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Ownership structure, market discipline, and banks' risk taking incentives under deposit insurance[♣]

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Abstract

The paper studies the effect of two governance factors, ownership structure and market discipline by creditors, on banks' risk-taking incentives in the presence of deposit insurance and related bank safety net components. A simple Jensen-Meckling-type model is developed, where optimal capitalization and the deposit-insurance-induced risk incentive are determined by equity and debt agency costs. Expectations on explicit and implicit deposit insurance determine the level of creditor discipline. It is demonstrated why shareholder control may have a non-linear effect on risk-taking, and how leverage partially determines the impact of the governance variables on risk. The implications of the model are tested on a panel of several hundred banks worldwide over the years 1994-2005. The empirical results strongly suggest a convex effect of insider ownership on risk, but whether the negative or positive effect dominates depends on the measure of risk used. Creditor discipline has an insignificant effect on risk as a stand-alone variable, but significantly tempers the effects of increased shareholder control, and reduces risk for poorly capitalized banks.

Key words: bank risk; ownership structure; market discipline; deposit insurance; corporate governance; capital structure

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1. Introduction

Banks' risk taking incentives is an issue of considerable importance for overall financial system stability – the more so the greater the importance of bank finance within a particular (national) financial system – and is therefore an issue of much interest for financial supervisory authorities, central banks, and equivalent government agencies entrusted with the task of overseeing financial and payment system stability in countries around the world. The importance of banks' risk taking has resulted in the imposition in most countries of various safety net arrangements targeting banks and intended, *inter alia*, to stave off excessive risk taking in banks and to protect bank customers from the possible consequences of such excessive risk taking should it occur. The importance of the issue has also sparked a considerable interest among researchers for the drivers of risky behavior within banking institutions in general and, in particular, the effects of the safety net arrangements on different bank stakeholder groups' taste for risk (i.e., the risk taking incentive effects of safety net arrangements on bank shareholders, managers, depositors and other creditors, etc). As a consequence of such research, the extent and design of safety net arrangements have progressively come to be widely recognized as an important determinant of the risk taking incentives of banks (particularly bank

shareholders). Because different stakeholder groups are differently affected by safety net arrangements, not only the safety net arrangements as such, but also corporate governance factors (such as ownership structure and the control powers associated with various forms of stakes in the bank) matter for banks' risk taking behavior.

The purpose of this paper is to study the effect of bank governance factors on the relationship between safety net characteristics and bank risk taking. Two specific governance factors are at the focus of interest: equity ownership structure and market discipline by the bank's creditors.

The discussion of the association between bank ownership structure and risk taking trails back to the issue of the 'moral hazard risk' introduced by deposit insurance (Merton, 1977, and many subsequent papers). The research on ownership structure and risk (e.g., Gorton and Rosen, 1995) suggests that the extent to which a bank's shareholders have the opportunity to exploit the subsidy introduced by deposit insurance by increasing risk, depends on the nature and severity of the conflict of interest between the bank's managers (who are presumably the ones who make the lending decisions and therefore have the most direct influence on the risk profile of the bank's asset portfolio) and its owners. Hence, this literature brings the issue of deposit insurance-induced moral hazard risk into the context of a traditional owner-manager agency conflict.

A certain 'consensus' view based on recent empirical findings is possibly starting to emerge within this research area – particularly as to the effect of insider, or managerial, control on bank risk-taking. However, in most of these contributions, the effect of deposit insurance is taken as a given, without considering market discipline. Partly as a consequence of this, and partly as a consequence of the dominance of

empirical results on US data alone, consideration of the effect of *variations* in deposit insurance coverage, related bank safety net characteristics, and other institutional factors has been limited.

A motivation for considering market discipline (by creditors) in the same context as ownership structure might take its point of departure in the observation that it is not deposit insurance as such that is the source of the moral hazard problem, it is limited liability: the conflict of interest between owners and creditors and the incentive of owners for risk shifting exist even in the absence of deposit insurance. What deposit insurance does is to take away the market's correction of it, by de-incentivizing depositors (and possibly other creditors) to charge an agency-cost-of-debt premium as compensation for this moral hazard problem. Therefore, creditors' beliefs about the prospects of being bailed out in case of insolvency, explicit and implicit deposit insurance coverage, and the credibility of *non*-insurance of formally uninsured claims on the bank – in a word, the extent of market discipline from creditors – is a major determinant of the 'severity' of the agency problems from debt, and thus a second main determinant of the relationship between the safety net and bank risk. Though the literature on market discipline in banking is somewhat richer than that on ownership structure and risk, the two are rarely considered simultaneously (with the odd exception – see Section 2).

In summation, this paper studies primarily two governance factors – ownership structure and disciplining by groups of holders of debt claims on the bank – as determinants of the relationship between safety net characteristics and bank risk taking. The empirical part makes use of a panel data set covering several hundred banks worldwide, with observations between the years 1994 and 2005. This affords the

opportunity to fully exploit variations in the institutional setting, both in terms of safety net characteristics and in terms of governance.

The paper is structured in the following way: Section 2 makes a selective review of the literature on deposit insurance, bank risk, and (debt) market discipline on the one hand, and ownership structure and banks' risk taking on the other. Section 3 develops a simple model along the lines of Jensen and Meckling's (1976) model of the determination of capital structure in the presence of equity and debt agency costs, sorts out the inter-relationships among the main variables of interest in the context of this model, and derives a number of testable hypotheses. In Section 4, the data and empirical method is presented, whereas Section 5 contains the results. Section 6, finally, concludes.

2. Related literature

The present section of the paper recaps previous literature on the relationship between deposit insurance, market discipline and banks' risk-taking, and bank ownership structure and risk, respectively.

2.1. Background

It is worth noting, first, that the source of the moral hazard risk associated with deposit insurance lies in the conflict of interest between owners and creditors induced by limited liability (Barth et al, 2006): limited liability, not deposit insurance *per se*, gives shareholders the incentive to transfer wealth at the expense of creditors by increasing asset risk and leverage, and creates the option value of equity. Absent third party guarantees of the debt the spontaneous market solution is for creditors to charge a risk

premium on the extended debt commensurate with their own costs of monitoring the borrower (and other agency-related costs; Jensen and Meckling, 1976).

Deposit insurance removes bank creditors' incentives to discipline the bank's risk-taking and so gives free(r)[1] play to the risk-shifting incentives of the shareholders. The value to shareholders of deposit insurance, as described by Merton (1977), Marcus and Shaked (1984), and several subsequent contributions, is thus in a sense equal to the value of having creditor discipline lifted. The 'victim' of this moral hazard risk is now no longer the (insured) creditor, but the insurer, and the result holds at least as long as the deposit insurance is not, or is only partially, funded by the insured banks themselves or – in the case where the banks collectively fund the deposit insurance scheme – as long as insurance premiums do not fully reflect the asset risk of each bank.

The usual motivation for the imposition of deposit insurance is to protect the public from the effects of systemic banking crises; in particular, by removing the threat of contagious bank runs, it is perceived that deposit insurance reduces overall banking system fragility. However, since deposit insurance unleashes the risk-increasing incentives of bank shareholders, it is clear that, unless these incentives can be otherwise sufficiently contained, the net effect on banking system stability is at best uncertain.[2]

2.2. Market discipline

In addition to minimum capital ratio requirements, a (partial) solution to the stability-reducing potential of deposit insurance which has become part of 'best practice' is to limit the coverage of deposit insurance, and thereby 'reinstituting' a degree of market

discipline by creditors (see, for instance, Bhattacharya et al, 1998; for evidence on the determinants of deposit insurance system design, see Laeven, 2004).

The (yet rather few) extant studies that empirically exploit cross-country variations in deposit insurance coverage indicate that restricting deposit insurance coverage does indeed reduce its destabilizing potential (Demirgüç-Kunt and Detragiache, 2002; Demirgüç-Kunt and Huizinga, 2004; Angkinand and Wihlborg, 2005).

There is a related market discipline literature, concerned primarily with studying the extent to which bank risk is reflected in the yields on large certificates of deposit, subordinated notes and debentures, and other types of bank debt not formally covered by deposit insurance. Risk-pricing of uninsured bank debt is taken as evidence of market monitoring of banks' risk behavior (if not necessarily *disciplining*). A key insight in this literature is that the extent to which non-insured bank creditors charge risk premiums corresponding to the bank's asset risk critically depends on their beliefs regarding the prospects of being bailed out despite being formally uninsured (Angkinand and Wihlborg, 2005, 2006, call this the 'credibility of non-insurance'). In other words, market discipline is exerted by creditors who do not perceive themselves to be covered by explicitly *or* implicitly issued guarantees, which would imply an inverse relationship between the extent of creditor discipline and the expected coverage of such guarantees.

Thus, Flannery and Sorescu (1996) find limited evidence of bank-specific risk measures reflected in the secondary market spreads of US banks' subordinated notes and debentures (SNDs) over the eight-year period preceding the reform of the US federal deposit insurance system in 1991, which committed more credibly to a no-bailout policy as regards US banks' subordinated debt.[3] They conclude that 'bank investors clearly

impounded the value of conjectural government guarantees into debentures prices' (p. 1373). Conversely, several later papers (Morgan and Stiroh, 2000; Jagtiani et al, 2002), studying the post-reform period, do find evidence that the pricing of US banks' sub-debt significantly depends on underlying credit risk, as traditionally measured.

