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BANKING INSTABILITY AND DEPOSIT INSURANCE: THE ROLE OF MORAL HAZARD

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The primary objective of this paper is to investigate the impact of moral hazard on the effectiveness of deposit insurance in achieving banking stability. If moral hazard explains banking instability arising from the adoption of deposit insurance, then deposit insurance will be associated with bank insolvency more than with bank runs. To test the hypothesis, we develop a new empirical framework distinguishing between banking instability initiated by panic withdrawals of deposits, and banking instability initiated by the insolvency problem of banks. Using a dataset covering 118 countries over the period 1980-2004, we find that deposit insurance per se has no significant effect either on bank insolvency or on bank runs. However, interacting deposit insurance with credit to the private sector, we observe a positive and significant effect on bank insolvency and bank runs, suggesting that moral hazard outweighs the positive effect of deposit insurance on banking stability.

JEL classification codes: G21, G28, E44
Key words: banking crises, deposit insurance, moral hazard

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I. Introduction

Countries adopting deposit insurance aim at minimising the risk of banking instability arising from self-fulfilling expectations.[1] The seminal paper of Diamond and Dybvig (1983) supported by several subsequent studies (see, for example, Hazlett 1997; Chang and Velasco 2001; Velasco 2001; Green and Lin 2003; Andolfatto, Nosal and Wallace 2006) rationalises the adoption of deposit insurance as a way of ensuring banking stability. The paper demonstrates that in a fractional reserve banking system, full deposit insurance is able to rule out bank runs, which are self-fulfilling prophecies of depositors. In the absence of such deposit insurance, rumours that a bank is on the brink of failure lead to fears (expectations) that the bank may not be able to repay all depositors in full and on time because its funds are tied up in loans and other interest earning assets that cannot be easily converted into cash. This prompts the depositors to rush and simultaneously attempt to withdraw all their deposits before the bank runs out of cash, bringing about failure of the bank and hence fulfillment of the prophecy.

Deposit insurance, however, also creates a moral hazard problem by freeing economic agents from the consequences of their actions (see Calomiris 1990; Gennotte and Pyle 1991; Mcdonald 1996) on both the liability and the asset sides of a bank's balance sheet, which may consequently lead to banking instability. On the liability side, depositors feel no longer obliged to assess the credit-risk associated with depositing money in a particular bank and end up choosing a bank based on the attractiveness of interest rates on offer rather than the bank's financial condition; while on the asset side, the knowledge that depositors will not suffer in the event of bank failure persuades banks to pursue high return risky business strategies more than they otherwise would (Macdonald, 1996). Thus, the discipline of the market is removed, excess risk-taking by existing commercial banks is encouraged and depositors of insured institutions have little incentive to discriminate with respect to where and with whom to place their funds (Calomiris

[1] In the literature, there are two main theoretical views on the causes of banking crises, namely the fundamental banking crises view and the self-fulfilling view. While the fundamental banking crises view perceives banking crises as a consequence of poor economic performance, the self-fulfilling view regards them as a realisation of a bad equilibrium arising from self-fulfilling expectations in a multiple equilibria framework (see Fontenla and Gonzalez 2007). In this paper, we test the self-fulfilling view while controlling for the fundamental banking crisis view.

1990). Demirgüç-Kunt and Detragiache (2002), using data for 61 countries covering the period 1980-1997, show that deposit insurance increases banking fragility, suggesting that the moral hazard component of deposit insurance is dominant in a general equilibrium framework. They further infer from their results that a more generous deposit insurance creates more moral hazard problems, which in turn increases banking fragility. Related work with similar findings has been carried out by Wheelock and Wilson (1995), Carapella and Di Giorgio (2004), and Cull, Senbet and Sorge (2005), among others.

To disentangle the conflicting predictions, we develop a new empirical framework where we distinguish between banking instability initiated by a bank run or panic withdrawals of deposits, and banking instability initiated by the insolvency problem of banks. Using this empirical framework, we estimate a baseline model whose primary objective is to investigate how banking instability is influenced by moral hazard arising from the adoption of deposit insurance. If the negative effect of deposit insurance on banking stability is through moral hazard, then deposit insurance will be associated with bank insolvency more than with bank runs. The study further examines how the likelihood of banking instability is affected by the generosity of deposit insurance payouts, extension of deposit insurance coverage to include foreign exchange and interbank deposits, administration of a deposit insurance scheme, and the nature of legal authority vested in a deposit insurance agency.

