



Deposit Insurance, Moral Hazard and Market Monitoring[★]

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Abstract. The paper analyses the relationship between deposit insurance, debt-holder monitoring, and risk taking. In a stylised banking model we show that deposit insurance may reduce moral hazard, if deposit insurance credibly leaves out non-deposit creditors. Testing the model using EU bank level data yields evidence consistent with the model, suggesting that explicit deposit insurance may serve as a commitment device to limit the safety net and permit monitoring by uninsured subordinated debt holders. We further find that credible limits to the safety net reduce risk taking of smaller banks with low charter values and sizeable subordinated debt shares only. However, we also find that the introduction of explicit deposit insurance tends to increase the share of insured deposits in banks' liabilities.

1. Introduction

Markets can limit the risk taking of banks, only if some market participants unambiguously have their money at stake. This implies that some liabilities of the bank must be credibly excluded from the safety net. In this paper, we argue that explicit deposit insurance may play a useful role as a commitment device of authorities to limit the safety net to those explicitly covered under the deposit insurance. This point stands in contrast to the frequently reiterated argument that deposit insurance generates moral hazard and incentives for excessive risk taking by banks. If prior to the introduction of deposit insurance implicit guarantees were broad, the effect of introducing explicit deposit insurance on market monitoring and risk taking of banks may be positive. The ample “blanket” guarantees to all bank creditors provided by the government during the Swedish and Finnish banking crises in

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the early 1990, where explicit and limited deposit insurance systems were not in place beforehand, can be taken as supporting evidence in favour of our story. These crises were systemic, however, which may impose particular pressure on the authorities to intervene regardless of the safety net arrangements. Evidence from failures of individual banks may be more instructive. In Germany (a country with explicit deposit insurance), there have been a number of small bank failures, in which depositors have been protected while subordinated debt holders and other creditors have taken a full loss. The most recent case was the failure of Gontard und Metallbank AG (in 2002). In contrast, in Greece, which did not have a deposit insurance system until 1995, in 1989 Bank of Crete failed and was taken over by the central bank. There is no evidence of any creditor losing funds due to the incident.

It should be stressed, however, that the point of this paper is primarily about *ex ante* risk taking of banks, rather than about *ex post* handling of crises. If the authorities are more credible (and if deposit insurance helps them be more credible) in excluding non-deposit creditors *ex ante*, and this results in more stringent market discipline, that would be in line with our argument. Based on the empirical evidence for the European Union (EU) presented in this paper, it appears that explicit deposit insurance may in fact be a useful way to limit the safety net, increase market monitoring of banks, and reduce moral hazard.

Previous empirical evidence concerning the impact of deposit insurance on bank risk taking and the potential for banking sector fragility is mixed. For example, Wheelock and Wilson (1995) fail to establish a relationship between historical US bank failure rates and deposit insurance. In addition, Karels and McClatchey (1999) fail to find evidence that the adoption of deposit insurance increased the risk taking of US credit unions. Conversely, Alston et al. (1994), Grossman (1992), Wheelock (1992) and Thies and Gerlowski (1989) find a positive and significant relationship. Similarly, Demirgüç-Kunt and Detragiache (2002) in a sample of 61 countries find that over a period from 1980–1997 deposit insurance significantly increased the probability of a banking crisis in the country. Most closely related to this paper, Hovakimian et al. (2003) examine the effect of explicit deposit insurance on risk shifting of banks in a sample of 56 countries. They find that risk shifting is maintained or even reduced in countries with strong contracting environments, in countries with high political and economic freedom and in countries that are characterised by low degrees of corruption.

The impact of deposit insurance on risk taking interacts with at least three other important factors: banks' charter values, the effectiveness of monitoring by non-deposit creditors and "too-big-to-fail". The failure to accurately reflect any one of these factors may account for the mixed findings of the empirical literature. If banks are able to earn rents, either through regulatory limits on competition (e.g., Keeley, 1990), valuable lending relations (Sharpe, 1990; and Rajan, 1992) or the acquisition of reputation (e.g., Boot and Greenbaum, 1993), the effects of deposit insurance on risk taking may be mitigated. Similarly, the degree of risk taking of

banks may be influenced by the amount of uninsured debt banks carry on their balance sheets (Dewatripont and Tirole, 1993a; and Calomiris, 1999). And third, if banks are perceived as “too-big-to-fail”, their risk taking might not be affected by the deposit insurance arrangement, as they enjoy a comprehensive implicit safety net in any case.

This paper aims to extend the literature in two main ways. First, the existing empirical evidence regarding banks’ risk taking tends to use U.S. data or use rather heterogeneous samples containing developing and developed countries, whose banking systems may be at widely different stages of liberalisation and sophistication. There is limited evidence for developed countries, concerning the impact of deposit insurance arrangements on risk taking in an environment of competitive banking outside the US. This paper attempts to fill part of this void. Second, our data set allows us to test a rich set of hypotheses regarding the interaction between deposit insurance, charter values, monitoring by non-deposit creditors, “too-big-to-fail” and moral hazard, closing some of the gap between the theoretical and empirical literatures.

Our main findings can be summarised as follows: (i) We find evidence that the introduction of explicit deposit insurance in the EU may have significantly reduced banks’ risk taking. (ii) We find that this effect is less prevalent for banks with high charter values and low subordinated debt shares. (iii) We further find that the risk taking of banks with a very large share in the national banking system is unaffected (“too big to fail”). (iv) We find some adjustment in the balance sheet structure of banks towards more insured deposits after the introduction of explicit deposit insurance.

The remainder of the paper is organised as follows. In Section 2 we motivate our empirical hypotheses by drawing on a simple model of banks with moral hazard. In Section 3, we provide some institutional background of deposit insurance and deregulation in the EU. In Section 4 we describe the data set we employ. The empirical specification and definitions of all variables are reported in Section 5. In Section 6, we report the main empirical results. In Section 7 we examine the effects of the introduction of explicit deposit insurance on banks’ share of deposits in their balance sheets. Section 8 examines the robustness of our results and Section 9 concludes the paper.

2. A Stylised Model of the Safety Net and Moral Hazard

The theoretical literature (e.g., Freixas and Rochet, 1997; Boot and Greenbaum, 1993; Dewatripont and Tirole, 1993a, b; and Matutes and Vives, 1995) is unambiguous in that the public safety net, providing assistance to banks in distress and protecting banks’ claim-holders from losses, increases the propensity by bank managers to take on excessive risk (moral hazard).¹ This is so, since insured claim-

¹ The safety net, defined as the protection of banks’ creditors against losses resulting from bank failures, is motivated in the first place by the short maturity structure of bank liabilities and the

holders of the bank do not have appropriate incentives to monitor the actions by banks' management. The bank manager will rationally maximise bank value taking the subsidy element of deposit insurance into account, resulting in higher risk taking. In this section, we present a simple model of banks, which permits a derivation of conditions under which the introduction of explicit deposit insurance results in an increase in market monitoring compared with an implicit safety net. The model also allows us to state a number of empirical hypotheses regarding the interaction of specific bank characteristics and risk taking under different safety net arrangements. The model relies heavily on the idea that banks' risk taking may largely be a function of the presence of a set of creditors, who are credibly excluded from the safety net.

Consider the following simple, one period banking model with I risk neutral banks denoted by subscript i . The banks are financed with deposits and subordinated debt. Each bank is run by an owner/manger, who maximises bank profits and enjoys limited liability protection.² In order to focus on the effects of the safety net, we abstract from conflicts of interest between different claimants of the bank. The associated return the bank pays on these two types of liabilities are r_i^D and r_i^B , respectively. The bank invests in a risky portfolio of loans and charges a rate of $(r_i^L - 1)$ on those loans. Banks offer a differentiated loan product, and are price takers in the deposit and subordinated debt markets. For simplicity, we normalise the length of each bank's balance sheet to unity.

Following Boot and Greenbaum (1993), the probability structure of bank i 's pay-off from its loan portfolio is

$$\begin{aligned} 0 & \quad \text{with probability } \rho(1 - m_i), \\ r_i^L & \quad \text{with probability } (1 - \rho) + m_i\rho, \end{aligned} \tag{1}$$

where m_i represents the bank's choice of monitoring effort, with $m_i \in [0, 1]$ and $\rho \in [0, 1]$ some exogenous default probability, which for simplicity we assume to be the same across banks. If the bank monitors fully, i.e., $m_i = 1$, the bank will receive r_i^L with certainty and will never default. Boot and Greenbaum (1993) show that this pay-off structure implies that monitoring improves the bank's return in a first-order stochastic dominance sense. Monitoring, however, is costly and, following Cordella and Yeyati (2002), we assume a quadratic monitoring cost schedule:³

$$V(m) = \beta m^2. \tag{2}$$

private information characteristic of their longer-maturity assets, reflecting banks' unique liquidity creation and intermediation functions (Diamond and Dybvig, 1983; Gorton and Pennacchi, 1990; and Calomiris and Kahn, 1991).