The pattern is far from consistent, however, with regard to the US experience of the effect of implicit creditor insurance. Hall et al. (2002) explicitly test the effect of deposit insurance reform on the risk sensitivity of average interest paid on uninsured deposits in a cross section of US banks, and find that the risk sensitivity did not significantly increase after 1991. Similar results are obtained by Covitz et al. (2004). On the other hand, some older papers do find cross-sectional links between spreads paid on large CDs and balance sheet risk in the *pre*-reform period (Baer and Brewer, 1986; Hannan and Hanweck, 1988; James, 1988, 1990; Keeley, 1990; and Ellis and Flannery, 1992).

Gropp and Vesala (2004) also make a point of distinguishing between explicit and implicit deposit insurance. They show theoretically that the adoption of an explicit deposit insurance scheme under reasonable assumptions can reduce moral hazard and risk taking in banks if the scheme effectively limits the scope of the safety net, thus providing space for 'residual' market discipline and reducing bailout expectations of formally uninsured creditors. They apply their model to a sample of European banks over the 1990s, and obtain results largely consistent with their predictions (except for large, 'too-big-to-fail' banks).[4]

Angkinand and Wihlborg (2006), finally, test for market discipline using proxies for deposit insurance coverage in a large sample of banks in both developed and

emerging-market countries. They posit, and find evidence of, a U-shaped relationship between these measures and deposit insurance coverage. The intuition is that zero or very low coverage is not credible, and will tend to push up risk due to expectations of *ad hoc* bailouts in the event of failure, intermediate levels of coverage will effectively increase the scope for market discipline by reducing bailout expectations (as in Gropp and Vesala, 2004), and higher levels of coverage will, again, drive up risk incentives, in line with the standard moral hazard view of deposit insurance (and consistent with the empirical results of, e.g., Demirgüç-Kunt and Detragiache, 2002).

2.3. Ownership structure

The central message of the literature on bank ownership structure and risk is to point out that the extent to which shareholders can exploit the option value of deposit insurance depends on their relative ability to make the bank's managers act in their interest. Therefore, the effects of deposit insurance on bank risk-taking depend not only on the extent of market discipline implied by effective limits on deposit insurance coverage, but also on the traditional owner-manager agency conflict.

Among the earliest widely quoted results on the relationship between banks' ownership structure and their risk taking are those of Saunders et al (1990), who test different stock market measures of risk as a (linear) function of the fraction of managerial ownership, the capital-asset ratio, and a number of control variables. They hypothesize a positive relationship between managerial ownership and risk taking, which is motivated by the following: bank managers with zero or small ownership stakes in the bank are more risk averse than outside owners of the bank for the traditional reasons (they are

more concerned with enjoying the perks of office than exploiting the option value of equity by increasing asset volatility, they have invested non-diversifiable human capital in the bank, etc.); as managers' ownership share in the bank increases, their interests, including their expected benefits of increased risk, become more aligned with those of outside equity holders, and so the bank's asset risk is consequently expected to increase. Moreover, changes in the regulatory environment toward more lax regulation are assumed to strengthen the positive association between stockholder control of the bank and risk taking.[5] The empirical results of Saunders et al. (1990) for US banks over the 1978-1985 period are mixed but are somewhat supportive of a positive relationship between managerial ownership and risk taking in periods of lax regulation.

Similar results are reached by Knopf and Teall (1996), who explicitly test the impact of the 1989 US bank reform on the relationship between risk and ownership structure. They find a positive association between several different measures of risk on the one hand and insider ownership on the other before the regime shift, but a negative one following it. They also find a strong negative relationship between risk and *outside* ownership throughout the sample period.

Gorton and Rosen (1995) provided the first more elaborate analytic treatment of the issue – also fundamentally based on the insight that managers, not shareholders, control banks' loan portfolios, and therefore their risk. They propose a game-theoretic model of the conflict of interest between shareholders and managers, of which the main prediction is an inverse U-shaped relationship between managerial ownership and risk. However, they also open up for the possibility of a U-shaped relationship; first, because the model's prediction of functional form is indeterminate short of an explicit assumption about the

relative size of an exogenous 'state of the industry' parameter;[6] second, based on the argument that under normal circumstances, outsiders' chances of controlling managers may be best either at low levels or at high levels of managerial ownership.

Their empirical results for US bank holding companies do not unequivocally support either form, but the latter argument, in particular, has subsequently been used to motivate the hypothesis of a non-linear relationship between ownership and risk (Brewer and Saidenberg, 1996; Cebenoyan et al., 1999; Knopf and Dolde, 2006). The idea is that at intermediate levels of ownership, managers become 'entrenched', and – while hard for outside owners to get rid of – are best able to maximize their benefits of control by acting in a more risk-averse manner than the outsiders would like them to.

Brewer and Saidenberg (1996) find evidence of a weakly convex relationship between risk (measured as the standard deviation of stock returns) and insider ownership for a sample of US savings and loan institutions over the latter half of the 1980s. Extending the sample period to cover 1986-1995 and using other risk measures, Cebenoyan et al (1999) obtain similar results (except for an intermediate period of regulatory stringency in the late 1980s and early 1990s; cf. Knopf and Teall, 1996). Both papers control for charter value (measured as the market-to-book equity ratio), and provide strong support for the supposition of a negative association between risk-taking and charter value.

Knopf and Dolde (2006) similarly hypothesize that increased insider (managerial) ownership will either linearly increase or have a U-shaped influence on bank risk taking. They use both capital market-based and accounting-based risk measures. The empirical results generated from their dataset on US thrift institutions from 1990 to 2003 are, again,

somewhat mixed, but do tend to lend some support to the idea of a U-shaped link from insider ownership to risk, whereas the effect of outsider ownership is indeterminate.

3. Analytics and hypotheses

In this section, I first develop a simple model of bank capital, which links deposit insurance with risk taking through, on the one hand, ownership structure and agency costs, and, on the other hand, the effect on creditor discipline. In the second sub-section, I analyze the implications of the model, briefly consider minimum capital adequacy requirements, and derive testable hypotheses.

3.1. A simple model

Safety net characteristics and capital structure choice

Let E_O denote outside equity capital and let D denote debt capital. Moreover, let lower-case letters indicate scaling by the amount of total external capital, so that $d = D/(D+E_O)$. Suppose, along the lines of Jensen and Meckling (1976), that for an unregulated firm the agency cost of equity is described by a function A_E on d such that $A_E(1) = 0$, $A_E'(d) < 0,$ and $A_E''(d) > 0, \forall d \in [0,1]$. Similarly, let the agency costs of debt be represented by a function A_{D_0} on d such that $A_{D_0}(0) = 0$, $A_{D_0}'(d) > 0,$ and $A_{D_0}''(d) > 0, \forall d \in [0,1]$. Optimal capital structure, d_0^*, is determined by minimizing total agency costs, $A_{T_0} = A_E + A_{D_0}$.

I use the concept of agency costs as basically meaning a spread, or a premium, over the risk-free rate of return, charged by the providers of external finance as compensation for monitoring activities and agency-related risks (I will henceforth use

'agency cost' and 'risk premium' synonymously). They are the market's solution to the agency problem in that outside investors will adjust the premium charged in accordance with their perception of monitoring needs and of the risks they incur by extending capital to the firm. The premium enters into the firm's optimization problem, and the firm is thereby disciplined not to behave in a manner unwanted by outside investors. The concept of agency costs as just described corresponds exactly to that of market discipline according to the generally accepted 'monitoring-and-influence' definition of this concept (see, e.g., Flannery, 2001; Bliss and Flannery, 2002). Thus, A_D can be interpreted as a manifestation of creditor discipline and A_E as market discipline by outside shareholders.

Now assume that the firm is a bank which benefits from deposit insurance. I effectively assume underpriced deposit insurance, possibly with a premium which is fixed-rate, or at least adjusts imperfectly to risk (and which can also be thought of as a limit on deposit insurance coverage, see below).[7] Deposit insurance enters the model in the following way. The holders of credibly insured debt will no longer charge a premium as compensation for monitoring activities and other agency-related risks since they are now essentially holding a risk-free asset. The agency costs attached to insured debt thus drop to zero: $A_{D_1}(d) = 0$. The insurance can effectively be seen as an exogenously financed 'risk subsidy' on some bank debt.[8] The rest of the bank's debt, however, will still carry the premium indicated by A_{D_0}, so that there are now two types of debt – insured and uninsured. However, there is also uncertainty about actual deposit insurance coverage; there might be both expected losses for formally insured debt, and expected bailouts for formally uninsured debt. This gives rise to (technically) four possible agency cost structures.

Let ϕ, γ, κ be fractions. ϕ denotes the share of formally insured debt, γ denotes public confidence in the deposit insurance system (the extent to which insured depositors trust that they will be bailed out), and κ indicates the credibility of *non*-insurance (the reverse probability of *ad hoc* bailouts of formally uninsured creditors). Explicitly and credibly insured debt carries the cost $\phi\gamma A_{D_1}(d) = 0$; formally but *non*-credibly insured debt follows $\phi(1-\gamma)A_{D_0}(d) \geq 0$; formally and credibly *uninsured* debt costs $(1-\phi)\kappa A_{D_0}(d) \geq 0$; and, finally, formally but *non*-credibly uninsured debt (i.e., implicitly insured debt) carries the premium $(1-\phi)(1-\kappa)A_{D_1}(d) = 0$. The agency costs of debt are now described by $A_{\bar{D}}(d) = \phi(1-\gamma)A_{D_0}(d) + (1-\phi)\kappa A_{D_0}(d) \; = [\phi(1-\gamma) + (1-\phi)\kappa]A_{D_0}(d)$. For simplicity, ϕ enters here as an exogenous parameter, but may be viewed partly as a choice variable. It is trivially zero for countries with no explicit deposit insurance. For countries *with* explicit deposit insurance, it will typically be less than unity for several reasons, among which are government-imposed limits on deposit insurance, bank or bank-customer co-financing of the deposit insurance scheme, etc., all of which imply that the benefit of insurance comes at a cost so that the net of this benefit does not fully cover the distance between $A_{D_0}(d)$ and the horizontal axis, which is equivalent to $\phi < 1$. It also seems reasonable to assume that public confidence in the deposit insurance system is never so complete so as to make an unconditional cover-all deposit insurance fully credible at all times. Less than full credibility indicates $\gamma < 1$.[9] The term $[\phi(1-\gamma) + (1-\phi)\kappa]$, henceforth Λ, is a summary measure of market discipline by creditors, with $\Lambda \in [0,1]$, and a higher Λ indicating more market discipline.

