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Market discipline, disclosure and moral hazard in banking ☆

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Abstract

This paper examines empirically the hypothesis that market discipline is effective in providing incentives for banks to limit their risk of default, by holding capital buffers against adverse outcomes in portfolio risk. We have constructed a large cross-country panel data set consisting of observations on 729 individual banks from 32 different countries over the years 1993 to 2000. Theory implies that the strength of market discipline ought to be related to the extent of the government safety net, the observability of bank risk choices and to the proportion of uninsured liabilities in the bank's balance sheet. Using panel data techniques, we test whether these factors provide incentives for banks to hold larger capital buffers against adverse outcomes in portfolio risk. Our results suggest that government safety nets result in lower capital buffers and that stronger market discipline resulting from uninsured liabilities and disclosure results in larger capital buffers, all else equal. While our results therefore point to the effectiveness of market discipline mechanisms in general, we also find that the effect of disclosure and uninsured funding is reduced when banks enjoy a high degree of government support. Our results finally suggest that while competition leads to greater risk taking incentives, market discipline is more effective in curbing these incentives in countries where competition among banks is strong.

JEL classification: G21; G28; G32; D82

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☆ This paper reflects the views of the authors only and not necessarily those of the Bank of England or other members of its staff.

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1. Introduction

In recent years considerable attention has been paid to the topic of market discipline in banking. Market discipline refers to a market-based incentive scheme in which investors in bank liabilities, such as subordinated debt or uninsured deposits, "punish" banks for greater risk-taking by demanding higher yields on those liabilities. The reason market discipline is needed is that banks are prone to engage in moral hazard behaviour. Banks collect deposits and invest these funds in risky assets (loans). To safeguard against insolvency, banks hold capital buffers against adverse outcomes in their investments in risky assets (loan default). But the bank's private solvency target may not take into account the interests of depositors, nor of society as a whole. Market discipline is a mechanism that can potentially curb the incentive to take excessive risk, by making risk-taking more costly.

A number of recent policy initiatives recognise the importance of market discipline in safeguarding financial stability. These include initiatives to create internationally accepted accounting standards (IAS) and proposals to make it mandatory for banks to issue subordinated debt, see Evanoff and Wall (2000a). Moreover, the Basel Committee on Banking Supervision[1] (BCBS) has taken the view that enhancing market discipline is increasingly important in a world where banking activities are becoming more and more complex. This view is reflected in Pillar 3 of the proposed revised capital framework (Basel 2), which encourages greater bank disclosure to strengthen market discipline. In particular, the hope is that greater disclosure of a bank's risk profile will provide banks with incentives to hold capital commensurate with the risks they take.

In view of these policy initiatives, it is important to ascertain whether market discipline can be effective, but also to assess under what conditions it might not be. However, as has been emphasised by Berger (1991), Bliss and Flannery (2002) and Hamalainen et al (2001), the "previous literature has concentrated primarily on whether the market prices [of bank liabilities] react adversely to information about risk" (Berger, 1991).[2] But this does not reveal the degree to which market discipline is effective as an incentive scheme, i.e. to what degree does the existence of market discipline actually influence bank behaviour? This paper seeks to address this question and examines empirically the hypothesis that market discipline is effective in providing incentives for banks to limit their risk of default, by holding capital buffers against adverse outcomes in portfolio risk.

For market discipline to be effective three conditions need to be satisfied. First, investors in bank liabilities need to consider themselves at risk of loss if the bank defaults. Second, market responses to changes in the bank's risk profile need to have cost implications for the bank and its managers. Third, the market must have adequate information to gauge the riskiness of the

[1] See Basel Committee on Banking Supervision (2003).

[2] Flannery (1998) and Hamalainen et al. (2001) provide extensive surveys of this literature. In addition, a small literature examines the extent to which banks respond to changes in the yield of their subordinated debt. Bliss and Flannery (2002) fail to find any evidence that following a change in yield spreads managers respond with changes in balance sheet allocations. As pointed out by Evanoff and Wall (2000b), this "study is attempting to capture one aspect of discipline imposed by the debt market—ex post discipline. [That is,] do managers change their behaviour following a change in yield spreads? Another form of discipline, and that most typically associated with sub debt proposals, [refers to how banks may change their behaviour] in an attempt to *avoid* having the market impose costs through increased spreads. This *ex ante* discipline encourages firms to prudently manage risk" (emphasis added). Moreover, Covitz et al. (2004) provide evidence that banks' decision to issue additional sub debt is influenced by yield spreads. They show that increases in yield are associated with a reduction of new issues of debt. In contrast to both these studies, our study is an attempt to examine the effectiveness of ex ante discipline.

bank. Specifically, Rochet (1992), Blum (2002) and Cordella and Yeyati (1998) show that in the absence of corporate governance problems between bank shareholders and manager, if bank deposits are uninsured and the bank's risk choice is observable by depositors, the bank's risk choice will be efficient.[3] The reason is that banks internalise the impact of their risk choice on depositors since these in turn will demand higher compensation if the bank incurs higher risk. In such a world there is perfect market discipline and no moral hazard. Conversely, if deposits are insured or the bank's risk choice is not observable by depositors, then the bank will choose a higher than the efficient risk profile at the expense of depositors. The reason is that depositors will not demand a higher return in response to higher risk choices by the bank. In such a world there is no market discipline and the bank's choice of its risk of default is subject to moral hazard.[4]

These studies suggest that the conditions needed for market discipline to be effective involve the following three key factors. First, the effectiveness of market discipline will depend on the extent of the government safety net (support). Explicit or implicit government guarantees may limit the responsiveness of the yield on bank liabilities to changes in the bank's risk of default and hence limit the incentive effects of market discipline. Second, effectiveness will depend on the degree to which the bank is financed by uninsured liabilities (funding). A larger proportion of uninsured liabilities will make it more costly for the bank to increase its risk of default. And third, it will depend on the extent of observability of the bank's risk choices (disclosure). Banks that disclose more information will be subject to more market discipline and have a greater incentive to limit their risk of default.

The basic hypothesis we would like to test is whether these three sets of factors that increase the strength of market discipline are associated with incentives for banks to limit their risk of default.

Simple models of bank default (e.g. Merton, 1977) suggest that a bank's risk of default depends on two key factors: its underlying asset risk and leverage. Leverage, in turn, is determined by the size of the capital buffer a bank holds as insurance against adverse shocks. Indeed, in practice, following the introduction of the 1988 Basel Accord and the 1996 Market Risk Amendment, the management of capital has increasingly become the main way in which banks attempt to manage their risk of insolvency.[5]

The strategy followed in this paper is therefore to test whether factors associated with the strength of market discipline lead banks to choose higher capital buffers for given asset risk, controlling for other factors affecting the amount of bank capital.[6] If this can be shown, then, by implication, market discipline factors are shown to lead banks to attempt to choose a lower prob-

[3] The studies mentioned analyse a single bank and thus abstract from systemic externalities that might arise from the knock-on effects on other banks when a bank defaults. In view of such externalities, banks may choose a level of risk that is too high from the social point of view even when the level of risk is privately optimal from the point of view of the bank and its shareholders. On the other hand, if managers are more cautious than shareholders and shareholders find it difficult to align managerial incentives with their own, bank capital buffers may be inefficiently high.

[4] In the Cordella and Yeyati model, disclosure enables banks to commit to low risk. There are two cases: (1) Under full disclosure the bank's risk choice is observable. Depositors demand a high interest rate if the bank chooses high risk. In equilibrium the bank chooses low risk and the interest rate is low. (2) Under no disclosure, depositors do not observe the bank's risk choice. Lower risk is not rewarded with a lower interest rate. In equilibrium the bank chooses maximum risk and depositors, anticipating this choice, choose an interest rate commensurate with this anticipation.

[5] See Gordy (2003) for a description of the approach underlying the proposed new Basel Framework.

[6] A bank's probability of default can alternatively be measured directly. However, the interpretation of such measures is not straightforward for banks. For example, measures derived from market prices, such as 'Merton model' PDs and z-scores are subject to difficult interpretation issues. This is because they only partly relate to risk management actions on the part of the bank and in addition reflect anticipation of how the official sector might behave in case of failure.

ability of default, all else equal, and that market discipline indeed has behavioural implications or is 'effective'.[7]

Our approach complements the existing literature on the determinants of capital buffers, see for example Alfon et al. (2004), Flannery and Rangan (2004), Ayuso et al. (2004), and Lindquist (2003). This literature has analysed the relationship between capital buffers, risk and the business cycle for individual countries, but does not provide a comprehensive analysis of market discipline factors as a key determinant of capital. By contrast, our approach is to analyse the effect of market discipline on bank capital, controlling for risk and general economic conditions, using a cross-country panel data set-up.

Our data set covers 729 individual listed banks from 32 different countries over the years 1993 to 2000. Using this data set, our strategy has been to identify the strength of market discipline at the bank level as measured by the three factors identified above (support, funding and disclosure). Note that this approach leads to a dramatic increase in statistical power when compared to existing cross-country studies on bank stability that rely on cross-country differences alone, e.g. Barth et al. (2004), Demirgüç-Kunt and Detragiache (2002). On the other hand, the advantage of assembling cross-country data for our purposes is that the strength and effectiveness of market discipline is likely to vary across countries. Using our data set these differences can be analysed, leading to a rich set of conclusions on the relative effectiveness of market discipline across countries and time.

Our main results suggest that implicit government safety nets reduce capital buffers held by banks, while discipline resulting from uninsured liabilities and disclosure creates incentives for banks to limit their risk of insolvency, by choosing a larger capital buffer for given risk. While our results therefore point to the effectiveness of market discipline mechanisms in general, we also find that the effect of disclosure and uninsured funding is reduced when banks enjoy a high degree of government support, pointing to limits to the effectiveness of market discipline for banking firms. Moreover our results suggest that competition leads to greater risk taking incentives, but that in turn, market discipline is more effective in limiting risk-taking in countries where competition among banks is strong. Finally, when comparing countries that underwent a banking crisis during our sample period with those countries that did not have a crisis, we find that for crisis countries, where bank franchise values are likely to have been low, the presence of market discipline provides stronger incentives for banks to manage their risks.

The rest of this paper is organised as follows. Section 2 describes the main market discipline variables used in this study. Section 3 details the econometric approach we take to test our hypotheses. It also outlines our sampling strategy and provides descriptive statistics for the main variables of interest. Section 4 presents bank level panel data analysis of the relationship between factors associated with market discipline and the size of bank capital buffers. Section 5 offers a number of extensions, to analyse what factors might increase or reduce the effectiveness of market discipline. Section 6 presents robustness checks. Section 7 summarises our findings and concludes.

Moreover, direct measures of a bank's risk of default might often be driven by events outside of the manager's control, such as macroeconomic shocks, making it difficult to isolate the effect of market discipline.

[7] We cannot necessarily assert that market discipline leads banks to exhibit a lower probability of default, since we do not know for certain whether the banks' risk management efforts will pay off. The latter question is analysed in a companion paper, see Nier (2005).

2. The strength of market discipline

Our data contain bank-level information on all three factors that are likely to affect the strength of market discipline—the strength of the safety net (support), the banks' funding structure (funding) and the transparency of banks' risk choices (disclosure). These measures were constructed based on information obtained from the BankScope database.

