilities. In principle, in the absence of social externalities this market discipline mechanism could make prudential regulation redundant: investors would ensure that banks do not behave in a socially harmful way by influencing management. The idea that investors may be able to effectively monitor financial institutions and constrain socially harmful risk-taking has been a cornerstone of regulatory policy for years. Basel II explicitly states that the purpose of "market discipline is to complement the minimum capital requirements (Pillar 1) and the supervisory review process (Pillar 2). The [Basel] Committee aims to encourage market discipline by developing a set of disclosure requirements which will allow market participants to assess key pieces of information on the scope of application, capital, risk exposures, risk assessment processes, and hence the capital adequacy of the institution" (Basel Committee on Banking Supervision 2006).

However, frictions exist which prevent this market discipline channel from functioning correctly. That leads to information asymmetries, a tendency for banks to become overly leveraged, and a higher probability of banking crises, all of which reduce social welfare.

Mandatory disclosure policies can – if correctly calibrated – correct for these market failures and increase social welfare. These can act as a complement to prudential regulation, allowing both market participants and regulators to take responsibility for ensuring that bank managers' incentives are aligned with those of their stakeholders, and leaving regulators to address any externalities to which stakeholders do not attend. This chapter discusses the evidence for whether investors monitor the financial institutions in which they invest and the reasons why this "monitoring channel" may break down. We conclude with a discussion of whether more information and increased market discipline is actually optimal for financial stability.

2 Modeling and measuring market discipline: testing the "monitoring channel"

Empirical studies disagree on whether private sector agents reliably engage in risk monitoring. Researchers cannot directly observe whether every agent pores over financial statements, or participates in conference calls with banks. In practice, testing for whether investors monitor a bank usually means examining whether the return that private sector agents demand is commensurate

with the risk that they face.[1] Prior to the 1990s, studies generally fail to find a significant relationship between bank risk and the yields investors demand. However, subsequent studies find evidence of market discipline: Ellis and Flannery (1992), James (1991), Keeley (1990) and Flannery and Sorescu (1996) all find that high certificate of deposit rates and subordinated debt spreads reflect different measurable elements of bank risk, providing evidence for the existence of market discipline. The change in results can perhaps be attributed to the FDIC and the Federal Deposit Insurance Corporation Improvement Act, passed in 1991 following the US savings and loan crisis, which made the safety net for banks more restrictive. Sironi (2003) finds similar results for Europe: he examines subordinated debt and debentures issued in Europe from 1991–2000 and finds that the sensitivity of subordinated debt issues to measures of standalone risk (i.e., without incorporating external guarantees) increased during the 1990s.

However, as Gorton and Santomero (1990) point out, a number of the studies above suffer from a failure to take into account how investors should respond in theory to the variables that they measure. In particular, many of these studies assume that the value of subordinated debt is a monotonic function of bank risk-taking. But, as Black and Cox (1976) show, while junior debt is initially a convex function of the value of the firm, it becomes a concave function when the value of the firm is sufficiently high. Unlike senior debt, the default risk premium on subordinated debt is a *decreasing* function of the riskiness of a firm's assets when the firm is close to bankruptcy and then an *increasing function* when the bank is relatively far away.

The intuition for this result is fairly simple: it arises from the fact that the deadweight cost of bankruptcy for banks is large. James (1991) estimates that direct expenses associated with bank failures are on average 10 percent of assets, with an average loss of 30 percent. As subordinated debt and equity tend to comprise a smaller proportion of banks' balance sheets than this, subordinated debt will receive a payoff that is close to zero in the event of bank failure. This means that, when a bank is close to failure, then subordinated debt has a risk-reward payoff similar to equity – i.e., it is initially zero, and its value increases with the risk-taking of the bank. But, when the probability of bank failure is low, subordinated debt behaves more like senior debt, and its value should decrease with the risk-taking of the bank. However, the studies mentioned above tend to assume that the default risk premium is an increasing function of riskiness; this means that assuming a linear model at a time when a bank is close to failure (and so the premium is actually decreasing in risk) will lead to an underestimate of the extent of market discipline.

All the above studies essentially focus on the change in the rate of return investors demand for bearing increased risk. The next section discusses how to measure this.

2.1 Finding empirical evidence of market discipline

Market discipline may be more evident in the markets for some instruments than others. For example, premiums on senior debt instruments may not be sufficiently sensitive to credit risk. A good candidate should be risk-sensitive, have reliable price data, and have a long residual maturity (so that investors cannot simply respond to credit risk by allowing the instrument to mature). Collateralized or government-guaranteed debt is clearly unsuitable for these purposes. As noted earlier most studies examine subordinated debt or large certificates of deposit. Several more recent studies use spreads on credit default swaps, which was not a market that existed in the early 1990s.

Market liquidity is crucial for price data to be reliable. For this reason most US studies are able to use secondary market data, but for European banks, liquidity in the secondary market for subordinated debt is often poor. Therefore, any econometric study of secondary market data should employ liquidity controls. This is a difficult area, as the section below discusses, because traditional measures of liquidity are heavily influenced by information asymmetries.

One solution may be to use data on primary issuance, as it reflects an updated assessment of risk premiums by investors purchasing the bonds. However, the decision of whether or not to issue in any given time period may be a form of market discipline in itself: for a risky bank, the required premium may be high enough to induce it not to issue subordinated debt, but instead to issue another less-sensitive instrument, or to delay issuing debt at all. It may be sensible to run a probit/logit model to test whether the decision to issue subordinated debt is affected by bank-specific risks. In any case, primary issuance is not usually a frequent event for any individual bank, so a large time series would be required to avoid small-sample problems in a fixed effects regression.