Total agency costs are now $A_{T_1}(d) = A_E(d) + \Lambda A_{D_0}(d)$, and the optimal capital structure is therefore:

$$d_1^* = \arg\min_{d \in [0,1]} \left\{ A_E(d) + \Lambda A_{D_0}(d) \right\} \tag{1}$$

The bearing idea here is thus that deposit insurance diminishes market discipline by the bank's creditors (as reflected in debt agency costs). The effect is a reduction in the bank's overall risk premium (total agency costs) and an accompanying change in capital structure. I shall assume that the subsidy on the total risk premium that the bank faces will be a determinant of its risk taking as measured by some proxy for asset risk (beyond the implied leverage effect).

The subsidy on debt financing generated by deposit insurance (or the would-be 'risk neutral' deposit insurance premium) is simply the drop in debt agency costs due to partial deposit insurance:

$$S_D = (1 - \Lambda) A_{D_0}(d_1^*). \tag{2}$$

However, the actual reduction in the bank's overall risk premium (total agency costs) is

$$S_T = A_E(d_0^*) + A_{D_0}(d_0^*) - [A_E(d_1^*) + \Lambda A_{D_0}(d_1^*)]. \tag{3}$$

Cross-sectional variation and the determinants of agency costs

Expression (3) describes the link between bank risk taking and governance factors. The governance factors, which are my primary interest, enter the equation through the agency cost functions and through the market discipline parameters (which in turn are determined by explicit and implicit deposit insurance coverage). Very generally, the sharper the average slope of the cost function over $d \in [1, 0]$, the greater the agency

problem, assuming owners and creditors price the problem adequately. But what determines the cross-sectional variation in these functions?

The original Jensen and Meckling (1976) article assumes that the slopes of A_E and A_{D_0} are mainly determined by the relationship between inside and outside financing of each individual firm ('ownership structure'), and I shall do likewise. Note that I have kept assumptions regarding the functional form of the agency cost functions at a minimum: the only requirement I have imposed beyond those of Jensen and Meckling (where the requirement is implicit) is that they be convex, so that it is actually possible to minimize the sum of the two functions. Without loss of generality the agency cost functions can be written as $A_{D_0}(d) = gd^h$ and $A_E(d) = k(1-d^m)$, where $g > 0,\ h > 1,\ k > 0,$ and $0 < m < 1$, in keeping with previous assumptions regarding first and second derivatives.

The slope coefficients are determined mainly by the bank's ownership structure (whereas *h* and *m* are best interpreted as risk aversion parameters which should be constant across firms). Let ω denote the share of inside to outside financing:

$$A_{D_0}(d) = g(\omega)d^h, \text{ and} \tag{4}$$

$$A_E(d) = k(\omega)(1-d^m) \tag{5}$$

Now plug in (4) and (5) into (3):

$$S_T = k(\omega)(1-d_0^{*m}) + g(\omega)d_0^{*h} - [k(\omega)(1-d_1^{*m}) + \Lambda g(\omega)d_1^{*h}]$$

$$= k(\omega)(d_1^{*m} - d_0^{*m}) + g(\omega)(d_0^{*h} - \Lambda d_1^{*h}), \tag{6}$$

or, with the components of the creditor discipline parameter given in full:

$$S_T = k(\omega)(d_1^{*m} - d_0^{*m}) + g(\omega)(d_0^{*h} - [\phi(1-\gamma) + (1-\phi)\kappa]d_1^{*h}) \tag{7}$$

Equations (6) and (7) indicate that the size of the deposit-insurance-induced risk subsidy depends on equity ownership structure (in terms of the ratio of inside to outside capital), a leverage effect, and explicit and implicit deposit insurance coverage (which are the mirror image of creditor discipline).

3.2. Implications and hypotheses

Evaluation of the individual effects of the governance factors on the risk subsidy is done by taking partial derivatives on equation (6) or (7). The effect of ownership structure is complex, and is given by:

$$\frac{\partial S_T}{\partial \omega} = k'(\omega)(d_1^{*m} - d_0^{*m}) + g'(\omega)(d_0^{*h} - \Lambda d_1^{*h}) \qquad (8)$$

It is now necessary to make some assumption regarding the relationship between the ratio of inside to outside financing on the one hand, and the steepness of the agency cost curves on the other. Jensen and Meckling (1976) suggest both curves become less steep with increased insider ownership, i.e., $k'(\omega) < 0$ and $g'(\omega) < 0$. In the case of equity agency costs, this is probably fairly unproblematic. The slope of the A_E function reflects the conflict of interest between outside shareholders and insiders/managers. It seems natural to assume that the conflict – and therefore the slope – increases as the share of insider financing drops, and vice versa, because as this share decreases (increases), the interests of insiders/managers and outside shareholders become less (more) aligned. For all cases except the trivial case of perfect creditor discipline (nothing happens), first-order conditions of the bank's optimization problem (1) ensure that $(d_1^{*m} - d_0^{*m}) > 0$. With $k'(\omega) < 0$ this makes the first term on the right hand side in (8) negative.

In the case of the debt agency cost curve, it is not equally clear that it should steepen with increased outside financing. The average slope of this curve reflects the conflict of interest between equity and debt claimants. But financing and investment policy is determined by managers; thus, the shareholder-debtholder conflict is affected by the extent of shareholder control (in other words, debt agency costs are affected by equity agency costs, as emphasized by, e.g., Brander and Poitevin, 1992). The manager of a leveraged firm has *always* the opportunity to shift risk for the benefit of the shareholders. If the manager has no ownership stake he has no incentive to do so (particularly, but not only, if he is more risk averse than shareholders), which would indicate a flatter debt agency cost curve for low levels of insider ownership/shareholder control.[10] As the ownership stake of the manager/insider increases, his incentives become more aligned with outside shareholders, effectively increasing shareholder control. This should exacerbate the shareholder-creditor conflict. Since the ratio of inside to outside financing is a monotonic positive function of the share of insider equity ownership, this line of reasoning would suggest that the slope of A_{D_0} increases with the share of *inside* rather than outside financing. Therefore, my first guess is that $g'(\omega) > 0$.[11] In that case, the sign of the second right hand side term of equation (8) depends on $(d_0^{*h} - \Lambda d_1^{*h})$, which is more likely to be positive if creditor discipline is lax (Λ is small).

It is evident from (8) that a necessary condition for insider control to have a non-linear effect on the risk subsidy is that that the effect of insider ownership on the slope of the debt agency cost curve is non-constant (i.e., $g''(\omega) \neq 0$), and/or that the marginal effect of insider ownership on the slope of the equity agency cost curve is increasing ($k''(\omega) > 0$). In the absence of g'' and k'' effects, insider ownership will affect risk

positively only if the sensitivity of the slope of A_D to changes in ownership structure is higher than that of the slope of A_E ($g'(\omega) > |k'(\omega)|$) *and* if creditor discipline is relatively low; short of these conditions, increased insider capital will affect risk negatively.

In summation, this yields the following main predictions for the effect of ownership structure on risk:

$$\begin{aligned} \frac{\partial S_T}{\partial \omega} &\lessgtr 0 \\ \frac{\partial^2 S_T}{\partial \omega^2} &\gtrless 0 \\ \frac{\partial^2 S_T}{\partial \omega \partial \Lambda} &< 0 \end{aligned} \tag{9}$$

The main thing driving the possible decrease in risk following increased shareholder control is the simultaneous increase in leverage. The intuition is that shareholders will trade off the benefits of increased leverage and exploiting the subsidy, and that increased shareholder control may decrease risk unless the marginal effect on the slope of the debt agency cost curve is sufficiently great to make that relatively less beneficial.[12] Creditor discipline reduces the effect of owner control.

The effects on the subsidy of the creditor discipline/bank safety net-related parameters are less ambiguous. The composite measure of creditor discipline has a negative effect on risk:

$$\frac{\partial S_T}{\partial \Lambda} = -g(\omega) d_1^{*h} < 0 \tag{10}$$

(10) also shows that the negative effect of creditor discipline is greater for higher levels of leverage (i.e., when capitalization is poorer). Increasing the share of formally insured debt will (generally)[13] increase risk by decreasing creditor discipline:

$$\frac{\partial S_T}{\partial \phi} = (\gamma + \kappa - 1) g(\omega) d_1^{*h} > 0 \qquad (11)$$

Similarly, confidence in the deposit insurance system increases risk by reducing uncertainty among insured depositors about the prospects of being bailed out:

$$\frac{\partial S_T}{\partial \gamma} = \phi g(\omega) d_1^{*h} > 0 \qquad (12)$$

The credibility of the no-bailout commitment for formally uninsured debtholders, finally, decreases risk taking by reducing implicit insurance:

$$\frac{\partial S_T}{\partial \kappa} = (\phi - 1) g(\omega) d_1^{*h} < 0 \qquad (13)$$

All the effects of the creditor discipline parameters are strengthened with increased leverage (as measured by the debt share of outside capital).