2.1. Support

Since the social cost of bank failure can be large, governments may decide to bail out, rather than close, a failed bank. But governments worry about the moral hazard this type of implicit insurance creates. They will therefore typically limit any official action to systemically important situations and, as suggested by Freixas (1999) by maintaining a measure of 'constructive ambiguity' with respect to their bailout policy. From the point of view of the market, therefore, a government bailout in the event of failure is uncertain and its probability may depend both on the bank in question and on the government concerned. The Fitch rating agency assigns a support rating that reflects its assessment of the probability of support from the government. The support rating ranges from 1 (near certain bail-out) to 5 (bail-out very unlikely). Gropp et al. (2002) show that subordinated debt yields reflect bank risk for banks with a public support rating of 3 and higher, but do not reflect bank risk for banks whose public support rating is 1 or 2. Their study suggests that market discipline is largely absent if markets believe that a bailout is very likely. We follow Gropp et al. (2002) and construct an indicator variable[8] (Support) which takes the value 1 if the public support rating indicates that a bail-out is very likely (support rating equal to 1 or 2) and 0 if the public support rating indicates a low probability of a bail-out (rating is 3, 4, or 5). Market discipline is expected to be weaker if Support = 1.

2.2. Funding

Theory suggests that the effect of market discipline ought to be stronger the larger the amount of uninsured funding. In particular, for a given increase in bank risk, the resulting market discipline is likely to have a stronger cost impact the larger is the amount of uninsured funding. Gropp and Vesala (2004) show formally that as a result, banks with a larger share of uninsured funding have incentives to take less risk. We consider two measures of uninsured liabilities. The first is the proportion of deposits received from other banks (Bankdeposits). Typically, interbank deposits are not covered by explicit deposit insurance schemes. In addition, banks are likely to be informed investors in the interbank market. A lending bank may be subject to the same kinds of shocks to risk and profitability as the borrowing bank. As a result, interbank deposits are likely to be sensitive to the risk the borrowing bank is taking. Consistent with this conjecture, Ellis and Flannery (1992) find that interbank rates paid by large US money centre banks include significant default risk premia. A second measure includes in addition the amount of subordinated debt issued by the bank. A number of studies have shown that subordinated debt spreads reflect the risk profile of the bank, see Flannery (1998) for a survey of this literature and Sironi (2003) and Gropp et al. (2002) for more recent European evidence. To capture in addition market discipline arising from the market for subordinated debt we construct the share of bank deposits

[8] While the study by Gropp et al. (2002) suggests the use of an indicator variable, an alternative is to use the support rating as assigned on the scale from 1 to 5. Our results are not materially affected by whether we use one or the other.

and subordinated debt in total liabilities (uninsured). Note that we do not consider the amount of subordinated debt separately, mainly because a large number of the banks in our sample do not issue subordinated debt or do not disclose the amount in issue in their annual accounts.

2.3. Disclosure

Cordella and Yeyati (1998) as well as Boot and Schmeits (2000) point to the commitment effect of bank disclosure. Banks that disclose more information choose lower default risk in equilibrium. The idea is that a bank that discloses its risk profile exposes itself to market discipline and will therefore be penalised by investors for choosing higher risk. This effect is absent if investors do not know the risk profile of the bank and weaker if the amount of information available to investors is limited.

Measuring the amount of information available to investors is difficult.[9] We have constructed three different measures of disclosure, two of which are simple binary measures and the third is an index of disclosure, which we have constructed by measuring the amount of information available in the bank's published accounts as represented in the Fitch IBCA BankScope data base.

Both the quality and the quantity of disclosure a bank provides may depend on where it is listed. Our first measure (Listing) is thus based on whether the bank had a listing on a primary US exchange.[10] Firms registered outside the US and listed on a primary US exchange may provide their US shareholders with financial statements prepared under their domestic (non-US) generally accepted accounting principles (GAAP). But the Securities and Exchange Commission (SEC) requires such firms to reconcile their reported earnings and shareholders' equity to US GAAP as part of a Form 20 filing. In addition, the Form 20 filing requires disclosure of information that may not be required under the bank's national accounting regulations. A US listing may therefore increase the quantity of information available to investors. Moreover, a number of empirical studies suggest that the quality of statements prepared in accordance with US GAAP may be superior to at least some alternative disclosure regimes.[11] Amir et al. (1993) find that the reconciliation of earnings and shareholders' equity in Form 20 filings increases the association between accounting earnings and security returns. Leutz and Verrecchia (2000) show that German firms which have voluntarily adopted US GAAP for their reporting show lower measures of information asymmetry and higher stock liquidity compared with a control group of firms employing the German reporting regime.

Second, investors should have more information about a bank if it is rated by a major rating agency. Rating agencies act as intermediaries in the disclosure process. They gain access to information that is not publicly available to investors and feed this information into the rating.

[9] In particular, it is difficult to measure all dimensions (i.e. quality, quantity and timeliness) of disclosure. The use of quantitative disclosure indices has been popularised recently by La Porta et al. (1998). Marston and Shrives (1991) provide a thoughtful survey of the older literature. Bushman and Smith (2003) survey more recent research.

[10] This variable takes the value one if the bank is listed on the NYSE, the NASDAQ or the AMEX and zero otherwise. It was also assigned to US banks, on the grounds that US banks listed on a primary US exchange would be subject to the same disclosure regime than foreign banks listed on a US exchange. Our regression results are not sensitive to this choice.

[11] A number of recent accounting scandals (e.g. Enron) may cast doubt on this conjecture. On the other hand, typically, in these cases the published accounts did not meet the US accounting standards. These cases may therefore not necessarily change the belief that accounts that do comply with US GAAP may be more informative than accounts that comply with alternative standards.

Indeed, Kliger and Sarig (2000) suggest that this is the very reason why firms usually pay for the rating. It allows firms to incorporate inside information into the assigned ratings without disclosing specific details to the public at large. A number of studies provide evidence that ratings do indeed contain information over and above other publicly known information, e.g. Kliger and Sarig (2000). We therefore construct a variable that captures whether a bank is rated or not (Rating).[12]

A third measure of disclosure was constructed from balance sheet information. This disclosure index (Disclosure) records whether or not the bank provides information on 18 categories of core disclosures in its published accounts as represented in the BankScope database. All of the categories are related to one or more dimensions of the bank's risk-profile (interest rate risk, credit risk, liquidity risk and market risk) or the capital/reserves it holds to back the risk. The variable was normalised to take values between zero and 1 and is available for each bank in each year of our sample. Appendix A describes the disclosure index in more detail.

Both the US listing and the rating variables are indirect measures of the amount of information available to investors. When a bank obtains a US listing this may have implications beyond improving the amount of disclosure provided to the market. A similar difficulty may apply to the rating variable. The advantage of the disclosure index is that it is a direct measure of the amount of disclosure provided to the market. But, compared to the US listing and the rating measure, it also suffers from some important drawbacks. In particular, while the quantity and the quality of disclosure are likely to be positively correlated, the index may be an imperfect proxy of disclosure quality.[13]

3. Econometric approach

Our approach for testing our basic hypothesis is to estimate a structural model of bank capital. In this model, we test whether factors associated with market discipline (*MKD*) affect the size of individual banks' capital buffers (*CAP*) when we control for a number of bank-level drivers of capital (B), including asset risk.[14]

Our model controls in addition for a number of differences at the country level (C) that might have an effect on the amount of capital banks hold as a buffer against risk. In this model, the various market discipline factors discussed above enter as shift variables, which will affect the bank's desired capital buffer for given asset risk and holding constant a number of other bank-level and country level drivers of banks' capital structure choices.[15]

[12] This indicator variable (*Rating*) takes the value 1 if the bank is rated by any of the major rating agencies (Standard and Poor's, Moody's or Fitch), and zero otherwise.

[13] For instance, it may not measure the extent to which accounting statements truthfully reflect economic reality. Despite this, related research suggests that more disclosure, as measured by our index, reduces investor uncertainty about a bank' performance and is thus 'value relevant', see Baumann and Nier (2004).

[14] Our basic specification is similar to the one estimated by Flannery and Rangan (2004) and Ayuso et al. (2004). The main difference lies in the use of country variables as well as in the use of the market discipline variables analysed here.

[15] In view of the likely persistence in our dependent variables over time an alternative to a static model would have been a dynamic specification. For the capital variable, persistence could arise since raising capital is costly. A lagged capital term could account for adjustment costs of attaining the desired level of capital. For two reasons, however, we do not pursue this route. First, the time-span of our sample is relatively short ($T = 6$ for most estimations since for many banks/variables the initial year is missing and since we have a lag structure in our regression equation), limiting the effectiveness of dynamic estimation procedures. Second, a major disadvantage of dynamic estimation procedures is that in order to achieve consistent estimates, one needs to eliminate time-invariant bank-specific effects. Since some

$$CAP_{it} = f(B_{it}, C_{jt}, MKD_{it}) + \upsilon_{it}, \quad (+) \tag{1}$$

where i denotes bank i, j denotes country j and t denotes the time period.

The capital buffer (*CAP*) is defined as the bank's equity capital as a proportion of its other liabilities—that is, it is the inverse of leverage in book value terms.[16] Note that for our purposes a measure based on the book value of equity is preferred over a measure based on the market capitalisation of the bank. The book value of equity is under the direct control of bank management since it can be affected by actions such as paying a dividend, issuing new capital or repurchasing shares. By contrast, a ratio based on the market value of bank equity is not as clearly a choice variable for bank management. In addition to capital structure decisions made by bank management, market capitalisation reflects the current and future business environment a bank operates in (i.e. the bank's franchise value), as well as the market's expectations as regards potential support by the government should the bank fail.[17]

Note that when market discipline is perfect, the bank's choice of capital buffer for a given underlying risk exposure is likely to be efficient. However, when market discipline is weak, banks' capital buffers are likely to be inefficiently low, all else equal. This leads to a number of testable hypotheses. First, banks that enjoy implicit government guarantees will tend to have lower capital buffers, all else equal. Second, a bank for which market responses to decreases in capital are less costly because the bank is funded largely by insured deposits, is likely to have lower capital buffers, ceteris paribus. And third, banks for which market discipline is weak as a result of low disclosure are likely to have a high risk of default and low capital buffers, all else equal.[18]

3.1. Bank-level controls

To isolate the effect of market discipline on capital we employ a number of bank-level control variables that in previous research have been shown to affect bank capital buffers. First, a bank's asset risk may be expected to have a positive effect on (desired) capital. A prudent bank, which targets a particular level of default risk, may want to hold a bigger capital buffer if it were to take on more portfolio risk. Consistent with this hypothesis, Shrieves and Dahl (1992), Calomiris and Wilson (2004) and Flannery and Rangan (2004) provide evidence that changes in bank risk are positively associated with changes in bank capital for US banks. However, there is an important distinction between ex ante measures of risk and ex post measures of realised risk, such as the ratio of non-performing loans or the ratio of loan loss provisions. The latter measures are usually found to reduce rather than increase measures of book capital, see Ayuso et al. (2004). Our

of our market discipline variable vary little or not at all over time, we would not be able to assess the effect of these variables in a dynamic framework. Thus, we largely use the time dimension of our data set to impose some structure on expected relationships and to eliminate endogeneity while capturing potential correlation across time and banks in the error structure.

16 Equity includes common stock, preferred stock, capital surplus, retained earnings as well as capital reserves.

17 Both aspects are illustrated in a model by Cordella and Yeyati (2003).

18 All banks disclose the amount of their equity capital. But the probability of default implied by the amount of capital may be difficult to judge by investors if this information is not put into context by additional information about the risk taken by the bank. Such additional information may commit the bank to choose a capital buffer commensurate with its risk.

approach is to account for both effects.[19] We measure ex ante asset risk by the standard deviation of a bank's assets, which is proxied by the volatility of the bank's weekly equity returns. In addition we measure ex post realised risk by the ratio of the bank's flow of loan loss provisions to total loans. To address the potential endogeneity of both these variables in the regressions we use their one year lag.

