EUROPEAN CENTRAL BANK

WORKING PAPER SERIES

NO. 302 / FEBRUARY 2004

DEPOSIT INSURANCE, MORAL HAZARD AND MARKET MONITORING

by Reint Gropp
and Jukka Vesala

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES

NO. 302 / FEBRUARY 2004

DEPOSIT INSURANCE, MORAL HAZARD AND MARKET MONITORING[1]

by Reint Gropp[2]
and Jukka Vesala

In 2004 all ECB publications will feature a motif taken from the €100 banknote.

This paper can be downloaded without charge from http://www.ecb.int or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=515064.

1 Research assistance by Sandrine Corvoisier and Andres Manzanares is gratefully acknowledged. All errors are the authors'. The views expressed in this paper are solely those of the authors and not those of the ECB or the Eurosystem. We are grateful for the comments received from Charles Calomiris, Asli Demirguc-Kunt, Xavier Freixas, Vitor Gaspar, Hans Gersbach, Philipp Hartmann, Martin Hellwig, Anil Kashyap, David Mayes, Benoit Mojon, Mitchell Petersen, Jean-Charles Rochet, two anonymous referees, seminar participants at the ECB, the 2nd Kiel Workshop in Economics "The Integration of Financial Markets in Europe", the IFS/Wharton Conference "Competition among Banks: Good or Bad?", the CEPR/EER/IAE Conference on Finance in Manresa/Spain, the Federal Reserve Bank of Chicago 38th Annual Conference on Bank Structure and Competition and the IMF.

2 European Central Bank, Kaiserstraße 29, D-60311 Frankfurt am Main, Germany. Corresponding authors email adress: reint.gropp@ecb.int.

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Internet
http://www.ecb.int

Fax
+49 69 1344 6000

Telex
411 144 ecb d

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

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.

JEL classification: G21, G28

Key words: Banking, Moral Hazard, Market Monitoring, Deposit Insurance

Non-technical summary

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 reason is that all creditors of the bank aside from those insured under the explicit system may have stronger incentives to monitor the bank. 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.

In this paper, we first present a simple model which suggests that profit maximising banks may increase or reduce their risk taking in response to the introduction of deposit insurance, depending on four factors. One, whether or not the explicit deposit insurance is credible in excluding all other creditors of the bank. Second, the charter value of the bank. Third, the share of liabilities aside from insured deposits on the balance sheet of the bank. And fourth, whether or not the banks is too-big-to-fail. The model highlights that the introduction of explicit deposit insurance, which credibly imposes limits on the safety net, will result in a reduction of risk for banks with low charter values, high shares of non-insured liabilities and for banks that are not too-big-to-fail.

The predictions of the model are tested in a sample of EU banks during the 1990s. The EU in the 1990s is a particularly suitable environment for testing the model, because a number of countries introduced explicit deposit insurance during that period. This implies that there is cross-sectional as well as time series variation in the existence of explicit deposit insurance in a sample of banks, which aside from deposit insurance operate in a largely similar regulatory environment. The empirical results are broadly consistent with the theory. In particular we find: (i) The introduction of explicit deposit insurance in the EU may have significantly reduced banks' risk taking. (ii) This effect is stronger for banks with low charter values and high subordinated debt shares. (iii) The risk taking of banks with a very large share in the banking system of the country is unaffected ("too big to fail"). The theoretical model also predicts that banks will increase the share of insured deposits in response to the introduction of explicit deposit insurance, precisely in order to avoid increased market discipline. In deposit share regressions, we find evidence in favour of this hypothesis.

The results of the paper highlight the importance of the institutional environment for effective market discipline of banks. It also provides evidence that banks in fact change their behaviour in response to signals from the market, i.e. that market discipline can be effective. In this sense, the paper contributes to the ongoing and extensive debate about the role markets as complements (or even substitutes) for supervisory review and capital requirements, as outlined in the proposals regarding the reform of the Basel Accord.

I. 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.[2] 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 [1994] and Alston et al. [1994] 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, Grossman [1992], Wheelok [1992] and Thies and Gerlowski [1989] find a positive and significant relationship. Similarly, Demirgűç-Kunt and Detragiache [2002] in a sample of 61 countries find that over a period from 1980-97 deposit insurance significantly increased the probability of a banking crisis in the country.

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]) or valuable lending relations (Sharpe [1990] and Rajan [1992]) or the acquisition of reputation (e.g. Boot and Greenbaum [1992]), 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])

---

[2] The ample intervention by the government during the Swedish and Finnish banking crises in the early 1990, where explicit and limited deposit insurance systems were not in place beforehand, can be taken as supporting evidence in favour of the latter contention.

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 safety net in any case.

This paper aims to extend the empirical 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, "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 banking system is unaffected ("too big to fail"). (iv) We find some adjustments 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 II we motivate our empirical hypotheses by drawing on a simple model of banks with moral hazard. In Section III, we provide some institutional background of deposit insurance and deregulation in the EU. In Section IV we describe the data set we employ, along with some summary statistics. Variable definitions, the empirical specification and baseline results are reported in Sections V and VI, respectively. In Section VII, we examine the effects of the introduction of explicit deposit insurance on banks' balance sheets. Section VIII examines the robustness of our results and Section IX concludes the paper.

II. 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, 1993b] 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).[3] This is so, since insured claim-holders of the bank do not have appropriate incentives to monitor the actions by banks' management. 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 if compared with an implicit bank 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. As we will see below, the model relies heavily on the idea that banks' risk taking may largely be a function of the presence of a set of creditors, which 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.[4] In order to focus on the effects of the safety net, we abstract from moral hazard related to limited liability and 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.

As in Boot and Greenbaum [1993], the probability structure of bank i's pay-off from its loan portfolio is

(1) 0 with probability $\rho_i(1-m_i)$

and

(2) r_i^L with probability $(1-\rho_i) + m_i\rho_i$.

where ρ_i is the probability of default in bank i's loan portfolio in the absence of monitoring and m_i represents the bank's choice of monitoring effort, where $m_i \in (0,1)$ and $\rho_i \in (0,1)$. The pay-off is a function of the exogenous default probability, ρ_i and the endogenous choice of the bank of how much monitoring effort to expend, m_i.[5] Note that if the bank monitors fully, i.e. m_i=1, the bank will receive $r^L{}_i$ with certainty and will never default. Monitoring, however, is costly and we assume a strictly positive and convex monitoring cost schedule $V(m)$ with $V'(m)>0$, $V''(m)>0$, and $V(m=0)=0$.

---

[3] 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 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])

[4] For simplicity we assume that banks do not have any equity. This assumption is relaxed subsequently in the discussion on charter values.

[5] The position of the business cycle of the economy a bank operates in would be one way to interpret the exogenous riskiness of the portfolio or riskiness of the sector that the bank primarily lends to.