² For simplicity we assume that banks' initial equity equals zero.

³ The main reason for this assumption is mathematical simplicity, as with this monitoring cost function we can obtain closed form solutions. Generally, any convex function should yield qualitatively similar results.

The bank operates for one period and fails if the pay-off to the loan portfolio is zero. Further, assume that γ^D represents the probability that the government compensates depositors and γ^B the probability of government compensation of subordinated (non-deposit) debt in case the bank fails. Hence, if the banks succeeds, depositors and subordinated debt holders receive r_i^D and r_i^B , respectively. If the bank fails, they receive (in expected terms) $\gamma^D r_i^D$ and $\gamma^B r_i^B$.

Subordinated debt holders are assumed to be risk averse. Hence, they require to be compensated for risk and for simplicity we specify the following relationship:

$$r_i^B = r + (1 - m_i)(1 - \gamma^B)(\bar{r} - r), \quad (3)$$

where r represents the risk free interest rate. Expression (3) implies that

$$r_i^B(\gamma^B = 1, m_i \in [0, 1]) = r_i^B(\gamma^B \in [0, 1], m_i = 1) = r$$

and

$$r_i^B(\gamma^B = 0, m_i = 0) = \bar{r}, \quad \text{with} \quad \bar{r} < r_i^L.$$

The latter implies that banks add value, essentially a participation constraint for the owner/manager of the bank to initiate operation. Expression (3) implies that if either there is complete monitoring or the probability of a bail out is 1, r_i^B will converge to the risk free rate, as in that case the bank's portfolio entails zero risk.

Equivalently, for the rate on deposits we have

$$r_i^D = r + (1 - m_i)(1 - \gamma^D)(\bar{r} - r). \quad (4)$$

Hence, the interest rate on subordinated debt and deposits is the same, as long as they are bailed out with the same probability. Once this probability differs, the bank will pay different interest rates on the two types of liabilities. The risk premium investors expect would be $(\bar{r} - r)$, if they invested in the risky asset directly (no monitoring). This risk premium is linear and declining in the bail out probability and in the level of monitoring of the bank.

Denoting the share of deposits in bank i 's liabilities with a_i , each bank maximises profits of the form:

$$\pi_i = (1 - \rho + m_i \rho)[r_i^L - r_i^D(m_i, \gamma^D)\alpha_i - r_i^B(m_i, \gamma^B)(1 - \alpha_i)] - V(m_i).^4 \quad (5)$$

Solving $\max_m \pi_i$ yields the following first-order condition:

$$\frac{\partial \pi_i}{\partial m_i} = \rho[r_i^L - r_i^D(m_i, \gamma^D)\alpha_i - r_i^B(m_i, \gamma^B)(1 - \alpha_i)]$$

⁴ Note that while we assume limited liability in the sense that the bank will only pay out its creditors if the project succeeds, monitoring costs will be paid in any case. Strictly speaking we assume that the owner manager expenses this cost before the outcome of the investment is known (see Boot and Greenbaum, 1993).

$$+ (1 - \rho + m_i \rho) \left[-\frac{\partial r_i^D}{\partial m_i} \alpha_i - \frac{\partial r_i^B}{\partial m_i} (1 - \alpha_i) \right] - \frac{\partial V(m_i)}{\partial m_i} \equiv 0.$$

The problem has an interior optimum only if we impose bounds on the parameter β in the monitoring cost function:

$$\bar{r} - r < \beta < r_i^L - r. \quad (6)$$

Inequality (6) states that the monitoring cost has to be bounded by the risk premium of investors and the gross return of the portfolio if it succeeds. Intuitively, we require that monitoring should not be too attractive relative to the financing costs of the bank, but also should not be so costly as to discourage the owner/manager from operating the bank in the first place.

Substituting expressions (2), (3) and (4), we obtain the optimal level of monitoring:

$$m_i^* = \frac{1}{2} \left[\frac{\rho(r_i^L - r) + (1 - 2\rho)(\bar{r} - r)[\alpha_i(1 - \gamma^D) + (1 - \alpha_i)(1 - \gamma^B)]}{\beta - \rho(\bar{r} - r)[\alpha_i(1 - \gamma^D) + (1 - \alpha_i)(1 - \gamma^B)]} \right]. \quad (7)$$

From (7) we see that, as expected, the optimal level of monitoring is a declining function of the monitoring cost parameter β . Further, it is an increasing function of the bank's pay-off to risk, as well as the exogenous risk, ρ .⁵ In the following we analyse a number of specific cases, which differ in their assumptions about the safety net arrangements facing banks.

2.1. "FREE BANKING"

If there is no chance of a bail out or any implicit or explicit deposit insurance, we have $\gamma^D = \gamma^B = 0$. The first thing to notice is that in this case the share of deposits in the liabilities of the bank, α_i , does not matter, as both bank liabilities are equally risky. Hence, the optimal level of monitoring becomes

$$m_i^{*FB} = \frac{1}{2} \left[\frac{\rho(r_i^L - r) + (1 - 2\rho)(\bar{r} - r)}{\beta - \rho(\bar{r} - r)} \right]. \quad (8)$$

Note that even in the "free banking" case the bank will not necessarily fully monitor and reduce the probability of failure to zero. By construction, the default probability of bank i is just $\rho(1 - m_i^*)$.

⁵ The fact that m_i^* is increasing with ρ is not obvious from (7), as the second term of the numerator changes signs depending on whether ρ is less than or equal to $\frac{1}{2}$. It can, however, be shown that $\frac{\partial m_i^*}{\partial \rho} > 0$ for $\rho \in [0, 1]$.

2.2. EXPLICIT DEPOSIT INSURANCE

Next, consider the case with explicit deposit insurance, hence $\gamma^D = 1$ and $\gamma^B = 0$.⁶ As subordinated debt holders are not bailed out, in the following we refer to this system as “credible deposit insurance”. The optimal level of monitoring of a bank operating in a credible system is given by

$$m_i^{*DI} = \frac{1}{2} \left[\frac{\rho(r_i^L - r) + (1 - 2\rho)(\bar{r} - r)(1 - \alpha_i)}{\beta - \rho(\bar{r} - r)(1 - \alpha_i)} \right]. \quad (9)$$

It is straightforward to show that for non-zero levels of deposits (i.e., $\alpha_i > 0$) the optimal level of monitoring with explicit deposit insurance (Equation (9)) will be less than in the “free banking case” (Equation (8)). The difference, however, is declining, but remains positive, as ρ approaches unity. This implies that in very risky environments, the effect of the safety net arrangements on monitoring become second order.⁷ The lower level of monitoring with explicit deposit insurance is also reflected in a correspondingly higher probability of bank failure.

2.3. IMPLICIT SAFETY NET

Now turn to the case with an implicit safety net. We define an implicit safety net as an arrangement in which all creditors of a bank are bailed out in the case the bank fails with some probability $\gamma^{D,B} \in [0, 1]$, but there is no explicit deposit insurance. Hence, in case of an implicit safety net, the bank’s optimal level of monitoring is just Equation (7), which we restate here

$$m_i^{*IS} = \frac{1}{2} \left[\frac{\rho(r_i^L - r) + (1 - 2\rho)(\bar{r} - r)[\alpha_i(1 - \gamma^{D,IS}) + (1 - \alpha_i)(1 - \gamma^{B,IS})]}{\beta - \rho(\bar{r} - r)[\alpha_i(1 - \gamma^{D,IS}) + (1 - \alpha_i)(1 - \gamma^{B,IS})]} \right]. \quad (7a)$$

The optimal level of monitoring depends on the probability of bail out of both deposits and subordinated debt, as well as their relative shares in the bank’s liabilities.

Using Equations (9) and (7a) we can ascertain the relative level of moral hazard under the implicit safety net versus an explicit, credible deposit insurance system. We obtain the following proposition:

⁶ One could also imagine a case in which the deposit insurance system does not credibly limit re-imbursement to depositors, i.e., $\gamma^B \in [0, 1]$ and $\gamma^D = 1$. This case is subsumed under what we label the “implicit” safety net.

⁷ We do not want to stress this point too much, as it is simply an outcome of the specific monitoring function and payoff structure that we have chosen.

PROPOSITION 1. Given ρ , r_i^L , r , $\bar{r}$ and constraint (6) the optimal level of monitoring under the implicit safety net is less than that under a credible explicit deposit insurance iff

$$\alpha_i < \frac{\gamma^{B,IS}}{1 - \gamma^{D,IS} + \gamma^{B,IS}}. \quad (10)$$

Proof. Follows directly from Equations (7a) and (9).