The rest of the paper is organised as follows. Section II discusses the interrelationships among deposit insurance, moral hazard and banking instability. An overview of the estimation methodology, data analysis techniques, scope of coverage, data sources and variables is presented in Section III. Estimation results and inferences are outlined in Section IV. A summary and conclusion follow in Section V.

II. Deposit insurance, moral hazard and banking instability

A. Deposit insurance

In most cases, a deposit insurance scheme is viewed as a supplement to other official measures such as a system of bank licensing and supervision, which are designed to protect bank depositors from the risk of loss or to contain that risk (Macdonald 1996). Thus, even with deposit insurance in place, the central bank continues to provide bank supervision services and play the role of lender of last resort. The central bank lending is widely regarded as part of the public safety net that supports the stability of the banking system since the bank can avert liquidity crises by providing large amounts of liquidity at short notice (Marini 2003).

Consistent with Bagehot's principle, the central bank as a lender of last resort is presumed to lend only to illiquid but solvent banks (Fischer 1999; Freixas et al. 2000; Wood 2003; Rochet and Vives 2004; Kahn and Santos 2005). In the wake of a run on a bank, the central bank provides the bank with credit to pay off depositors without having to liquidate the bank's assets. Deposit insurance, on the other hand, ensures that all depositors are paid off to the coverage limit even if all the bank's assets have been liquidated. The complementary roles of deposit insurance and the central bank's lender of last resort function, therefore, ascertain that depositors do not 'run' on banks, whether they are illiquid or insolvent.

Since the first recorded scheme in history, deposit insurance has been rationalised by the desire to instill confidence among depositors on the safety of their funds, and consequently guard against panic withdrawals of deposits and breakdown of the payments system, which may adversely affect the production sector of the economy[2]. Diamond and Dybvig (1983) demonstrate that full deposit insurance is able to rule out bank runs. They argue that while uninsured demand deposit contracts are able to provide liquidity, they leave banks vulnerable to multiple equilibria, one of which is a bank run where all depositors panic and immediately withdraw their funds because of concerns with the possibility of the banks failing. Since deposit insurance provides a safe asset to depositors, they do not rush to withdraw their deposits from insolvent banks, consequently preventing the costly liquidation of the banks' assets that can aggravate the banks' insolvency (Marini 2003). In a later study, Diamond and Dybvig (1986) re-affirm that full deposit insurance is the only known effective measure to prevent bank runs.

[2] The first recorded deposit insurance in history is the New York Safety Fund in the US, which was established in 1829, funded by limited annual contributions of members and regulated by the state government (Calomiris 1990).

B. Moral hazard

While deposit insurance may be regarded as a tool for stopping or minimising bank runs, it is also a source of moral hazard for excessive risk taking, which in turn may lead to more bank failures. With deposit insurance, banks are encouraged to finance high-risk, high-return projects as their ability to attract deposits no longer reflects the risk of their asset portfolio (Demirgüç-Kunt and Detragiache 2002). This crop-up of moral hazard with deposit insurance has been widely supported in the empirical literature. For instance, Demirgüç-Kunt and Detragiache (2002) conclude that moral hazard matters based on the finding that explicit deposit insurance tends to increase the likelihood of banking instability. Laeven (2002) observed that the cost of deposit insurance has some power in predicting bank failures, which he interpreted as evidence of support for the view that deposit insurance creates moral hazard for banks. His results further show a strong positive correlation between credit growth and the cost of deposit insurance, against which he concludes that deposit insurance promotes excessive risk taking behaviour. In a study of Kansas, Wheelock and Wilson (1995) found out that deposit insurance membership increases the probability of bank failure, consistent with the hypothesis that deposit insurance encourages banks to hold higher risk portfolios than they otherwise would. Similar findings are reported by Carapella and Di Giorgio (2004), who demonstrate that deposit insurance increases the lending-deposit spread in banking, the main effect of which arises not from the deposit side, but from an increase in the lending rate. They interpret this result as evidence of the presence of moral hazard behaviour emanating from deposit insurance. Cull, Senbet and Sorge (2005) use the volatility of credit to the private sector as a proxy for risk in a cross-country analysis and establish that the decision to introduce deposit insurance increases the volatility of credit and hence risky behaviour in the financial sector, particularly in countries with weak institutions.