The bank operates for a succession of equivalent periods until it fails, where failure is defined as the case of a pay-off to the loan portfolio of zero. To save notation we suppress subscripts t. 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 $\gamma^D r_i^D$ and $\gamma^B r_i^B$.

We specify the following no arbitrage relationship between monitoring, m_i, the probability of bail out, γ^B and r^L and the risk free rate, r:

(3) $$r_i^B = r + (1 - m_i)(1 - \gamma^B)(r_i^L - r)$$

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

$$r_i^B(\gamma^B = 0, m_i = 0) = r_i^L .$$

Hence, if the bank does not monitor and the probability of a bail out is zero, the borrowing rate will be equal to the lending rate. Further, expression (3) shows that if either there is complete monitoring or the probability of a bail out is 1, r^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

(4) $$r_i^D = r + (1 - m_i)(1 - \gamma^D)(r_i^L - r)$$

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. While we do not model the preferences of investors explicitly, equations (3) and (4) suggest that they are risk-averse. The risk premium investors expect would be $(r_i^L - r)$, if they invested in the risky asset directly (no monitoring). Further, 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 α_i, each bank maximises profits of the form

$$\pi_i = ((1 - \rho_i) + m_i \rho_i) r_i^L - \mathrm{V}(m_i) - r_i^D(m_i, \gamma^D)\alpha_i - r_i^B(m_i, \gamma^B)(1 - \alpha_i).$$

Solving

(5) $$\max_m \pi_i$$

yields the following first-order condition:

$$\frac{\partial \pi_i}{\partial m_i} = \rho_i r_i^L - \frac{\partial V(m_i)}{\partial m_i} - \frac{\partial r_i^D}{\partial m_i}\alpha_i - \frac{\partial r_i^B}{\partial m_i}(1-\alpha_i) \equiv 0.$$

Assuming the monitoring cost function has the specific form of[6]

(6) $$V(m_i) = m_i^\beta \text{, where } \beta > 1$$

and substituting expressions (3) and (4), we obtain the optimal level of monitoring

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

From (7) we see that the optimal level of monitoring is an increasing function of bank i's portfolio riskiness, ρ_i and the interest rate spread between risky loans and the risk free rate. If the portfolio is riskier and the relative pay-off to risk greater, the bank will monitor more. In contrast, higher probabilities of bail out for either deposits or subordinated debt will reduce the bank's level of monitoring. Note also, that in case deposits and subordinated debt are bailed out by the government with different probabilities, the proportion of the bank that is financed with subordinated debt will matter. For the moment, we assume that α_i's are fixed, but we will return to this issue below. In the following we analyse a number of specific cases.

"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

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

Note that even in the "free banking" case the bank will not necessarily fully monitor and reduce the probability of failure to zero. We can now calculate the default probability of bank i, p_i, by substituting equation (8) into (1)

(9) $$p_i^{FB} = \rho\left[1 - \left[\frac{1}{\beta}\left[\rho_i r_i^L + (r_i^L - r)\right]\right]^{\frac{1}{\beta-1}}\right].$$

As one would expect, this probability is independent of the government's actions. The probability of a bank's failure is simply a function of the riskiness of its portfolio and the pay-off to monitoring, as represented by the interest rate spread.

---

[6] Any other strictly positive and convex function V(m) would yield qualitatively the same results.

Explicit deposit insurance

Next, consider the case with explicit deposit insurance, hence γ^D=1 and $\gamma^B \in (0,1)$. We allow for non-zero γ^B to permit deposit insurance systems that credibly limit coverage to depositors as well as deposit insurance systems, which are not credible in their limitation to depositors, i.e. subordinated debt holders could be also bailed out with some non-zero probability. In the following we refer to a system with a zero bail out probability for subordinated debt holders as "credible deposit insurance." The optimal level of monitoring of a bank operating in a non-credible system becomes

$$(10) \qquad m_{iDI}^{*NC} = \left[\frac{1}{\beta} \left[\rho_i r_i^L + (1-\alpha_i)(1-\gamma^B)(r_i^L - r\ ) \right] \right]^{\frac{1}{\beta-1}}$$

and

$$(11) \qquad m_{iDI}^{*C} = \left[\frac{1}{\beta} \left[\rho_i r_i^L + (1-\alpha_i)(r_i^L - r\ ) \right] \right]^{\frac{1}{\beta-1}}$$

for a credible system with γ^B=0.

Comparing (10) to (8) it is clear that for non-zero levels of deposits or a non-zero probability of a bail out of subordinated debt holders, the optimal level of monitoring with explicit deposit insurance will be less than in the "free banking case." This is also reflected in a higher probability of bank failure

$$(12) \qquad p_{iDI}^{NC} = \rho_i \left[1 - \left[\frac{1}{\beta} \left[\rho_i r_i^L + (1-\alpha_i)(1-\gamma^B)(r_i^L - r\ ) \right] \right]^{\frac{1}{\beta-1}} \right]$$

in case the system is not credible and

$$(13) \qquad p_{iDI}^{C} = \rho_i \left[1 - \left[\frac{1}{\beta} \left[\rho_i r_i^L + (1-\alpha_i)(r_i^L - r\ ) \right] \right]^{\frac{1}{\beta-1}} \right],$$

if it is credible. The default probability is strictly increasing with the likelihood that subordinated debt holders are also compensated in case of a bank failure. More interestingly, for $\gamma^B << 1$, equations (12) and (13) show that the probability of bank failure is also strictly increasing with the share of deposits in bank liabilities.

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 $\gamma^{D,S} \in (0,1)$, 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 (8), which we restate here

$$\text{(7a)} \qquad m_{iIS}^{*} = \left[\frac{1}{\beta} \left[\rho_i r_i^L + \alpha_i (1-\gamma^D)(r_i^L - r \ ) + (1-\alpha_i)(1-\gamma^B)(r_i^L - r \ ) \right] \right]^{\frac{1}{\beta-1}}$$

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 (11) 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:

Proposition 1. For given levels of riskiness, ρ and a given associated risk premium, r^L-r, the level of monitoring under the implicit safety net is less than that under a credible explicit deposit insurance iff

$$\text{(14)} \quad \alpha_i < \frac{\gamma^{B,IS}}{1-\gamma^{D,IS}+\gamma^{B,IS}} \,.$$

Proof: Follows directly from equations (7a) and (11).

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). Alternatively, 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.

We can now state the probability of default, p_{tIS}, under an implicit safety net system

$$\text{(15)} \quad p_{iIS} = \rho_i \left[1 - \left[\frac{1}{\beta} \left[\rho_i r_i^L + \alpha_i (1-\gamma^D)(r_i^L - r\ ) + (1-\alpha_i)(1-\gamma^B)(r_i^L - r) \right] \right]^{\frac{1}{\beta-1}} \right]$$

In case of the implicit safety net, an increase in the probability of depositor or subordinated debt holder compensation (i.e. higher γ^D and/or γ^B) increases the probability of default, as monitoring declines and moral hazard increases.