Now briefly consider the effect of capital requirements. Let ς be the minimum ratio of equity capital, as defined on the book value of total assets (V_B). So long as the equity share of capital exceeds the required ratio, minimum capital requirements will have no effect on the bank's capital structure choice or risk taking. In terms of the debt share of outside capital, the minimum capital regulation kicks in when $(\varsigma - E_I / V_B) V_B / (V_B - E_I) > 1 - d_1^*$, where E_I is equity held by insiders. In that case, the optimization problem in equation (1) will be overridden by regulation, and d_1^* will be replaced by $1 - (\varsigma - E_I / V_B) V_B / (V_B - E_I) = V_B (\varsigma - 1) / (E_I - V_B)$ in expression (3). In principle, this prediction requires an assumption of effective and more or less immediate enforcement of capital requirements (no regulatory forbearance), which may or may not be a realistic assumption. However, the analysis does indicate that undercapitalization should be accounted for in the empirical implementation.

3.3. Discussion

In the model I have assumed that market discipline is exerted by the imposition of a premium on capital extended to the bank, which is set by claimants in accordance with their perception of the risk they incur by extending the capital. This premium was interpreted and analyzed along the lines of a standard agency cost model. Deposit insurance lowers the risk incurred by (some) creditors, and therefore lowers the debt service costs of the bank. The extent to which this occurs depends on the explicit and implicit coverage of the deposit insurance. Conversely, the extent of market discipline by creditors was defined in terms of the share of debt credibly exempt from insurance. The decrease in debt costs will lower the *overall* risk premium faced by the bank (total agency costs) by some amount, which is determined both by creditor discipline and equity ownership structure (and by leverage), and which I have called the (total) 'risk subsidy' (S_T).

For the purposes of the empirical section of the paper, I will assume that the determinants of this risk subsidy are also correlated with the overall risk of the bank (as measured by some suitable proxy for default risk). It may be worth pointing out that this does not follow directly from the model – it is a hypothesis. I here rely on the intuitive appeal of the suggestion that a reduction in the punitive costs of risk will generate higher risk taking. In that case, overall risk taking – when controlled for other determinants – should also be correlated with the determinants of the reduction in the risk premium. This is what I am effectively testing in the empirical section of the paper.

Moreover, insofar as a reduction in the overall risk premium induces more risk taking, it is not clear what the function projecting a reduction in the premium onto overall risk should look like. The hypothesis suggests not that we move along a (presumably) positive curve between risk and risk premium, but – on the contrary – that the curve shifts to allow higher risk at an equal (or lower) cost.

4. Data and empirics

4.1. Estimation

Baseline regression

The model presented in Section 3 suggests that banks' risk taking (or, to be specific, the 'risk subsidy' following from deposit insurance) is determined by the scale of inside to outside financing, by formal and informal deposit insurance coverage (which taken together determine the level of market discipline imposed by creditors), and the debt share of outside capital. The effect of ownership structure may be non-linear, and is partially determined by the level of creditor discipline; the effect of overall creditor discipline is negative, and this effect is strengthened by increased leverage.

Allowing for other factors to influence banks' overall risk, a number of control variables are included in the empirical specifications. The choice of control variables at the bank level is largely made on the basis of previous literature. I thus follow Marcus (1984) and Keeley (1990), and include Tobin's *q* as a measure of charter value, which should negatively affect risk. Like Gorton and Rosen (1995), Brewer and Saidenberg (1996), and Cebenoyan et al. (1999), for instance, I also add bank size and a measure of institutional or outside ownership (in this case, institutions' share of outside equity).

Saunders et al. (1990) include fixed assets; I instead use liquid assets over total assets (in parallel with Angkinand and Wihlborg, 2006).

The predictions of the model hinge on the bank's basic optimization problem (1), which determines its optimal capitalization. However, capital requirements set an exogenous bound on leverage, which implies that at a certain leverage ratio, the predictions do not necessarily hold. In particular, signing partial derivatives becomes problematic if first-order conditions from (1) cannot be imposed. The proper prediction may therefore be different for undercapitalized banks. To account for this possible effect, I include a dummy for banks that are undercapitalized. In addition, I include dummies for foreign ownership and government ownership, since these types of ownership arrangement may be well as important for bank governance seen in a global perspective (see La Porta et al., 2002, and Caprio et al., 2004).

Another effect of studying banks across a wide range of different countries is the necessity to consider country-level control variables. Most existing empirical results, including the ones just cited as sources for the choice of bank-level control variables, study US banks alone. An exception is Angkinand and Wihlborg (2006), and I follow them in controlling for income level (measured as the log of GDP/capita), real GDP growth, the real interest rate, and the inflation rate. An additional country-level control is a measure of overall regulatory stringency (see section 4.2 for details). Finally, a potentially complicating factor is the inclusion in the sample of observations for banks/countries severely hit by the Asian financial crisis in 1997-98. The sample also contains several other episodes of systemic financial turbulence (for instance, a number of Argentinean banks hit by crisis in 2001). If these observations are affected by factors

outside the model, such as contagion, etc., it is conceivable that the inclusion of them will affect estimation results in an unforeseen way. I therefore include a 'crisis dummy' to control for this possible effect.[14]

Based on the model's main implications and the above considerations regarding control variables the basic empirical specification is formulated as follows (where subscripts *i, j* and *t* denote bank, country and year):

$$\begin{aligned}\text{Risk}_{it} &= \beta_0 + \beta_1(\text{Inside to outside capital})_{it} + \beta_2(\text{Inside to outside capital})_{it}^2 \\ &+ \beta_3(\text{Inside to outside capital})_{it} \times (\text{Market discipline})_{it} + \beta_4(\text{Market discipline})_{it} \\ &+ \beta_5(\text{Market discipline})_{it} \times (\text{Leverage})_{it} + \beta_6(\text{Leverage})_{it} \\ &+ \sum_{m=1}^{6} \beta_{7+m}(\text{Bank-level control})_{itm} + \sum_{n=1}^{6} \beta_{14+n}(\text{Country-level control})_{jtn} + \varepsilon_{it}\end{aligned} \quad (14)$$

Two of the right hand side variables in the above model are potentially endogenous: leverage and charter value. As for the leverage variable, it is obvious that it is partially determined within the model described in Section 3; as for charter value, the reasoning is that since risk shifting increases the option value of equity, riskier banks should be more highly valued – hence a higher Tobin's *q*. I use different measures of risk and of creditor discipline, and start by running a Hausman test to check for endogeneity of the charter-value and leverage variables for each combination of risk and market discipline measures. I then run model (14) for all banks in the dataset by either panel OLS or 2SLS, depending on the results of the Hausman tests.

The effects of the individual components of the market discipline parameter

Equation (14) is estimated with a composite measure of creditor discipline constructed in accordance with the model from proxies of the individual components (the share of formally insured debt, public confidence in the deposit insurance scheme, and the

credibility of the deposit insurer's no-bailout commitment for uninsured debt). Although the overall effect of creditor discipline is at the center of interest together with ownership structure, it may be of interest also to consider the effect of each individual component of the market discipline parameter. As is clear from partial derivatives (11) – (13) the direction of the effects of these components should be fairly unambiguous, but the size of the effect depends on interaction between the three components, interaction with ownership structure, and interaction with leverage. In order to keep the specification tractable in terms of interpretation, I estimate a simplified version of the implied estimation equation, where I drop the interaction between the creditor discipline components. This results in an equation which differs from (14) in that the individual components have been substituted for overall creditor discipline, the interaction variable between inside to outside capital and market discipline is replaced by three interaction variables (one for each creditor discipline component), and similarly for interaction with leverage.

Alternative specifications

In order further to test the general predictions of the model, I test a number of alternative specifications. First, there may be concern that the effect of the institutional setting (beyond characteristics of the deposit insurance system and banking regulation stringency) and other effects specific to each country are not sufficiently taken into account. This may be particularly important if the risk measure used is based on accounting variables, in which case different accounting practices, definitions of particular financial statement items related to risk, etc., may impact on the variation in the

dependent variable. For this reason, I test a model replacing the country-specific control variables with country fixed effects, which should soak up any systematic effects of the type just mentioned.

Second, market discipline may be measured by a composite of institutional variables; as explained above, I first construct the market discipline parameter from such variables. However, market discipline may possibly also be inferred from some other characteristic of a bank if that characteristic is correlated with market discipline. It has been suggested in the literature (see, for instance, Calomiris, 1999; Evanoff and Wall, 2000; Sironi, 2001; Benink and Wihlborg, 2002) that requiring banks to carry a minimum portion of subordinated debt on their books (a 'mandatory subordinated debt policy') could enhance market discipline. In the spirit of this argument (and following Gropp and Vesala, 2004), I reestimate the basic specification (14) with the composite measure of market discipline replaced by the ratio of subordinated debt to total assets, as an alternative proxy for creditor discipline.

4.2. Data

The main source for the bank-level data (balance sheet and income statement data) is BankScope. The sample is limited to publicly traded banks to allow the use of stock market data. The data is an unbalanced panel covering a maximum of 331 banks in 47 countries over the period 1994-2005. The exact number of countries/banks included depends on the combination of variables used in a particular specification, as data availability varies considerably for different variables; coverage is also fragmentary for the first three years.