Previous literature has found that larger banks tend to have lower levels of capital, e.g. Ayuso et al. (2004), Alfon et al. (2004), Flannery and Rangan (2004). One reason is that larger banks enjoy better opportunities to diversify their lending across business lines and regions, leading to smaller exposure to idiosyncratic shocks and a reduced need for capital to cover such risks. Another reason is that larger banks will tend to find it easier to raise new capital from the market, should they need it. Myers and Majluf (1984) show that in the presence of asymmetric information, raising new equity results in dilution costs to the issuer. For large banks, which are typically monitored by a larger number of security analysts, asymmetric information should be less of an impediment to raising new equity. For both reasons, larger banks can afford to hold relatively less capital.

When raising new capital is costly, capital accumulation may rely on internally generated funds, in line with the 'Pecking order theory of finance'. More profitable banks will find it easy to accumulate equity through retained earnings. By contrast, less profitable banks, facing the costs of issuing equity, might decide not to increase capital as much as their more profitable peers. Consistent with this reasoning, Berger (1995) documents a positive relationship between return on equity and capital ratios for a sample of US banks in the mid-to-late 1980s. Similar evidence is found in Flannery and Rangan (2004) for the 1990s.[20] We therefore include the bank's return on equity and expect this variable to be positively associated with the capital ratio.[21]

3.2. *Country-level controls*

Various factors that operate at the country-level might affect the level of capital held by the banks in our sample and our model attempts to control for these effects. First, a number of theoretical studies suggest that bank risk-taking is related to the degree of competition between banks. The main argument is due to Keeley (1990): anticompetitive restrictions endow banks with market power and increase the value of the bank's charter. This in turn reduces banks' incentives to take risk. Restrictions that lead to less competition are therefore associated with larger capital ratios.[22] To account for this we use a measure of legal and administrative restrictions on bank entry that we obtain from a database provided by Barth et al. (2001).[23]

[19] Note that for a given bank and in any given year measures of ex ante risk and measures of ex post realised risk are likely to be different, since credit losses are associated with macroeconomic factors that vary through time.

[20] On the other hand, both Ayuso et al. (2004) and Alfon et al. (2004) find a negative relationship between capital and (past values of) the return on equity. In these studies the return on equity is thought to proxy for the bank's cost of raising equity capital.

[21] Under the assumption that all banks are aiming to maximise profits the return on equity is determined by the constraints on this optimisation problem e.g. demand conditions and the degree of competition—and can thus be thought of as exogenous. We therefore decided not to lag this variable.

[22] Similar conclusions are reached by Suarez (1994) and Matutes and Vives (2000), among others.

[23] We have checked whether a measure of concentration provided by Barth et al. (2001), had an effect in our capital regressions, but have not found this variable to be significant. As argued by Beck et al. (2005) concentration ratios are not necessarily closely related to the degree of competition among banks. One difficulty is that competition is local, rather than national in many countries, so that cross-country comparisons of concentration can be misleading.

The risk taking incentives of bank managers may further depend on the degree to which their preferences are tied to those of value-maximising shareholders. Managers that are not closely controlled by their shareholders might choose a lower degree of risk and a higher amount of capital than managers whose preferences are more closely aligned with shareholders, see Saunders et al. (1990). In addition, managers who act in the interest of existing shareholders might have incentives to refrain from raising new capital since under asymmetric information on the value of the bank this will lead to a dilution of the stake of existing shareholders, Myers and Majluf (1984). In countries where shareholders have more control over managers one might therefore expect banks to have lower capital buffers. To account for this we use a summary measure of the extent of shareholders rights that was obtained from La Porta et al. (1998).

An extensive literature has analysed how the existence and extent of deposit insurance might affect bank risk taking incentives. While such schemes are introduced to protect the banks from depositor runs, the literature suggests that generous depositor protection schemes may increase bank's incentives to take risks, e.g. Hovakimian et al. (2003), Demirgüç-Kunt and Detragiache (2002). On the other hand, Gropp and Vesala (2004) provide evidence that the existence of an explicit deposit insurance scheme per se might reduce risk-taking incentives, since an explicit scheme may provide a commitment to limit the safety net to insured depositors. We control for the effect of the existence of an explicit deposit insurance scheme (explicit) as well as the effect of generous protection resulting from unlimited coverage (unlimited). These variables were obtained from Demirgüç-Kunt and Sobaci (2000) and were used in previous research by Demirgüç-Kunt and Detragiache (2002).

Risk-taking incentives of bank managers might further depend on the quality of law enforcement. La Porta et al. (1998) provide a measure of law and order in different countries compiled by private credit risk agencies (rule of law). In countries with strong traditions of rule of law, managers might have reduced incentives to engage in fraud and strategic default at the expense of depositors. Empirical research has subsequently shown that a strong rule of law tends to mitigate moral hazard incentives arising from deposit insurance protection, see Demirgüç-Kunt and Detragiache (2002).[24]

A further aspect we need to control for is the regulatory minimum requirement on capital. According to Barth et al. (2001), all countries in our sample stipulate minimum risk-based capital requirements in line with the 1988 Basel Accord. However, while most countries in our sample require minimum capital of at least 8% of risk-weighted assets, a number of countries demand a larger multiple, which ranges between 8.5 and 12%.[25] We therefore include the minimum requirement (capreq), which was obtained from Barth et al. (2001).

The ease with which banks can issue new capital and therefore the average level of bank capital might further be affected by the degree of financial development and in particular the development of a country's stock market. Lack of depth might increase the costs of issuing new equity and reduce the average level of bank capital. As an indicator of the size and depth of the stock market we use the stock market capitalisation to GDP ratio (mcap). This measure equals the value of listed shares divided by GDP and was obtained from Beck et al. (1999).

[24] Barth et al. (2001) provide a number of variables that are designed to capture the quality of supervision across countries. However, previous research has not been able to show that these variables have a measurable effect on bank performance and stability, e.g. Barth et al. (2004) and Beck et al. (2005). In our regressions, likewise, these variables were not found to have significant effects and were therefore discarded from the analysis.

[25] These are Argentina (11.5), Brazil (11), Israel (9), Singapore (12) and Thailand (8.5).

Finally, the level of capital banks hold may depend on macroeconomic conditions in the bank's country of origin, as measured by the (annual) growth of GDP. However, since economic conditions may affect both the numerator (equity) and—through asset growth—the denominator (assets − equity) of the capital ratio, the direction of this effect is not clear a priori.[26] Controlling for non-performing loans and other cyclical determinants of capital, Ayuso et al. (2004) find that capital buffers were counter-cyclical in Spain over the period 1986–2000.[27] Lindquist (2003) and Alfon et al. (2004) found similar evidence for Norwegian and UK banks respectively. Since in our study, likewise, loan losses and other cyclical determinants of the numerator are included separately, we would expect the growth of GDP to be negatively associated with capital ratios.

3.3. Sampling and descriptive statistics

Our sampling rule was to collect information on all banks which the BankScope database identifies as listed banks and which, again according to information available on BankScope, are incorporated in one of the 32 countries we selected for our analysis. The countries chosen are the G10 countries in addition to a number of relatively well developed emerging market economies.[28] The BankScope database provided information for the years 1993–2000. Accounting data were collected from the BankScope database for each bank for which some observations were available. This procedure yielded an initial sample of 729 banks. As a result of keeping banks for which the time series is shorter than eight years the initial sample is unbalanced.

We identified weekly series of equity prices for each bank where available on Bloomberg and computed the standard deviation of returns for each year and each bank. Equity price series were available for the majority of banks going back to the start of 1993. Banks whose price series was shorter were kept in the sample.

Outliers for the capital ratio were defined as all observations where equity was more than three times other liabilities. Although the chosen threshold is somewhat arbitrary, the aim was to exclude banks for which a different structural relationship might hold between bank capital and our market discipline and control variables than for retail banks. For instance, we aimed to exclude banks that had a very low share of deposit liabilities and which for that reason had very high capital ratios. 33 observations by a total of 9 banks were excluded in this way.[29]

[26] This is an important question in the light of the debate on the likely procyclical effects of capital requirements, see Ayuso et al. (2004). On the one hand, banks may use periods of expansion to accumulate capital through retained earnings. In addition, recessions are associated with loan defaults, which through higher provisions might eat into banks' earnings and (possibly) capital. One might therefore expect capital ratios to be procyclical. On the other hand, banks may face higher loan demand during periods of economic expansion. In addition, banks might be overconfident in boom times and increase their lending, but reduce supply when they are caught out by losses that realise in recessions, see Berger and Udell (2004). Banks' balance sheets might therefore expand in boom times and contract in recessions, so that capital ratios might be expected to be countercyclical.

[27] Borio et al. (2001) report simple correlations between capital ratios and GDP growth for a number of countries. They find that measured capital ratios are pro-cyclical in some countries and counter-cyclical in others.

[28] The countries in the sample are Austria, Australia, Argentina, Belgium, Brazil, Canada, Chile, Finland, France, Germany, Greece, Hong Kong, Indonesia, Ireland, Israel, Italy, Japan, Korea, Malaysia, the Netherlands, Norway, Poland, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, the UK and the US.

[29] As regards the independent variables a procedure based on the Welsch distance was used in order to eliminate influential data points. Observations for which the Welsch distance was greater than a cut-off value of $3\sqrt{k}$ (where k represents the number of independent variables in the model including the constant) were thus eliminated, leading to an exclusion of on average about 50 observations, but substantially improving the precision of our point estimates.

Table 1
Summary statistics for the bank-specific variables

	Mean	Standard deviation			Overall coefficient of variation	Min	5th percentile	Median	95th percentile	Max	No. of obs.
		Overall	Between[a]	Within[b]							
Risk and capital variables											
Capital ratio	0.10	0.19	0.22	0.08	1.84	−0.56	0.03	0.08	0.20	2.95	5027
Logsize	15.59	1.78	1.80	0.35	0.11	9.14	12.67	15.53	18.72	20.97	5043
Roe	0.09	0.38	0.20	0.33	4.22	−8.72	−0.07	0.12	0.27	3.28	4880
Provisions	0.01	0.11	0.05	0.10	8.51	−3.97	0.00	0.00	0.04	5.01	4509
Stdev	0.05	0.23	0.10	0.21	4.66	0.00	0.01	0.04	0.11	14.94	4267
Market discipline variables											
Support	0.38	0.49	0.49	0	1.28	0	0	0	1	1	1981
Bankdeposits	0.20	0.23	0.23	0.07	1.19	0	0.00	0.11	0.76	1	3335
Uninsured	0.14	0.14	0.14	0.05	1.00	0	0.01	0.10	0.41	0.91	2476
Listing	0.31	0.46	0.45	0	1.50	0	0	0	1	1	5027
Rating	0.54	0.50	0.50	0	0.92	0	0	1	1	1	5027
Disclosure	0.65	0.22	0.18	0.13	0.35	0	0.05	0.75	0.85	0.95	4916

All variables are described in Table B.1 in Appendix B.

[a] The between standard deviation is the standard deviation across banks of the average across time for each bank. It therefore ignores any variation over time.

[b] The within standard deviation is the average across banks of the standard deviation across time for each bank. It therefore ignores any cross-sectional variation.

Table B.1 (in Appendix B) summarises the data source and variable definition for all variables used. Table 1 presents some aggregate summary statistics about the main variables of interest. It shows that some variables vary little or not at all over time. For example, the within variation is considerably lower than the between variation for the capital ratio and the bank deposit ratio. The within variation of the support rating, the US listing and the rating variables is zero, indicating the importance of the cross-sectional dimension.