We can immediately obtain a corollary to Proposition 1:

Corollary 1. For given levels of riskiness, ρ and a given associated risk premium, r^L-r, the probability of bank failure is higher under an implicit system than under credible deposit insurance iff

$$(14a) \qquad \alpha_i < \frac{\gamma^{B,IS}}{1-\gamma^{D,IS}+\gamma^{B,IS}},$$

which is exactly the same condition as for proposition 1 and follows directly. Corollary 1 states that 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.

Charter values, "too big to fail" and balance sheet structure

We will now consider the effect of the existence of charter values for banks' risk taking under the different safety net arrangements. For that we modify the banks pay-off structure as follows

(16) $\quad 0\text{-}C_i \quad$ with a probability $\rho_i(1–m_i)$ and

(17) $\quad r_t^L + C_i \quad$ with a probability $(1–\rho_i) + m_i\rho_i$.

C_i represents a charter value, which should be interpreted as a fixed value of staying in operation, arising from market power, reputation or other factors. We assume that $0<C_i<1$. The bank will loose C_i if its loan portfolio defaults and retains this value if it succeeds.[7] With this modification, the bank's maximisation problem becomes

$$(18) \qquad \begin{aligned}\pi_i &= \rho_i(1-m_i)(-C_i) + \left((1-\rho_i)+m_i\rho_i\right)\left[r_i^L + C_i\right] \\ &- \mathrm{V}(m_i) - r_i^D(m_i,\gamma^D)\alpha_i - r_i^B\left(m_i,\gamma^B\right)(1-\alpha_i).\end{aligned}$$

Taking first order conditions and re-arranging yields the optimal level of monitoring with charter values

$$(19) \quad m_i^* = \left[\frac{1}{\beta}\left[\rho_i r_i^L + (1+\rho_i)C_i + \alpha_i(1-\gamma^D)(r_i^L - r\ \ ) + (1-\alpha_i)(1-\gamma^B)(r_i^L - r\ \ )\right]\right]^{\frac{1}{\beta-1}}$$

Comparing equation (8) to (19), one obtains Proposition 2

---

[7] 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).

Proposition 2. For given levels of riskiness, ρ, a given associated risk premium, r^L-r, and given the safety net arrangements, the level of monitoring will be higher in the presence of charter values.

Corollary 2. Given some non-zero level of subordinated debt (α_i<1), banks with high charter values will 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: We prove the Corollary by showing that with charter values less than 1, even if the banking system is fully insured, monitoring could be as high as in the free banking case. Suppose under the implicit safety net, we have $\gamma^D = \gamma^B$ =1, i.e. the banking system is perfectly insured against default. Setting equation (19) equal to equation (10) and solving for C_i we obtain $C_i = \frac{r_i^L - r}{1+\rho_i} < 1.$

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. It is obvious that the optimal level of monitoring will be

(20) $$m^*_{iTBTF} = \left[\frac{1}{\beta}\left[\rho_i r_i^L\right]\right]^{\frac{1}{\beta-1}}.$$

Hence, we can state Proposition 3:

Proposition 3. Banks that are "too big to fail" will 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 only second. Then

if γ^D>γ^B the bank chooses α_i=1

if γ^D<γ^B the bank chooses α_i=0

if γ^D=γ^B the bank chooses $\alpha_i \in [0,1]$.[8]

Proof: Follows immediately from (5).

Proposition 4 has an important empirical implication: If a country moves from an implicit system, in which the probability of bail out for subordinated debt and deposits was equal

[8] Given α_i all previous propositions and corollaries hold.

or 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.[9]

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 Sections VII and VIII, 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.

III. 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

---

[9] 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).

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 issued for internationally active banks to all banks in the EU. The Basel Accord meant on one hand an important change in banking regulation away from intrusive conduct regulations towards greater reliance on prudential standards. On the other hand, it 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 a Directive on Deposit Guarantee Schemes (94/19/EC) 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.[10] 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.[11] 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.

IV. Data sources and description

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 necessary to calculate our measure of charter value, *q* and which existed under the same name throughout the sample period.[12]

---

[10] 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.

[11] Belgium, Ireland, Luxembourg and the Netherlands had a coverage lower than 20 0000 euro before the Directive.

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

This process yields a sample of 128 banks for 1991-1998. A few of the banks recorded by 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 1). 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. Table 2 gives some descriptive summary statistics for the banks in the sample. The banks 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 the 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 in the share of loans in total assets, which has remained approximately constant around the overall sample mean of 55 percent.

V. Definitions of dependent and independent variables

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 details 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.[13]

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:

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

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

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

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

---

13 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).

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.[14]

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.

Further, we include a normalised country specific stock market index[15], 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.[16] For definitions of all variables see Appendix II.

---

[14] 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.

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

[16] With few exceptions, our choice of control variables corresponds closely to those of Keeley [1990].

VI. Econometric model and baseline results

We estimate the following reduced form model:

(23) $$risk_{jt} = \delta_0 + \delta_1 D_{it} + \Pi_1 X_{jt} + \Pi_2 C_{it} + u_i + \varepsilon \ ,$$

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 (23) 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). The different measures of bank risk are discussed below.

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. Higher gearing may also reflect a readjustment in the balance structure towards deposits (Proposition 4). 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 defined the volatility as

(24) $$Sd_{tj} \, [\mathrm{Ln} \, [p_d/p_{d-1}]]^* \sqrt{n} \ .$$

for any year t and bank j, where p_d represents the stock price on day d, n represents the number of trading days and Sd is the standard deviation of the daily stock price during period t. From (24) we extracted the non-diversifiable component. This was done, as we were concerned that our measure of overall risk may be driven by the volatility of the market portfolio rather than by non-diversified risk. Hence, 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.

The baseline estimates for the relationship between risk and deposit insurance are presented in Table 3. Table 3 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. For asset risk and overall risk, the absence of explicit deposit insurance is associated with significantly higher risk taking.[17]

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).[18]

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 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.

---

[17] 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.

[18] 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]) and Furlong and Keeley [1989]).

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.[19] 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.

---

[19] 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].

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 4 displays the results for this exercise. We have limited the table to the interaction terms, as they are of particular interest.[20] 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

[20] 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.

deterrence against additional risk taking (albeit not against higher leverage), regardless of the safety net arrangements in place.

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.[21]

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.

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

---

[21] 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, developments in supervision and market disclosure have not been in Europe directly related to the changes in the deposit insurance arrangements.

across countries unaccounted for by the control variables. The results for this exercise are presented in Table 5. 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 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.