The paper uses two measures of bank risk – one accounting-based and one market-based measure. The accounting-based measure used is the ratio of non-performing loans to equity capital. The market-based measure is a market version of the so-called Z-score, which is defined by

$$Z_{it} = \frac{\mu_{it} - k_{it}}{\sigma_{it}}, \tag{15}$$

where μ_{it} and σ_{it} are the mean and standard deviation, respectively, of bank *i*'s return on assets, and k_{it} is the average share of capital to total assets over the period *t*. The Z-score is negatively related to the probability of default (and I therefore use it in the negative as a dependent variable for simplicity of comparison). The 'market version' Z-score is calculated using the return on equity and the standard deviation of stock returns.[15] Stock market data for the included banks were collected from Datastream.

Ownership data were collected from Reuters. The Reuters database distinguishes between ownership by insiders/stakeholders, institutions, and mutual funds, and contains percentages of ownership by the different categories and by individual shareholders. The Reuters figures were used to calculate the share of inside to outside capital (since the model focuses on inside to outside capital rather than shares of equity ownership), based on the total ownership share of all stakeholders and insiders. All ownership data are originally time-invariant, but since I use balance sheet data to transform equity ownership shares to proxies for inside to outside capital, the resulting variables are time-variant. The same source was used to obtain the measure of institutions' share of outside equity, and indicator variables for foreign and government ownership. The latter take on unit value if

the largest insider/stakeholder is foreign or is the government, respectively, and zero otherwise.

Variables related to market discipline and capital structure were constructed using a combination of balance-sheet data and country-level institutional data collected from World Bank databases. Leverage is BankScope's indications of debt to total assets transformed to correspond to the model's focus on the debt share of outside (rather than total) capital. For banks, this share is typically very large (close to unity), so to be able to interact it with other variables it is standardized around the mean.

As a proxy for the share of formally insured debt (at the bank level), I use country-level data on the fraction of deposit value covered by explicit deposit insurance (net of the coinsurance ratio; available from Demirgüç-Kunt et al., 2005), and multiply it by the ratio of deposits to total debt for each bank and year.[16] For countries where a specific coverage percentage is not available in the World Bank database, I use $\min\left(1,\ \frac{\text{coverage limit}}{\text{deposits/capita}}\right) - \text{coinsurance ratio}$ as a proxy (also from Demirgüç-Kunt et al., 2005), and multiply by the ratio of deposits to total debt for each bank and year, as previously.[17] The share of formally insured debt is always zero for countries/years with no explicit deposit insurance scheme.

The proxy for public confidence in the deposit insurance system is the average 1996-2005 scores on the 'Government effectiveness' index in Kaufmann et al. (2006). Confidence in the deposit insurance system obviously requires that such a system be in place; therefore, the confidence proxy is only assigned a positive value for the countries/years for which such is the case.

The preferred measure of non-insurance credibility for formally uninsured debt is the Fitch Support Rating, which is an index variable showing the probability that a bank will be bailed out in case of default. However, because of limitations in the number of banks in the dataset covered by these ratings, full reliance on this indicator alone would result in the loss of a large number of observations (and possible bias toward larger, developed-country banks). My alternate proxy is based on a combination of the Fitch rating and the bank's share of deposits in its home country – a measure intended to capture the role of a bank's systemic importance for the credibility of non-insurance and the possibility to exert market discipline (in line with the results of, e.g., Gropp and Vesala, 2004, who document muted market discipline for 'too-big-to-fail' banks). The combination variable equals the Fitch rating for banks where such a rating is available; for all other banks, I take one less the bank's share of total deposits in its country of origin and transform the result to the Fitch scale. Balance-sheet data on deposits for each bank are from BankScope, as before, and data on total deposits in each country (or M2, depending on data availability) are from IMF's *International Financial Statistics*.

Bank-level control variables include the market to book value of assets (Tobin's *Q*), which measures charter value (see Marcus, 1984; Keeley, 1990). I use the same definition as Keeley (1990) and many others: *Q* equals the sum of the market value of equity and the book value of liabilities, divided by the book value of total assets. I also use the size of the bank, defined as the natural logarithm of total assets (in thousands of USD), liquid assets over total assets, and in some specifications – as an alternative measure of overall market discipline – the ratio of subordinated debt to total assets (cf., e.g., Gropp and Vesala, 2004). The balance-sheet data and the stock-price data used for

calculating these control variables are from BankScope and Datastream, respectively, as before.

Country-level control variables are real GDP growth, real interest rate, inflation rate, and the natural logarithm of GDP per capita (in thousands of USD) – all from the World Bank's *World Development Indicators*. I also use a summary measure of regulatory stringency, based on the sum of the index variables 'Capital regulation', 'Official supervisory power', and 'Prompt corrective power' from Barth et al. (2001, 2006). These indices are based on comprehensive surveys of banking regulation and supervision in countries around the world, and the summary measure takes on higher values for higher total levels of regulation, supervision and enforcement.

Dummies were constructed to identify undercapitalized banks and countries undergoing a systemic banking crisis. Capital adequacy requirements for each country with banks represented in the sample were taken from Barth et al. (2001, 2006). A bank was considered undercapitalized if its ratio of tier-one capital (all equity) to total assets was less than 0.5 of the minimum regulatory requirement on *total* capital in the bank's country of origin. The source for identifying countries/years where there was a systemic crisis was Honohan and Laeven (2005). The source covers the period up to and including the year 2002. At that time, a number of countries were still affected by crises, according to the source (i.e., no 'end date' is available). For banks from these countries, I flag observations from the subsequent years as well, effectively assuming that the crisis was still ongoing between 2003 and 2005.

Definitions of all variables used in the analysis are presented in Table 1, whereas descriptive statistics appear in Table 2.

[Table 1]

[Table 2]

5. Results

Results from baseline regressions, with risk measured as either non-performing loans over equity capital or the negative market Z-score, and two different market discipline composite measures based on the two different proxies for no-bailout credibility, are presented in Table 3. All models use period fixed effects. Hausman tests showed that leverage was endogenous when the Z-score was used as dependent variable, and so these models are estimated by 2SLS, adding country dummy variables to the list of instruments. Coefficient standard errors for all models are White-type errors robust to time-varying residual variance and correlation over time within cross-sections. A priori, it is not evident which problem is worse – heteroscedasticity in the cross-section dimension, or in the period dimension with serial correlation within cross-sections – but the White period standard errors reported are 'stricter' (they are usually more than 60 percent greater than normal standard errors), so I use them.

[Table 3]

Looking first at the effect of ownership structure, the results in Table 3-6 seem to strongly suggest a convex relationship between shareholder control (as measured by

inside to outside capital) and risk, but whether the negative or the positive effect dominates seems to depend on which risk measure is used. When the (negative) Z-score is used, the negative effect is the dominant one for the vast majority of observations. The break-point comes only at around 40 percent of inside to outside capital. The ratio of non-performing loans to equity, on the other hand, typically drops slightly until about 3 percent of insider capital, then increases. The mean for the insider capital ratio is 3.6 percent, but the distribution is quite skewed, which suggests that a good portion of the observations are on the negatively sloping part of the estimated non-performing-loans functions as well.

Market discipline is not significant as a stand-alone variable in any of the specifications in Table 3. Instead, its strongest effect is in interaction with insider ownership. Coefficients for this interaction term are relatively large, highly significant in three of four specifications, and are negative when the positive effect of ownership on risk dominates, and vice versa when the negative effect of ownership dominates These results would suggest that creditor discipline reduces the effect of ownership on risk (whether that effect is primarily negative or primarily positive). Interacted with leverage, the coefficient is (marginally) significant with the right sign only in one of the specifications. The individual effect of leverage, in turn, is positive and highly significant when the Z-score is the dependent variable, but small and insignificant for estimations on non-performing loans. (This result for non-performing loans is perhaps a bit surprising, since lower capitalization would tend to increase the share of bad loans, *ceteris paribus*.) The Z-score specifications marginally support the suggestion that increased creditor discipline reduces the risk-increasing effect of lower capitalization.

As for the control variables, most of those at the bank level are small and insignificant. One more exception is that undercapitalized banks have a systematically higher share of non-performing loans to equity (which is true almost by definition and may in part explain the insensitivity of the NPL/equity ratio to leverage). At the country level, banks from faster-growing countries have a significantly lower portion of bad loans, and banks from higher-income countries are less risky, regardless of risk measure used. Banks from countries undergoing a systemic financial crisis, finally, are also significantly riskier.

[Table 4]

Table 4 shows the results of regressions in which the components of the creditor discipline measure have been entered separately (rather than as a composite measure of creditor discipline). The altered specification with respect to the market discipline variables does not challenge the overall impression of the effect of insider capital share on risk. The only difference is that the initial negative effect of insider ownership on non-performing loans is not present in specification (3).

Expectations on the individual market-discipline components are as follows: the share of formally insured debt and confidence in the deposit insurance system should increase risk (by discouraging market discipline), whereas higher credibility of the no-bailout commitment for non-insured debt should decrease risk (by encouraging market discipline). On balance, these predictions only pan out for the first component, which is significantly positive in three out of four specifications. The other two components are

either statistically insignificant or point in different directions depending on the specification. To some extent, this is of course consistent with the precious finding that the stand-alone impact of creditor discipline on risk is weak or absent.

Looking at the interdependence of the market discipline components with other risk determinants, the following observations emerge. In interaction with insiders' share of capital, both the share of formally insured debt and no-bailout credibility mimic the results for the composite market discipline measure in that they reduce the dominant effect of insider capital on risk (coefficients for the interaction variables are negative for NPL/equity ratio and positive for Z-score models). In the case of the 'no-bailout credibility' variable, this makes sense, since it affects market discipline positively (higher credibility implies lower reliance on informal guarantees, and so increases market discipline). It is therefore not surprising that it interacts with the insider capital share in the same way as the overall market discipline measure. In the case of formal deposit insurance coverage, the result is counter-intuitive, since this variable has the opposite effect on market discipline. However, the coefficients for deposit insurance coverage interacted with ownership are only marginally significant in specifications (3) and (4).