Controls specific to the particular instrument are needed. Time to maturity, the seniority of the issue and liquidity of the bond are all obvious candidates. But there are controls which are particularly related to information and market discipline. The most notable of these is probably *issue size*. When information is costly to analyze and monitor, major buyers of subordinated debt may prefer to specialize. If so, they would purchase large amounts of debt of a small number of firms.

2.2 Measuring bank risk

One of the most important challenges in determining market discipline is how to measure bank risk. For investors to exert discipline, they must be able to observe bank risk. Measures of bank risk can be broadly categorized as accounting-based measures (those based on firms' published balance sheet information), ratings-based measures (based on the assessment of credit ratings

agencies or other delegated monitors) and market-based measures (i.e., those based on the prices of traded instruments).

2.2.1 Accounting-based measures

The Z-score developed by Boyd and Graham (1988) is an accounting-based measure of bank's distance to default – that is, the number of standard deviations that a bank's return on assets can fall by before it becomes insolvent. It is calculated as the sum of return on assets and the equity-to-asset (leverage) ratio divided by the standard deviation of the return on assets, usually measured over four quarters to allow sufficient variation in the return on assets. This measure encompasses a number of popular accounting measures such as the standard deviation of return on equity/assets and leverage. Caution is needed for interpretation. A higher return on assets could reflect higher risk-taking, but it may also represent greater efficiency, making default less likely.

Other popular accounting measures of credit risk include the proportion of non-performing loans and concentration of lending in a particular sector. However, modeling approaches which focus solely on credit risk do not capture important elements of bank risk-taking, such as liquidity and trading risk. Since the 1999 repeal of the US Glass-Steagall act – which separated trading and lending activities – trading and wholesale funding have become an important part of the activities of commercial banks, making it more important for the recent literature to focus on these risks. Liquidity risk can be captured in a number of different ways: past papers have tended to focus on the liability side and used some kind of ratio of short-term debt to total debt. More recent papers such as Sironi (2003) consider liquidity on the asset side of the balance sheet too.

2.2.2 Ratings-based measures

Credit ratings can be considered an amalgamation of all the risk factors above in a summary statistic: the credit rating. These have some advantages over accounting or market-based measures of risk in that they are more standardized allowing for better cross-country comparisons. For example, the definition of non-performing loans varies considerably across countries and this can be difficult for an individual investor to analyze. Credit ratings aim to rate "through the cycle" meaning that they should be forward-looking and take into account macroeconomic conditions. Crucially, credit rating agencies are delegated monitors: the ratings are public information and free to acquire. The downside is that these are the subjective opinion of a rating agency, and ratings are slow to be updated in response to events and emerging risks.[2]

2.2.3 Market-based measures

Market-based measures use observable and timely information from market prices, rather than relying on accounting information or delegated monitors.

For example, "distance to default" is a market measure of credit risk analogous to the Z-score mentioned above. It is based on the seminal work of Merton (1974), which treats the equity value of the firm as a call option on the firm's assets. Distance to default is the difference between the asset value of the firm and the face value of its debt, scaled by the standard deviation of the firm's asset value. In other words, it is a proxy for the likelihood of the bank being unable to pay its debt in future: a higher distance to default implies a lower probability of insolvency. The value and standard deviation of the firm's assets can be derived using market prices for equity in the Merton model framework. This metric is commonly used for non-financial corporates but has also been often applied to banks, particularly for the analysis of deposit insurance payouts.

2.2.4 Comparing market-based and accounting-based measures

Market-based measures contain information that is absent from accounting ratios. The data is timelier, less prone to manipulation and less targeted. By contrast, accounting data is backwards-looking and is released infrequently, with between reports gaps of at least a quarter being common practice. If the equity market is at least semi-strong form efficient, then it should contain all of the relevant data from previous publications of accounts, so it may be argued that market-based measures contain strictly more information than accounting-based measures.

This can be illustrated by comparing regulatory capital requirements – which are based on accounting measures and so are backwards-looking – with a market-based capital ratio equivalent. Figure 3.1a compares Basel II Tier 1 capital ratios for banks which did and did not fail during the period of most intense financial market distress in autumn 2008. At the time, this was the prevailing measure of regulatory capital. As can be seen, there is no discernible difference between the two groups of banks, suggesting that this measure is a poor predictor of distress.

Figure 3.1b presents, for the same banks, a market-based equivalent, namely the ratio of market capitalization (based on the contemporaneous traded share price) divided by book value of assets. As can be seen, the two sets of banks can be clearly distinguished under this measure, which is a much better predictor of bank failure. As Haldane (2011) states, market-based measures offer the advantage of simplicity and transparency: "200 million separate calculations would condense to a simple sum."[3]

This is not to say that accounting-based ratios are useless. The drawbacks of Basel II even as an accounting-based measure of risk are well-documented: we find, for example, that regulatory capital ratios under Basel III have a higher correlation with market-based capital ratios, suggesting that they may do better at predicting crises. See Table 3.1 below.