VII. 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

$$(25) \quad IDS_{jt} = \gamma_0 + \gamma_1 D_{it} + \mathrm{H}_1 X_{jt} + \mathrm{H}_2 C_{it} + u_i + \varepsilon_2 ,$$

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 (25).[22]

The results, presented in Table 6, suggest that indeed banks may have shifted their liabilities towards more insured deposits in response to introducing explicit deposit

[22] 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.

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 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 alternatives, bonds and the stockmarket, show a negative effect on the share of deposits. 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).

VIII. 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 was related to charter values and orthogonal to risk. Hence, we experimented with models identified through country specific effects and used q lagged by one period. The results are reported in Appendix IV.1 and 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 (Appendix IV.2).

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 and are available from the authors upon request.

Third, we report results from OLS regression using bank averages in Table 7. 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. Note that the sample sizes are 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.

IX. 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 [2000], or historical data sets from the 1920s as in Grossman [1992] or Wheelock [1992]. 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 insurance. Clearly, in those countries deposit insurance may have quite different effects from those shown in this paper.[23]

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. However, the results also point to the fact that market monitoring 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").

[23] Some evidence of functioning equity and debt markets is given in Gropp et al. [2002] and Sironi [2002], while Gropp and Richards [2001] find evidence that while equity markets may reflect risk, subordinated debt in Europe may do so insufficiently.

Literature

Alston, L., A. Grove, and D. Wheelock [1994] "Why Do Banks Fail? Evidence from the 1920s" **Explorations in Economic History** 31(4), pp. 409-431.

Boot A. and S. Greenbaum [1993] "Bank Regulation, Reputation and Rents: Theory and Policy Implications" Mayer,-Colin; Vives,-Xavier, eds. **Capital Markets and Financial Intermediation.** Cambridge; New York and Melbourne: Cambridge University Press, pp. 262-285.

Brewer, E. and T. Mondschean [1994] "An Empirical Test of the Incentive Effects of Deposit Insurance: The Case of Junk Bonds at Savings and Loan Associations" **Journal of Money, Credit, and Banking** 26, pp. 146-64.

Calomiris, C. and C. Kahn [1991] "The Role of Demandable Debt in Structuring Optimal Banking Arrangements", **American Economic Review**, pp. 497-513.

Calomiris, C. [1999] "Building an Incentive-compatible Safety Net", **Journal of Banking and Finance,** 23, pp. 1499-1519.

Canals, J. [1993] **Competitive Strategies in European Banking**, Calarendon Press, Oxford.

Cordella, T. and E. Yeyati [1998] "Financial Opening, Deposit Insurance and Risk in a Model of Banking Competition", **IMF Working Paper** No WP/98/97.

Demirgüç-Kunt, A. and E. Detragiache [2002] "Does Deposit Insurance Increase Banking System Stability? An Empirical Investigation", **Journal of Monetary Economics** 49 pp. 1373-1406.

Demsetz, R., M. Saidenberg and P. Strahan [1996] "Banks with Something to Lose: The Disciplinary Role of Franchise Value", **Federal Reserve Bank of New York Economic Policy Review** 2, pp. 1-14.

Dewatripont M. and J. Tirole [1993a] "Efficient Governance Structure: Implications for Banking Regulation" Mayer,-Colin; Vives,-Xavier, eds. **Capital Markets and Financial Intermediation.** Cambridge; New York and Melbourne: Cambridge University Press, pp. 12-35.

Dewatripont M. and J. Tirole [1993b] **The Prudential Regulation of Banks**, Editions Payot, Lausanne.

Diamond D. and P. Dybvig [1983] "Bank Runs, Deposit Insurance and Liquidity" **Journal of Political Economy** Vol. 91, pp.401-409.

Freixas X. and J. Rochet [1997] **Microeconomics of Banking,** The MIT Press, Cambridge.

Furlong, F. and M. Keeley [1987] "Bank Capital Regulation and Asset Risk". **Economic Review**, Federal Reserve Bank of San Francisco, pp. 20-40.

Furlong, F. and M. Keeley, [1989] "Bank Capital Regulation and Risk Taking: A Note" **Journal of Banking and Finance** Vol.13, pp.883-891.

Garcia, G. [1999] "Deposit Insurance: A Survey of Actual and Best Practices", **IMF Working Paper**.

Gorton G. and G. Pennacchi [1990] "Financial Intermediaries and Liquidity Creation", **Journal of Finance**, pp. 49-71.

Gropp, R. and A. Richards [2001] "Rating Agency Actions and the Pricing of Debt and Equity of European Banks: What Can We Infer about Private Sector Monitoring of Bank Soundness?" **Economic Notes** 30(3) pp. 373-398.

Gropp, R., J. Vesala and G. Vulpes [2002] "Equity and Bond Market Signals as Leading Indicators of Bank Fragility" **ECB Working Papers No 150**, June.

Grossman, R. [1992] "Deposit Insurance, Regulation, and Moral Hazard in the Thrift Industry: Evidence from the 1930s", **American Economic Review** Vol. 82, pp. 800-821.

Kane, E. [1989] **The S&L Mess: How Did It Happen?** Urban Institute Press.

Karels, G. and C. McClatchey [1999] "Deposit Insurance and Risk-Taking Behavior in the Credit Union Industry", **Journal of Banking and Finance** 23(1), pp. 105-134.

Keeley, M. [1990] "Deposit Insurance, Risk, and Market Power in Banking" **American Economic Review** Vol. 80, pp. 1183-1200.

MacKinlay, C. [1997] "Event Studies in Economics and Finance" **Journal of Economic Literature** 35, pp. 13-39.

Matutes, C and X. Vives [1995] "Imperfect Competition, Risk Taking, and Regulation in Banking", **European Economic Review**, Vol. 44, 1-34.

McKenzie, J., R. Cole and R. Brown [1992] "Moral Hazard, Portfolio Allocation, and Asset Returns for Thrift Institutions", **Journal of Financial Services Research** 5, pp. 315-339.

Merton, R. [1977] "An Analytical Derivation of the Cost of Deposit Insurance Loan Guarantees", **Journal of Banking and Finance** 1, pp. 3-11.

Pelizzon, L. [2001] "Franchise Value, Capital Requirements and Closure Rules in a Dynamic Model of Bank Portfolio Management" **Mimeo**, University of Padoa.

Rajan, R. [1992] "Insiders and Outsiders: The Choice between Informed and Arm's-length Debt", **Journal of Finance** 47, pp. 1367-1400.

Sharpe, S. [1990] "Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships", **Journal of Finance** 45, pp. 1069-1087.

Sironi, A. [2002] "Testing for Market Discipline in the European Banking Industry: Evidence from Subordinated Debt Spreads", Board of Governors of the Federal Reserve System**, Finance and Economics Discussion Series,** No. 2000-40 (July).

Smirlock, M. [1984] "Tobin's *q* and the Structure Performance Relationship", **American Economic Review** 74, pp. 1051-60.

Thies, C. and D. Gerlowski [1989] "Deposit insurance; A history of failure", **Cato Journal**, 8(3), 677-693.