C. Banking instability

Banking instability can occur either as a bank run or an insolvency problem of banks. In a bank run, depositors rush to withdraw their deposits in full following expectations of looming bank failure, consequently forcing the bank to liquidate its assets at a loss and fail indeed. A number of studies have presented various explanations of the trigger mechanism of bank runs. Among the earliest are Irving

Fisher in 1911, who holds that a bank run occurs when the value of a bank's total assets falls short of its holdings of deposits, which incites depositors to rush and quickly withdraw their deposits in order to cut on losses (see also Bryant 1980). Presenting a different view, Diamond and Dybvig (1983) argue that a bank run is caused by a shift in expectations, which could depend on almost anything, referred to as sunspots run equilibrium (Diamond and Dybvig 1983; Adao and Temzelides 1998; Carmona 2004). In yet another explanation, Chari and Jagannathan (1988) maintain that a bank run can occur even if no one has any adverse information about future returns of the bank. The essence of the model is that if individuals observe long queues of depositors at a bank, regardless of the information content held by the people on queues, they correctly infer that there is a possibility that the bank is about to fail and precipitate a bank run. Unlike the Diamond-Dybvig model which presents a bank run as a bad equilibrium in a series of possible multiple equilibria, the Chari and Jagannathan (1988) framework models a bank run as an equilibrium phenomenon in a formulation where all equilibria have bank runs.

Banking instability can also show-up through the insolvency of banks, usually characterised by large amounts of unanticipated non-performing loans. Caprio and Klingebiel (1997) define insolvency as a case where the net worth of the banking system has been entirely or almost eliminated. This situation is more likely during an economic downturn and after a period of a boom in lending to the private sector (Caprio and Klingebiel 1997; Allen and Gale 1998).

III. Methodology and Data

A. Data and data sources

The study is carried out using a panel dataset covering 118 countries over the period 1980-2004. The choice of both the number of countries and cut-off dates has been dictated by data availability. We started off with 211 countries that appear on the World Bank list of all countries, and eliminated countries where data was not available, losing 93 countries in the process (see Appendix A for a list of countries in the sample). Deposit insurance data was collected from Demirgüç-Kunt, Karacaovali and Laeven (2005) comprehensive database of deposit insurance around the world. The World Development Indicators, a World Bank database of economic and demographic indicators, was used as a primary source for selected macroeconomic indicators used as control variables. Additional data was sourced from International Financial Statistics (IFS), an International Monetary Fund (IMF) database.

In our sample, only 12 countries had deposit insurance at the beginning of the study period in 1980. The number rose to 27 by 1990 and 52 by 2003 (see Table 1 below). According to the data, deposit insurance with unlimited coverage (full guarantee) is not popular. It had been adopted only in six of the 52 countries with deposit insurance (in the sample) as of 2003. Coinsurance and risk adjusted deposit insurance schemes are also rare. There were only eight countries with coinsurance mechanisms and seven with risk adjusted premiums as of 2003 (in the sample).

Table 1. Summary statistics of deposit insurance around the world

Number of countries with:	1980	1980-1985	1986-1990	1991-1995	1996-2000	2001-2004
Deposit insurance	12	19	27	34	46	52
Unlimited guarantee (full) deposit insurance	3	3	4	5	9	6
Coinsurance	3	4	6	7	8	8
Risk adjusted premiums of deposit insurance	1	2	3	6	7	7
Deposit insurance covering foreign currency deposits	10	14	18	25	31	32
Deposit insurance covering interbank deposits	2	3	4	5	8	8
Deposit insurance with a permanent fund	10	15	22	29	37	39
A compulsory membership deposit insurance	10	15	23	32	40	42

Note: All figures are for end period. Source: Demirguc-Kunt et al. (2005)

We further observe that a large number of countries extend coverage of deposit insurance to include foreign exchange deposits (32 of the 52 countries in the sample) while only a few (8 of the 52 countries in the sample) extend coverage to include interbank deposits. In addition, we observe that most deposit insurance schemes have a permanent fund. In our sample, 39 countries out of 52 have a permanent fund in place. On the whole, countries prefer compulsory membership to their deposit insurance systems. Against the 52 countries that adopted deposit insurance in the sample, as at 2003, a total of 42 had compulsory membership.