Note also that the number of observations available for the regression analysis changes according to which variables are included in the regressions. The most restrictive variables in terms of sample size of the variables are the support rating, the bank deposit ratio and the ratio of uninsured liabilities. The support rating is only available for about 290 banks and no data exist for Austrian and Belgian banks. Including the bank deposit ratio reduces the sample to about 530 banks. This variable was not obtained for US banks (the US is otherwise the country most strongly represented in our sample). The same applies to the ratio of uninsured liabilities, for which bank deposits are the main component. Further statistics on the main variables by country are provided in Table B.2 (in Appendix B).

3.4. Estimation procedure

One major difficulty for our analysis is that some of the market discipline variables are likely to be endogenous, i.e. themselves dependent on bank capital. While the safety net variable (Support) is clearly strictly exogenous from the point of view of the bank, endogeneity is likely to be a problem both for the funding and disclosure variables. In particular, banks that hold little capital may have to rely on attracting bank deposits or other uninsured funding in order to fund their assets. This would result in a negative relationship between capital and the bank deposit ratio and between capital and the ratio of uninsured liabilities. On the other hand, banks that

hold little equity capital could be perceived as risky by investors. This could increase their cost of uninsured funding and reduce their reliance on such funds, resulting in a positive relationship between capital and bank deposits and between capital and uninsured liabilities, see Covitz et al. (2004).[30]

Similarly, bank disclosure may be determined jointly with the amount of capital a bank chooses to hold. Again, this may affect the results, in two ways. First, a bank that wishes to raise more equity in the capital market may need to increase its disclosure in order to lower its cost of equity capital. The effect of this reverse causality would result in a positive relationship between disclosure and capital. A negative relationship may arise when capital and disclosure are alternative mechanisms to attract deposits. Depending on the marginal cost of holding equity capital relative to the cost of disclosing information, some banks may disclose more information while others decide to hold more capital. Across banks, this would result in a negative relationship between disclosure and capital, which may obscure the potential positive relationship arising from market discipline.[31]

Endogeneity problems were likely to affect the measured effect of the market discipline variables, such as disclosure, bank deposits and uninsured funding on bank capital. Potential endogeneity biases therefore needed to be addressed by a suitable choice of estimation method. In particular, an instrumental variables Two Stage Least Squares (TSLS) procedure was employed.[32] The first-stage regression was used to generate predicted values that take account only of the exogenous information. The predicted value of the first-stage regression, rather than the actual value was then used in the second stage regression. The TSLS approach was adopted for three endogenous variables: the ratio of interbank deposits, the ratio of uninsured liabilities and the disclosure index. The other two disclosure variables—US Listing and Rating—are likely to suffer from an endogeneity bias to a lesser extent, since these are fixed across all years. In addition, again because these variables are fixed across time, it is much harder to satisfactorily predict their values from available exogenous variables.

We have used the same set of instruments for the funding variables and for the disclosure index. The set of instruments includes a number of bank level variables (loan ratio, return on equity, size, market share and the cost–income ratio). While all of these variables are endogenous over longer horizons, they are unlikely to be controlled by the bank over a one-year period. In addition to these bank-level variables, we exploit the cross-country dimension of our data set and include country dummy variables, which would reflect the average level of the instrumented variable in each country. Since we know that all three variables vary through time, we also include a linear time trend as an explanatory variable. Finally, to make sure that as a result of including year we do not create variables which have a simple time trend, we interact year with the set of country dummy variables. As a result the predicted change in the instrumented variable through

[30] However, in their regressions, Covitz et al. (2004) do not find capital ratios to have a significant effect on the decision to issue subordinated debt.

[31] Even if disclosure was exogenous and not chosen by the firm, there might be reason to believe that banks with low disclosure have an incentive to aim for higher equity capital in order to reduce the cost of debt finance. However, equity capital is not cheap. For a negative relationship between disclosure and equity capital to hold with exogenous disclosure one would require that the relative cost of equity and debt depended on the amount of disclosure. In particular, it would have to be true that for low disclosure banks equity capital is cheap relative to the cost of debt. There is evidence that the cost of debt capital is higher for low disclosure firms, Sengupta (1998). But equally, there is evidence that the cost of equity capital is higher if disclosure is low, Botosan (1997). There appears to be no existing evidence on how the relative costs of equity and debt might depend on disclosure.

[32] This method is standard, see Wooldridge (2002).

time will be specific to each country and therefore mimic the actual change in that variable at the country level. Again, this approach is motivated by our finding that the average change in the variables is different across countries.

Diagnostic tests on the residuals of this regression (not shown here) suggest non-normal residuals, which imply that GLS procedures may be preferred to OLS since the former give less weight to large residuals when minimising the (weighted) sum of squared residuals to derive parameter estimates. Further tests point to the presence of both heteroskedasticity and autocorrelation in the residuals. As a result, we employ the random effects feasible generalised least squares (FGLS) estimator, which estimates the error variance–covariance matrix assuming that the error follows a panel-specific autoregressive process.[33] In addition, the variance of the error is allowed to be different across units (heteroskedastic).[34]

4. Results

Table 2 presents the main results. Column (1) shows a basic model with bank-specific and country-specific control variables. We add one of the market discipline variables at a time to this basic model in columns (2) to (7). The expectation of government support, as measured using Fitch support ratings, is found to have a negative effect on bank capital buffers, column (2), reflecting the moral hazard incentives arising from implicit government insurance. As regards the funding variables we find that a larger proportion of interbank deposits is associated with larger capital ratios, consistent with a disciplining role of the interbank market. Moreover, the ratio of uninsured funding—composed of interbank funds and subordinated debt—likewise, is associated with a larger capital ratio, all else equal. Finally, we find that bank disclosure is associated with larger capital ratios, across all three measures employed.[35] In particular, all of the US listing variable, the ratings variable and the disclosure index show a statistically significant positive coefficient, suggesting that more disclosure leads banks to hold larger capital buffers, all else equal.

In addition to judging the statistical significance of the coefficients on the market discipline variables it is useful to check the economic relevance of the size of these coefficients. All the bank-level market discipline variables range between zero and unity. The coefficient on each of these variables can therefore be interpreted as the absolute change in the capital ratio resulting from a unit increase in the market discipline variable. To put this in perspective note that the mean capital ratio is about 10%. First, banks thought likely to receive government support have capital ratios about half a percentage point lower than those not expected to receive government support. Second, the coefficient on uninsured funding suggests that a bank which is financed fully by uninsured funds would have a capital ratio some 5 percentage points higher than a bank that had no uninsured liabilities. Third, as regards the disclosure variables, rated banks have capital ratios, on average, 0.6 percentage points higher than banks without a rating, while the coefficients

[33] More formally, it is assumed that the error follows a process of the form $\varepsilon_{it} = \rho_i \varepsilon_{it-1} + \upsilon_{it}$. Likelihood-Ratio Tests for models with panel-specific autocorrelation coefficients versus models with a common AR(1) coefficient across panels support the former specification.

[34] Formally, this means that $E(\varepsilon_{it}^2) = \sigma_i^2$. Our estimation procedure also assumes that errors are not contemporaneously correlated across banks, i.e. $E(\varepsilon_{it}\varepsilon_{jt}) = 0$. Models that assume contemporaneously correlated errors can only be applied to balanced samples. But as a result of limited data availability for some of our key variables all our regressions are estimated on unbalanced samples.

[35] Importantly, the effect of the US listing variable turns out to be robust when the regression is run on a sub sample excluding all US banks.

Table 2
The effect of market discipline on capital ratios

	(1) Cap	(2) Cap	(3) Cap	(4) Cap	(5) Cap	(6) Cap	(7) Cap
Logsize	−0.0098***	−0.0049***	−0.0147***	−0.0137***	−0.0100***	−0.0117***	−0.0116***
	(50.01)	(15.44)	(47.40)	(41.17)	(67.74)	(48.47)	(66.34)
Roe	0.0585***	0.0284***	0.0401***	0.0409***	0.0621***	0.0618***	0.0581***
	(49.19)	(10.70)	(29.61)	(23.55)	(71.43)	(60.94)	(52.57)
Stdev (lag 1)	0.0074***	−0.0107***	0.0190***	0.0254***	0.0050**	0.0035	0.0122***
	(3.04)	(3.86)	(7.17)	(3.68)	(2.16)	(1.50)	(8.10)
Provisions (lag 1)	−0.0394***	−0.0565***	−0.0432***	−0.0287***	−0.0530***	−0.0533***	−0.0488***
	(4.42)	(3.01)	(7.75)	(3.11)	(8.36)	(5.91)	(15.91)
Year	0.0016***	0.0012***	0.0011***	0.0008***	0.0017***	0.0014***	0.0000***
	(21.51)	(6.37)	(12.17)	(6.49)	(25.77)	(20.12)	(9.65)
GDP_g	−0.0213***	0.0735***	−0.0507***	−0.0362***	−0.0366***	−0.0335***	0.0116**
	(5.75)	(9.87)	(8.74)	(5.30)	(10.33)	(7.92)	(2.47)
Capreq	0.0151***	0.0172***	0.0150***	0.0179***	0.0165***	0.0149***	0.0145***
	(20.47)	(32.96)	(16.62)	(19.49)	(20.42)	(20.41)	(21.42)
Rlaw	0.0006	0.0022***	0.0023***	0.0027***	0.0003	0.0008*	−0.0002
	(1.32)	(5.61)	(4.79)	(7.29)	(1.00)	(1.88)	(0.55)
Mcap	0.0002	−0.0031**	0.0027***	0.0010	0.0002	0.0038***	0.0049***
	(0.32)	(2.37)	(2.86)	(1.02)	(0.29)	(6.27)	(6.67)
Srights	−0.0005	0.0037***	0.0007**	−0.0003	−0.0037***	−0.0013***	−0.0036***
	(1.50)	(9.57)	(2.00)	(0.77)	(8.07)	(4.89)	(12.63)
Entry	0.0046***	0.0043***	0.0056***	0.0056***	0.0041***	0.0045***	0.0019***
	(16.06)	(11.36)	(13.70)	(13.60)	(11.41)	(29.33)	(4.67)
Explicit	0.0093***	0.0028	−0.0055**	−0.0030	0.0067***	0.0088***	0.0111***
	(4.41)	(1.31)	(2.04)	(1.29)	(2.74)	(4.75)	(5.73)
Unlimited	−0.0188***	−0.0097***	−0.0059***	−0.0077***	−0.0111***	−0.0163***	−0.0214***
	(25.40)	(7.08)	(5.48)	(5.60)	(9.58)	(25.44)	(24.83)
Support		−0.0055***					
		(3.93)					
Bankdeposits			0.0573***				
			(24.65)				
Uninsured				0.0489***			
				(7.17)			
Listing					0.0130***		
					(9.08)		
Rating						0.0060***	
						(10.52)	
Disclosure							0.0648***
							(18.25)
Constant	−3.2082***	−2.3842***	−1.9777***	−1.5466***	−3.2919***	−2.7918***	0.0000
	(20.91)	(6.49)	(11.30)	(6.10)	(24.94)	(19.31)	(.)
Observations	2591	989	1441	1133	2590	2593	2570
Number of id	454	180	269	225	454	454	451
Goodness of fit	0.41	0.46	0.47	0.51	0.41	0.39	0.42
Log likelihood	8873	3368	5147	4006	8882	8864	8694

Results of bank-level panel regressions of capital ratios on market discipline and control variables, based on a cross-country sample of banks observed over the 1993–2000 period. Absolute value of z statistics in parentheses. All variables are described in Table B.1 in Appendix B.

* Significant at the 10% level.
** Idem, 5%.
*** Idem, 1%.

on the US Listing and the Disclosure index are more sizeable, implying an increase in the capital ratio of some 1.3 and 6.5 percentage points respectively, as a result of an increase in disclosure from zero to unity.