Wheelock, D. [1992] "Deposit Insurance and Bank Failures: New Evidence from the 1920s", **Economic Inquiry** 30(3), pp. 530-543.

Wheelock, D. and P. Wilson [1994] "Productivity Changes in U.S. Banking: 1984-93" **Federal Reserve Bank of St. Louis Working Paper**: 94/021A, pp. 30.

Table 1. 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**

Table 2. Descriptive statistics

For the definition of all variables, see Appendix II.

	n	Mean	Min	Max	Std. dev
Leverage risk: equity to debt ratio	896	0.053	0	0.26	0.04
Asset risk: problem loans as a percent of total assets	343	0.026	0	0.27	0.031
Overall risk: stock price volatility	672	0.31	0.018	4.05	0.31
Idiosyncratic risk	672	0.30	0.029	3.46	0.30
Total assets ($ millions)	896	47148.9	261.7	704686.8	91281.4
Market-to-book asset ratio, *q*	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
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
Share of co-operative banks	896	0.13	0	1	0.34
Share of mortgage banks	896	0.13	0	1	0.34
Share of bank's assets in country's total assets of the banking system	896	0.047	0.0001	0.47	0.084
Interaction: Absence of deposit insurance * high q	896	0.029	0	1	0.17
Interaction: Absence of deposit insurance * low q	896	0.058	0	1	0.23
Interaction: Absence of deposit insurance * high subordinated debt	896	0.064	0	1	0.25
Interaction: Absence of deposit insurance * low subordinated debt	896	0.022	0	1	0.15
Interaction: Absence of deposit insurance * high market share	896	0.015	0	1	0.12
Interaction: Absence of deposit insurance * low market share	896	0.071	0	1	0.26
Non-interest earnings/Total earnings (%)	896	32.5	-7.6	87.8	16.6
Market value capital-to-asset ratio (%)	896	5.3	0.00	25.8	3.98

Table 3. Charter Values, Deposit Insurance and Risk

*All models were estimated using fixed effects across countries. Heteroskedasticity corrected standard errors in parenthesis. *, **, *** 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***	0.022***	0.126***
		(0.003)	(0.008)	(0.035)
	Deposit insurance coverage high	0.003	0.004	-0.014
		(0.002)	(0.007)	(0.022)
Liberalisation	EC Directive implemented	0.005*	0.011*	-0.075***
		(0.003)	(0.006)	(0.028)
Charter values	*q*	-0.69***	0.067	-0.432*
		(0.026)	(0.076)	(0.257)
Balance sheet	Demand deposit share	-0.045***	0.027	-0.057
		(0.005)	(0.023)	(0.059)
	Loan share	0.007	0.045***	-0.092
		(0.006)	(0.018)	(0.065)
	Share of non-interest Earnings	0.003	0.036**	0.016
		(0.006)	(0.017)	(0.073)
	Share of subordinated debt	0.415***	-0.041	-2.40**
		(0.087)	(0.148)	(0.955)
	Share of total assets of bank in banking system	0.024***	-0.003	-0.023
		(0.009)	(0.026)	(0.094)
Market indicators	Stock market index	0.005***	-0.014***	0.081***
		(0.001)	(0.003)	(0.012)
	Money market rate	-0.008**	0.002*	0.014**
		(0.005)	(0.001)	(0.007)
	Money market rate-government bond yield	0.000	0.002**	0.023**
		(0.000)	(0.001)	(0.011)
Bank specialisation	Co-operative banks	-0.165***	-0.004	-0.011
		(0.003)	(0.007)	(0.029)
	Mortgage banks	0.002	0.000	0.009
		(0.002)	(0.005)	(0.019)
Constant		0.66***	-0.064	0.754***
		(0.026)	(0.083)	(0.253)
Wald test (ch^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		910	349	672

Table 4. Refinements: Charter Values, "Too Big to Fail", and Monitoring

*All models were estimated using fixed effects across countries. Heteroskedasticity corrected standard errors in parenthesis. *, **, *** 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.*

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

1/ *, **, *** represents that equality of the two coefficients can be rejected at the 10%, 5% or 1% level, respectively.

Table 5. Sample limited to Finland, Greece, Portugal and Sweden

All models were estimated using fixed effects across countries. Heteroskedasticity corrected standard errors in parenthesis. *, **, *** 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	0.132*	-0.052
		(0.071)	(0.076)	(0.140)
Interaction term 2/		0.126**	0.096*	0.121**
		(0.057)	(0.057)	(0.052)
EC directive	-0.412***	-0.418***	-0.406***	-0.406***
	(0.067)	(0.067)	(0.068)	(0.066)
q	-0.624	-0.619	-0.723	-0.560
	(0.491)	(0.489)	(0.556)	(0.487)
Deposit share	0.76***	0.724**	0.751***	0.804***
	(0.251)	(0.256)	(0.252)	(0.251)
Loan share	-0.419*	-0.402*	-0.458*	-0.405*
	(0.226)	(0.227)	(0.240)	(0.223)
Subordinated debt share	1.39	-0.624	1.79	1.63
	(3.52)	(4.580)	(3.62)	(3.48)
Share of non-interest earnings	0.032	0.059	0.026	0.015
	(0.177)	(0.181)	(0.178)	(0.176)
Share of assets in banking system	0.181	0.155	0.179	0.371
	(0.547)	(0.546)	(0.547)	(0.560)
Stock index	0.10***	0.10***	0.10***	0.099***
	(0.022)	(0.022)	(0.022)	(0.022)
Money market rate	-0.072***	-0.081***	-0.068**	-0.070**
	(0.028)	(0.031)	(0.029)	(0.028)
Money market rate-bond yield	0.005	0.002*	0.010*	0.010*
	(0.007)	(0.001)	(0.007)	(0.007)
Constant	0.500	0.526	0.625	0.396
	(0.477)	(0.477)	(0.564)	(0.479)
Wald test	62.7***	63.61***	62.22***	66.37***
n	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.