Proposition 1 states that moral hazard and the likelihood of a banking crisis is reduced with the introduction of credible explicit deposit insurance relative to an implicit safety net, if the share of subordinated debt (the share of insured deposits) in bank liabilities is relatively high (low) or, if the probabilities for a bail out of deposits and subordinated debt are high under the implicit system. Proposition 1 also implies that the effect on moral hazard of the introduction of explicit deposit insurance in a country which had been characterised by widespread implicit guarantees is ambiguous *ex ante*. It depends upon whether the limit of the safety net to depositors is indeed credible, the share of subordinated debt on banks' balance sheets and the prevalence of implicit guarantees prior to the introduction. Hence, the introduction of deposit insurance does not necessarily increase moral hazard. By construction, the same condition is required for the probability of bank failure to be higher under an implicit system than under credible deposit insurance. Empirically, upon introduction of deposit insurance, under the condition that the limitation of the safety net to depositors is in fact credible, a bank with a higher subordinated debt share should adjust its risk taking more than a bank with a low subordinated debt share. We will test for this below.

2.4. CHARTER VALUES, "TOO BIG TO FAIL" AND BALANCE SHEET STRUCTURE

The literature (e.g., Keeley, 1990) has stressed that moral hazard may be mitigated if banks have charter values. One way to interpret inequality (6) would be to say that the margin between the lending rate and the risky borrowing rate, $r_i^L - \bar{r}$, represents the incentive to the bank (its owner/manager) to stay in operation. We left the source of this margin unspecified, but one could imagine it arising from market power, reputation or other factors.⁸ We immediately obtain an additional proposition.

PROPOSITION 2. Given the safety net arrangements, the optimal level of monitoring is higher for banks with larger charter values.

⁸ There are many other ways to model the presence of charter values. Generally, they require multi-period models. To maintain simplicity, we have abstracted from these issues, as the question of how a charter value may arise is not the focus of this paper. For more discussion, see Boot and Greenbaum (1993); Matutes and Vives (1997) and most recently Pelizzon (2001).

Proof. Differentiating the optimal level of monitoring, m^* with respect to the charter value we find $\frac{\partial m_i^*}{\partial (r_i^L - \bar{r})} > 0$.

COROLLARY 2. Given some non-zero level of subordinated debt ($\alpha_i < 1$), banks with high charter values adjust their monitoring (and risk taking) less than banks with low charter values in response to a shift from an implicit safety net to explicit deposit insurance.

Proof. As $r_i^L \rightarrow \infty$ and/or $\bar{r} \rightarrow r$, $m_i^{*DI} \rightarrow m_i^{*IS}$.

Corollary 2 gives us an important empirical prediction. Banks with high charter values, as they have less incentives under the implicit safety net to take on excessive risk, will reduce their risk taking less upon the introduction of a credible deposit insurance system compared to banks with low charter values.

At this point, we are also in a position to discuss “too big to fail” in the context of our model. “Too big to fail” simply suggests that $\gamma^D = \gamma^B = 1$ for large systemic banks, regardless of the safety net arrangements for all other banks. For these banks, the optimal level of monitoring is

$$m_i^{*TBTf} = \frac{1}{2} \left[\frac{\rho(r_i^L - r)}{\beta} \right]. \quad (11)$$

Hence, we can state Proposition 3.

PROPOSITION 3. Banks that are “too big to fail” do not adjust their risk taking in response to the introduction of credible explicit deposit insurance.

So far we have taken the balance sheet structure of banks as given, i.e., the share of deposits α_i was exogenous. Relaxing this assumption yields the following additional proposition.

PROPOSITION 4. Suppose the bank chooses α_i first and m_i second. Then

if $\gamma^D > \gamma^B$ the bank chooses $\alpha_i = 1$

if $\gamma^D < \gamma^B$ the bank chooses $\alpha_i = 0$

if $\gamma^D = \gamma^B$ the bank chooses $\alpha_i \in [0, 1]$.¹⁰

Proof. Follows immediately from (5).

Empirically, Proposition 4 implies that if a country moves from an implicit system, in which the probability of bail out for subordinated debt and deposits was equal or

¹⁰ Given α_i all previous propositions and corollaries hold.

greater, to an explicit system in which the probability of depositor compensation is 1, banks will adjust their balance sheet structures towards relying more heavily on insured deposits.¹⁰

In summary, the model in this section shows that the effect of introducing explicit deposit insurance on banks risk taking may be ambiguous *ex ante* and depends on assumptions about the counterfactual to deposit insurance (no safety net vs. an implicit safety net). The model yields a number of empirical predictions regarding moral hazard and risk taking of banks. In the following, we use a data set of European banks to test for Propositions 1 and 2 as well as Corollaries 1 and 2, and for Propositions 3 and 4.

3. Institutional Background

As we propose to test the model using European data, it may be useful to give some background information on the regulatory environment in Europe. Banking deregulation in Europe began in the late 1970s and continued through the early 1990s, with significant differences in the timing and speed of the process across countries (Canals, 1993). With few exceptions, regulations on banks' competitive conduct have now largely been eliminated. These regulations included controls on banks' deposit and lending rates, fees and commissions, as well as direct credit quotas and branching limitations. Functional separation of financial institutions, if it existed, has generally ceased. There was a shift in regulatory thinking from conduct regulations towards the use of prudential regulations (capital adequacy, exposure concentration limitations), freeing competition and abolishing regulatory protection of national markets. However, some country specific distortions remain, mainly related to taxation and subsidies, but they distort banking markets to a much more limited extent than in the past. While conclusive empirical evidence is still outstanding, the result of deregulation is generally believed to be a sharp increase in banking competition.

European Community legislation, primarily since the White Paper of 1985 "Completing the Internal Market", has significantly contributed to this process and has provided incentives for national legislators to deregulate and streamline banking legislation. The most important piece of Community legislation was the 2nd Banking Co-ordination Directive (89/646/EEC) leading to unification of the regulatory framework for "entry control" and cancelling the major elements of national separation of markets in legal/regulatory terms. The Directives on banks' own funds (89/299/EEC) and required solvency ratio (89/647/EEC) were adopted within the same time frame. However, these regulations in effect extended the scope of the 1988 Capital Accord of the Basel Committee on Banking Supervision

¹⁰ Clearly, we do not observe banks fully financed with either subordinated debt or insured deposits; rather banks tend to use a combination of both. One simple way to reconcile this stylised fact with our model would be to introduce some fixed supply of insured deposits (as deposit insurance is limited to some amount per depositor).

issued for internationally active banks to all banks in the EU. The Basel Accord meant an important change in banking regulation away from intrusive conduct regulations towards greater reliance on prudential standards. However, it also introduced more stringent capital requirements, which may have influenced banks' risk taking. We will use in the empirical analysis the implementation of the 2nd Banking Directive as a summary proxy for the "ultimate" deregulation process, while recognising that significant aspects of deregulation affecting banking competition and banks' risk taking incentives took place also before the implementation of this Directive.

Central in the context of this paper is the Directive on Deposit Guarantee Schemes (94/19/EC). It was issued in order to support the orderly functioning of banking markets under the liberalised environment. It set the minimum formal deposit guarantee at 20 000 euro.¹¹ At the time of the directive, four EU countries did not have explicit deposit insurance: Finland, Greece, Portugal and Sweden. Greece and Portugal introduced deposit insurance in 1996, Sweden in 1997 and Finland not until 1999.¹² We use this cross-country and time series variation in the econometric analysis below to identify the effects of deposit insurance on bank behaviour. None of the EU schemes guarantee interbank deposits and all have limits of the coverage per depositor (Appendix I). Other debt instruments issued by banks are all outside the scope of the coverage, while some schemes may provide a limited coverage. The coverage per bank per depositor ranges up to over EUR 100 000 in Italy, but for our purposes it is important that all explicit schemes in Europe have limits of the coverage per depositor. As the EU Directive is by nature a minimum Directive, the practical features of national schemes can differ significantly. For instance, the number of schemes ranges from a single scheme in most countries to several parallel schemes (France and Germany). The nature of the schemes also differs from fully private over mixed private/public to entirely public schemes. Some aspects of participation (e.g., acquisition of additional cover) can also be voluntary.