B. Measures of banking instability and moral hazard

To quantify banking instability, we build on the ideas of Eichengreen, Rose and Wyplosz (1995, 1996a and 1996b) and von Hagen and Ho (2007). Using monthly time series data, we compute deseasonalised growth rates of demand deposits (DD_t) and time deposits (TD_t) to construct a measure of bank runs ($brun_t$) and credit extended to the private sector (CR_t) to calculate a measure of bank insolvency ($insolv_t$).[3]

We follow a four-step procedure. Firstly we compute the deseasonalised growth rates of each series. For instance the deseasonalised growth rate of demand deposits (gr_DD_t) is computed as:

$$gr\_DD_t = \frac{(DD_t - DD_{t-12})}{DD_{t-12}} \tag{1}$$

The deseasonalised growth rates for time deposits (gr_TD_t) and credit to the private sector (gr_CR_t) are calculated analogously, replacing DD_t with TD_t and CR_t, respectively.

Secondly, we compute indices of bank runs and bank insolvency. The index of bank runs is given by the formula:

$$run_t = \frac{\left[\left(\frac{gr\_DD_t - \overline{gr\_DD_t}}{\sigma_{gr\_DD_t}}\right) + \left(\frac{gr\_TD_t - \overline{gr\_TD_t}}{\sigma_{gr\_TD_t}}\right)\right]}{2} \tag{2}$$

while the index of bank insolvency is given by

$$solv_t = \left(\frac{gr\_CR_t - \overline{gr\_CR_t}}{\sigma_{gr\_CR_t}}\right) \tag{3}$$

where $\overline{gr\_DD_t}$, $\overline{gr\_TD_t}$, and $\overline{gr\_CR_t}$ are mean growth rates and $\sigma_{gr\_DD_t}$, $\sigma_{gr\_TD_t}$, and $\sigma_{gr\_CR_t}$ are standard deviations of deseasonalised growth rates of demand deposits, time deposits and credit extended to the private sector, respectively.

Thirdly, given that bank runs and insolvency are generally characterised by a sharp decrease in bank deposits and credit extended to the private sector, in that order, we use extreme values of run_t and $solv_t$ to calculate measures of bank runs and insolvency, denoted as $brun_t$ and $insolv_t$, respectively. We distinguish between

[3] All the measures are in real terms to avoid the influence of inflationary episodes on our indicators.

narrow and broad definitions of banking instability described by these measures. We define the narrow measure of banking instability (*nbrun* and *ninsolv*) as cases where the calculated indices (*run* and *solv* respectevely) fall within the lowest 5 percent of the standard normal distribution and we let the measure take the value 1 reflecting a period of banking instability. When the calculated indices fall within the highest 95 percent of the standard normal distribution, we classify this as a period of banking stability and the measure takes the value zero. The broad definition is characterised analogously. The indices take the value 1 if they fall within the lowest 10 percent of the standard normal distribution, which we define as a period of banking instability, and zero otherwise.

Fourthly, we convert the data from monthly to annual frequency. We describe any year that has no recording of banking instability as a year of banking stability and the variable takes the value zero; and a year that has at least one month of recorded banking instability is defined as a year of banking instability and the variable gets the value one.

While the rationale for the proxy of bank runs is straightforward, the proxy for bank insolvency might require clarification. When a bank in going through a period of insolvency due to non-performing loans, it is more likely that it will change dramatically its lending policy and its credit line managers, in an effort to stop this negative pattern and ultimately a bank failure. During this restructuring phase, the bank is extremely cautious and this can explain the extreme drop in its credit to the private sector.[4] Moreover, if the bank had already declared an insolvency problem and has been taken over by a new management team or by government authorities, this bank too will experience extremely low levels of credit to the private sector during the restructuring phase, because of the lack of liquidity and the need to adopt a safe credit policy.

A correlation matrix for the constructed indicators of banking instability shows that there is a high degree of cross correlation between the narrow and broad definitions of each of the classifications of banking instability (see Table A1 in the online appendix). This is not unexpected since the broad definitions contain all the information in the corresponding narrow definitions of banking instability plus some additional information.

[4] Of course during this phase it can continue to extend credit to the government, if the credit rating of the government is high or shift its credit line to well rated external entities.

On the whole, however, the correlations of our identifiers of bank runs and bank insolvency show relatively low cross correlations, indicating that the two need not necessarily occur together. This finding demonstrates the importance of distinguishing between the two forms of banking instability, an approach that has been adopted in this study.