Table 6. Banks' liability structure

*The dependent variable is the share of deposits (excluding interbank deposits) in total liabilities. Model was estimated with fixed effects across countries. Heteroskedasticity corrected standard errors in parenthesis. ***, **, * 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***	-0.074***
	(0.023)	(0.023)
High coverage	0.022*	
	(0.013)	
EC directive	0.072***	0.094***
	(0.018)	(0.027)
q	0.217	0.332
	(0.175)	(0.266)
Share of loans	0.125***	0.154**
	(0.041)	(0.063)
Share of subordinated debt	0.385	-0.655***
	(0.548)	(0.126)
Share of assets in the banking system	-0.091	-0.875***
	(0.071)	(0.125)
Total assets/100000	-0.004***	-0.004
	(0.001)	(0.01)
Money market rate	0.037***	0.014***
	(0.002)	(0.004)
Bond yield	-0.025***	-0.008
	(0.005)	(0.007)
Stockmarket indicator	0.073***	-0.005
	(0.008)	(0.012)
Savings banks	0.191**	
	(0.078)	
Co-operative banks	0.021	
	(0.020)	
Mortgage banks	0.003	0.038
	(0.014)	(0.028)
Specialised lending institutions	-0.077***	-0.080***
	(0.020)	(0.023)
Constant	-0.215	0.219
	(0.183)	(0.280)
Wald statistic (15)	414.3*** (15)	440.5*** (12)
n	896	126

Table 7. OLS with bank averages

*OLS regression using bank averages. Standard errors in parenthesis. *, **, *** 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.*

Dependent variable		
Deposit insurance	Absence of explicit deposit insurance	0.251**
		(0.127)
	Deposit insurance coverage high	-0.064
		(0.051)
Liberalisation	EC Directive implemented	0.063
		(0.227)
Charter values	*q*	0.332
		(0.664)
Balance sheet	Demand deposit share	-0.218**
		(0.099)
	Loan share	-0.381***
		(0.120)
	Share of non-interest Earnings	0.003
		(0.006)
	Share of subordinated debt	0.823
		(2.27)
	Share of total assets of bank in banking system	0.002
		(0.279)
Market indicators	Stock market index	-0.148*
		(0.089)
	Money market rate	0.008**
		(0.005)
	Money market rate-government bond yield	0.023**
		(0.011)
Bank specialisation	Co-operative banks	0.050
		(0.056)
	Mortgage banks	0.001
		(0.042)
Constant		0.59
		(0.72)
Wald statistic		0.25
N		73

Appendix I. Deposit insurance system features in EU countries (end 1998)

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)	unfunded
Luxembourg	1989	12,500 euro (20,000 in 2000)			private	
Netherlands	1979	20,000 euro	Yes	No	government	unfunded
Portugal	1995	25,000 euro	Yes	No	government	funded
Spain	1977	20,000 (from 2000)	Na	No	joint	funded
Sweden	1996	28,000 euro	Yes	No	government	funded
United Kingdom	1982	22,200 euro	No	No	private	mixed[3]

Sources: European Central Bank and Garcia (1999).

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 = DE, GR, FR, IE, IT, NL, PT, SE, UK and $t \geq 1993$

i = BE, LU, AT, FI and $t \geq 1994$

i = ES and $t \geq 1995$

i = DK and $t \geq 1996$

= 0 otherwise.

Absence of explicit deposit insurance = 1 if i = GR, PT, SE and $t \geq 1996$

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 $assets_{jt}$.

Overall risk = Sd_{tj} [Ln $[p_d/p_{d-1}]]*\sqrt{n}$, where p_d represents the stock price on day d, n the number of active trading days and Sd the standard deviation during period t.

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 $earnings_{jt}$]

Growth rate of assets since 1991 = $[assets_{jt}-assets_{jt-1}]\ /assets_{jt-1}$

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 $index_{i1991}$]*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 form[24]

$$\mathrm{R}_{\mathrm{jt}} = \alpha_{\mathrm{jt}} + \beta_{jt} R_{it} + \varepsilon_{jt} \qquad \text{(A1)}$$

where R_{it} denotes the log daily stock return of bank j during year t and R_{ct} 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.[25] The residuals of this regression are commonly referred to as "abnormal" returns in the event study literature (e.g. MacKinlay [1997]) and would be represented by

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

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

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

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

---

[24] See MacKinlay [1997] for further discussion on estimating such models, as well as their relative advantages and disadvantages relative to other methods.

[25] 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.

Appendix IV.1 Instrumental variable results

*Models were estimated using fixed effects across time periods (instrument: country effects) or fixed effects across countries (instrument: lagged q). Heteroskasticity corrected standard errors in parenthesis. *, **, *** 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, respectively.*

		Instrument: Country effects			Instrument: Lagged q		
Dependent variable		Leverage Risk	Asset Risk	Overall Risk	Leverage risk	Asset risk	Overall risk
Deposit insurance	Absence of explicit deposit insurance	0.032***	0.022***	0.124***	-0.004	0.025***	0.086***
		(0.007)	(0.006)	(0.036)	(0.004)	(0.009)	(0.033)
	Deposit insurance coverage high	-0.033**	-0.0014	-0.029	0.010***	0.013**	0.0007
		(0.017)	(0.007)	(0.021)	(0.003)	(0.006)	(0.019)
Liberalisation	EC Directive implemented	0.020**	0.015**	-0.056***	0.006	-0.011	-0.035
		(0.008)	(0.006)	(0.016)	(0.005)	(0.008)	(0.035)
Charter values	Instrumented q	-1.25***	-1.92***	-0.685***	-0.507***	0.156*	-0.334
		(0.323)	(0.369)	(0.196)	(0.036)	(0.085)	(0.242)
Balance sheet	Demand deposit share	-0.007	0.016	-0.146***	-0.051***	-0.002	-0.132**
		(0.008)	(0.016)	(0.038)	(0.006)	(0.031)	(0.056)
	Loan share	-0.280***	0.044***	-0.237***	-0.009	0.041**	-0.102*
		(0.007)	(0.016)	(0.046)	(0.008)	(0.019)	(0.058)
	Share of non-interest Earnings	0.262***	0.106***	0.243***	-0.014*	0.046***	0.059
		(0.076)	(0.015)	(0.074)	(0.008)	(0.016)	(0.064)
	Share of subordinated debt	0.621***	-0.131	-1.48**	0.509***	0.017	-0.488
		(0.111)	(0.117)	(0.619)	(0.113)	(0.152)	(0.885)
	Share of total assets of bank in banking system	-0.070	-0.054**	0.044	0.023*	-0.010	-0.068
		(0.044)	(0.024)	(0.078)	(0.013)	(0.027)	(0.097)
Market indicators	Stock market index	0.117***		0.175***	-0.008***	-0.013***	0.094***
		(0.032)		(0.025)	(0.0014)	(0.003)	(0.010)
	Money market rate	-0.018***	-0.010***	-0.038**	-0.012**	-0.011***	-0.035**
		(0.005)	(0.001)	(0.019)	(0.005)	(0.003)	(0.015)
	Money market rate-government bond yield	0.036***	0.012***	0.023***	0.026**	0.013***	0.023***
		(0.010)	(0.002)	(0.005)	(0.010)	(0.003)	(0.006)
Bank specialisation	Co-operative banks	-0.234***	-0.033***	-0.119***	-0.008*	0.0007	0.014
		(0.062)	(0.008)	(0.043)	(0.004)	(0.007)	(0.025)
	Mortgage banks	0.055***	0.010**	0.034**	0.003	0.003	0.045***
		(0.016)	(0.005)	(0.015)	(0.003)	(0.006)	(0.017)
Constant		1.24***	1.94***	0.703***	0.493***	-0.125	0.600**
		(0.322)	(0.380)	(0.191)	(0.037)	(0.10)	(0.255)
n		896	343	672	783	312	454