4. Data

The data used in this study were obtained from a number of different sources. The balance sheets and the income statements of EU banks are from the Fitch-IBCA Bankscope data set, which contains balance sheet data for a wide variety of European banks. We used consolidated balance sheets, supplemented by unconsolidated balance sheets for banks, which did not have consolidated data in Bankscope and did not have significant subsidiaries. We retained those banks, for which we could ascertain market values using Datastream, as market values are

¹¹ This was required to exist in all EU Member Countries by 1 July 1995. A limitation to Ecu 15,000 was possible until 31 December 1999.

¹² Belgium, Ireland, Luxembourg and the Netherlands had a coverage lower than 20,000 euro before the Directive.

Table I. Composition of the banks by country over the 1992–1998 period

Austria	3	Italy	24
Belgium	1	Luxembourg	4
Denmark	10	Netherlands	3
Finland	2	Portugal	6
France	20	Spain	14
Germany	22	Sweden	2
Greece	7	United Kingdom	7
Ireland	3	Total	128

necessary to calculate our measure of charter value, q , and which existed under the same name throughout the sample period.¹³ This process yields a sample of 128 banks for 1991–1998. A few of the banks recorded by Fitch-IBCA only report partial information on important data items. We used lagged variable regression or bank-specific means to impute these missing values. We also excluded 1991, as in Bankscope no information was available for all French banks and a large number of Italian banks, and we wanted to keep these important banking markets in the sample. The end result is a balanced panel containing 128 banks with data from 1992 to 1998 and a sample size of 896 observations. We supplemented this bank specific information with the stock market index for the country of origin of the bank, which we also obtained from Datastream. Datastream also provided us with the inter-day volatility of share prices, which we use in the risk equations. Other financial variables collected are 10-year Government bond yields as a measure of the long-term nominal interest rate and the money market rate as a nominal short-term interest rate. The rates were obtained from the IMF's International Financial Statistics.

The resulting sample contains data for banks in all 15 EU countries (Table I). The composition by country broadly corresponds to market size with the exception of the UK and Sweden, for which market values for banks were difficult to obtain in Datastream. The banks in the sample are relatively large, the average total assets is \$48 billion. The banks, hence, are approximately seven times the average size of all EU banks in the Bankscope. We attribute this size difference to our requirement that the banks be traded at a stock exchange. The sample banks represent approximately one sixth of the total assets of the EU banking sector.

The banks in our sample quite accurately reflect some of the stylised facts in European banking. For example, while the overall mean of the share of non-interest earnings in total earnings is 32.5 percent, this share has continuously increased from 27 percent in 1992 to 38 percent in 1998. Interestingly this is not reflected

¹³ This implies that some banks in the sample may have taken over smaller banks during the sample period.

in the share of loans in total assets, which has remained approximately constant around the overall sample mean of 55 percent.

5. Econometric Model and Definitions of Dependent and Independent Variables

We estimate the following reduced form model:

$$\text{risk}_{jt} = \delta_0 + \delta_1 D_{it} + \Pi_1 X_{jt} + \Pi_2 C_{it} + u_i + \varepsilon, \quad (12)$$

where risk_{jt} represents a measure of riskiness for bank j at time t , D_{it} represents a set of indicator variables describing the deposit insurance system and the degree of deregulation in country i at time t , X_{jt} represent a set of control variables unique to bank j at time t , and C_{it} are country specific control variables. Equation (12) is estimated using country-specific fixed effects in order to control for country specific differences, which are unaccounted for in the control variables. These country specific effects pick up any other policy differences across countries, which are not included explicitly in the set of control variables (such as taxes and any remaining differences in national banking regulations).

In line with the theoretical literature (e.g., Matutes and Vives, 1995), we distinguish between the three different types of risk: leverage risk, asset risk and overall bank risk. Leverage risk is defined as the book value of debt divided by the market value of assets (the market value of equity plus the book value of liabilities). It measures the degree of gearing of the bank; the more highly geared a bank is, the riskier it, as its cushion against an unexpected deterioration in the quality of its assets is smaller than in a less leveraged bank. Our second measure of risk, asset risk, is approximated by using the share of problem loans in total assets. Finally, we use the inter-day volatility of the bank's share price, corrected for the market component as a measure of the overall risk of the bank. We estimated a standard market model and calculated the standard deviation of the residuals, which gives us a measure of idiosyncratic volatility. For the details of the calculation see Appendix III.

All three measures suffer from shortcomings. In particular, our measure of leverage would benefit from a market-based measure of liabilities, which we did not have access to. The measure of asset risk is backward looking, not a measure of current risk, as default or payment difficulties of the clients of a bank will only appear in our measure with a lag. For example, the bank may extend further loans, which enable its troubled customer to remain current on the initial credit. And third, differences in inter-day volatility may not only reflect the riskiness of a bank, but also the liquidity depth of the market for its shares, although we would consider this problem to be relatively small given the size of the banks in our sample and the liquidity of EU stock markets.

Problem loans and stock price volatility are not available for all banks and, hence, samples are smaller, when we use these risk measures. Problem loans are not

available in Bankscope for banks in Austria, Belgium, Germany, Greece, Ireland, the Netherlands and Spain. In total, sample size is reduced to 349 observations (57 banks). The calculation of stock price volatility requires that the bank be sufficiently actively traded at a stock exchange.¹⁴ This was the case for 73 of the 128 banks in the sample, yielding a sample size of 525 observations. Table II shows, however, only very small differences in the descriptive statistics of all variables used in the estimation across samples and no systematic selection problems are apparent.

We are particularly interested in the effect of deposit insurance on bank behaviour. Given the cross-sectional and time series variation in deposit insurance in EU countries we are able to explicitly control for the effect of the existence of deposit insurance. We create an indicator variable, which is equal to one when no system is in place, which was the case in Greece, Portugal until 1995, for Sweden until 1996 and for Finland for the entire sample period. We also created an indicator capturing differences in deposit insurance coverage. The indicator equals one when coverage is extraordinarily high (Italy and France, which had coverage levels of 6 to 12 times the sample average, respectively and Germany, where the coverage is limited only by the book value of capital of the bank). Details on the coverage of EU deposit insurance schemes, as well as other information on EU deposit insurance schemes are given in Appendix I. Finally, in order to measure the impact of deregulation, we created an indicator, which reflects the implementation date of the Community legislation through the 2nd Banking Co-ordination Directive. The indicator equals one after the actual implementation date and implies that we model the liberalisation based on the Directive as a structural shift.¹⁵

A bank's charter value can be defined as the present value of the stream of profits that it expects to earn when staying in business. Hence, the charter value would equal to the market value (present value of the future expected earnings/dividend) of its assets minus the replacement cost of the bank, i.e., the expense of rebuilding the existing bank from scratch (Demsetz et. al., 1996). The market value is set to equal the market value of equity (E) (stock price times the amount of equities outstanding) plus the book value of banks' liabilities (L). This is reasonable, since the value of going concern would be reflected in the market value of the equity, as the equity holders would be the beneficiaries, not the debt holders. The replacement cost of a bank is simply the book value of its assets (A). Hence, the charter value (CV), which is divided by the book value of assets in order to obtain a scale-free measure, can be expressed as:

¹⁴ We deleted all banks that had a trading volume of below 1000 stocks or zero returns on more than 30 percent of all trading days.

¹⁵ Note that even though the Directive was passed at the European level, the implementation dates vary in the individual countries: The Netherlands and Sweden (1991), UK (1992), France, Germany, Portugal, Greece, Ireland and Italy (1993), Austria, Belgium, Finland and Luxembourg (1994), Spain (1995), and Denmark (1996).

Table II. Descriptive statistics

For the definition of all variables, see Appendix II.