Finally, to ascertain that our indicators of banking instability are measuring what is intended, we compare our data with similar data compiled in other studies. Our measured insolvency, narrowly and broadly defined, compares very well with major bank insolvencies identified by Caprio and Klingebiel (1997) in selected countries.[5] Most of Caprio and Klingebiel's (1997) identified insolvencies are captured in our measures of banking instability. The few cases that do not match between the two datasets are a consequence of definitional differences between our measures of insolvency and Caprio and Klingebiel's (1997) measures.

C. Moral hazard and control variables

We measure moral hazard using the ratio of private sector credit to real GDP (*crgdp*). In fact, many studies have considered a sharp increase of this variable as a sign of moral hazard in the banking system. In our case, we describe moral hazard as a situation where deposit insurance is associated with a sharp increase in credit to the private sector relative to the size of the economy.

We use six control variables, namely, growth of real GDP (*gdpgr*), real interest rates (*rir*), inflation rates (*inflatn*), ratio of M2 to foreign exchange reserves (*m2fxres*) exchange rate depreciation (*xrdepr*), which is just the percentage change in local currency-dollar exchange rate, and GDP per capita (*gdppc*) to control for macroeconomic factors that are expected to have a significant impact on banking fragility.[6] Following Demirgüç-Kunt and Detragiache (2002), inflation, real GDP growth and real interest rates are used to capture macroeconomic developments that are likely to affect the quality of bank assets. Higher values of real GDP growth reflect a higher ability of borrowers to repay their loans while higher inflation rates entail higher operating costs and a lower ability of borrowers to repay their loans. Real interest rates are expected to have an adverse effect on banks' profitability

[5] See Table A2 in the online appendix.

[6] See Section B in the Appendix for brief definitions of variables used in the model and how they are measured.

through their impact on the cost of funds. Besides being associated with high default rates, high real interest rates indicate high cost of funds to banks. Since bank loans and other assets are usually fixed over long periods, rising real interest rates push up the cost of funds, adversely affecting the liability side of the banks' balance sheets and consequently squeezing the banks' profits.

Exchange rate depreciation and the ratio of M2 to foreign exchange reserves are used to capture commercial banks' vulnerability to sudden capital outflows triggered by a run on the currency and the banks' exposure to foreign exchange risk (Demirgüç-Kunt and Detragiache 2002). Demirgüç-Kunt and Detragiache (2002) argue that since deposit insurance guarantees the domestic value of deposits and not their foreign currency value, the expectation of a devaluation triggers withdrawals of domestic currency deposits to purchase foreign assets even in the presence of deposit insurance.

Finally, GDP per capita is used to capture institutional as well as regulatory characteristics of countries in every time period. An increase in GDP per capita can be interpreted as an improvement of institutional quality as well as banking system regulatory framework.

D. Deposit insurance variables

A simple dummy variable, which takes the value 1 when a country has deposit insurance and zero otherwise, is used to investigate the effect of deposit insurance on banking instability. As already alluded to, the theory is inconclusive on whether deposit insurance destabilises or stabilises the banking system. Most empirical studies, albeit without distinguishing between banking instability caused by bank runs and banking instability caused by insolvency of banks, have found that deposit insurance increases the vulnerability of a banking system to instability (see Gonzalez-Hermosillo et al. 1997; Demirgüç-Kunt and Detragiache 1998, 2002).

To examine the behaviour of banking instability in relation to certain features of deposit insurance, we estimate four sets of equations, each characterising particular features in the design of deposit insurance, namely, generosity of payouts, coverage, legal environment and administration of the deposit insurance. Generosity of payouts is represented by a single variable, *guarantee*, which takes the value one if a country has full deposit insurance (unlimited guarantee) and zero if the deposit insurance scheme provides partial coverage (limited guarantee). Demirgüç-Kunt et al. (2005) argue that in any deposit insurance scheme, the amount of coverage matters since it directly affects market discipline exerted by depositors. The sign of the marginal effects of *guarantee* on banking instability cannot be determined *a priori*. In fact, full deposit insurance is expected to be associated with a marginally low likelihood of banking instability if the Diamond-Dybvig (1983) hypothesis is correct; whereas if the moral hazard problem dominates, full deposit insurance will be associated with a high probability of banking instability.

Coverage is captured by two variables, namely, whether or not interbank deposits are covered (*intbank*) and whether or not foreign currency deposits are covered (*fxcoverd*). Countries with deposit insurance need to decide on the type of deposits to be covered and the type of financial institutions to be included or excluded from the coverage.