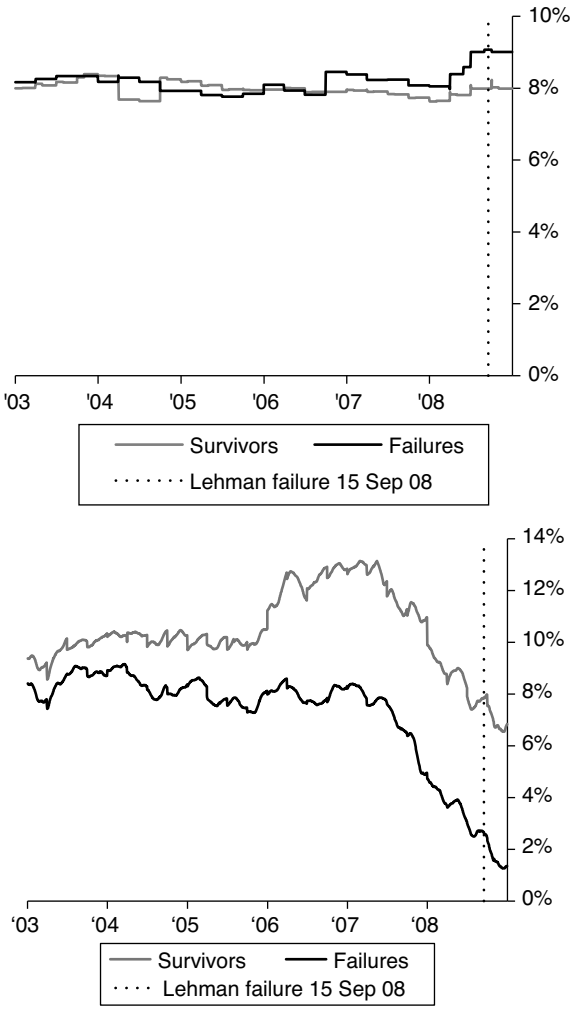

Figure 3.1 a Basel II tier 1 capital ratio as a predictor of bank distress, January 2003–December 2008; b Market-based capital ratio as a predictor of bank distress, January 2003–December 2008

Notes: (a) "Failures" are a set of major financial institutions, which in autumn 2008 either failed, required government capital or were taken over in distressed circumstances. These are RBS, HBOS, Lloyds TSB, Bradford & Bingley, Alliance & Leicester, Citigroup, Washington Mutual, Wachovia, Merrill Lynch, Freddie Mac, Fannie Mae, Goldman Sachs, ING Group, Dexia and Commerzbank. The chart shows an unweighted average for those institutions in the sample for which data are available on the given day.
(b) "Survivors" are HSBC, Barclays, Wells Fargo, JP Morgan, Santander, BNP Paribas, Deutsche Bank, Crédit Agricole, Société Générale, BBVA, Banco Popular, Banco Sabadell, Unicredit, Banca Popolare di Milano, Royal Bank of Canada, National Australia Bank, Commonwealth Bank of Australia and ANZ Banking Group. The chart shows an unweighted average for those banks in the sample for which data are available on the given day.
(c) 30-day moving average of market-based capital ratio measure.

Source: Capital IQ and authors' calculations.

Table 3.1 Correlations with market-based capital ratio

Basel II tier 1 capital ratio	Basel III core equity tier 1 capital ratio	Basel III leverage ratio
0.39	0.81	0.89

Source: Bloomberg, reported data and authors' calculations. Data are for five largest UK banks, Dec 2011–Nov 2012. This short period is selected as one in which banks may reasonably be thought to be targeting both Basel II and Basel III capital ratios.

Of course, one reason for this may be that in the recent post-crisis period, equity investors reward banks with healthy capital ratios under the new regime – we cannot be so sure that this correlation will remain strong in crisis times. Moreover, as a bank may have to enter resolution if its regulatory capital ratio falls below a certain level, it will aim to maintain a constant, healthy ratio above almost all other objectives.

2.3 Equity investors

Measures of market discipline typically relate to the response of debt investors to changes in risk. This is partly because the literature has focused on the disciplining role of debtors and the conflict between debt and equity investors. But examining the pricing of equity can shed light on the issue too. In particular, if we observe that equity investors distinguish between banks but debt investors do not, then we may be able to rule out that the failure of market discipline for creditors is due to a lack of information or an inability to process it. More bluntly, it may be that equity investors monitor the bank, while debt investors fail to do so.

However, caution should be drawn against jumping to this conclusion. An alternative explanation is that in the econometric analysis carried out in the literature, too much is asked of debt investors to distinguish between banks on the basis of the variables used, especially when measures of risk are used that are based on potentially manipulated or targeted accounting measures (such as regulatory capital ratios as explored above).

Moreover, the payoffs of equity and debt – and their sensitivity to underlying risk – are very different, and vary with the state of the world. For equity investors, a change in risk in any state of the world in which the bank is solvent (or close to being so) will affect their payoff. But, by contrast, the sensitivity of debt to risk is higher in states of the world where the bank is insolvent or close to being so. This means that debt investors may require different information to equity investors, and it may be harder to collect, especially as firms' disclosure policies are more likely to be driven by shareholders' rather than creditors'

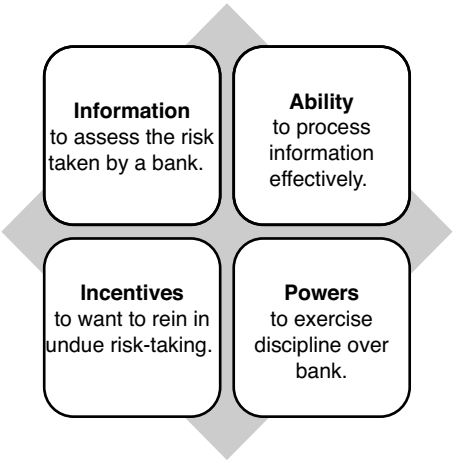

Figure 3.2 The four requisites for effective market discipline
Source: Sowerbutts et al. (2013).

preferences. The reasons why market discipline may break down is the subject of the next section of this chapter.