Interaction variables involving the proxy for confidence in the deposit insurance system, and those conditioning the effect of the market discipline components on leverage, generally turn out to small and insignificant effects on risk, as does leverage entered individually. None of these results differ dramatically form those reported in Table 3. Nor do the estimated effects of the control variables, which are, overall, similar. The one notable exception is that both the real interest rate and inflation now turn out to significantly influence the market Z-score.

[Table 5]

Tables 5 and 6 report the results of alternative specifications with respect to country effects and market-discipline proxy employed, respectively. Two differences between the baseline specifications and the country fixed effects specifications of Table 5 (estimated only on NPL/equity) stand out. First, the convexity of the insider capital effect is reinforced. Whereas Table 3 suggested that non-performing loans are only marginally negatively affected by an initial increase in the share of insider capital, and the effect turns positive at about 3 percent, the Table 5 specifications suggest a stronger initial negative effect, which turns positive only at around 15 percent. In this respect, the latter make the results on non-performing loans more aligned with those for the Z-score. Second, the market discipline variable no longer significantly affects the insider capital effect. In fact, market discipline is insignificant both individually and in interactivity with ownership structure and leverage.

In light of the latter result, it may be of interest to see if the estimated effects of market discipline from the baseline regressions stand up to the use of a different proxy for creditor discipline. These results are reported in Table 6, where market discipline is proxied by the share of subordinated debt to total assets, but the specifications in all other respects are as in Table 3. The share of sub-debt works in a similar way as the composite measure of creditor discipline, when risk is proxied by the market Z-score – i.e., it tempers the (negative) effect of insider ownership and the (positive) effect of leverage, but is individually not significant. When risk is proxied by the bad-loans ratio, on the

other hand, there is no discernible disciplinary effect of sub-debt. Another observation can be made for specification (1) in table 6: the estimated effect of the insider capital share is much more similar to the results previously obtained for the Z-score. The negative effect now predominates and bottoms out only at about 42 percent of inside over outside capital.

[Table 6]

Summarizing the overall impression of the empirical results, the U-shaped influence of insider control on bank risk seems relatively robust, although the relative strength of the negative and positive varies – not only depending on the risk measure used, as observed already in Table 3, but, insofar as risk is proxied by the ratio of non-performing loans to equity, also depending on exactly how the regression equation is specified. A plausible explanation for the differences in test results across different risk measures (with similar specifications of the right-hand side) may be that the non-performing loans ratio and the Z-score measure somewhat different aspects of risk. This explanation seems all the more plausible because the effects of control variables are generally consistent across specifications so long as the same risk measure is used, but not always otherwise. For example, undercapitalized banks always have a significantly higher ratio of non-performing loans to equity (as should be expected, since undercapitalized banks are low on equity), but undercapitalization never significantly impacts the Z-score. Moreover, GDP growth is also consistently negatively associated with non-performing loans, but has the opposite effect on risk measured as the Z-score. Finally, given the cross-specification

instability of the parameter estimates for ownership structure in the regressions on the non-performing loans ratio, on is inclined to attach more weight to the results obtained using the Z-score as dependent variable. A greater reliance on these results would also allow clearer conclusions in terms of the role of creditor discipline in restraining bank risk: this role is a supporting one, in the sense that it comes to light only as a mechanism to counterbalance the risk effects of increased shareholder control and reduced capitalization, but not as an individually significant determinant of risk.

6. Conclusion

The bearing idea in this paper was that governance variables, in the guise of ownership structure and varying degrees of market discipline by creditors, are major determinants of banks' risk taking incentives in the presence of (partial) deposit insurance. Deposit insurance – so long as it is not funded entirely by the insured banks and the insurance premia charged of the banks are not perfectly risk-adjusted – introduces a subsidy on increased risk, but the extent to which this subsidy is exploited depends on the agency cost structure of the bank, and therefore its ownership structure. The structure of equity ownership – insofar as it is related to the extent to which (outside) shareholders can enforce their interests – may affect both equity and debt agency costs, but possibly in different directions. Market discipline by creditors depends not only on the formal coverage of deposit insurance, but also on the credibility of the guarantees, and formally non-insured creditors' expectations of *ad hoc* bailouts of in the event of default.

The interrelationships between the variables of interest were analyzed in a standard capital-structure determination model, augmented in a simple way to account for

partial deposit insurance. The model demonstrates why insider ownership may have a non-monotonic influence on risk (a common empirical result in the literature), and how the effect of market discipline by creditors depends both on the degree of shareholder control and on the level of capitalization. The effect of minimum capital requirements and regulatory forbearance on undercapitalized banks were also briefly considered.

By exploiting a dataset with bank-level data for several hundred banks worldwide and the World Bank's datasets on bank safety net characteristics at the country level, I was able to test the general predictions of the analysis. The results strongly suggest a convex effect of insider ownership on risk, but whether the negative or positive effect dominates depends on the measure of risk used. Creditor discipline has an insignificant effect on risk as a stand-alone variable, but interacted with ownership structure and/or leverage affects risk in the predicted way in several of the specifications.

This result suggests that creditor discipline tempers the effect of increased shareholder control (whether that effect works primarily to increase leverage or to increase risk), and kicks in as an anti-risk mechanism when capitalization starts to look poor. Overall, however, the results on creditor discipline are more mixed than those on ownership structure.

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Table 1. Variable definitions

Variable	Description	Source
1. Risk proxies		
a. Non-performing loans / equity	Non-performing loans divided by equity capital	BankScope
b. Z-score	(Average return on equity – equity capital over total assets) divided by standard deviation of equity returns	Datastream, BankScope
2. Ownership variables		
a. Inside to outside capital	Equity held by all insiders/stakeholders divided by the sum of equity *not* held by insiders/stakeholders and total liabilities	Reuters, BankScope
b. Institutions' share of outside equity	Equity held by institutional investors divided by all equity not held by insider/stakeholders	Reuters
c. Government ownership	Dummy variable indicating largest insider/stakeholder is the government	Reuters
d. Foreign ownership	Dummy variable indicating largest insider/stakeholder is foreign	Reuters
3. Market discipline / deposit insurance		
a. Share of formally (explicitly) insured debt[a]	% country-wide deposit insurance coverage multiplied by each bank's ratio of deposits to total debt	BankScope, Demirgüç-Kunt et al. (2005)
b. Public confidence in the deposit insurance system[a]	Index value of 'government effectiveness'	Kaufmann et al. (2006)
c. No-bailout credibility 1	The Fitch support index of probability of bailout	Fitch/BankScope
d. No-bailout credibility 2	The Fitch support index (c) wherever available, otherwise one minus the bank's share of total deposits (alt. M2) in its country of residence	BankScope + IMF International Financial Statistics
e. Market discipline 1	$a \times (1-b)+(1-a) \times c$	As above
f. Market discipline 2	$a \times (1-b)+(1-a) \times d$	As above
4. Capital structure		
a. Leverage of outside capital	Total liabilities divided by total non-insider capital, standardized around the mean	BankScope, Reuters
b. Undercapitalization indicator	Dummy variable indicating if equity divided by total assets < 50% of the total applicable capital requirements	BankScope, Barth et al. (2001, 2006)
c. Subdebt	Subordinated debt divided by total assets	BankScope
5. Bank-level variables		
a. Charter value (Tobin's *Q*)	The sum of market value of equity and book value of liabilities divided by the book value of total assets	BankScope, Datastream
b. Bank size	The natural logarithm of total assets in thousands of USD	BankScope
c. Liquid assets	Liquid assets divided by total assets	BankScope

6. Country-level control variables		
a. Country income level	The natural logarithm of real GDP per capita in thousands of USD (constant 2000 prices)	World Development Indicators
b. Real interest rate	Real interest rate	World Development Indicators
c. Inflation	Inflation rate	World Development Indicators
d. Growth	The growth rate of real USD GDP (constant 2000 prices)	World Development Indicators
e. Systemic financial crisis	Dummy variable equal to one if the country was undergoing a systemic financial crisis, zero otherwise	Honohan and Laeven (2005)
7. Institutional variables		
a. Summary regulation	Sum of Capital Regulation, Supervisory Power, and Prompt Corrective Power indices	Barth et al. (2001, 2006)

Note: a) For countries/years with explicit deposit insurance system in place. All other countries: entries equal zero.