Table 2 yields a number of additional results that are worth drawing out. First, as regards the country specific controls, we find statistically strong evidence that restrictions on entry are associated with larger capital buffers and thus reduced risk-taking. This evidence is consistent with the theory outlined by Keeley (1990), according to which entry restrictions reduce competition, increase franchise values and thus reduce the incentive to take risk. Moreover, we find that banks in countries with a strong tradition of law and order appear to keep larger capital buffers, where the evidence is consistent with prior evidence presented by Demirgüç-Kunt and Detragiache (2002). Moreover, in line with Saunders et al. (1990), there is some, if weaker, evidence that banks in countries where shareholder rights are strong appear to hold smaller capital buffers. There is clear evidence that capital requirements increase capital, while there is only relatively weak evidence to support the hypothesis that the level of financial development, as reflected in the size of the stock market, has an effect on bank capital holdings. Our results on deposit insurance are consistent with the notions that explicit insurance per se might reduce moral hazard incentives, resulting in larger capital buffers, while generous protection exacerbates risk-taking incentives, see Gropp and Vesala (2004) and Demirgüç-Kunt and Detragiache (2002), respectively. Finally, on balance and again in line with previous research, we find that GDP growth affects capital ratios negatively.

As regards the bank-specific controls, a measure of ex ante risk (stdev) tends to be associated with larger buffers, while a measure of ex post realised risk (provisions) is shown to decrease capital, in line with Flannery and Rangan (2004) and Ayuso et al. (2004) respectively. As expected, we also find larger banks to hold smaller capital buffers and more profitable banks to hold larger buffers.

In sum, the regression results yield plausible results as regards a number of bank-level and country-level drivers of capital buffers. Moreover, they are consistent with the notion that an increase in market discipline can enhance the incentives for banks to limit their risk of insolvency. The results show that a generous safety net—measured by the Fitch public support rating—results in lower capital buffers, everything else being equal. In addition there is evidence that interbank deposits and uninsured funding more generally have a disciplining effect. Finally, banks that disclose more information—measured by whether a bank has a US listing, whether it is rated or by the disclosure index—tend to choose a higher capital buffer and thus more protection against unexpected losses than banks that disclose less.

5. Extensions

Our main results point to the general effectiveness of market discipline. But important questions remain: under what conditions is market discipline likely to be less effective? And under what conditions might its effectiveness be enhanced?

5.1. High versus low support—interactions

One hypothesis we can test is that the disciplining effect of disclosure as well as that of uninsured liabilities may be weaker for those banks that enjoy a high degree of implicit government guarantees. In particular, we hypothesise that for banks for which yields do not respond to variations in risk, as a result of a high probability of a bail-out, the presence of uninsured (interbank)

liabilities will not result in a strong incentive to maintain high capital buffers. Similarly, for banks that enjoy a high probability of bail-out, disclosure may work less well as an incentive mechanism which induces banks to keep high capital buffers.

We test these hypotheses by concentrating on the subset of banks in our sample that are rated by Fitch IBCA and consequently have a public support rating. For this sample we interact the support variable with the disclosure index as well as with the bank deposit variable.[36] Two results stand out, see Table 3. First, while the benchmark effect of disclosure is positive in column (1), government support appears to reduce this effect, suggesting that the effectiveness of disclosure in providing incentives to hold higher capital buffers is less pronounced if the market expects the bank to be bailed out in case of failure. Second, while the benchmark effect of interbank deposits continues to be positive, again government support expectations appear to reduce the disciplining effect of interbank deposits for capital buffers.[37]

In sum, these results point to some important limitations to the effectiveness of market discipline mechanisms. For banks for which government support is strong, neither uninsured funding sources nor transparency of risk choices can be relied upon to discipline banks.

5.2. *Country characteristics—interactions*

We further explore how market discipline might be affected by a number of country-characteristics. First, we conjecture that competition should affect the marginal effect of market discipline on bank risk-taking. To see this note that when competition is fierce, franchise values will be low and banks have strong incentives to take a gamble. In this case if market discipline is strong, this would prevent banks from taking excessive risk. When competition is not as strong, however, franchise values will be high and there is little incentive for managers to take excessive risk. In this case whether or not market discipline is strong should not lead to a marked difference in risk taking. In sum, if competition is relatively fierce, this should increase the marginal effect of market discipline on banks' propensity to take risks.

We examine this hypothesis by interacting our measure of entry restrictions with the market discipline variables. Since entry restrictions should be associated with a reduced degree of competition between banks, we should expect the effect of market discipline to be less pronounced if entry restrictions are high. Consistent with this hypothesis we find that the interaction with entry yields a negative effect for most (5 out of 6) of our market discipline variables (see Table 4). The effect of all of US listing, rating variable, disclosure, bank deposits and uninsured funding on capital buffers is reduced when entry restrictions are high and competition is slack.[38]

[36] We have also interacted support with the overall level of uninsured funding. However, the number of observations available for this exercise is smaller—due to a number of banks not reporting their levels of subordinated debt. As a result, a number of variables, including 'uninsured' and the interaction term turned out insignificant, pointing to a relatively severe multicollinearity problem. The results are therefore not shown.

[37] In some of the exercises shown in this section the effect of support is measured as positive, in some others support retains the negative effect shown in Table 2. A paper by Cordella and Yeyati (2003) argues that support has two competing effects on risk-taking incentives. First, support increases the incentive to gamble. But second, support increases franchise value and this in turn may reduce moral hazard. Overall, the balance of the evidence in this paper is in favour of the first effect.

[38] In principle, a positive coefficient on disclosure is consistent with two alternative channels of market discipline. First, more disclosure may result in an incentive to reduce risk-taking by increasing capital. Second, more disclosure may result in a lower cost of capital. Note that the 'difference in difference' results presented here strengthen the case for an interpretation of market discipline effects as working through incentives. This is because competition should affect the marginal effect of disclosure on risk-taking, rather than on the cost of capital.

Table 3
Support interactions

	(1) Cap	(2) Cap
Logsize	−0.0072***	−0.0099***
	(19.08)	(15.56)
Roe	0.0324***	0.0295***
	(13.92)	(20.79)
Stdev (lag 1)	0.0116**	0.0167***
	(2.53)	(4.38)
Provisions (lag 1)	−0.0888***	−0.1211***
	(5.16)	(19.24)
Year	0.0004***	0.0005***
	(3.49)	(2.87)
GDP_g	0.0651***	−0.0150**
	(7.40)	(2.11)
Capreq	0.0190***	0.0168***
	(36.23)	(21.02)
Rlaw	0.0020***	−0.0003
	(5.82)	(0.46)
Mcap	−0.0003	−0.0050***
	(0.32)	(3.58)
Srights	−0.0002	−0.0000
	(0.51)	(0.02)
Entry	0.0027***	0.0046***
	(6.25)	(11.11)
Explicit	0.0095***	−0.0021
	(4.28)	(0.98)
Unlimited	−0.0097***	0.0006
	(6.32)	(0.35)
Support	0.0132*	0.0099***
	(1.89)	(3.45)
Disclosure	0.0933***	
	(11.73)	
Support ∗ Disclosure	−0.0256**	
	(2.56)	
Bankdeposits		0.0181***
		(2.60)
Support ∗ Bankdeposits		−0.0238***
		(2.86)
Constant	−0.8492***	−0.8921***
	(3.83)	(2.65)
Observations	983	651
Number of id	179	128
Goodness of fit	0.51	0.46
Log likelihood	3352	2310

Bank-level panel regression results on the differential effect of market discipline on capital ratios for banks with high and with low support expectations. Absolute value of z statistics in parentheses. All variables are described in Table B.1 in Appendix B.

* Significant at the 10% level.
** Idem, 5%.
*** Idem, 1%.

Table 4
Interaction with country-specific variables[a]

	Interaction dummy:	
	Entry	Bank crisis
Support	0.0078**	−0.0136***
	(2.52)	(9.37)
Support ∗ Dummy	−0.0019***	0.0148***
	(3.54)	(5.14)
Bankdeposits	0.2038***	0.0312***
	(8.53)	(6.90)
Bankdeposits ∗ Dummy	−0.0234***	0.0620***
	(6.59)	(6.11)
Uninsured	0.2528***	0.0365***
	(5.87)	(6.09)
Uninsured ∗ Dummy	−0.0275***	0.2119***
	(4.32)	(8.69)
Listing	0.0426***	0.0120***
	(4.08)	(7.72)
Listing ∗ Dummy	−0.0041***	−0.0237***
	(2.82)	(5.38)
Rating	0.0652***	0.0001
	(14.36)	(0.13)
Rating ∗ Dummy	−0.0088***	0.0165***
	(12.48)	(15.64)
Disclosure	0.1467***	−0.0034
	(6.42)	(0.54)
Disclosure ∗ Dummy	−0.0200***	0.0948***
	(5.69)	(12.10)

Bank-level panel regression results on the differential effect of market discipline on capital ratios for countries with high versus with low entry restrictions and for countries that suffered a banking crisis over the 1993–2000 period, respectively. Absolute value of z statistics in parentheses. All variables are described in Table B.1 in Appendix B.

[a] Regressions are based on the basic model as in Table 2 including the relevant dummy variable and the above interaction terms.

** Significant at the 5% level.

*** Idem, 1%.

Second, a number of countries experienced a banking crisis during our sample period (1993–2000). According to Caprio and Klingebiel (2003) these are Argentina (1995), Brazil (1994–1999), Indonesia (1994 and 1997–), Japan (1991–), Korea (1997–), Malaysia (1997–), Thailand (1997), Poland (1990s), Turkey (1994). We therefore explore whether the effect of market discipline may be different for crisis countries and for those countries that did not experience a crisis during our sample period. We conjecture that the effect of market discipline on capital should be more pronounced in countries that experienced a banking crisis. The reason is that in crisis countries, franchise values are likely to be low. This would exacerbate risk taking incentives and increase the difference in risks taken between those banks for which market discipline is weak and those banks for which market discipline is strong.

Consistent with this conjecture we find that the effect of market discipline on bank capital buffers is more pronounced for crisis countries for most (4 out of 6) market discipline variables.

All of rating, disclosure, bank deposits and uninsured funding have stronger effects on bank capital in countries that underwent a banking crisis.

6. Robustness

In this section we report a number of further exercises that were undertaken to probe the overall robustness of our results. In particular, we introduce a number of changes to the benchmark specification shown in Table 2, above, and check whether the results change materially.

First, our benchmark regression may not account exhaustively for all aspects of the bank's environment that might differ across countries and that might conceivably have an independent effect on the size of the capital buffers held by banking firms. One way of making sure that we account for all (time-invariant) differences across countries is to replace the set of country controls by a set of country dummy variables. Note that this is a strong test as regards the robustness of our effects on the market discipline variables, since part of their explanatory power might derive from cross-country differences in their average value. Table 5 shows the results of this exercise. Overall, we find our results to be robust to the inclusion of country fixed effects for most (5 out of 6) of the market discipline variables.

Second, in our sample banks from countries with a high level of economic development are pooled with banks from less well developed economies (such as Malaysia, Turkey and Chile). While country-fixed effects take care of unexplained differences across these two groups in the amount of capital banks hold on average, the inclusion of less well developed economies in the regression might conceivably still have an effect on the measured slope coefficients on the market discipline variables. To check whether this is the case we drop all countries from the sample that show a lower than average level of economic development, as measured by per capita GDP in 2000.[39] Table 6 shows the results. We find that the exclusion of less well developed economies does not have a marked effect on the measured slope coefficients and that the sign and size of all market discipline variables are as in the benchmark regressions shown in Table 2. One reason for this is that the sample of banks from less developed economies is quite small and that exclusion of these countries leads to the exclusion of at most 65 banks in the regressions.[40] Another is that our benchmark regressions already incorporate an effective outlier control that takes care of strong influences on the measured slope of particular observations.