Appendix IV.2 Refinements, uninstrumented with country effects

*All models were estimated using fixed effects across countries. Heteroscedasticity corrected standard errors in parenthesis. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The dependent variables are the total liabilities divided by the market value of assets, the share of problem loans in total loans, the inter-day volatility and the inter-day volatility corrected for market volatility, respectively. All other control variables are as in Table 4.*

	q instrumented: country effects						q instrumented: lagged q					
	subordinated debt			"Too big to fail"			subordinated debt			"Too big to fail"		
Interaction terms: Absence of explicit deposit insurance interacted with:	Leverage Risk	Asset Risk	Overall Risk	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)	0.143	0.023**	0.116**				0.008	-0.010	0.057			
	(0.091)	(0.009)	(0.051)				(0.007)	(0.019)	(0.053)			
Dummy=1 if subordinated debt share>0.013 (median)	0.145**	0.037***	0.130***				0.002	0.032***	0.146***			
	(0.072)	(0.007)	(0.044)				(0.004)	(0.010)	(0.040)			
Dummy=1 if share in assets of banking system>0.12 (95th perc.)				0.014	0.011	-0.006				-0.016**	0.027*	-0.056
				(0.012)	(0.010)	(0.140)				(0.007)	(0.014)	(0.141)
Dummy=1 if share in assets of banking system≤0.12 (95th perc.)				0.036***	0.029***	0.136***				0.002	0.024**	0.125***
				(0.007)	(0.007)	(0.037)				(0.004)	(0.011)	(0.033)
Equality of coefficients 1/		**		***	**	***		**	*	*		*

1/ *, **, *** represents that equality of the two coefficients can be rejected at the 10%, 5% or 1% level, respectively.

European Central Bank working paper series

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.int).

202 "Aggregate loans to the euro area private sector" by A. Calza, M. Manrique and J. Sousa, January 2003.

203 "Myopic loss aversion, disappointment aversion and the equity premium puzzle" by D. Fielding and L. Stracca, January 2003.

204 "Asymmetric dynamics in the correlations of global equity and bond returns" by L. Cappiello, R.F. Engle and K. Sheppard, January 2003.

205 "Real exchange rate in an inter-temporal n-country-model with incomplete markets" by B. Mercereau, January 2003.

206 "Empirical estimates of reaction functions for the euro area" by D. Gerdesmeier and B. Roffia, January 2003.

207 "A comprehensive model on the euro overnight rate" by F. R. Würtz, January 2003.

208 "Do demographic changes affect risk premiums? Evidence from international data" by A. Ang and A. Maddaloni, January 2003.

209 "A framework for collateral risk control determination" by D. Cossin, Z. Huang, D. Aunon-Nerin and F. González, January 2003.

210 "Anticipated Ramsey reforms and the uniform taxation principle: the role of international financial markets" by S. Schmitt-Grohé and M. Uribe, January 2003.

211 "Self-control and savings" by P. Michel and J.P. Vidal, January 2003.

212 "Modelling the implied probability of stock market movements" by E. Glatzer and M. Scheicher, January 2003.

213 "Aggregation and euro area Phillips curves" by S. Fabiani and J. Morgan, February 2003.

214 "On the selection of forecasting models" by A. Inoue and L. Kilian, February 2003.

215 "Budget institutions and fiscal performance in Central and Eastern European countries" by H. Gleich, February 2003.

216 "The admission of accession countries to an enlarged monetary union: a tentative assessment" by M. Ca'Zorzi and R. A. De Santis, February 2003.

217 "The role of product market regulations in the process of structural change" by J. Messina, March 2003.

218 “The zero-interest-rate bound and the role of the exchange rate for monetary policy in Japan” by G. Coenen and V. Wieland, March 2003.

219 “Extra-euro area manufacturing import prices and exchange rate pass-through” by B. Anderton, March 2003.

220 “The allocation of competencies in an international union: a positive analysis” by M. Ruta, April 2003.

221 “Estimating risk premia in money market rates” by A. Durré, S. Evjen and R. Pilegaard, April 2003.

222 “Inflation dynamics and subjective expectations in the United States” by K. Adam and M. Padula, April 2003.

223 “Optimal monetary policy with imperfect common knowledge” by K. Adam, April 2003.

224 “The rise of the yen vis-à-vis the (“synthetic”) euro: is it supported by economic fundamentals?” by C. Osbat, R. Rüffer and B. Schnatz, April 2003.

225 “Productivity and the (“synthetic”) euro-dollar exchange rate” by C. Osbat, F. Vijselaar and B. Schnatz, April 2003.

226 “The central banker as a risk manager: quantifying and forecasting inflation risks” by L. Kilian and S. Manganelli, April 2003.

227 “Monetary policy in a low pass-through environment” by T. Monacelli, April 2003.

228 “Monetary policy shocks – a nonfundamental look at the data” by M. Klaeffing, May 2003.

229 “How does the ECB target inflation?” by P. Surico, May 2003.

230 “The euro area financial system: structure, integration and policy initiatives” by P. Hartmann, A. Maddaloni and S. Manganelli, May 2003.

231 “Price stability and monetary policy effectiveness when nominal interest rates are bounded at zero” by G. Coenen, A. Orphanides and V. Wieland, May 2003.

232 “Describing the Fed’s conduct with Taylor rules: is interest rate smoothing important?” by E. Castelnuovo, May 2003.

233 “The natural real rate of interest in the euro area” by N. Giammarioli and N. Valla, May 2003.

234 “Unemployment, hysteresis and transition” by M. León-Ledesma and P. McAdam, May 2003.

235 “Volatility of interest rates in the euro area: evidence from high frequency data” by N. Cassola and C. Morana, June 2003.

236 “Swiss monetary targeting 1974-1996: the role of internal policy analysis” by G. Rich, June 2003.

237 “Growth expectations, capital flows and international risk sharing” by O. Castrén, M. Miller and R. Stiegert, June 2003.

238 “The impact of monetary union on trade prices” by R. Anderton, R. E. Baldwin and D. Taglioni, June 2003.

239 “Temporary shocks and unavoidable transitions to a high-unemployment regime” by W. J. Denhaan, June 2003.

240 “Monetary policy transmission in the euro area: any changes after EMU?” by I. Angeloni and M. Ehrmann, July 2003.

241 Maintaining price stability under free-floating: a fearless way out of the corner?” by C. Detken and V. Gaspar, July 2003.

242 “Public sector efficiency: an international comparison” by A. Afonso, L. Schuknecht and V. Tanzi, July 2003.

243 “Pass-through of external shocks to euro area inflation” by E. Hahn, July 2003.