3 Why market discipline can break down

Our discussion so far has focused on the issue of whether or not investors respond to the risks that banks are taking. The literature finds evidence that investors do not effectively impose market discipline, neither by monitoring bank risk nor by influencing management.

This section focuses on the reasons *why* market discipline can break down. Crockett (2001) identifies four requisites for effective market discipline, which are illustrated in Figure 3.2 above. Debt investors need to have: sufficient information to understand the risks that banks are taking; the ability to process this information; powers to discipline banks to rein in risk-taking where necessary; and incentives to exercise these powers.

3.1 Do investors have the information that they need?

Sowerbutts et al. (2013) introduce a quantitative framework to assess the first of these channels. Their metric assesses whether investors have sufficient information to understand the risks that banks are facing in a number of areas: funding risk; group structures; asset valuation; intra-annual information and financial interconnections. These contrast with the measures of risk mentioned in the previous section, which mainly focus on credit risk.

However, the financial crisis revealed that disclosure in these other non-credit areas had been insufficient prior to the crisis, and that investors had failed to demand that banks disclose more (Bank of England 2009). Therefore measuring improvements in these areas in the post-crisis period is a useful way of tracking whether disclosure has improved. For this reason, the index measures disclosure over and above minimum international regulatory standards.

The index in Sowerbutts et al. scores a bank between zero and one for each indicator, depending on whether the relevant information was disclosed in a public annual report. The figures below show that on a global level there has been a broad improvement in disclosures since the crisis. Figures 3.3a, b and c show the average disclosure scores for three of these categories over the period 2000–2012. Each line shows the average for the group of banks in that jurisdiction. There is an upward trend in all three categories, though progress varies between jurisdictions.

This kind of quantitative index cannot capture qualitative or subjective information such as clarity of exposition in banks' disclosures or standardization and comparability of reporting. Even so, it is very labor-intensive to produce. The US Securities and Exchange Commission requires standardized templates for financial reporting (10-Q and 10-K reports), but in general this is not the case in most other countries, where lack of standardization between reporting makes comparability harder. Accounting standards vary between countries and are often principles-based. This means that management must use its judgment in providing reliable and relevant information, and this could lead to substantial variation between banks. To the extent that market discipline is effective, investors may wish to encourage management to standardize reporting between banks and across time, to make direct comparability easier.

3.2 Shedding light on bank opacity

Opacity can be characterized as three nested cases: some outsiders (i.e., investors) are informed; only insiders (managers) are informed; or the business is fundamentally unknowable, even by managers. Figure 3.4 illustrates.

Each of these cases can be analyzed and measured separately, and each leads to different predictions for asset prices. This subtlety may explain some of the apparently conflicting results which exist in the literature.

3.2.1 Measuring asymmetric information between managers and investors

If outsiders are unable to completely observe the firm's actions, then managers will have some ability to capture cash flows for their private benefit. However, if agents are aware of this, they can increase the return they demand with the expected value of the missing information. This has important implications for the cost of raising equity. In the "pecking order theory" model introduced by Myers and Majluf (1984), managers have more information than outside

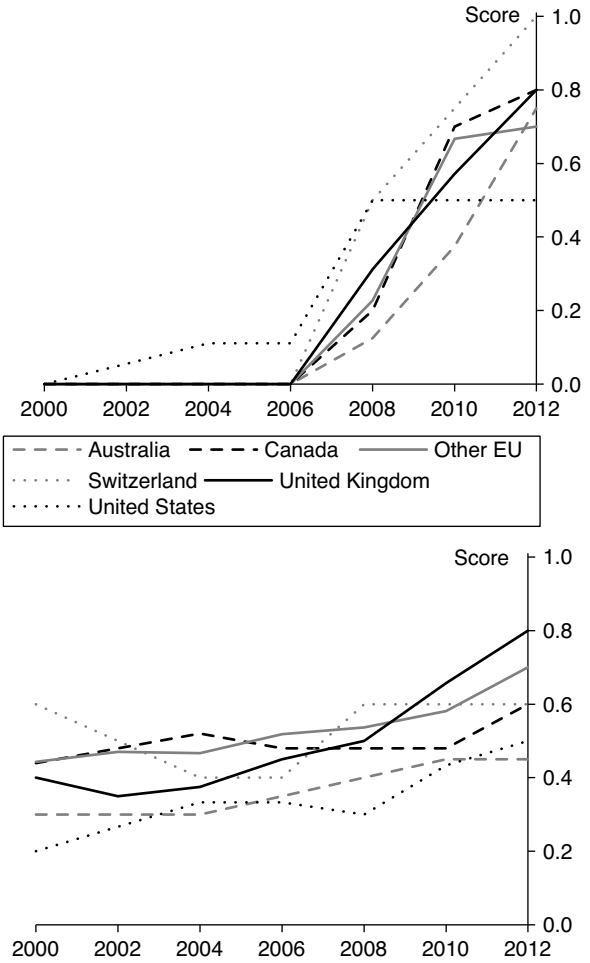

Figure 3.3 a Valuation category scores; b Funding risk category scores; c Financial interconnections category scores