There are three variables capturing the legal environment, and each answers one of the following yes/no questions:

(i) Does the deposit insurance authority have the mandate to intervene in a bank's affairs (*interven*)?

(ii) Does the deposit insurance authority have the legal power to cancel or revoke deposit insurance for any participating bank (*leglcancel*)?

(iii) Can the deposit insurance agency/fund take legal action against bank directors or other bank officials (*leglmgr*)?

An explicit deposit insurance scheme founded on a sound legal system with proper enforcement mechanisms is *a priori* expected to command credibility. Banks are likely to be restrained from indulging in certain activities that interfere with banking stability while depositors are reassured of the safety of their funds even in the event of bank failure. The expected outcome, therefore, is banking stability. This state, however, may also create moral hazard in both depositors and banks, which may expose the banks to instability. For these reasons, the expected signs of the legal environment indicators are indeterminate.

Administration is covered in six variables, namely, whether the deposit insurance is administered by government, by the private sector or jointly by government and the private sector (*admin*); whether there is coinsurance or not (*coinsur*); whether the deposit insurance is funded or not (*funding*); whether deposit insurance premiums are risk adjusted or not (*rskadj*); whether membership to the deposit insurance scheme is compulsory or voluntary ; and whether the deposit insurance is solely funded by government or by the private sector or jointly by the two (*sourcefnd*). In all cases, the signs of the marginal effects may be positive or negative depending on whether the moral hazard problem is dominant or not.

With a coinsurance system, depositors are required to bear part of the cost in the event of bank failure (Demirgüç-Kunt et al. 2005). The system, therefore, is used as a technique for quelling moral hazard (McCoy 2007). It provides a risk-sharing mechanism between depositors and the insurer, thereby instilling a considerable degree of market discipline (Talley and Mas 1990) that minimises the probability of banking instability. To the extent that some component of deposits is left uninsured, depositors are incentivised to monitor the financial condition of their banks, which leads to market discipline in the banking industry. By exposing some of the deposits to non-protection, however, coinsurance may also increase the probability of bank runs. On rumours that a bank is likely to fail, its depositors may run on it to secure the uninsured component of their deposits. Since coinsurance is expressed as a component of the deposit, depositors will simultaneously attempt to withdraw all their funds to ensure that they minimise their losses. On their part, banks may undertake high-risk high-return projects proportionate to the level of their clients' deposits that are covered by the deposit insurance, which may increase the probability of insolvency.

E. Model and estimation

We employ the random effects logit model to estimate the probability of banking instability using the maximum likelihood method. The logit is a large-sample technique which has been commonly used in a number of similar studies (see for example Cole and Gunther 1995; Gonzalez-Hermosillo et al. 1997; Demirgüç-Kunt and Detragiache 1998). Our use of the random effects (rather than fixed effects) is aimed at preserving information. If fixed effects (rather than random effects) are included in the model, it may require omitting from the panel all countries that did not experience banking instability during the period under consideration, which would imply throwing away a large amount of information (Greene 2003; Demirgüç-Kunt and Detragiache 1998). In addition, limiting the panel to countries with banking instability only would produce a biased sample (Demirgüç-Kunt and Detragiache 1998).

IV. Results analysis

A. Baseline model

In this section we present and discuss estimation of the model with the broad indicators of banking instability. The narrow indicators are used to study robustness and sensitivity of the results.

Bank runs and deposit insurance

Table 2 presents regression results showing the relationship between bank runs (broadly defined) and deposit insurance controlling for macroeconomic conditions. In the first column, we just regress the bank run dummy *bbrun* on a set of standard macroeconomic variables and the indicator for deposit insurance *dinsur*. Deposit insurance alone does not seem to be correlated with a significant change in the probability of bunk runs. Thus, deposit insurance appears inefficient in reducing the likelihood of bank runs in a given economy. Deposit insurance becomes correlated with a reduction in the probability of bank runs once we introduce interaction terms which attempt to capture the separate effect of moral hazard. Among the many we have experimented with, we present the results of introducing the interaction of deposit insurance with per capita GDP (column 2), with real interest rates (column 3) and with credit growth (column 4). Notice that with the introduction of the interaction terms in column four the interpretation of the results becomes transparent: deposit insurance reduces the probability of bank runs directly and has a contervailing effect to promote credit growth and risk taking behaviour which reduces the stability of the banking system.