Leverage risk sample	<i>n</i>	Mean	Min	Max	Std. dev.
Number of banks	128				
Total assets (\$ billions)	896	47.1	0.3	704.7	91.3
Leverage risk: equity to debt ratio	896	0.053	0	0.26	0.04
Absence of deposit insurance	896	0.09	0	1	0.28
High deposit insurance coverage	896	0.52	0	1	0.50
EC directive implemented	896	0.80	0	1	0.40
Market-to-book asset ratio, <i>q</i>	896	0.99	0.86	1.10	0.04
Demand deposits/Total assets (%)	896	69.4	2.7	94.7	21.1
Loans/Total assets (%)	896	54.8	0.05	98.8	21.1
Non-interest earnings/Total earnings (%)	896	32.5	-7.6	87.8	16.6
Subordinated debt/Total assets (%)	896	1.3	0	8.3	1.1
Share of bank's assets in country's total assets of the banking system (%)	896	4.7	0.01	47.0	8.4
Dummy: co-operative banks	896	0.13	0	1	0.34
Dummy: mortgage banks	896	0.13	0	1	0.34
Asset risk sample	<i>n</i>	Mean	Min	Max	Std. dev.
Number of banks	57				
Total assets (\$ billions)	349	55.0	0.4	475.5	89.3
Asset risk: problem loans as a percent of total assets (%)	349	2.6	0	27.0	3.1
Absence of deposit insurance	349	0.12	0	1	0.33
High deposit insurance coverage	349	0.58	0	1	0.49
EC directive implemented	349	0.87	0	1	0.34
Market-to-book asset ratio, <i>q</i>	349	0.99	0.91	1.09	0.03
Demand deposits/Total assets (%)	349	77.1	3.3	89.8	11.1
Loans/Total assets (%)	349	49.1	0.05	81.9	13.6
Non-interest earnings/Total earnings (%)	349	36.0	7.1	87.8	14.2
Subordinated debt/Total assets (%)	349	1.5	0	8.3	1.3
Share of bank's assets in country's total assets of the banking system (%)	349	6.7	0.01	47.0	9.1
Dummy: co-operative banks	349	0.16	0	1	0.37
Dummy: mortgage banks	349	0.19	0	1	0.39
Overall risk sample	<i>n</i>	Mean	Min	Max	Std. dev.
Number of banks	73				
Total assets (\$ billions)	525	47.6	0.3	704.7	89.2
Overall risk: Idiosyncratic stock price volatility	525	0.30	0.029	3.46	0.30
Absence of deposit insurance	525	0.07	0	1	0.3
High deposit insurance coverage	525	0.49	0	1	0.5
EC directive implemented	525	0.81	0	1	0.39
Market-to-book asset ratio, <i>q</i>	525	0.99	0.86	1.10	0.04
Demand deposits/Total assets (%)	525	74.1	2.7	94.7	20.3
Loans/Total assets (%)	525	53.3	4.1	98.8	17.2
Non-interest earnings/Total earnings (%)	525	34.6	-5.5	87.8	16.2
Subordinated debt/Total assets (%)	525	1.1	0	5.1	0.9
Share of bank's assets in country's total assets of the banking system (%)	525	3.7	0.01	43.8	7.2
Dummy: co-operative banks	525	0.18	0	1	0.38
Dummy: mortgage banks	525	0.25	0	1	0.43

$$\frac{CV}{A} = \frac{E + L - A}{A}. \quad (13)$$

Adding 1 and simplifying gives Tobin's q , which in the following will be used as a proxy for a bank's charter value:

$$q = \frac{E + L}{A}. \quad (14)$$

This measure is also used by Keeley (1990) and Demsetz et. al. (1996). For a bank with pricing power in loan, deposit or other markets, the market value of assets ($E + L$) would exceed their book value (A), and q would exceed one. In equilibrium q would exactly equal one for an uninsured bank with no pricing power.

The measure q as a proxy for charter value has the advantage of permitting comparability across different bank sizes. Furthermore, it directly reflects the extent of monopoly rents earned by banks due to pricing power. Smirlock (1984) argues that because q relates the market value of banks' assets to their current cost, it is an ideal "all-in" measure of the rents. Any pricing power, irrespective of its source, would be reflected in the market value of banks' equity, and thus assets, but not in the cost of acquired assets. This circumvents also the significant measurement problems in trying to proxy the extent of pricing power through interest rates charged by banks for loans and deposits, and even more so through accounting-based measures of margins which can be driven by many auxiliary factors and accounting peculiarities.¹⁶

In the regression analysis we also utilise balance sheet ratios to control for bank specific differences, including the share of deposits in total liabilities, the share of non-interest earnings in total earnings, and the share of loans in total assets. The share of non-interest income in total income was included to measure the bank's willingness and ability to diversify into non-lending, non-traditional activities, such as underwriting and to some extent will also proxy for the bank's "innovation ability". In the relationship between moral hazard and deposit insurance the monitoring of uninsured debt-holders may be quite important, as discussed in Section II. Therefore, we included the share of subordinated debt in total liabilities as an independent variable. In the European context, with significant differences in the size of countries' economies, we use the share of the bank's total assets in the total assets of the country's banking system to control for the "too-big-to-fail" effects on charter value and risk taking.

¹⁶ A problem may arise in using q as a measure of banks' rents (or charter value), as the book value of assets reflects historical costs, rather than current costs of the assets. Therefore, *ex post* q may diverge from 1 simply because asset return realisations may have been different from expectations, rather than as a reflection of market power. Hence, the theoretically correct *ex ante* q is measured with error when using the *ex post* q . One could also argue that q and risk taking may be simultaneously determined. This would suggest an instrumental variable approach. We experimented with a number of instruments, but were unable to find one with an economic justification.

Further, we include a normalised country specific stock market index,¹⁷ money market rates and a measure of the steepness of the yield curve, which we defined as the difference between money market rates and 10-year government bond yields. Finally, not all banks in the sample were commercial banks. We also had a limited number of co-operative banks and mortgage banks, which might experience valuations that are quite different from those of commercial banks. Specialised banks or banks with a somewhat different organisational form might face different constraints, as well as pursue different objectives relative to commercial banks.¹⁸ For descriptive statistics of all variables see Table II and for detailed definitions see Appendix II.

6. Results

The baseline estimates for the relationship between risk and deposit insurance are presented in Table III. Table III shows that banks tend to reduce their risk taking for two of the three measures of risk in response to the introduction of explicit deposit insurance. Conflicting evidence is provided by the third measure: Leverage risk tends to increase with explicit deposit insurance. This is weak evidence in favour of Proposition 4; namely that banks increase their share of insured deposits when explicit deposit insurance is introduced. In the next section, we will present evidence, which more directly addresses this issue.¹⁹ For asset risk and overall risk, the absence of explicit deposit insurance is associated with significantly higher risk taking.²⁰

The effects of the 2nd Banking Directive on risk taking appear to have been mixed. We find a weakly positive effect on leverage and asset risk. Overall risk, as measured by the idiosyncratic stock price volatility, is lower after the implementation of the directive, which we interpret to reflect the tighter solvency standards associated with the directive. Now turn to the effect of changes in the charter value (q) on risk taking. As argued in the literature, banks with higher charter values tend to exhibit lower levels of leverage and overall risk (Proposition 2).²¹

The estimates for the control variables largely conform to expectations. For example, banks with a higher proportion of loans in their portfolios have also a higher proportion of problem loans and, hence, more asset risk, but generally are

¹⁷ The respective stock market indices were normalised, such that for all countries 1991 = 100. This will ensure comparability across countries.

¹⁸ With few exceptions, our choice of control variables corresponds closely to those of Keeley (1990).

¹⁹ Both the reduction in volatility and the increase in leverage in response to the introduction of explicit deposit insurance are consistent with the findings in Hovakimian et al. (2003).

²⁰ Higher coverage is not associated with an effect on banks' risk, which is consistent with our argument that what matters is not the characteristics of the scheme, but rather its existence in the sense of leaving some creditors of the bank uncovered altogether.

²¹ This is consistent with the previous empirical literature using US data (e.g., Keeley, 1990; Demsetz et al., 1996; Grossman, 1992; McKenzie et al., 1992; Brewer and Mondschean, 1994).

Table III. Charter values, deposit insurance and risk

All models were estimated using fixed effects across countries. Heteroskedasticity-corrected standard errors in parenthesis. The asterisks *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The dependent variables are the total book value of liabilities divided by the market value of assets, the share of problem loans in total loans, and the inter-day volatility of the bank's stock price corrected for market volatility, respectively.

Dependent variable		Leverage Risk	Asset Risk	Overall Risk
Deposit insurance	Absence of explicit deposit insurance	-0.007*** (0.003)	0.022*** (0.008)	0.126*** (0.035)
	Deposit insurance coverage high	0.003 (0.002)	0.004 (0.007)	-0.014 (0.022)
	EC Directive implemented	0.005* (0.003)	0.011* (0.006)	-0.075*** (0.028)
	Charter values q	-0.69*** (0.026)	0.067 (0.076)	-0.432* (0.257)
Balance sheet	Demand deposit share	-0.045*** (0.005)	0.027 (0.023)	-0.057 (0.059)
	Loan share	0.007 (0.006)	0.045*** (0.018)	-0.092 (0.065)
	Share of non-interest Earnings	0.003 (0.006)	0.036** (0.017)	0.016 (0.073)
	Share of subordinated debt	0.415*** (0.087)	-0.041 (0.148)	-2.40** (0.955)
	Share of total assets of bank in banking system	0.024*** (0.009)	-0.003 (0.026)	-0.023 (0.094)
	Market indicators			
	Stock market index	0.005*** (0.001)	-0.014*** (0.003)	0.081*** (0.012)
Bank specialisation	Money market rate	-0.008** (0.005)	0.002* (0.001)	0.014** (0.007)
	Money market rate-government bond yield	0.000 (0.000)	0.002** (0.001)	0.023** (0.011)
	Co-operative banks	-0.165*** (0.003)	-0.004 (0.007)	-0.011 (0.029)
	Mortgage banks	0.002 (0.002)	0.000 (0.005)	0.009 (0.019)
	Constant	0.66*** (0.026)	-0.064 (0.083)	0.754*** (0.253)
Wald test (χ^2) (13)		1181.6***	35.97***	110.1***
Hausman test		2.77	2.20	2.90
Lagrange multiplier test		1.27	0.14	2.33
N		896	349	525

not riskier overall. Banks with a higher share in the total assets of the banking system in their country are more highly leveraged, but also not riskier overall. This suggests that these banks may be better diversified and, hence, hold less capital. We find some evidence that subordinated debt holders are able to exert influence on the risk taking of banks (corollary 1). The coefficient has the expected significantly negative sign for overall risk. Interestingly, it is positive for leverage risk, suggesting some substitution of tier 1 (equity) and tier 2 (subordinated debt) capital. We provide further evidence on the question of subordinated debt holder monitoring below.