Third, while we have routinely included a time trend to account for the fact that capital ratios are trending up, on average, through the sample period, a tighter control is to introduce time fixed effects. These account for any average change year on year in average capital buffers without imposing these changes to be the same. Note again that this a reasonably tough test for our market discipline variables since some of the changes in capital that are common across countries might in fact be driven by changes in market discipline that are common across countries. Table 7 shows the results. We find that our results are robust to the inclusion of time

[39] The countries that are above average on this measure are Australia, Austria, Belgium, Canada, Finland, France, Germany, Italy, Hong Kong, Ireland, Japan, Netherlands, Norway, Singapore, Spain, Sweden, Switzerland, Taiwan, United Kingdom, USA.

[40] For the same reason it is difficult to draw firm conclusions on the sign and size of coefficients for the subsample of less developed economies. While in regressions using this subsample some of the coefficients on the market discipline and control variables are found not significant (disclosure index, uninsured) or change sign (support, bank deposits), this is true also of a number of control variables. This suggests that the sample of banks from less developed economies is likely too small to allow separate inferences for this group of countries. The results are therefore not shown.

Table 5
Country dummies[a]

	(1) Cap	(2) Cap	(3) Cap	(4) Cap	(5) Cap	(6) Cap
Logsize	−0.0039***	−0.0094***	−0.0102***	−0.0109***	−0.0097***	−0.0083***
	(9.99)	(31.38)	(35.16)	(44.23)	(42.34)	(37.67)
Roe	0.0219***	0.0439***	0.0458***	0.0581***	0.0603***	0.0540***
	(31.90)	(34.85)	(25.51)	(61.52)	(93.96)	(52.70)
Stdev (lag 1)	−0.0057***	0.0020	0.0166***	−0.0020	−0.0082***	−0.0081***
	(3.98)	(0.54)	(2.59)	(0.59)	(3.81)	(3.22)
Provisions (lag 1)	0.1368***	−0.0244***	−0.0195**	−0.0198***	−0.0814***	−0.0412***
	(7.05)	(3.94)	(2.03)	(2.70)	(16.26)	(5.07)
Year	0.0008***	0.0011***	0.0010***	0.0013***	0.0001***	0.0013***
	(6.97)	(15.97)	(9.87)	(17.89)	(68.93)	(14.46)
Support	−0.0024**					
	(2.17)					
Bankdeposits		−0.0301***				
		(3.81)				
Uninsured			0.0516***			
			(4.52)			
Listing				0.0105***		
				(7.94)		
Rating					0.0074***	
					(17.37)	
Disclosure						0.0404***
						(7.12)
Constant	−1.5020***	−1.9856***	0.0000	−2.4589***	0.0000	−2.3142***
	(6.35)	(14.12)	(.)	(16.34)	(.)	(13.51)
Observations	1170	1699	1255	1707	2864	2841
Number of id	219	322	252	324	507	503
Goodness of fit	0.64	0.48	0.06	0.47	0.43	0.44
Log likelihood	4045	6068	4543	5981	9494	9791

Bank-level panel regression results on the effect of market discipline on capital ratios when a set of country dummy variables is included in lieu of country-specific variables. Absolute value of z statistics in parentheses. All variables are described in Table B.1 in Appendix B.

[a] Country dummies are included in this regression, but coefficients not shown.

** Significant at the 5% level.

*** Idem, 1%.

fixed effects, with all market discipline variables retaining the sign and significance shown in the benchmark.

Finally, we were concerned that some of the bank-level control variables used in our model of bank capital, such as stdev, provisions and return on equity might introduce endogeneity biases. As a check on our results we drop all of roe, stdev and provisions. Table 8 shows the results. It turns out that the sign and significance of all market discipline variables is robust to the exclusion of potentially endogenous bank-specific variables.[41]

[41] Note that omitting these variables does not necessarily result in a superior specification, since such an omission in turn might create omitted variable biases. Interestingly, omitting (cyclical) bank-specific variables, results in a change in the sign of the coefficient on GDP growth. This could suggest that capital ratios are high in upturns and low in recessions, in contrast to the benchmark results and in contrast to Ayuso et al. (2004).

Table 6
Developed economies

	(1) Cap	(2) Cap	(3) Cap	(4) Cap	(5) Cap	(6) Cap	(7) Cap
Logsize	−0.0078***	−0.0034***	−0.0116***	−0.0102***	−0.0083***	−0.0092***	−0.0091***
	(44.62)	(9.62)	(34.10)	(25.25)	(50.84)	(35.14)	(40.96)
Roe	0.0277***	0.0114***	0.0340***	0.0460***	0.0286***	0.0235***	0.0263***
	(17.72)	(6.83)	(21.72)	(19.13)	(18.25)	(14.99)	(17.25)
Stdev (lag 1)	−0.0092***	−0.0027	0.0101***	0.0069	−0.0063***	−0.0095***	−0.0081***
	(4.36)	(0.35)	(2.65)	(1.17)	(3.00)	(4.60)	(3.96)
Provisions (lag 1)	0.0254	−0.0343*	0.0602**	0.0093	0.0255	0.0780***	0.0163
	(1.39)	(1.71)	(2.50)	(0.38)	(1.41)	(4.85)	(1.40)
Year	0.0018***	0.0012***	0.0012***	0.0008***	0.0017***	0.0000**	0.0012***
	(16.58)	(6.08)	(10.49)	(5.15)	(15.40)	(2.37)	(8.64)
GDP_g	−0.0191***	0.0464***	−0.0485***	-0.0514***	−0.0254***	−0.0246***	−0.0187***
	(3.20)	(3.92)	(8.09)	(6.30)	(4.64)	(4.22)	(3.13)
Capreq	0.0206***	0.0176***	0.0168***	0.0157***	0.0222***	0.0153***	0.0218***
	(10.99)	(17.77)	(7.78)	(7.48)	(12.51)	(8.34)	(13.58)
Rlaw	0.0043***	0.0031***	−0.0019*	-0.0026**	−0.0017	0.0016	0.0062***
	(4.28)	(2.72)	(1.69)	(2.08)	(1.24)	(1.58)	(5.93)
Mcap	−0.0030***	−0.0051***	0.0001	−0.0005	−0.0012	0.0086***	0.0014
	(2.92)	(3.14)	(0.08)	(0.41)	(1.20)	(10.86)	(1.31)
Srights	0.0001	0.0039***	−0.0016***	−0.0026***	−0.0029***	−0.0016***	−0.0035***
	(0.23)	(8.78)	(3.18)	(5.21)	(5.78)	(3.93)	(7.76)
Entry	0.0044***	0.0029***	0.0040***	0.0047***	0.0029***	0.0046***	0.0047***
	(7.28)	(4.37)	(7.33)	(9.10)	(4.90)	(8.76)	(8.34)
Explicit	0.0088**	−0.0029	−0.0145**	−0.0166***	0.0091***	0.0026	0.0143***
	(2.38)	(0.80)	(2.57)	(2.96)	(3.10)	(0.69)	(3.70)
Unlimited	−0.0260***	−0.0092***	−0.0142***	−0.0050**	−0.0188***	−0.0231***	−0.0263***
	(22.97)	(6.19)	(6.77)	(1.98)	(12.65)	(21.04)	(23.66)
Support		−0.0171***					
		(9.09)					
Bankdeposits			0.0166**				
			(2.02)				
Uninsured				0.0294*			
				(1.74)			
Listing					0.0176***		
					(7.10)		
Rating						0.0058***	
						(8.31)	
Disclosure							0.0529***
							(11.03)
Constant	−3.6070***	−2.5000***	−2.3193***	−1.3897***	−3.3024***	0.0000	−2.4315***
	(16.47)	(6.11)	(9.74)	(4.65)	(14.95)	(.)	(8.73)
Observations	2297	795	1190	922	2297	2297	2287
Number of id	390	139	212	175	390	390	388
Goodness of fit	0.34	0.52	0.49	0.47	0.36	0.33	0.36
Log likelihood	8104	2851	4332	3336	8114	7987	8060

Bank-level panel regression results on the effect of market discipline on capital ratios when the sample is restricted to developed economies. Absolute value of z statistics in parentheses. All variables are described in Table B.1 in Appendix B.

* Significant at the 10% level.
** Idem, 5%.
*** Idem, 1%.

Table 7
Time dummies[a]

	(1) Cap	(2) Cap	(3) Cap	(4) Cap	(5) Cap	(6) Cap
Logsize	−0.0046***	−0.0131***	−0.0122***	−0.0096***	−0.0103***	−0.0093***
	(16.78)	(35.55)	(38.68)	(50.83)	(34.93)	(39.62)
Roe	0.0295***	0.0352***	0.0400***	0.0581***	0.0573***	0.0535***
	(11.90)	(28.40)	(24.22)	(50.53)	(49.15)	(39.68)
Stdev (lag 1)	−0.0141***	0.0133***	0.0076	0.0068**	0.0122***	0.0147***
	(6.93)	(3.14)	(1.04)	(2.39)	(5.27)	(5.07)
Provisions (lag 1)	−0.0462**	−0.0337***	−0.0370***	−0.0591***	−0.0539***	−0.0641***
	(2.00)	(8.23)	(3.68)	(11.54)	(5.83)	(13.65)
GDP_g	0.0519***	−0.0145**	−0.0207***	−0.0375***	−0.0156***	−0.0007
	(4.88)	(2.34)	(2.73)	(6.24)	(2.77)	(0.12)
Capreq	0.0169***	0.0156***	0.0184***	0.0160***	0.0155***	0.0150***
	(23.61)	(14.33)	(17.99)	(20.20)	(23.13)	(21.81)
Rlaw	0.0018***	0.0014**	0.0021***	−0.0004	0.0008**	0.0001
	(4.33)	(2.34)	(5.12)	(1.28)	(1.97)	(0.23)
Mcap	−0.0010	−0.0035***	−0.0020**	0.0018**	0.0015*	0.0022**
	(0.68)	(3.45)	(2.44)	(2.18)	(1.78)	(2.18)
Srights	0.0035***	0.0002	−0.0003	−0.0032***	−0.0007**	−0.0018***
	(8.13)	(0.51)	(1.06)	(7.12)	(2.01)	(5.20)
Entry	0.0042***	0.0058***	0.0052***	0.0040***	0.0049***	0.0046***
	(10.86)	(18.65)	(13.33)	(9.40)	(13.19)	(12.00)
Explicit	0.0034	−0.0042	−0.0053**	0.0090***	0.0123***	0.0135***
	(1.45)	(1.58)	(2.12)	(3.60)	(5.85)	(6.60)
Unlimited	−0.0101***	−0.0068***	−0.0076***	−0.0126***	−0.0166***	−0.0207***
	(6.59)	(5.83)	(4.64)	(11.75)	(22.65)	(28.38)
Support	−0.0050***					
	(3.59)					
Bankdeposits		0.0449***				
		(8.42)				
Uninsured			0.0465***			
			(4.93)			
Listing				0.0110***		
				(8.11)		
Rating					0.0057***	
					(7.53)	
Disclosure						0.0258***
						(4.34)
Constant	−0.0476***	0.1109***	0.0726***	0.0802***	0.0677***	0.0515***
	(4.79)	(8.16)	(5.62)	(8.97)	(8.16)	(6.30)
Observations	988	1440	1129	2589	2589	2568
Number of id	180	269	224	454	454	451
Goodness of fit	0.46	0.46	0.45	0.42	0.43	0.44
Log likelihood	3354	5169	4038	8846	8830	8805

Bank-level panel regression results on the effect of market discipline on capital ratios when time-fixed effects are included in lieu of a time trend. Absolute value of z statistics in parentheses. All variables are described in Table B.1 in Appendix B.