Table 2. Bank runs and deposit insurance

	(1) bbrun	(2) bbrun	(3) bbrun	(4) bbrun
gdpgr	-0.0608***	-0.0589***	-0.0583***	-0.0565***
	(-4.90)	(-4.74)	(-4.68)	(-4.54)
rir	-0.00705*	-0.00647	-0.0120**	-0.0100**
	(-1.72)	(-1.63)	(-2.35)	(-1.99)
inflatn	-0.000219	-0.000227	-0.000279	-0.000268
	(-1.20)	(-1.24)	(-1.43)	(-1.38)
m2fxres	0.000106	0.0000858	0.0000875	0.0000785
	(0.88)	(0.73)	(0.73)	(0.66)
crgdp	0.00235	0.00244	0.00290	-0.00152
	(1.05)	(1.10)	(1.29)	(-0.49)
xrdepr	-0.0136***	-0.0137***	-0.0132***	-0.0133***
	(-3.65)	(-3.72)	(-3.55)	(-3.59)
gdppc	-0.0000206*	-0.0000535***	-0.0000534***	-0.0000376*
	(-1.70)	(-2.71)	(-2.67)	(-1.80)
dinsur	-0.132	-0.382**	-0.358*	-0.608***
	(-0.85)	(-2.00)	(-1.85)	(-2.70)
gdppcdinsur		0.0000458**	0.0000432**	0.0000119
		(2.19)	(2.04)	(0.47)
rirdinsur			0.0133*	0.0113
			(1.93)	(1.64)
crgdpdinsur				0.00913**
				(2.12)
Constant	-1.198***	-1.104***	-1.130***	-1.026***
	(-10.19)	(-9.17)	(-9.17)	(-7.88)
Obs.	1980	1980	1980	1980
No. of countries	105	105	105	105

Note: *t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Bank insolvency and deposit insurance

The results of the previous section are confirmed by analysing the effect of deposit insurance on the probability of insolvency. Table 3 presents regression results showing the relationship between bank insolvency (broadly defined) and deposit insurance. The estimation results reveal that deposit insurance does not significantly explain insolvency, either. The only case where it is significant is when it is interacted with the ratio of private sector credit to GDP. In this case the introduction of deposit insurance increases the probability of bank insolvency. It follows, therefore, that when deposit insurance is coupled with an increase in credit to the private sector relative to the size of the economy (i.e., a measure of moral hazard), it increases the likelihood of insolvency. There are many regulatory tools to control for risky lending in many banking systems. These can mitigate the effect of deposit insurance in increasing moral hazard behaviour. In countries where these tools are missing or where these regulations are not well enforced, deposit insurance can create moral hazard which will then translate into a higher probability of bank insolvency.

Table 3. Bank insolvency and deposit insurance

	(1) *binsolv*	(2) *binsolv*
gdpgr	-0.0561***	-0.0540***
	(-3.96)	(-3.81)
rir	-0.00420	-0.00294
	(-1.01)	(-0.74)
inflatn	-0.0000163	-0.0000193
	(-0.11)	(-0.13)
m2fxres	-0.000780	-0.000821
	(-1.03)	(-1.06)
crgdp	0.00513	-0.000615
	(1.51)	(-0.14)
xrdepr	-0.0249***	-0.0250***
	(-5.31)	(-5.37)
gdppc	-0.0000124	-0.0000183
	(-0.61)	(-0.88)
dinsur	0.135	-0.371
	(0.63)	(-1.19)
crgdpdinsur		0.0104**
		(2.24)
Constant	-2.109***	-1.893***
	(-11.36)	(-9.14)
Observations	2135	2135
No. of countries	105	105

Note: *t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B. Design features of deposit insurance

Generosity of payouts

Estimation results presented in Table 4 show that *guarantee* has significant marginal effects (at 10 percent) and is positively correlated with banking instability characterised by bank runs (in columns 1 and 2) as well as insolvency (in column 3 and 4), suggesting that full deposit insurance is associated with some susceptibility to banking instability. More importantly the interaction term of *guarantee* and *crgdp* significantly increases the probability of bank runs and bank insolvency. This result about bank runs is at odds with the Diamond and Dybvig (1983) argument that full deposit insurance rules out bank runs.