Ex ante, we had no strong priors on the effects of market conditions on risk taking. A high stock market may suggest a favourable economic environment and, hence, would be associated with lower risk of banks' portfolios. This is reflected in the significantly negative coefficient of the stock market index on asset risk. However, we also find that leverage and stock price volatility increase when stock markets are high. Similar arguments apply to the effects of interest rates.

While we have taken care to use a number of different measures of bank risk and found sensible results across all measures, we were concerned that the results may tell us little about the effect of deposit insurance, but rather highlight differences in countries unrelated to deposit insurance. Recall that the group of countries without deposit insurance includes Finland (throughout the sample period), Greece, Portugal (until 1995) and Sweden (until 1996). We considered the possibility that coefficient on the dummy on the absence of explicit deposit insurance simply measures that these countries are different from the remainder of the sample for reasons completely unrelated to deposit insurance. For example, both Finland and Sweden experienced banking crises at the beginning of our sample period; it is possible that this may be driving our results.²² Regarding Greece and Portugal, we were concerned that our results could reflect the fact that the banking sector in these countries may have been less developed or otherwise dissimilar from the "core" EU countries. The country differences might also reflect differences in intensity of bank regulation and supervision, which are unrelated to deposit insurance and the country effects are too crude a measure to pick up these differences.

In order to address these concerns, we have taken two complementary approaches. One, we interact the deposit insurance indicator with bank specific characteristics, such that the effects of deposit insurance are identified using bank characteristics, rather than country characteristics. And second, we limit our sample to the countries that at some point did not have explicit deposit insurance (Finland, Sweden, Portugal and Greece) and estimate the effects of the introduction of explicit deposit insurance relying largely on time series evidence.

²² Note, however, that we could argue that it may not be a coincidence that banking crises occurred in two countries without deposit insurance. This is the opposite point of the one in Demirgüç-Kunt and Detragiache (2002).

6.1. IDENTIFICATION USING BANK CHARACTERISTICS

First consider the following indicators, which we interact with the “no deposit insurance” indicator:

- A set of indicators, which distinguish between banks with subordinated debt shares above and below the median of the distribution, which permits us to test for Corollary 1. The share of subordinated debt is used as a proxy for uninsured debt more generally, as we were able to measure it more accurately than the other debt categories.
- A set of indicators, which distinguishes between banks with high charter values (charter values greater than 1) and other banks. This would allow testing for Corollary 2.
- A set of indicators, which distinguish banks, based on their relative size in the banking system. We set the cut-off point at banks with more than 12 percent of the total assets of a banking system in their country of incorporation, which represents the 90th percentile of the distribution. The failure of banks with such a high share in the total assets of the banking system would clearly represent a systemic risk to the banking system as a whole. Hence, this distinction allows us to test Proposition 3.

Table IV displays the results for this exercise. We have limited the table to the interaction terms, as they are of particular interest.²³ Consider first the interaction terms with subordinated debt. We find evidence in favour of the notion that subordinated debt may act as market-based limit to moral hazard and excessive risk taking of banks (Corollary 1). For asset risk and overall risk, banks with higher subordinated debt shares reduce their risk taking more than those with lower subordinated debt shares and the difference is significant at the 5 percent level in the case of asset risk (and marginally significant at the 10 percent level for overall risk). This finding is especially striking as we find further evidence for Proposition 4, namely that banks have increased their leverage in response to the introduction of explicit deposit insurance (see below). It also further corroborates the notion that explicit deposit insurance was credible at limiting insurance to depositors. Second, for the charter value/no deposit insurance interaction terms, we find support for Corollary 2. In case of asset and overall risk banks with high charter values do not adjust their risk taking downwards in response to the introduction of deposit insurance and banks with low charter values do. For asset risk, we can reject that the two coefficients are equal at the 5 percent confidence level. Higher charter values act as deterrence against additional risk taking (albeit not against higher leverage), regardless of the safety net arrangements in place.

²³ The coefficients on all other variables are robust to the introduction of these interaction terms. The complete results are available from the authors upon request.

Table IV. Refinements: charter values, "too big to fail", and monitoring

All models were estimated using fixed effects across countries. Heteroskedasticity-corrected standard errors in parenthesis. The asterisks * ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The dependent variables are the total book value of liabilities divided by the market value of assets, the share of problem loans in total loans, and the inter-day volatility of the bank's stock price corrected for market volatility, respectively.

Interaction terms: Absence of explicit deposit insurance interacted with:	Monitoring by debt-holders			Charter values			"Too big to fail"		
	Leverage risk	Asset risk	Overall risk	Leverage risk	Asset risk	Overall risk	Leverage risk	Asset risk	Overall risk
Dummy = 1 if subordinated debt share ≤ 0.013 (median)	-0.10** (0.005)	-0.006 (0.014)	0.111** (0.051)						
Dummy = 1 if subordinated debt share > 0.013 (median)	-0.006* (0.003)	0.028*** (0.009)	0.173*** (0.044)						
Dummy = 1 if predicted $q > 1$				-0.008** (0.004)	0.007 (0.010)	0.068 (0.056)			
Dummy = 1 if predicted $q \leq 1$				-0.006* (0.004)	0.034*** (0.010)	0.157*** (0.042)			
Dummy = 1 if share in assets of banking system > 0.12 (95th perc.)							-0.013** (0.005)	0.022* (0.013)	-0.006 (0.170)
Dummy=1 if share in assets of banking system ≤ 0.12 (95th perc.)							-0.005** (0.003)	0.022** (0.009)	0.160*** (0.034)
Equality of coefficients ¹		**			**			**	

¹The asterisks *, **, and *** indicate that the equality of the two coefficients can be rejected at the 10%, 5% or 1% level, respectively.

Finally, we also find support for Proposition 3, namely, that banks, which constitute a particularly large share of the banking system in a given country, do not adjust their risk taking. The coefficients are statistically significantly different at the five- percent level for overall risk. We interpret this finding as evidence that “too big to fail” has remained a relevant issue before and after the introduction of explicit deposit insurance and further that the limit of the safety net to depositors is only credible for smaller banks.

These findings deserve some further discussion. They suggest that the regime prior to the introduction of deposit insurance was not characterised by the absence of any safety net, but the presence of a broad and implicit one. In this case, the establishment of explicit deposit insurance limits the scope of the safety net and reduces moral hazard, since, first, explicit deposit insurance typically leaves out large depositors, as the coverage per depositor is limited. Second, the coverage is limited to depositors only, leaving out other creditors altogether. All these aspects generally are true for the deposit insurance systems in the EU (see Appendix I). Hence, our results would suggest that the counterfactual that has been assumed in the empirical literature, namely that, in the absence of explicit deposit insurance, banks operate in a completely uninsured environment, may be flawed, at least in the context of developed economies.²⁴

Economically, the effects are quite substantial. For example, upon the introduction of deposit insurance, banks with high shares of subordinated debt (low charter values) tended to have three percent (two percent) less problem loans on their books compared to under the no-deposit insurance case. Similarly, the idiosyncratic stock price volatility is 20 percent (25 percent) lower. For banks, which we do not classify as “too big to fail”, we also find that stock price volatility is 25 percent lower after the introduction of deposit insurance compared to before.