[a] Time dummies are included in this regression, but coefficients not shown.

* Significant at the 10% level.

** Idem, 5%.

*** Idem, 1%.

Table 8
Reduced form

	(1) Cap	(2) Cap	(3) Cap	(4) Cap	(5) Cap	(6) Cap
Logsize	−0.0053***	−0.0149***	−0.0136***	−0.0131***	−0.0156***	−0.0124***
	(18.06)	(41.44)	(72.02)	(64.43)	(63.36)	(99.74)
Year	0.0018***	0.0013***	0.0010***	0.0011***	0.0010***	0.0014***
	(10.02)	(12.23)	(10.32)	(10.13)	(8.26)	(14.94)
GDP_g	0.2639***	0.2005***	0.2929***	0.1170***	0.1114***	0.1501***
	(18.55)	(67.80)	(49.31)	(17.31)	(15.25)	(18.42)
Capreq	0.0202***	0.0165***	0.0141***	0.0164***	0.0129***	0.0171***
	(35.38)	(19.84)	(18.71)	(22.71)	(16.29)	(31.31)
Rlaw	0.0069***	0.0007	0.0017***	0.0004	0.0024***	0.0009**
	(14.49)	(1.55)	(4.08)	(1.28)	(5.67)	(2.26)
Mcap	−0.0114***	0.0010	0.0063***	0.0072***	0.0095***	−0.0009*
	(9.51)	(1.17)	(9.42)	(7.73)	(9.73)	(1.87)
Srights	0.0037***	0.0042***	0.0028***	0.0004	0.0003	0.0012***
	(9.35)	(10.58)	(10.58)	(1.49)	(1.00)	(7.06)
Entry	0.0038***	0.0083***	0.0077***	0.0077***	0.0078***	0.0065***
	(12.41)	(27.93)	(24.50)	(29.42)	(30.38)	(31.49)
Explicit	0.0115***	0.0066***	0.0083***	0.0180***	0.0139***	0.0192***
	(9.11)	(3.44)	(5.66)	(13.55)	(6.54)	(9.53)
Unlimited	−0.0072***	−0.0034***	−0.0038***	−0.0067***	−0.0079***	−0.0180***
	(4.10)	(3.09)	(3.42)	(7.09)	(9.24)	(20.15)
Support	−0.0052***					
	(4.72)					
Bankdeposits		0.0448***				
		(11.46)				
Uninsured			0.0472***			
			(9.43)			
Listing				0.0043***		
				(4.24)		
Rating					0.0157***	
					(19.93)	
Disclosure						0.0469***
						(16.93)
Constant	−3.7242***	−2.5489***	−1.8980***	−2.2092***	−1.8661***	−2.7990***
	(10.34)	(11.91)	(9.95)	(9.77)	(7.80)	(14.70)
Observations	1469	2367	1843	3998	3999	3795
Number of id	239	401	335	650	650	618
Goodness of fit	0.29	0.23	0.31	0.25	0.25	0.28
Log likelihood	4586	7814	5934	12851	12775	12281

Bank-level panel regression results on the effect of market discipline on capital ratios when potentially endogenous bank-specific controls are excluded from the equation. Absolute value of z statistics in parentheses. All variables are described in Table B.1 in Appendix B.

* Significant at the 10% level.
** Idem, 5%.
*** Idem, 1%.

7. Conclusions and caveats

This paper examines empirically the hypothesis that market discipline is effective in providing incentives for banks to limit their risk of default, by holding capital buffers against adverse

outcomes in portfolio risk. We analyse the effect of three sets of factors related to the strength of market discipline. These are

(i) the degree of implicit bailout guarantees (support),
(ii) the amount of uninsured liabilities in the bank's balance sheet (funding), and
(iii) the degree of observability of the bank's risk choices (disclosure).

In analysing these three sets of factors in a unified framework, this paper contributes to the existing literature in a number of ways. First, we assess whether implicit government support, as measured by the Fitch public support rating, exacerbates risk-taking incentives. In addition, we analyse whether uninsured (interbank) funding reduces risk-taking incentives. Finally, to our knowledge, this paper is the first to study empirically whether bank disclosure has any impact on risk-taking incentives.

Capital regressions test whether these market discipline factors affect the size of capital buffers banks hold, controlling for asset risk and other factors affecting bank capital. Our regressions yield results that are consistent with the notion that market discipline affects the incentives of banks to limit their risk of insolvency. We find that implicit government guarantees lead banks to choose lower capital buffers, ceteris paribus. We also find that a higher share of uninsured funding has a disciplining effect, leading banks to choose larger capital buffers, all else equal. And we find evidence in favour of the idea that banks that disclose more information on their risk profile and thus are subject to stronger market discipline limit their probability of default by choosing a higher capital buffer.

Our results are thus broadly supportive of recent policy initiatives that aim to strengthen financial stability by improving market discipline. They lend support in particular to the third Pillar of Basel 2, which encourages enhanced disclosure as a way of improving market discipline of banks. But our results also indicate that the beneficial effect of market discipline mechanisms is likely to be weaker for banks that benefit from implicit government guarantees.

Finally, this paper examines differences in the strength of risk-taking incentives and the relative effectiveness of market discipline across countries. A key result here is that competition increases risk-taking incentives, but that at the same time, in more competitive environments market discipline can play an enhanced role in curbing these incentives. This suggests that financial liberalisation and increases in competition more generally may harbour dangers for banking system stability in particular if market discipline on banks is weak. Finally, and consistent with the previous result, we find that risk-taking incentives appear stronger when countries undergo a banking crisis, but that market discipline again can play an important role in curbing these incentives.

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Appendix A. A disclosure index based on Fitch Bankscope information

As one of our market discipline variables, we have constructed a disclosure index using the BankScope database as our source of information. The purpose of this exercise is to arrive at bank-level information on disclosure. The basic idea of the index is to measure the level of detail which banks provide in their published accounts. To arrive at the disclosure index we define a number of dimensions of accounting information which we think can be mapped into indicators of bank risk. A total of 18 subindices are created which reflect whether the bank's accounts (as presented in BankScope) provide any detail on each dimension. The subindices are then aggregated to form a composite disclosure index.

The composite index is defined as

$$\mathrm{DISC} = \frac{1}{20}\sum_{i=1}^{18} s_i$$

where each subindex, s_i, can be related to one or more sources of risk (interest rate risk, credit risk, liquidity risk, market risk). We have defined a total of 18 subindices. Rather than ordering the subindices with respect to the source of risk on which they inform, the definition and ordering of the subindices follows the presentation in the BankScope database.

Table A.1 lists the subindices used to construct the composite disclosure score. For all subindices, we assign a 0 if there is no entry in any of the corresponding categories and a 1 otherwise, except for the capital subindex. For the latter, we assign a 0 if there is no entry in any of these categories, a 1 if there is one entry only, a 2 if there are two entries and a 3 if there are three or four entries. Note that whenever a bank provides information on three of these items, one can infer the fourth. Providing three items is therefore viewed as informationally equivalent to providing four items. The maximum attainable score on the sum of the subindices is 20.

Table A.1
Subindices used to construct the composite disclosure index

	Subindex	Categories
Assets		
Loans	S_1: Loans by maturity	Sub 3 months, 3–6 months, 6 months–1 year, 1–5 years, 5 years +
	S_2: Loans by type[a]	Loans to Municipalities/Government, Mortgages, HP/Lease, Other Loans
	S_3: Loans by counterparty	Loans to Group Companies, Loans to other Corporate, Loans to Banks
	S_4: Problem loans	Total Problem loans
	S_5: Problem loans by type	Overdue/Restructured/Other non-performing
Other earning assets	S_6: Securities by type (detailed breakdown)	Treasury Bills, Other Bills, Bonds, CDs, Equity Investments, Other Investments
	S_7: Securities by type (coarse breakdown)	Government Securities, Other Listed Securities, Non-listed Securities
	S_8: Securities by holding purpose	Investment Securities, Trading Securities

(*continued on next page*)

Table A.1 (*continued*)

	Subindex	Categories
Liabilities		
Deposits	S_9: Deposits by maturity	Demand, Savings, Sub 3 months, 3–6 months, 6 months–1 year, 1–5 years, 5 years +
	S_{10}: Deposit by type of customer	Banks Deposits, Municipal/Government
Other funding	S_{11}: Money market funding	Total Money Market Funding
	S_{12}: Long-term funding	Convertible Bonds, Mortgage Bonds, Other Bonds, Subordinated Debt, Hybrid Capital
Memo lines		
	S_{13}: Reserves	Loan Loss Reserves (Memo)
	S_{14}: Capital	Total Capital Ratio, Tier 1 Ratio, Total Capital, Tier 1 Capital
	S_{15}: Contingent Liabilities	Total Contingent Liabilities
	S_{16}: Off-Balance Sheet Items	Off-Balance Sheet Items
Income statement		
	S_{17}: Non-interest Income	Net Commission Income, Net Fee Income, Net Trading Income
	S_{18}: Loan Loss Provisions	Loan Loss Provisions

[a] The categories chosen reflect the presentation in the BankScope database.

Appendix B. Data

Table B.1
Variable definitions and data sources

Data source	Date	Variable	Description	Details
BankScope	2001	Provisions	Ratio of loan loss provisions	Ratio of loan loss provisions to total loans
		Support	Support rating	Support = 1 if FITCH IBCA support rating equals 1 or 2, 0 otherwise
		Bankdeposits	Bank deposit ratio	Ratio of deposits due to banks to total deposits
		Disclosure	Disclosure index	Disclosure index, as described in main text
		Listing	Second listing	Listing = 1 if bank is listed on NYSE, NASDAQ or AMEX, otherwise 0
		Rating	Rating	Rating = 1 if rated by Moody's, Standard&Poor or FITCH IBCA, otherwise 0
		ROE	Return on equity	Net income divided by the book value of equity from the previous period
		Cap	Equity ratio	Ratio of equity capital to debt and deposits
		Logsize	Log of total assets	Logarithm of total assets
Bloomberg	2001	Stdev	Standard deviation of assets	Standard deviation of weekly equity returns
International Financial Statistics (IFS)	2002	GDP_g	Real GDP growth	
Demirgüç-Kunt and Sobaci (2000)	2000	Explicit	Deposit insurance index	Explicit = 1 if the country has an explicit deposit insurance scheme
		Unlimited	Deposit insurance index	Unlimited = 1 if there exists an explicit scheme which provides unlimited coverage
Barth et al. (2001)	2001	Capreq	Minimum capital requirement	Capreq equals the amount of capital expressed in percent of risk-weighted assets all banks in a country are required to hold

(*continued on next page*)

Table B.1 (*continued*)

Data source	Date	Variable	Description	Details
		Entry	Entry into banking requirements	The sum of 8 sub-indices related to administrative entry requirements imposed by supervisors, as further described in Barth et al. (2001)
Beck et al. (1999)	1999	Mcap	Stock market capitalisation	Ratio of stock market capitalisation to GDP
La Porta et al. (1998)		Srights	Shareholder rights	The sum of 5 sub-indices related to shareholder rights, as described further in La Porta et al. (1998)
		Rlaw	Rule of Law	Assessment of the law and order tradition in the country produced by the country risk rating agency International Country Risk (ICR), on a scale of 1 to 10, as described further in La Porta et al. (1998)

Table B.2
Descriptive statistics on capital and market discipline variables by country