Notes: (a) Each category assigns a score between 0 and 1 for a bank based on whether or not detailed quantitative disclosure takes place. The scores are measured for a panel of 50 banks – these scores show the progress made by jurisdiction.
(b) "Valuation" score assesses disclosure of valuation methodology and sensitivity to the underlying assumptions.
(c) "Funding risk" score assesses disclosure of funding breakdown across five different metrics: by type, maturity, currency, asset encumbrance, and a stress ratio measure.
(d) "Financial interconnections" assesses disclosure of exposures to other banks and off-balance sheet entities, as well as implicit support.

Source: Sowerbutts et al. (2013).

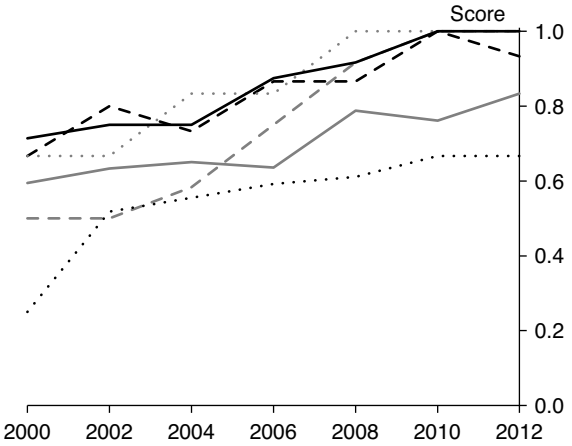

Figure 3.3 (*Continued*)

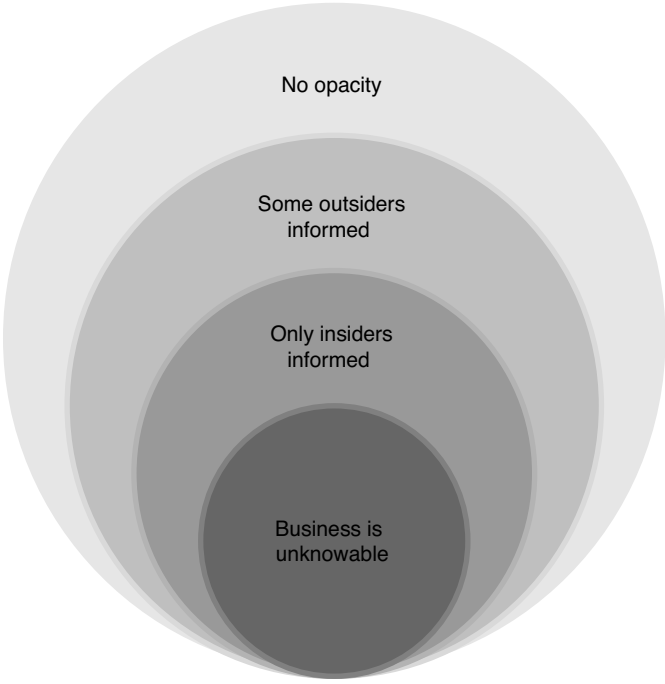

Figure 3.4 Opacity in firms

investors, and so investors perceive issuance of equity as a negative signal of managers' expectations of future firm value. This makes raising equity more expensive than issuing debt or using internal funds to finance projects. An implication of this is that more opaque firms – for example, banks – will be more leveraged than more transparent firms.

However, there are a number of other factors that contribute to capital structure decisions, making this theory challenging to test empirically, particularly for large and complex firms such as banks. Indeed, most tests of Modigliani-Miller's capital structure invariance hypothesis – which postulates that a firm's total funding costs should be independent of capital structure – exclude banks and other financial firms: they tend to have more complex capital structures than other types of firm. Jin and Myers (2006) develop an extension to Myers (2000) in which investors receive news that is a combination of firm-specific information and macroeconomic or industry information. The predictions are fairly clear: firms with more managerial inside information will have equity returns which are less likely to reflect firm-specific information and instead equity returns will be more likely to reflect market (and perhaps industry) information. Several studies examine the relationship between this type of information symmetry and the goodness of fit (R-squared) from asset pricing regressions. Haggard and Howe (2012) test this prediction by comparing banks to non-financial firms with similar equity market characteristics. Their results suggest that banks are more subject to this form of insider-outsider information asymmetry than other types of firm.

3.2.2 Measuring asymmetric information between investors

Easley and O'Hara (2004) develop a theoretical model of informed and uninformed investors and show that investors demand a higher return for holding assets with greater private information. This is because private information increases the risk to uninformed investors of holding the asset, and this risk cannot be diversified away.

Aspects of market microstructure are frequently used to analyze asymmetric information between investors. If all investors know all the information about an asset – and agree that they do – then it will trade with a small bid-ask spread. But, when some investors have private information, bid-ask spreads will increase as market makers seek to protect themselves against trading with informed traders. The greater the proportion of informed traders, the less likely price changes are to be reversed (Kyle 1985). But predictions on volume are unclear. If *no* investor knows an asset's fundamental value then it can be very liquid (Dang et al. 2013), as market makers have no concerns about information asymmetries. But as soon as some trader has some private information about the asset value, then this market can break down as uninformed investors are not willing to hold the asset. The market microstructure literature generally

decomposes the quoted bid-ask spread into three components: order-processing costs, inventory-holding costs, and adverse-selection costs.