6.2. IDENTIFICATION USING TIME SERIES VARIATION

Recall that we have both cross sectional as well as time series variation in the existence of deposit insurance. Hence, we can limit our sample to those countries that at some point during the sample did not have explicit deposit insurance. In this case the effects of explicit deposit insurance would be identified largely through time series effects, reducing concerns that the results are driven by other cross-sectional differences across countries unaccounted for by the control variables. The results for this exercise are presented in Table V. We limit ourselves to present results for the preferred measure of risk, overall risk. Notice that this reduces the sample size to 56 observations. Even so, we find consistent evidence that the introduction of

²⁴ If a reform establishing an explicit deposit insurance scheme coincides with improvements in supervision or more stringent disclosure requirements (heightened market discipline), the reduction in risk taking could be attributed to these factors rather than the limitation of the safety net. However, the relevant developments in supervision and market disclosure in Europe have taken place much before the changes in the deposit insurance arrangements examined in this paper.

Table V. Sample limited to Finland, Greece, Portugal and Sweden

All models were estimated using fixed effects across countries. Heteroskedasticity-corrected standard errors in parenthesis. The asterisks *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The dependent variable is the inter-day volatility of the bank's stock price corrected for market volatility. The interaction terms are defined as before.

	Baseline	Interaction: Subordinated debt	Interaction: Charter value	Interaction: "too big to fail"
Absence of explicit deposit insurance	0.109*** (0.052)			
Interaction term ¹		0.076 (0.071)	0.132* (0.076)	−0.052 (0.140)
Interaction term ²		0.126** (0.057)	0.096* (0.057)	0.121** (0.052)
EC directive	−0.412*** (0.067)	−0.418*** (0.067)	−0.406*** (0.068)	−0.406*** (0.066)
<i>q</i>	−0.624 (0.491)	−0.619 (0.489)	−0.723 (0.556)	−0.560 (0.487)
Deposit share	0.76*** (0.251)	0.724** (0.256)	0.751*** (0.252)	0.804*** (0.251)
Loan share	−0.419* (0.226)	−0.402* (0.227)	−0.458* (0.240)	−0.405* (0.223)
Subordinated debt share	1.39 (3.52)	−0.624 (4.580)	1.79 (3.62)	1.63 (3.48)
Share of non-interest earnings	0.032 (0.177)	0.059 (0.181)	0.026 (0.178)	0.015 (0.176)
Share of assets in banking system	0.181 (0.547)	0.155 (0.546)	0.179 (0.547)	0.371 (0.560)
Stock index	0.10*** (0.022)	0.10*** (0.022)	0.10*** (0.022)	0.099*** (0.022)
Money market rate	−0.072*** (0.028)	−0.081*** (0.031)	−0.068** (0.029)	−0.070** (0.028)
Money market rate-bond yield	0.005 (0.007)	0.002* (0.001)	0.010* (0.007)	0.010* (0.007)
Constant	0.500 (0.477)	0.526 (0.477)	0.625 (0.564)	0.396 (0.479)
Wald test	62.7***	63.61***	62.22***	66.37***
<i>n</i>	56	56	56	56

¹ Low subordinated debt share; high *q*; high share in banking system, respectively.

² High subordinated debt share; low *q*; low share in banking system. See text for further explanation.

deposit insurance has reduced risk taking by banks. Further, when interacted with bank characteristics, our main findings go through. Banks with higher subordinated debt shares and that are not “too-big-to-fail” adjust their risk taking more than other banks, in line with the predictions of the theoretical model (Propositions 1 and 3). The evidence on charter values is weaker, however.

7. Banks’ Balance Sheet Structure

While the above evidence is suggestive that the effect on risk taking is somewhat mitigated by banks’ move towards more insured liabilities (given the increase in leverage subsequent to the introduction of explicit deposit insurance), we would like to examine Proposition 4 and estimate (insured) deposit share equations. Hence we estimate

$$IDS_{jt} = \gamma_0 + \gamma_1 D_{it} + H_1 X_{jt} + H_2 C_{it} + u_i + \varepsilon_2, \quad (15)$$

where IDS_{jt} represents the share of insured deposits in bank j ’s liabilities in period t . All other symbols are defined as before. Given that we are estimating a quantity equation, we need proxies for the own price (i.e., the price of deposits) and the price of substitutes. As we do not have access to bank specific interest rates, we use the money market rate as the price of deposits and the bond yield as the price of a substitute. Deposit rates tend to follow short-term money market rates as they are often priced at a margin below banks’ prime rates (which follow the money market rates with some lag). The bond yield can be used as a proxy of the return on alternative investments by household investors, which in the EU consist of bonds to a large extent. Further, the share of insured deposits is not directly observable. We use the share of total deposits minus the share of interbank deposits, as in all EU deposit insurance schemes they are excluded from coverage. However, in most cases foreign currency deposits are also excluded and all schemes have a ceiling (except Germany) per depositor. Unfortunately, we do not have information on foreign currency deposits and due to the ceiling our measure of insured deposits will overstate their true share. These caveats should be kept in mind when considering the results from estimating Equation (15).²⁵

The results, presented in Table VI, suggest that indeed banks may have shifted their liabilities towards more insured deposits in response to introducing explicit deposit insurance. The coefficient on the absence of deposit insurance is negative and significant in the full sample, as well as when we limit the sample to those countries, which at some point did not have explicit deposit insurance. The finding is even more striking as insured deposits are measured with some error here and underlines the finding earlier that even given this shift, risk taking diminished with explicit deposit insurance. One might ask why didn’t banks shift their liability

²⁵ There are also important issues in relation to the identification of loan demand and supply, which we leave unresolved here. Equation (26) should be viewed as a reduced form estimating equation.

Table VI. Banks' liability structure

The dependent variable is the share of deposits (excluding interbank deposits) in total liabilities. The model was estimated with fixed effects across countries. Heteroskedasticity-corrected standard errors in parenthesis. The asterisks *, ** and *** indicates statistical significance at the 1, 5 and 10 percent level, respectively. All independent variables are defined as before.

	Full sample	Sample limited to Finland, Greece, Portugal and Sweden
Absence of deposit insurance	−0.065*** (0.023)	−0.074*** (0.023)
High coverage	0.022* (0.013)	
EC directive	0.072*** (0.018)	0.094*** (0.027)
q	0.217 (0.175)	0.332 (0.266)
Share of loans	0.125*** (0.041)	0.154** (0.063)
Share of subordinated debt	0.385 (0.548)	−0.655*** (0.126)
Share of assets in the banking system	−0.091 (0.071)	−0.875*** (0.125)
Total assets/100000	−0.004*** (0.001)	−0.004 (0.01)
Money market rate	0.037*** (0.002)	0.014*** (0.004)
Bond yield	−0.025*** (0.005)	−0.008 (0.007)
Stockmarket indicator	0.073*** (0.008)	−0.005 (0.012)
Savings banks	0.191** (0.078)	
Co-operative banks	0.021 (0.020)	
Mortgage banks	0.003 (0.014)	0.038 (0.028)
Specialised lending institutions	−0.077*** (0.020)	−0.080*** (0.023)
Constant	−0.215 (0.183)	0.219 (0.280)
Wald statistic	414.3*** (15)	440.5*** (12)
n	896	126

structure entirely towards insured deposits. There are a number of answers to this question, which lies outside the scope of this paper, but most straightforwardly, insured deposits may be in limited supply, given that explicit deposit insurance schemes typically only insure a fixed amount per depositor. In addition, interest rates on insured deposits, which we only capture in a rudimentary way here, may adjust, offsetting the advantage due to insurance.

The other coefficients conform to expectations. The coefficients on the money market rate (which serves as the proxy for the own interest rate) is positive and highly significant, suggesting that supply effects dominate. Consistent with this finding, the rate on the alternative, bond yields, shows a negative effect on the share of deposits. High levels of stock prices, on the other hand, tend to be associated with more deposit financing. Further, banks with higher loan shares in their assets also have higher deposit shares in their liabilities, larger banks tend to finance themselves less with deposits and, finally, specialised lending institutions and mortgage banks have lower shares of deposits than commercial banks (the omitted category).

8. Robustness

We performed a number of additional robustness checks. One, charter values (q) and risk taking of banks may be simultaneously determined (see e.g., Keeley, 1990). However, we were unable to obtain an instrument with an economic justification for why it would be related to charter values but orthogonal to risk. Hence, we experimented with models identified through country specific effects and used q lagged by one period. The results suggest that there may be some simultaneity problems in relation to leverage risk. Recall that q is defined as the market value of assets divided by the book value and we measure leverage ratio by calculating the debt equity ratio as the book value of debt divided by the market value of equity plus the book value of debt. The market value of equity enters both definitions (once in the numerator and once in the denominator) and consequently market movements may spuriously generate a high negative correlation. Using country specific effects to identify the instrumental variable model resolves this problem. The estimated coefficients for our central variable of interest, namely the variable indicating the absence of explicit deposit insurance, are unchanged for asset and overall risk. The same is true for the results with the interaction terms.