	Cap		Support		Bankdeposits		Uninsured		Listing		Rating		Disclosure	
	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean
Argentina	40	0.17	24	0	40	0.12	21	0.11	40	0.28	40	0.60	40	0.60
Australia	86	0.07	70	0.69	84	0.06	71	0.05	86	0.28	87	0.91	86	0.74
Austria	45	0.05	0	n/a	45	0.39	39	0.28	45	0	45	0.36	45	0.34
Belgium	12	0.05	0	n/a	8	0.42	8	0.23	12	0	12	0.67	12	0.61
Brazil	132	0.14	67	0.48	130	0.09	107	0.05	132	0	132	0.51	112	0.64
Canada	63	0.11	42	1	48	0.14	6	0.17	63	0.44	63	0.84	63	0.56
Chile	55	0.08	32	0.84	55	0.16	54	0.14	55	0.45	55	0.93	55	0.62
Finland	19	0.06	8	1	19	0.32	19	0.18	19	0	19	0.42	19	0.68
France	156	0.20	40	0.60	152	0.63	110	0.44	156	0	156	0.49	156	0.55
Germany	321	0.07	51	0.51	318	0.32	252	0.18	321	0.02	321	0.34	295	0.41
Greece	46	0.10	31	1	45	0.10	40	0.09	46	0.15	46	0.72	46	0.50
Hong Kong	108	0.20	64	0	65	0.04	47	0.39	108	0	108	0.59	108	0.71
Indonesia	98	0.06	69	0	73	0.12	64	0.10	98	0	98	0.70	93	0.60
Ireland	31	0.06	20	0.80	31	0.18	30	0.15	31	0	31	0.74	23	0.84
Israel	97	0.22	24	0.67	97	0.16	82	0.10	97	0	97	0.41	97	0.71
Italy	282	0.10	151	0.25	282	0.32	260	0.19	282	0	282	0.63	282	0.64
Japan	698	0.05	112	0.86	661	0.02	406	0.03	698	0	698	0.49	698	0.74
Rep. of Korea	98	0.05	73	0.67	54	0.43	21	0.23	98	0.06	98	0.75	98	0.62
Malaysia	65	0.21	29	0.55	62	0.20	45	0.18	65	0	65	0.45	65	0.64
Netherlands	38	0.30	21	0.62	31	0.22	30	0.16	38	0.34	38	0.63	38	0.57
Norway	98	0.07	40	1	98	0.14	98	0.11	98	0	98	0.41	98	0.77
Poland	79	0.17	50	0.14	78	0.22	64	0.18	79	0	79	0.63	79	0.55
Portugal	54	0.09	32	0.50	54	0.34	49	0.26	54	0.15	54	0.59	54	0.70
Singapore	47	0.17	32	1	44	0.19	32	0.18	47	0	47	0.85	47	0.65
Spain	146	0.12	100	0.32	146	0.19	146	0.17	146	0.11	146	0.74	146	0.71
Sweden	41	0.05	24	1	41	0.52	41	0.28	41	0	41	0.59	34	0.80
Switzerland	101	0.19	4	1	85	0.19	74	0.11	101	0.09	101	0.09	93	0.55
Taiwan	186	0.17	139	0.40	185	0.10	0	n/a	186	0	186	0.78	186	0.66
Thailand	66	0.07	62	0.35	66	0.10	54	0.11	66	0	66	0.94	51	0.63
Turkey	62	0.17	29	0	57	0.43	33	0.29	62	0	62	0.84	62	0.44
UK	184	0.09	117	0.33	183	0.20	173	0.11	184	0.17	184	0.79	184	0.69
USA	1489	0.10	432	0	3	1	0	n/a	1489	0.91	1489	0.44	1473	0.68

References

Alfon, I., Argimon, I., Bascunana-Ambros, P., 2004. What determines how much capital is held by UK banks and building societies? Occasional paper No 22. UK Financial Services Authority.

Amir, E., Harris, T.S., Venuti, E.K., 1993. A comparison of the value-relevance of US versus non-US GAAP accounting measures using Form 20-F reconciliations. J. Acc. Res. 31 (Supplement), 230–264.

Ayuso, J., Perez, D., Saurina, J., 2004. Are capital buffers procyclical? Evidence from Spanish panel data. J. Finan. Intermediation 13, 249–264.

Barth, J.R., Caprio, G., Levine, R., 2001. The Regulation and Supervision of Banks Around the World: A New Database. The World Bank.

Barth, J.R., Caprio, G., Levine, R., 2004. Bank regulation and supervision: What works best? J. Finan. Intermediation 13 (2), 205–248.

Basel Committee on Banking Supervision, 2003. The New Basel Capital Accord. Consultative document. Bank for International Settlements.

Baumann, U., Nier, E.W., 2004. Disclosure, volatility, and transparency: An empirical investigation into the value of bank disclosure. Fed. Reserve Bank New York Econ. Pol. Rev. 10 (2), 31–46.

Beck, T., Demirgüç-Kunt, A., Levine, R., 1999. A New Database on Financial Development and Structure. The World Bank.

Beck, T., Demirgüç-Kunt, A., Levine, R., 2005. Bank Concentration and Fragility: Impact and Mechanics. Working paper 11500. NBER.

Berger, A.N., 1991. Market discipline in banking. Proceedings of a Conference on Bank Structure and Competition. Federal Reserve Bank of Chicago, pp. 419–437.

Berger, A.N., 1995. The relationship between capital and earnings in banking. J. Money, Credit, Banking 27 (2), 432–456.

Berger, A.N., Udell, G.F., 2004. The institutional memory hypothesis and the procyclicality of bank lending behaviour. J. Finan. Intermediation 13 (4), 458–495.

Bliss, R.R., Flannery, M.J., 2002. Market discipline in the governance of US bank holding companies: Monitoring versus influence. Europ. Finance Rev. 6, 419–437.

Blum, J., 2002. Subordinated debt, market discipline, and banks' risk taking. J. Banking Finance 26 (7), 1427–1441.

Boot, A.W., Schmeits, A., 2000. Marked discipline and incentive problems in conglomerate firms with applications to banking. J. Finan. Intermediation 9, 240–273.

Borio, C., Furfine, C., Lowe, P., 2001. Procyclicality of the financial system and financial stability: Issues and policy options. BIS Pap. 1.

Botosan, C.A., 1997. Disclosure level and the cost of equity capital. Acc. Rev. 72 (3), 323–349.

Bushman, R.M., Smith, A.J., 2003. Transparency, financial accounting information and corporate governance. Fed. Reserve Bank New York Econ. Pol. Rev. 9 (1), 65–87.

Calomiris, C.W., Wilson, B., 2004. Bank capital and portfolio management: The 1930' 'Capital Crunch' and scramble to shed risk. J. Bus. 77 (3), 421–455.

Caprio, G., Klingebiel, D., 2003. Episodes of Systemic and Borderline Financial Crises. The World Bank.

Cordella, T., Yeyati, E.L., 1998. Public disclosure and bank failures. Discussion paper No. 1886. CEPR.

Cordella, T., Yeyati, E.L., 2003. Bank bailouts: Moral hazard vs. value effect. J. Finan. Intermediation 12, 300–330.

Covitz, D.M., Hancock, D., Myron, K.W., 2004. A Reconsideration of the risk sensitivity of US banking organization subordinated debt spreads: A sample selection approach. Fed. Reserve Bank New York Econ. Pol. Rev. 10 (2), 73–95.

Demirgüç-Kunt, A., Detragiache, E., 2002. Does deposit insurance increase banking system stability? An empirical investigation. J. Monet. Econ. 49 (7), 1373–1406.

Demirgüç-Kunt, A., Sobaci, T., 2000. Deposit Insurance Around the World: A Data Base. The World Bank.

Ellis, D.M., Flannery, M.J., 1992. Does the Debt Market Assess Large Banks' Risk? Time series evidence from money center CDs. J. Monet. Econ. 30 (3), 481–502.

Evanoff, D.D., Wall, L.D., 2000a. Subordinated debt as bank capital: A proposal for regulatory reform. Fed. Reserve Bank Chicago Econ. Perspect 24 (2), 40–53.

Evanoff, D.D., Wall, L.D., 2000b. The role of subordinated debt in bank safety and soundness regulation. In: Proceedings to the 36th Annual Conference on Bank Structure and Competition. Federal Reserve Bank of Chicago.

Flannery, M.J., 1998. Using market information in prudential bank supervision: A review of the US empirical evidence. J. Money, Credit, Banking 30 (3), 273–305.

Flannery, M., Rangan, K., 2004. What caused the bank capital build-up of the 1990s? Working paper No. 2004-03-03. FDIC Center for Financial Research.

Freixas, X., 1999. Optimal bail out policy, conditionality and creative ambiguity, financial markets group. Discussion paper No. 327. London School of Economics.

Gordy, M.B., 2003. A risk-factor model foundation for ratings-based bank capital rules. J. Finan. Intermediation 12, 199–232.

Gropp, R., Vesala, J., 2004. Deposit insurance, moral hazard and market monitoring. J. Finance 8 (4), 571–602.

Gropp, R., Vesala, J., Vulpes, G., 2002. Equity and bond market signals as leading indicators of bank fragility. Working paper Nr. 150. European Central Bank.

Hamalainen, P., Hall, J.B.M., Howcroft, B., 2001. A framework for implementing market discipline in financial regulatory design. Research paper No. 147/01. Loughborough University Banking Centre.

Hovakimian, A., Kane, E.J., Laeven, L., 2003. How country and safety-net characteristics affect bank risk-shifting. J. Finan. Services Res. 23 (3), 177–204.

Keeley, M.C., 1990. Deposit insurance, risk and market power in banking. Amer. Econ. Rev. 80, 1183–2000.

Kliger, D., Sarig, O., 2000. The information value of bond ratings. J. Finance 55 (6), 2879–2902.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., 1998. Law and finance. J. Public Econ. 106, 1113–1155.

Leutz, C., Verrecchia, R.E., 2000. The economic consequences of increased disclosure. J. Acc. Res. 38, 92–124.

Lindquist, K.G., 2003. Banks buffer capital: How important is risk? Norges Bank. Mimeo.

Marston, C.L., Shrives, P.J., 1991. The use of disclosure indices in accounting research: A review article. British Acc. Rev. 23, 195–210.

Matutes, C., Vives, X., 2000. Imperfect competition, risk taking and regulation in banking. Europ. Econ. Rev. 44, 1–34.

Merton, R.C., 1977. An analytic derivation of the cost of deposit insurance loan guarantees. J. Banking Finance 1, 3–11.

Myers, S., Majluf, N.S., 1984. Corporate financing and investment decisions when firms have information investors do not have. J. Finan. Econ. 13, 187–221.

Nier, E.W., 2005. Bank stability and transparency. J. Finan. Stability 1, 342–354.

Rochet, J.C., 1992. Capital requirements and the behaviour of commercial banks. Europ. Econ. Rev. 36, 1137–1178.

Saunders, A., Strock, E., Travlos, N.G., 1990. Ownership structure, deregulation, and bank risk taking. J. Finance 45 (2), 643–654.

Sengupta, P., 1998. Corporate disclosure quality and the cost of debt. Acc. Rev. 73 (4), 459–474.

Shrieves, R.E., Dahl, D., 1992. The relationship between risk and capital in commercial banks. J. Banking Finance 16, 439–457.

Suarez, J., 1994. Closure rules, market power and risk taking in a dynamic model of bank behaviour. DP No. 196. LSE Financial Markets Group.

Sironi, A., 2003. Testing for market discipline in the European banking industry: Evidence from subordinated debt issues. J. Money, Credit, Banking 35 (3), 443–472.

Wooldridge, J.M., 2002. Econometric Analysis of Cross Section and Panel Data. MIT Press.