Flannery et al. (2004) is an important paper in this literature, using these market microstructure measures of bank's equity to measure opacity. Opacity is defined to mean that some investors cannot value the asset very accurately but (perhaps) insiders or informed traders can; by this definition a more opaque asset would have a bigger bid-ask spread. The authors also examine data on analyst earnings forecasts, measuring both accuracy and dispersion: they conclude that "banking assets are not unusually opaque; they are simply boring." They also find that forecast dispersion for banks is virtually indistinguishable from non-banks, and that the median forecast errors are smaller for non-banks – although the latter result could be due to banks being better able than other firms to "manage" their earnings to meet analysts' expectations. Large bank holding companies (BHCs) are found to have similar trading properties to their matched non-financial firms, suggesting that they are as transparent as similar large non-financial firms.[4] But smaller BHCs trade much less frequently than comparable non-banks, despite having similar bid-ask spreads. They also have lower return volatilities and are more easily forecastable relative to comparable non-financial firms, suggesting that banks are not especially opaque.

Flannery et al. (2013) repeat the same exercise but over a longer time period, which incorporates the global financial crisis and the failure of LTCM in 1998. They find that, although banks are no more opaque than their non-financial counterparts pre-crisis, during crisis times both the spreads and price impacts of BHC stocks are significantly higher than those of non-banks. As the authors note, "The general pattern of time-varying relative bank opacity is troubling, since it suggests a reduction in bank stability during crisis periods, even beyond the obvious deterioration in bank balance sheet values."

3.2.3 Unknowable business models and information uncertainty

Morgan (2002) uses a very simple model to capture uncertainty, looking at disagreement among credit rating agencies, who are considered to be insiders with access to private information about the firm. Morgan considers the hypothesis that, if risk is harder to observe in banks than non-banks, then rating agencies should disagree more over ratings to a greater extent. This means that opacity can be proxied using statistics such as the average difference between ratings, their correlation, and the percentage of issues where there is disagreement between agencies. For a sample of bonds issued by firms between 1983 and 1993, Morgan finds that disagreement is greater for bank bonds than non-bank bonds. Interestingly he shows that rating agencies disagreed more about banks after 1986, which he attributes to the demise of the "too big to fail" safety net in the US following the collapse of Continental Illinois and subsequent regulatory reform. One weakness of this argument is that, until the global financial

crisis, the rating agencies in the paper – S&P and Moody's – had not properly formalized the way that government support was factored into ratings, making it harder to test these hypothesis. The amount of disagreement is increasing in the level of loans and trading assets of banks, and in their degree of leverage. Morgan interprets these results as suggesting that it is the business of banking that makes it inherently more opaque than other industries.

Iannotta (2006) undertakes a similar analysis for European banks and finds similar results, although he also identifies construction, energy and utility and "other" as being more opaque than the banking industry. He also finds that a higher capital ratio increases the likelihood of a split rating.

3.3 Using stress tests to assess opacity

A number of papers use the recent US and EU bank stress test disclosures as a way to further unpack the sources of bank opacity. In the wake of the recent financial crisis, regulators have regularly carried out stress tests on banks and published the results in order to increase confidence in the banking system. This has created an ideal environment to study empirical informational issues. In contrast to their own disclosures, firms are unable to choose what is disclosed in the stress test. Information contained in stress test disclosures is often considered by investors to be as informative as the outcome of the test itself. In addition, investors may draw inferences from a regulator's selection of stress scenario, or the banks chosen to participate in the test.

Stress tests are concerned with a downside scenario, which is of direct interest to debt investors. This contrasts with information in annual reports, which is generally designed to be informative to shareholders. Therefore disclosure of stress test results can complement disclosure that banks voluntarily provide, giving all market participants information required to assess the risks of the instruments that they hold.

Morgan et al. (2014) examine whether the 2009 US stress tests were informative to investors. They measure information using several events around the tests and calculate cumulative abnormal equity returns. They find a significant negative relationship between abnormal returns around the release of the stress test results and the capital gap that banks were found to have; this is consistent with the view that the stress test produced information about the banks the private sector analysts did not already have. However, a recent paper by Glasserman and Tangirala (2015) show that there is some predictability in the stress test outcomes over time, and so diversity of scenario design can ensure that the tests remain meaningful for investors.

Ellahie (2013) examines the European Banking Authority stress tests in 2010 and 2011 and tests for information asymmetry across investors – using bid-ask spreads – and information uncertainty, using equity option-implied volatilities and relative CDS spreads for one- vs. five-year debt. Unfortunately, the author

is unable to empirically disentangle whether the increased uncertainty is due to greater underlying volatility from the worsening sovereign credit crisis, or due to poor quality information contained in the stress test disclosures. This is something that plagues the earlier literature on stress tests, which were frequently undertaken in crisis conditions. More regular stress testing – and a more tranquil economic environment – will hopefully overcome this problem; for example in the UK stress tests will take place on an annual basis (Bank of England 2013). But this may result in the risk – at least, for research purposes – that investors will pay less attention to stress test disclosures in non-crisis times.