Table 2. Descriptive statistics (all banks/countries)

Variable	Mean	Std.dev.	Min	Max	Obs
Risk measures					
Non-performing loans / equity	0.67	0.73	0.00	4.89	2534
Z-score	5.35	5.28	0.35	40.3	2688
Governance variables					
Inside to outside capital	0.036	0.056	0.00	0.75	2745
Institutions' share of outside equity	0.15	0.19	0.00	0.99	2755
Leverage (debt share of outside capital, standardized)	0.00	1.00	-9.80	1.19	2720
Share of formally insured debt	0.53	0.35	0.00	0.99	2881
Public confidence in the deposit insurance system	0.55	0.30	0.00	0.96	47 countries
No-bailout credibility 1	0.48	0.26	0.10	0.90	3444
No-bailout credibility 2	0.61	0.29	0.10	0.90	5066
Composite market discipline 1	0.43	0.18	0.076	0.90	1509
Composite market discipline 2	0.53	0.22	0.04	0.90	2896
Bank-level control variables					
Charter value	1.01	0.13	0.41	2.89	2669
Bank size	15.1	2.10	6.94	21.2	3389
Liquid assets / total assets	0.25	0.19	0.00	0.97	3388
Subordinated debt / total assets	2.7×10^{-4}	0.0016	0.00	0.055	2100
Country-level control variables					
Country income level	8.82	1.56	5.87	10.6	47 countries
Growth	0.033	0.031	-0.13	0.18	47 countries
Inflation	0.067	0.14	-0.039	1.55	47 countries
Real interest rate	0.060	0.091	-0.91	0.78	47 countries
Summary regulation	20.4	4.41	11.0	28.0	47 countries

Table 3. Results from estimation of the baseline regression specification (equation [14])

Dependent variable	1. Non-performing loans / equity	2. Negative market Z-score	3. Non-performing loans / equity	4. Negative market Z-score
Estimation method[a]	OLS	2SLS	OLS	2SLS
Inside to outside capital	-2.06 (-.65)	-90.9 (-6.87)***	-.47 (-.30)	-57.2 (-3.49)***
(Inside to outside capital)^2	39.5 (2.81)***	105.5 (1.65)*	7.14 (2.10)**	68.77 (3.31)***
(Inside to outside capital) × (Market discipline 1)	-16.6 (-2.89)***	71.6 (2.28)**		
Market discipline 1	.54 (1.17)	.36 (.27)		
(Market discipline 1) × Leverage	.21 (.44)	-4.06 (-1.89)*		
(Inside to outside capital) × (Market discipline 2)			-7.42 (-2.16)**	23.1 (.84)
Market discipline 2			.12 (.37)	2.19 (1.18)
(Market discipline 2) × Leverage			.43 (1.35)	-2.22 (-.54)
Leverage	.21 (.44)	4.91 (4.48)***	-.027 (-.15)	5.13 (2.03)**
Charter value (Q)	-.26 (-1.39)	-.41 (-.49)	-.085 (-.59)	.047 (.030)
Bank size	-.0033 (-.10)	.0051 (.041)	-.012 (-.54)	.56 (3.21)
Liquid assets / total assets	-.20 (-.53)	.71 (.83)	-.39 (-1.38)	-1.19 (-.95)
Institutions' share of outside equity	-.34 (-1.64)	-.069 (-.076)	-.41 (-2.44)**	1.02 (.82)
Foreign-owned	.067 (.67)	.33 (.97)	.16 (1.97)**	.040 (.056)
Government-owned	.21 (1.57)	.96 (2.97)***	.18 (1.61)	-.48 (-.76)
Undercapitalized	.44 (3.78)***	-.084 (-.32)	.76 (6.93)***	.086 (.20)
Growth	-3.24 (-3.22)***	4.91 (1.64)	-3.66 (-3.19)***	7.73 (2.24)**
Inflation	-.44 (-.89)	4.77 (3.44)	-.68 (-1.57)	2.76 (1.30)
Real interest rate	-.30 (-.84)	.82 (.75)	-.065 (-.20)	-1.04 (-.68)
Income level	-.15 (-2.25)**	-.21 (-1.80)*	-.13 (-2.96)***	-1.07 (6.21)***
Summary regulation	-.018 (-1.31)	.016 (.51)	-.015 (-1.35)	-.034 (-.79)
Systemic financial crisis	.40 (4.08)***	1.30 (4.67)***	.44 (5.59)***	2.01 (4.64)***
Period fixed effects (F-statistic)	5.09***		5.25***	
Regression F	22.3***	40.4***	38.9***	53.7***
Adj. R^2	.36	.56	.40	.46
No of obs.	1001	1131	1556	1873
No of banks	185	206	282	330

The table reports coefficient estimates from panel OLS/2SLS estimation with period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance and correlation over time within cross-sections. */**/*** denotes significance at 10/5/1 percent confidence level.

Note: a) Estimation method was determined by Hausman tests of possible endogeneity of leverage and charter value. 2SLS uses country dummies as additional instruments.

Table 4. Results from estimation on individual market discipline components

Dependent variable	1. Non-performing loans / equity	2. Negative market Z-score	3. Non-performing loans / equity	4. Negative market Z-score
Estimation method[a]	OLS	2SLS	OLS	2SLS
Inside to outside capital	-2.33 (-.57)	-86.6 (-4.52)***	2.77 (1.02)	-97.0 (-7.18)***
(Inside to outside capital)^2	38.2 (2.74)***	122.9 (2.23)**	7.23 (1.72)*	135.1 (3.15)***
(Inside to outside capital) × (Share of formally insured debt)	-4.68 (-1.47)	12.54 (1.48)	-5.27 (-1.83)*	21.1 (1.76)*
(Inside to outside capital) × (Confidence in deposit insurance)	-4.22 (-.75)	-13.0 (-.45)	.65 (.17)	-28.3 (-1.30)
(Inside to outside capital) × (No-bailout credibility 1)	-5.80 (-1.80)*	51.7 (4.44)***		
(Inside to outside capital) × (No-bailout credibility 2)			-6.59 (-2.77)***	53.2 (4.22)***
Share of formally insured debt	.55 (2.58)**	-.061 (-.13)	.61 (3.47)***	1.16 (1.68)*
Confidence in deposit insurance	-.33 (-1.24)	1.43 (2.13)**	-.27 (-1.25)	-1.95 (-1.96)**
No-bailout credibility 1	.033 (.13)	-.32 (-.41)		
No-bailout credibility 2			.46 (2.54)**	-2.60 (-3.00)***
(Share of formally insured debt) × Leverage	-.17 (-.46)	.95 (.65)	-.21 (-1.32)	-6.35 (-5.24)***
(Confidence in deposit insurance) × Leverage	.22 (.38)	1.63 (.79)	.12 (.53)	13.1 (5.93)***
(No-bailout credibility 1) × Leverage	-.12 (-.35)	-1.10 (-.72)		
(No-bailout credibility 2) × Leverage			.18 (.65)	-1.46 (-.86)
Leverage	.37 (.89)	2.49 (1.63)	.090 (.36)	1.29 (.90)
Charter value (Q)	-.27 (-1.25)	-.51 (-.74)	-.079 (-.55)	.67 (.67)
Bank size	-.023 (-.59)	-.052 (-.38)	.016 (.64)	-.58 (-2.34)**
Liquid assets / total assets	-.40 (-.96)	.17 (.19)	-.46 (-1.57)	-.015 (-.014)
Institutions' share of outside equity	-.26 (-1.16)	-.55 (-.61)	-.31 (-1.72)*	1.83 (1.31)
Foreign-owned	-.010 (-.092)	.51 (1.31)	.096 (1.32)	-1.01 (-2.03)**
Government-owned	.17 (1.10)	.93 (2.76)***	.17 (1.49)	.20 (.37)
Undercapitalized	.46 (4.20)***	-.27 (-.86)	.72 (6.89)***	.12 (.35)
Growth	-2.65 (-2.61)***	4.99 (1.72)*	-3.33 (-2.80)***	5.30 (1.60)
Inflation	-.11 (-.20)	4.78 (3.56)***	-.58 (-1.27)	4.50 (2.71)***
Real interest rate	-.24 (-.64)	3.05 (2.74)***	-.24 (-.75)	3.77 (2.12)**
Income level	-.15 (-2.42)**	-.30 (-2.51)**	-.11 (-2.59)***	-.45 (-2.97)***
Summary regulation	-.017 (-1.23)	.0093 (.33)	-.016 (-1.51)	.0077 (.21)
Systemic financial crisis	.21 (3.08)***	.89 (3.75)***	.20 (3.22)***	1.17 (3.08)***
Period fixed effects (F-statistic)	4.73***		5.96***	
Regression F	18.9***	39.7***	34.8***	61.3***
Adj. R^2	.37	.59	.42	.51
No of obs.	993	1122	1535	1852
No of banks	185	206	282	330

The table reports coefficient estimates from panel OLS/2SLS estimation with period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance

and correlation over time within cross-sections. */**/*** denotes significance at 10/5/1 percent confidence level.
Note: a) Estimation method was determined by Hausman tests of possible endogeneity of leverage and charter value. 2SLS uses country dummies as additional instruments.

Table 5. Results from estimation of country fixed effects models[a]

Dependent variable	1. Non-performing loans / equity	2. Non-performing loans / equity
Estimation method	OLS	OLS
Inside to outside capital	-17.3 (-4.19)***	-4.41 (-1.84)*
(Inside to outside capital)^2	62.4 (4.12)***	11.4 (2.14)**
(Inside to outside capital) × (Market discipline 1)	2.47 (.45)	
Market discipline 1	-.017 (-.045)	
(Market discipline 1) × Leverage	-.42 (-.98)	
(Inside to outside capital) × (Market discipline 2)		-1.83 (-.40)
Market discipline 2		.052 (.19)
(Market discipline 2) × Leverage		.027 (.079)
Leverage	.79 (3.26)***	.31 (1.58)
Charter value (Q)	-.047 (-.32)	-.051 (-.39)
Bank size	-.027 (.71)	-.019 (-.71)
Liquid assets / total assets	-.80 (-1.64)	-.070 (-.23)
Institutions' share of outside equity	-.19 (-.75)	-.26 (-1.32)
Foreign-owned	-.13 (-1.29)	.15 (2.31)**
Undercapitalized	.37 (3.59)***	.78 (7.28)***
Systemic financial crisis	.27 (2.18)**	.19 (2.06)**
Country fixed effects (F-statistic)	39.9***	65.6***
Period fixed effects (F-statistic)	9.65***	8.30***
Regression F	24.9***	31.0***
Adj. R^2	.58	.52
No of obs.	1034	1609
No of banks	192	292

The table reports coefficient estimates from panel OLS estimation with country and period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance and correlation over time within cross-sections. */**/*** denotes significance at 10/5/1 percent confidence level.