Second, we considered the possibility that a more sophisticated error structure may be more appropriate in our measure of overall risk, for example to allow for persistence in stock price volatilities. We experimented with an autocorrelated error structure of up to 6 lags and also estimated generalised linear models with stationary, unstructured and non-stationary correlation matrices. All specifications yielded quite consistent results.

Third, we calculated variable averages for each bank and fitted an OLS model to this data. The objective is to address potential mismeasurement through mergers

or acquisitions during the sample period. The approach minimises not the overall squared differences, but the cross-sectional squared differences. We limit ourselves to reporting results for our preferred measure of risk, overall risk. In this model the sample size is reduced to 73 (the number of banks for which we were able to calculate overall risk). We find consistent results, suggesting that our results are unlikely to be significantly affected by distortions due to mergers.²⁶

9. Conclusion

This paper analysed the relationship between deposit insurance, bank charter values, debt-holder monitoring, and risk taking for European banks. Utilising cross-sectional and time series variation in the existence of deposit insurance schemes in the EU, we find that the establishment of explicit deposit insurance may significantly reduce the risk taking of banks. We draw two conclusions from this finding. One, in the absence of deposit insurance, European banking systems may have been characterised by strong implicit insurance operating through the expectation of public intervention at times of distress. And second, the introduction of an *explicit* deposit insurance system may imply a *de facto* reduction in the scope of the safety net and enable authorities to credibly exclude some creditors of the bank from the safety net. Our findings generally support the idea that explicit safety net arrangements are more “incentive-compatible” than the implicit ones, representing a vague but *ex ante* unlimited commitments by the government to intervene and protect banks’ claim-holders. The government may not be able to eliminate the safety net altogether and credibly commit not to intervene under times of distress. We find this despite some tendency of banks to increase their financing with insured deposits, when explicit deposit insurance is introduced.

We have stressed in our analysis that the limit to the safety net has to be credible for deposit insurance to have a “beneficial” effect. The credibility of the system may hold the key to reconciling the evidence presented in this paper with some of the evidence in the previous literature, which tended to find that deposit insurance increases moral hazard. The previous literature which found that the existence of deposit insurance increase banks’ risk taking, largely used data from developing or emerging markets, e.g., Demirgüç-Kunt and Detragiache (2002), or historical data sets from the 1920s as in Grossman (1992) or Wheelock (1992). As stressed also by Hovakimian et al. (2003), it is plausible that weaker institutional structures (for example concerning the liquidation regimes for banks), or the non-existence of liquid markets for banks’ liabilities, as for example in emerging markets, make a limitation to the safety net less credible. Under these circumstances, “constructive ambiguity” could be a better solution to containing moral hazard. In addition, in countries with underdeveloped subordinated debt markets, subordinated debt holders or other uninsured bank creditors may not be able to perform the monitoring role that would have the risk reducing effect on banks in the presence of deposit

²⁶ All results are available from the authors upon request.

insurance. Clearly, in those countries deposit insurance may have quite different effects from those shown in this paper.²⁷

The evidence should also be viewed as supportive of the notion that creditors are able not only to effectively monitor banks, but also to impose discipline on at least some banks. In this sense, the paper should be viewed as complementary to the recent literature that finds support for market discipline in European banks (Gropp and Richards, 2001; Gropp et al., forthcoming; and Sironi, 2003). However, also consistent with that literature, the results also point to the fact that market monitoring by debt holders may be inadequate for large, systemically important banks as their creditors (this includes subordinated debt holders) expect that authorities will not let those banks fail in any event ("too big to fail").

²⁷ Some evidence of functioning equity and debt markets is given in Gropp et al. (forthcoming) and Sironi (2003), while Gropp and Richards (2001) find evidence that while equity markets may reflect risk, subordinated debt in Europe may do so insufficiently.

Appendix I. Characteristics of Deposit Insurance Systems in EU Countries

The data in the table refer to the end of 1998. Sources: European Central Bank and Garcia (1999).

Country	Date established	Coverage limit (per bank per depositor)	Foreign currency deposits covered	Interbank deposits covered	Administration ¹	Funding
Austria	1979	20,000 euro	No	No	Private	Unfunded
Belgium	1974	15,000 euro (20,000 in 2000)	No	No	Joint	Funded
Denmark	1988	40,000 euro	Yes	No	Joint	Funded
Finland	1999	25,000 euro	Yes	No	Private	Funded
France	1980	60,000 euro	No	No	Private	Unfunded
Greece	1995	20,000 euro	No	No	Joint	Funded
Germany	1966	20,000 euro ²	Yes	No	Private (private) Joint ⁴ (official)	Funded
Ireland	1989	15,000 euro (20,000 in 2000)	No	No	Government	Funded
Italy	1987	103,291 euro	Yes	No	Private (CB approves decisions) Private	Unfunded
Luxembourg	1989	12,500 euro (20,000 in 2000)				
Netherlands	1979	20,000 euro	Yes	No	Government	Unfunded
Portugal	1995	25,000 euro	Yes	No	Government	Funded
Spain	1977	20,000 (from 2000)	No	No	Joint	Funded
Sweden	1996	28,000 euro	Yes	No	Government	Funded
United Kingdom	1982	22,200 euro	No	No	Private	Mixed ³

¹ The government includes the central bank.

² The public scheme provides a coverage up to 20,000 euro, but the private scheme provides a coverage up to 0.3% of the liable capital of the bank for each depositor.

³ There is an initial contribution and ex post funding when needed.

⁴ "Joint": both governmental and private.

Appendix II. Definition of Variables

SYMBOLS:

j = banks; t = periods; i = countries

EC Directive Implemented

= 1 if i = NL, SE, UK,
 if i = DE, FR, GR, IE, IT, PT, and $t \geq 1993$,
 if i = BE, LU, AT, FI and $t \geq 1994$,
 if i = ES and $t \geq 1995$,
 if i = DK and $t \geq 1996$,
 = 0 otherwise.

Absence of explicit deposit insurance

= 1 if i = GR, PT, and $t < 1996$,
 if i = SE and $t < 1997$,
 if i = FI,
 = 0 otherwise.

Deposit insurance coverage high

= 1 if i = DE, FR, IT,
 = 0 otherwise.

Leverage risk = book value of debt _{jt} /(book value of debt _{jt} + market value of equity _{jt}).

Asset risk = problem loans _{jt} /total assets _{jt} .

Idiosyncratic risk: see Appendix III.

Demand deposit share = Demand deposits _{jt} /Total liabilities _{jt} .

Loan share = Customer loans _{jt} /Total assets _{jt} .

Share of non-interest earnings = 1-[interest earnings _{jt} /total operational earnings _{jt}].

Total assets of bank divided by total assets of banking system = Total assets _{jt} /Total assets of banking system _{it} .

Stock market index = [Stock market index _{it} /Stock market index _{$i1991$}] $\times$ 100.

Money market rate-government bond yield = Money market rate _{it} -Government bond yield _{it} .

Money market rate = Money market rate _{it} .

Appendix III. Computation of Idiosyncratic Risk

We computed our measure of idiosyncratic risk by first estimating a standard market model of the form²⁸

$$R_{jt} = \alpha_{jt} + \beta_{jt} R_{it} + \varepsilon_{jt}, \quad (A1)$$

²⁸ See MacKinlay (1997) for further discussion on estimating such models, as well as their relative advantages and disadvantages relative to other methods.

where R_{jt} denotes the log daily stock return of bank j during year t and R_{it} represents the log daily return of the market portfolio in country i during year t . Hence, we estimate the model with about 250 daily observations for each bank in each year.²⁹ The residuals of this regression are commonly referred to as “ab-normal” returns in the event study literature (e.g., MacKinlay (1997)) and would be represented by

$$\hat{\varepsilon}_{jt} \equiv AR_{jt} = R_{jt} - \hat{\alpha}_{jt} - \hat{\beta}_{jt} R_{it}, \quad (\text{A2})$$

where $\hat{\alpha}_{jt}$ and $\hat{\beta}_{jt}$ are the estimated coefficients from Equation (A1). If we take the standard deviation of both sides of (A2) we obtain

$$\sigma_{AR_{jt}} = \sqrt{\sigma_{R_{jt}}^2 - \hat{\beta}_{jt}^2 \sigma_{R_{it}}^2}. \quad (\text{A3})$$

Equation (A3) can be interpreted as the idiosyncratic volatility of the stock price of bank j during period t .

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²⁹ As the model was estimated with daily data, it is likely that the normality assumption is violated at least in some cases and OLS estimation (which is what we use) may not be entirely appropriate. However, as Cable and Holland (2000) show, robust estimation will not necessarily solve the problem. At present, to our knowledge, there does not exist a solution to this issue.

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