3.4 The big black box of banking?

The above findings suggest that banking is – to an extent – a business which is opaque and difficult to assess. Even before the crisis, banking was described as a "black box" (see, e.g., *The Economist* 2007). The nature of banking is by some definitions, opaque. One of the many functions of banks is to overcome information asymmetries and lend to borrowers who are unable to raise market finance or who may wish to use bank finance to avoid disclosing sensitive information. A bank may have advantages in being able to screen borrowers, overcome moral hazard, and negotiate in default. This has to suggestions that banks are inherently opaque. But opacity at the individual loan level does not mean that the portfolio of a bank must necessarily be opaque, nor that the payoffs of its liabilities must be. A classic and simple example of this can be found in the model of Diamond (1984), in which creditors do not monitor the bank's individual loans but do understand the bank's incentives and so are perfectly informed about the bank's portfolio.

3.5 Guarantees in the banking system

The literature on market discipline in banks almost disappears in the early 2000s. This reflects a number of factors. One reason is that policy interest declined considerably after the 1990s: while a paper by the Board of Governors of the Federal Reserve System and Secretary of the Treasury (2000) counts no fewer than 14 proposals for mandatory subordinated debt issuance made in the 1990s, interest becomes scarcer after this period until just before the global financial crisis. The importance of market discipline was cemented in Pillar 3 of Basel II, which encourages greater disclosure of a bank's risk in order to enhance market discipline.

Another factor is that interest in the literature turned away from explicit discussion of market discipline, and focused more on assessment and measurement of the implicit subsidy of banks. However, many of the techniques used are similar. A recent strand of the literature attempts to examine whether there is an implicit guarantee for banks which are expected to be bailed out by governments in the event of failure – in other words, which are "too big to fail."

Typically these papers examine whether there is a relationship between risk-taking by banks and the spread that investors demand, and then analyze how this is affected by expectations of implicit guarantees. It is important to bear in mind that, even though in many cases pricing does appear to be risk-sensitive, this does not necessarily mean that there is no guarantee. The question is: is risk priced *enough?*

Acharya et al. (2014) adapt the usual market discipline equation – i.e., a fixed effects regression of spread against credit risk – but add a number of control variables, all of which capture different measurements of risk. The authors use a number of different measures of "too big to fail" status, such as CoVaR (which measures a firm's contribution to systemic risk) and bank size. Their results suggest that large institutions have lower spreads due to implicit government support, not because they have lower risk. Siegert and Willison (2015) provide a literature review of similar papers.

Morgan and Stiroh (1999) investigate market discipline using bond spreads, ratings and bank data for bonds issued between 1993 and 1998 and find evidence that the spread on bank bonds increases as credit ratings deteriorate. However, they show that this effect is weaker for bigger and less transparent banks, pointing to possible slippage in the disciplinary mechanism for banks either considered too big to fail or too hard to understand by the bond market.

Guarantees and government support of any form can undermine market discipline as they disrupt the transmission of the risks that a bank is taking into the risks that investors actually face. This does not always mean that guarantees would increase incentives for banks to increase risk-taking: the effect will depend on the nature of the guarantee. In a case where a bank is insured against all losses, then it will certainly seek to maximize risk-taking. But support which occurs in states of the world that are not strongly correlated with the bank's risk choices – for example, lender of last resort activities in the event of systemic liquidity shortages – is less likely to distort the bank's incentives to take risks. Moreover, the existence of guarantees can increase the charter value of a bank, possibly reducing the incentive to take risks as shareholder value is maximized when the bank continues its operations. Cordella and Levy Yeyati (2003) illustrate this problem with a lender of last resort who is able to only pay out in bad states of the world. In practice, it is very difficult to design a "zero moral hazard" policy of bail out or support which is credible ex ante.

There is a plethora of papers which examine this effect, of which a selection are summarized in this paragraph. An influential paper by Keeley (1990) suggests that an increase in competition in the 1980s led bank charter values to decline, which caused banks to take more risk and reduce their capital, increasing their risk of default. But later papers suggest that guarantees can increase risk-taking. Nier and Baumann (2006) examine a panel of banks between 1993 and 2000. They find that, while government safety nets result in lower capital

buffers, stronger market discipline resulting from uninsured liabilities and disclosure leads to larger capital buffers, all else being equal. Gropp et al. (2014) exploit a natural experiment to examine the effect of government guarantees on bank risk-taking. Their results suggest that banks whose government guarantees were removed reduced their credit risk by cutting off the riskiest borrowers from credit. They also find that yield spreads of savings banks' bonds increased significantly after the announcement of the decision to remove guarantees, while the yield spread of a sample of bonds issued by a control group remained unchanged. Gropp et al. (2011) use ratings as a proxy for state support and find evidence in favor of the charter value effect. They find no evidence that public guarantees increase the protected banks' risk-taking, but they do find that government guarantees strongly increase the risk-taking of competitor banks.

4 Is market discipline optimal? How much is the right amount?

So far our discussion has focused on whether banks are opaque. This section examines whether transparency or opacity is socially optimal.

In an influential recent paper Dang et al. (2014) examine whether banks are optimally opaque. If a bank's assets are highly transparent, then its market value will fluctuate more often, making its debt liabilities a poorer store of value and thus less useful as a transaction medium. This could be argued as a reason why increasing transparency might not be socially optimal, since money creation is an important social function of banks. However, Gorton and Pennacchi (1990) show that trading losses from information asymmetries can be mitigated by tranching, which should stabilize the value of the most senior liabilities, making them more suitable to use as a transaction medium. They cite bank debt as an example of a type of liquid security which protects relatively uninformed agents, and they provide a rationale for deposit insurance.