244 “How does the ECB allot liquidity in its weekly main refinancing operations? A look at the empirical evidence” by S. Ejerskov, C. Martin Moss and L. Stracca, July 2003.

245 “Money and payments: a modern perspective” by C. Holthausen and C. Monnet, July 2003.

246 “Public finances and long-term growth in Europe – evidence from a panel data analysis” by D. R. de Ávila Torrijos and R. Strauch, July 2003.

247 “Forecasting euro area inflation: does aggregating forecasts by HICP component improve forecast accuracy?” by K. Hubrich, August 2003.

248 “Exchange rates and fundamentals” by C. Engel and K. D. West, August 2003.

249 “Trade advantages and specialisation dynamics in acceding countries” by A. Zaghini, August 2003.

250 “Persistence, the transmission mechanism and robust monetary policy” by I. Angeloni, G. Coenen and F. Smets, August 2003.

251 “Consumption, habit persistence, imperfect information and the lifetime budget constraint” by A. Willman, August 2003.

252 “Interpolation and backdating with a large information set” by E. Angelini, J. Henry and M. Marcellino, August 2003.

253 “Bond market inflation expectations and longer-term trends in broad monetary growth and inflation in industrial countries, 1880-2001” by W. G. Dewald, September 2003.

254 "Forecasting real GDP: what role for narrow money?" by C. Brand, H.-E. Reimers and F. Seitz, September 2003.

255 "Is the demand for euro area M3 stable?" by A. Bruggeman, P. Donati and A. Warne, September 2003.

256 "Information acquisition and decision making in committees: a survey" by K. Gerling, H. P. Grüner, A. Kiel and E. Schulte, September 2003.

257 "Macroeconomic modelling of monetary policy" by M. Klaeffling, September 2003.

258 "Interest rate reaction functions and the Taylor rule in the euro area" by P. Gerlach-Kristen, September 2003.

259 "Implicit tax co-ordination under repeated policy interactions" by M. Catenaro and J.-P. Vidal, September 2003.

260 "Aggregation-theoretic monetary aggregation over the euro area, when countries are heterogeneous" by W. A. Barnett, September 2003.

261 "Why has broad money demand been more stable in the euro area than in other economies? A literature review" by A. Calza and J. Sousa, September 2003.

262 "Indeterminacy of rational expectations equilibria in sequential financial markets" by P. Donati, September 2003.

263 "Measuring contagion with a Bayesian, time-varying coefficient model" by M. Ciccarelli and A. Rebucci, September 2003.

264 "A monthly monetary model with banking intermediation for the euro area" by A. Bruggeman and M. Donnay, September 2003.

265 "New Keynesian Phillips Curves: a reassessment using euro area data" by P. McAdam and A. Willman, September 2003.

266 "Finance and growth in the EU: new evidence from the liberalisation and harmonisation of the banking industry" by D. Romero de Ávila, September 2003.

267 "Comparing economic dynamics in the EU and CEE accession countries" by R. Süppel, September 2003.

268 "The output composition puzzle: a difference in the monetary transmission mechanism in the euro area and the US" by I. Angeloni, A. K. Kashyap, B. Mojon and D. Terlizzese, September 2003.

269 "Zero lower bound: is it a problem with the euro area?" by G. Coenen, September 2003.

270 "Downward nominal wage rigidity and the long-run Phillips curve: simulation-based evidence for the euro area" by G. Coenen, September 2003.

271 "Indeterminacy and search theory" by N. Giammarioli, September 2003.

272 "Inflation targets and the liquidity trap" by M. Klaeffling and V. López Pérez, September 2003.

273 "Definition of price stability, range and point inflation targets: the anchoring of long-term inflation expectations" by E. Castelnuovo, S. Nicoletti-Altimari and D. Rodriguez-Palenzuela, September 2003.

274 "Interpreting implied risk neutral densities: the role of risk premia" by P. Hördahl and D. Vestin, September 2003.

275 "Identifying the monetary transmission mechanism using structural breaks" by A. Beyer and R. Farmer, September 2003.

276 "Short-term estimates of euro area real GDP by means of monthly data" by G. Rünstler, September 2003.

277 "On the indeterminacy of determinacy and indeterminacy" by A. Beyer and R. Farmer, September 2003.

278 "Relevant economic issues concerning the optimal rate of inflation" by D. R. Palenzuela, G. Camba-Méndez and J. Á. García, September 2003.

279 "Designing targeting rules for international monetary policy cooperation" by G. Benigno and P. Benigno, October 2003.

280 "Inflation, factor substitution and growth" by R. Klump, October 2003.

281 "Identifying fiscal shocks and policy regimes in OECD countries" by G. de Arcangelis and S. Lamartina, October 2003.

282 "Optimal dynamic risk sharing when enforcement is a decision variable" by T. V. Koeppl, October 2003.

283 "US, Japan and the euro area: comparing business-cycle features" by P. McAdam, November 2003.

284 "The credibility of the monetary policy 'free lunch'" by J. Yetman, November 2003.

285 "Government deficits, wealth effects and the price level in an optimizing model" by B. Annicchiarico, November 2003.

286 "Country and sector-specific spillover effects in the euro area, the United States and Japan" by B. Kaltenhaeuser, November 2003.

287 "Consumer inflation expectations in Poland" by T. Łyziak, November 2003.

288 "Implementing optimal control cointegrated I(1) structural VAR models" by F. V. Monti, November 2003.

289 "Monetary and fiscal interactions in open economies" by G. Lombardo and A. Sutherland, November 2003.

290 “Inflation persistence and robust monetary policy design” by G. Coenen, November 2003.

291 “Measuring the time-inconsitency of US monetary policy” by P. Surico, November 2003.

292 “Bank mergers, competition and liquidity” by E. Carletti, P. Hartmann and G. Spagnolo, November 2003.

293 “Committees and special interests” by M. Felgenhauer and H. P. Grüner, November 2003.

294 “Does the yield spread predict recessions in the euro area?” by F. Moneta, December 2003.

295 “Optimal allotment policy in the eurosystem’s main refinancing operations?” by C. Ewerhart, N. Cassola, S. Ejerskov and N. Valla, December 2003.

296 “Monetary policy analysis in a small open economy using bayesian cointegrated structural VARs?” by M. Villani and A. Warne, December 2003.

297 “Measurement of contagion in banks’ equity prices” by R. Gropp and G. Moerman, December 2003.

298 “The lender of last resort: a 21st century approach” by X. Freixas, B. M. Parigi and J.-C. Rochet, December 2003.

299 “Import prices and pricing-to-market effects in the euro area” by T. Warmedinger, January 2004.

300 “Developing statistical indicators of the integration of the euro area banking system” by M. Manna, January 2004.

301 “Inflation and relative price asymmetry” by A. Rátfai, January 2004.

302 “Deposit insurance, moral hazard and market monitoring” by R. Gropp and J. Vesala, February 2004.