Note: a) The government ownership dummy variable had to be dropped from these specifications to accommodate fixed effects for all countries.

Table 6. Results from estimation of the baseline regression specification with market discipline measured as subordinated debt/total assets[a]

Dependent variable	1. Non-performing loans / equity	2. Negative market Z-score
Estimation method[b]	OLS	2SLS
Inside to outside capital	-3.52 (-2.59)***	-57.3 (-4.23)***
(Inside to outside capital)^2	4.22 (1.35)	79.1 (1.96)*
(Inside to outside capital) × (Subordinated debt/total assets)	-28.9 (-.71)	879.5 (1.72)*
Subordinated debt/total assets	2.07 (.83)	-43.5 (-1.39)
(Subordinated debt/total assets) × Leverage	.62 (.70)	-60.0 (-2.09)**
Leverage	.19 (2.22)**	5.76 (4.95)***
Charter value (Q)	-.15 (-.91)	-2.66 (-1.12)
Bank size	-.023 (-1.05)	.50 (2.12)**
Liquid assets / total assets	-.36 (-1.11)	.25 (.14)
Institutions' share of outside equity	-.35 (-1.79)*	-.16 (-.095)
Foreign-owned	.24 (2.40)**	.53 (.54)
Government-owned	.24 (1.73)*	-.46 (-1.00)
Undercapitalized	.67 (5.80)***	.33 (.62)
Growth	-4.89 (-3.24)***	.88 (.20)
Inflation	-2.42 (-3.14)***	2.96 (.75)
Real interest rate	-.052 (-.15)	-1.13 (-.71)
Income level	-.16 (-3.50)***	-.98 (-5.35)***
Summary regulation	-.022 (-1.84)*	-.015 (-.26)
Systemic financial crisis	.53 (4.95)***	1.62 (4.08)***
Period fixed effects (F-statistic)	2.28**	
Regression F	30.8***	64.4***
Adj. R^2	.42	.33
No of obs.	1120	1391
No of banks	241	282

The table reports coefficient estimates from panel OLS/2SLS estimation with period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance and correlation over time within cross-sections. */**/*** denotes significance at 10/5/1 percent confidence level.

Notes:

a) Coefficients reported are for subordinated debt/total assets measured in percent (rather than as fractions as in Table 2.

b) Estimation method was determined by Hausman tests of possible endogeneity of leverage and charter value. 2SLS uses country dummies as additional instruments.

Notes

[1] Some aspects of bank or banking system characteristics may counterbalance this effect – e.g., entry barriers caused by restrictive regulation or market concentration (Marcus, 1984; Keeley, 1990), creating rents from valuable bank charters for 'incumbent' banks.

[2] At country-level, recent studies indicate that the existence of an explicit deposit insurance system increases the probability of systemic banking crises, and that such systems have a more detrimental effect on banking system stability in weak institutional environments, where effective prudential supervision and overall transparency and reliability of the legal system, etc., cannot easily counterbalance the moral hazard risk introduced by deposit insurance (Demirgüc-Kunt and Detragiache, 2002). These results parallel historical studies of bank failures in the US before and after the introduction of federal deposit insurance, which have found bank risk-taking and failure rates to correlate with the presence of deposit insurance. For instance, Calomiris (1990) and Alston et al (1994) found that US banks in the 1920s were on average riskier and more susceptible to failure in states where a deposit insurance system was present than in states without such a system. Grossman (1992) found that the introduction of federal deposit insurance in the 1930s initially lowered banks' risk taking, but that once insured, banks increased risk beyond pre-deposit-insurance levels. The effect was particularly pronounced in states with comparatively lax supervision.

[3] Benston and Kaufman (1997) report that formally uninsured deposit holders incurred losses in only 17 percent of bank failures in 1991, and that the deposit insurance reform pushed that number up to 54 percent in the following year.

[4] One weakness with their results, however, may be that they are not necessarily particularly representative 'out of sample'. Clearly, their results imply comprehensive implicit guarantees in European countries before the introduction of formal deposit insurance systems. However, several European countries introduced such systems, if not as a direct consequence of, then very shortly after having experienced major banking crises, involving massive bailouts. Crises were particularly prevalent in smaller, highly concentrated banking markets centered around a small number of systemic banks (Finland, Norway, Sweden) – a factor which contributed to the extensive bailouts. It is not clear that post-crisis, pre-deposit-insurance risk behavior in these countries' banks reflects average *ex ante* bailout expectations for countries without explicit deposit insurance in general. If the authors' observations on 'no deposit insurance' are

unbalanced toward such countries and such circumstances, they will overestimate the risk-reducing potential of explicit deposit insurance.

[5] This is consistent with the predictions of, e.g., Marcus (1984) and Keeley (1990) that deregulation will tend to erode the value of incumbent banks' charters that otherwise serves to counterbalance the risk-increasing incentives of deposit insurance.

[6] The 'state of the industry' parameter assumes a role similar to that of charter value in other studies: an exogenous conditioning variable representing investment opportunities, the regulatory climate, the level of competition, etc.

[7] Whether the assumption of underpriced deposit insurance is a realistic one is open to debate. Laeven (2002) finds that the difference between average 'fair' (option-value) premia and average official premia over the 1990s in a number of countries with explicit deposit insurance was not significantly different from zero (although official premia were substantially lower for some countries). However, this non-significance is hardly surprising given the variation in option-implied premia over the cross-section of banks. Demirgüç-Kunt and Huizinga (2004), on the other hand, find that explicit deposit insurance does indeed provide a subsidy, in terms of a reduction in average debt-service rates net of deposit insurance premia, for a (larger) sample of countries over the same time period. The assumption of imperfect risk adjustment of insurance premia is probably less controversial, given that during the period covered here, the vast majority of countries did not risk-adjust premia. Exceptions were Finland, Peru, Sweden, and the US (again, see Demirgüç-Kunt and Huizinga, 2004).

[8] Note that a necessary condition for deposit insurance to shift the agency cost curve is that disciplining by the 'exogenous' insurer – i.e., in practice government supervision – is less effective than disciplining by holders of risky debt. This is a less dramatic assumption than it might seem at first, since the supervisory authorities' main disciplinary tool is a more or less discrete capital adequacy requirement (the effect of which is considered in the model). Moreover, I don't make any *a priori* assumption about the effectiveness of market discipline by creditors, and the effect of bank co-financing of the deposit insurance scheme, finally, has already been mentioned.

[9] For a motivation, see, e.g., Cook and Spellman (1994). I also assume that outside financing purely by (insured) deposits is not possible because of a number of 'institutional' constraints related to equity: for

instance (though, perhaps, rather trivially), the included banks are all listed on a stock exchange, and maintaining that listing presumes that a certain share of the equity capital be tradable (which would imply that at least some *outside* equity capital is maintained). However, the assumptions on the debt-related parameters are what most generally prevent optimal capital structure from simply turning to $d = \phi = 1$ within the model.

[10] This does not mean that the shareholders' moral hazard incentive is not there, only that it is not exploited, and that the creditors know about the shareholders' weak position and price the debt accordingly.

[11] Previous research provides surprisingly few clues as to the effect of equity ownership structure on debt agency costs, as noted by Anderson et al. (2003): "little, if any, work examines the relation between ownership structure and the shareholder-bondholder conflict" (p. 264). The work that does exist is somewhat contradictory. Kim and Sorensen (1986) find that firms with more insider ownership have higher debt ratios, but cannot distinguish between the effect of equity and debt agency costs. Bagnani et al. (1994) argue for a non-monotonic relationship between managerial ownership and bondholder returns, but only find evidence of a positive association at intermediate levels of managerial ownership. Anderson et al. (2003) also find evidence that equity ownership structure affects debt costs, but they focus on a particular aspect of ownership structure – ownership by founding families – that makes the results difficult to generalize. Cremers et al. (2006) conclude that the net impact of shareholder control on bondholders is theoretically unclear, and produce results where the effect of shareholder control on credit risk premia depends on takeover vulnerability.

[12] In option-pricing-based analyses of the value to shareholders of deposit insurance, value can be created both by increasing asset risk and/or by increasing leverage (defined as the ratio of insured debt to total assets) – see, e.g., Merton (1977). The 'tradeoff' between asset risk and leverage is unclear. In this paper, it is determined by ownership structure.

[13] The condition is that the sum of γ and κ, confidence in the deposit insurance scheme and the received probability that uninsured creditors will not be bailed out, exceeds unity.

[14] See, e.g., Martinez Peria and Schmukler, 2001, for evidence on bank risk and depositor discipline during banking crises.

[15] The Z-score is widely used as a risk measure in the banking literature, see, e.g., Hannan and Hanweck (1988), Boyd et al. (1993), Beck and Laeven (2006); the market-based version is used by, e.g., Crouzille et al. (2004).

[16] A potential weakness with this proxy is that it assumes that banks within a country generally have similar portions of insured and uninsured deposits; that is, that no individual bank, for instance, has an unusually large share of very large (and hence uninsured) deposits.

[17] This proxy is equivalent to the share of deposit value covered under the assumption of one deposit per capita, and may overstate coverage, particularly in rich countries where the deposit count can reasonably be expected to well exceed the population count; it may be less of an overestimation for developing countries where the average number of bank accounts per capita is lower.