The conventional wisdom is that higher transparency via greater disclosure may lead to more market discipline. Goldstein and Sapra (2014) provide an excellent discussion showing analytically that this may not necessarily be the case for banks. This is because banks operate in the "second-best" environment – in other words, the presence of market distortions means that introducing another friction may lead to a more efficient outcome. Examples of such distortions are the interconnected nature of banks, the presence of social externalities, principal-agent problems, and taxes and bankruptcy costs.

Even if greater disclosure boosts market discipline, it may be the case that more effective market discipline does not result in higher economic efficiency. Goldstein and Sapra (2014) show that, although greater disclosure is ex post efficient, this does not necessarily translate into ex ante inefficiencies. They argue that disclosure of stress test information may be beneficial ex post in that it improves market discipline, but if the opacity of the bank's operations means

that market participants do not have an adequate understanding of a bank's operations, then market discipline may be hampered by inducing the bank to choose sub-optimal portfolios or inefficient asset sales, thereby reducing economic efficiency. Kleymenova (2013) provides empirical evidence of this in the disclosure of banks' borrowing from the US Federal Reserve's Discount Window during the financial crisis. She finds that these disclosures contained positive information for the market and that they decrease banks' cost of capital. But she also documents how banks change their behavior: banks respond to the discount window disclosures by increasing their liquidity holdings and decreasing risky assets. Thakor (2015) analytically predicts that mandatory disclosure for financial institutions might be inefficient and make banks more fragile. This result comes from banks not wishing to disclose information which may lead to an increase in disagreement. Overall, these two studies argue that, in response to increased mandatory disclosure, banks change their behavior to avoid further disclosures. On the other hand Bischof and Daske (2013) find a substantial and relative increase in stress test participants' voluntary disclosure of sovereign credit risk exposures subsequent to the mandated release of credit risk-related disclosures.

Morris and Shin (2002) show that greater disclosure may be harmful because it induces market participants to put excessive weight on the public information. If the public information is not very precise, then such excessive weight may actually hamper market discipline because market participants rely too much on the non-fundamental or noise component of the disclosure. Similarly, Goldstein and Leitner (2015) examine the issue of opacity, but from the perspective of the regulator. In their setup a regulator has information about banks' ability to overcome future liquidity shocks. Disclosing information may prevent a market breakdown but also destroy risk-sharing opportunities. They show that risk-sharing arrangements work well if the overall state of the financial industry is perceived to be strong. But in bad times, partial disclosure by the regulator can be the optimal solution.

Unfortunately this is easier to pose as a policy than to put into practice. Disclosure standards are slow to change and it is difficult to remove sensitive information from regular reports once investors have become accustomed to it, without creating a perceived signal and increasing further panic. This may explain why strong banks do not necessarily choose to signal their strength by disclosing more, for fear they may become weak banks in future and be unable to stop disclosing this information.

5 Concluding remarks

Insufficient disclosure of information by commercial banks can act as an amplifier of financial stress. It can also distort funding choices and prices in non-crisis times, by contributing to information asymmetry between insiders (such as

managers) and outsiders (market participants). Theoretical and empirical evidence suggests that investors do not appear to adequately discipline banks or demand that they disclose the information required to properly assess the risks that they take. This can be partially explained by the "too big to fail" effect, which leads to some of these risks being shared with the government. But there is also evidence to suggest that banks may be too complex for their risks to be properly understood by outside investors.

Mandatory disclosure by regulators can help address some of these asymmetry problems, especially if it helps overcome principal-agent problems, which prevent outside investors from achieving the desired level of disclosure. It is important, however, to consider the effect it may have on the behavior of banks and their investors. Simply publishing as much information as possible is not likely to be helpful to outsiders trying to understand a complex business, and it may actually exacerbate problems during times of stress. Regulation on disclosure can take several forms – for example, information can be published by the firm itself (e.g., enhanced reporting standards) or the regulator (e.g., stress test disclosures) – and these choices may have important consequences for the way that the material is perceived by outsiders at different points in the financial cycle. We do not yet have a good understanding of what policies would optimize social welfare on a time-consistent "through the cycle" basis: this may be an area for further research.

Notes

* Any views expressed are solely those of the authors and so cannot be taken to represent those of the Bank of England or to state Bank of England policy. This paper should therefore not be reported as representing the views of the Bank of England or members of the Monetary Policy Committee or Financial Policy Committee.

1. This may change in future. An exciting new area of research concerns the use of search terms and news articles. For example Drake et al. (2012) examine investors' searches around the days of earning announcements and Drake et al. (2015) examines traffic on the SEC's EDGAR servers.
2. Rating agencies received considerable criticism after the financial crisis for having skewed incentives as the issuer pays the rating agency to rate them, which led them to assign higher ratings to products. This is a valid criticism but should apply to almost all ratings of banks almost equally. This 'uprating' mainly involved structured products for which fees were much larger and for which it was possible to "shop" for ratings. By contrast, for publically traded bank debt, a bank is rated by all rating agencies. See Bolton et al. (2012) for more on the incentives of ratings agencies.
3. An earlier version of these charts – calculated by the authors – can be found in Haldane's speech.
4. One interpretation of this may be that large non-financial firms are also opaque. Cohen and Lou (2012) find evidence that investors take longer to process information for multi-industry conglomerates than for simpler single-industry firms.

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