Our empirical results suggest that in an economy with a more generous deposit insurance scheme, the moral hazard problem dominates, making it more vulnerable to banking fragility triggered by insolvency problems as well as bank runs. We, therefore, argue that if moral hazard can be triggered by bank insolvency, it has also some probability of causing a bank run. A probable explanation is that when the banking system is facing a crisis, depositors do not know the exact cause and given that some depositors do not trust the government guarantee (especially in low income countries and in countries facing budgetary difficulties), they will run on the bank to cut on their losses that may accrue when the bank eventually fails.

Table 4. Bank runs and insolvency, and the generosity of deposit insurance

	(1)	(2)	(3)	(4)
	bbrun	*bbrun*	*binsolv*	*binsolv*
gdpgr	-0.0772**	-0.0772**	-0.0778*	-0.0783*
	(-2.11)	(-2.10)	(-1.86)	(-1.86)
rir	0.00115	0.000945	-0.0489**	-0.0520**
	(0.18)	(0.15)	(-2.35)	(-2.49)
inflatn	-0.000198	-0.000201	-0.0130	-0.0115
	(-0.22)	(-0.23)	(-1.54)	(-1.56)
m2fxres	0.000283*	0.000272	-0.00225	-0.00188
	(1.65)	(1.61)	(-0.42)	(-0.54)
crgdp	0.00809**	0.00484	0.00719	0.000719
	(2.13)	(1.17)	(1.64)	(0.13)
xrdepr	-0.0231**	-0.0236***	-0.0314**	-0.0323**
	(-2.51)	(-2.58)	(-2.47)	(-2.55)
gdppc	-0.0000116	-0.00000132	-0.00000147	0.0000251
	(-0.60)	(-0.07)	(-0.06)	(0.92)
guarantee	0.631*		0.385*	-0.822
	(1.71)		(0.228)	(-1.08)
crgdpguarantee		0.0111**		0.0200**
		(2.33)		(2.09)
Constant	-2.076***	-1.994***	-2.140***	-2.066***
	(-6.01)	(-5.87)	(-5.50)	(-5.18)
Observations	581	581	595	595
No. of countries	47	47	48	48

Note: *t* statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Coverage

Table 5 presents in columns 1 and 2, estimation results illustrating the impact of extending deposit insurance coverage to foreign currency and interbank deposits on banking instability. The table shows that marginal effects of both variables are insignificant for both types of banking instability, illustrating that whether foreign currency or interbank deposits are covered by a deposit insurance scheme or not does not significantly affect banking fragility. While a more comprehensive coverage provides a better guarantee against depositor runs, the theory suggests that it also creates more incentives for excessive risk taking (Demirgüç-Kunt and Detragiache 2002). Exclusion of interbank deposits in the coverage of insured deposits, for instance, may increase the probability of banking instability because banks, who are regarded as the most well informed depositors, are now without protection and may lead to a run at the slightest suspicion of failure in one of the banks holding their deposits. Also, in the event that one bank fails, other banks that had placed deposits in the failing bank would sustain losses that would weaken their financial position, making them susceptible to failure too (see Talley and Mas 1990). Inclusion of the interbank deposits in the coverage of insured deposits, on the other hand, may also increase the likelihood of banking instability, since the banks now have no incentive to monitor each other's financial conditions. In the process, market discipline deteriorates leading to excessive risk-taking behaviour by the banks. Our result shows that empirically, none of these two contradictory arguments is dominant.

Foreign currency deposits coverage in a deposit insurance scheme does not necessarily reassure depositors of the safety of their funds in the event of bank failure. One reason, particularly applicable to developing countries, is that the deposit insurance companies might not be able to acquire needed foreign exchange in order to pay off holders of the foreign currency deposits, which may compel the depositors to force the agency into bankruptcy for failing to honour its obligations (Talley and Mas 1990). If insurances companies have the option of paying off the foreign currency deposits in local currency at the prevailing exchange rate, the depositors may end up in a worse off position as the exchange rate may not be realistic enough to compensate them for their foreign currency deposits lost in the failed bank (Talley and Mas 1990).

Some studies suggest that the inclusion of foreign currency deposits in deposit insurance coverage makes a banking system more vulnerable to instability (Demirgüç-Kunt and Detragiache 2002). Coverage of foreign currency deposits may also serve to reassure depositors of the safety of their funds. While this reassurance may take away the depositors' incentives to monitor the financial soundness of their bankers, leading to increased risk-taking behaviour by the banks and hence a higher probability of banking instability, it may also prevent bank runs. Even in the wake of news that a bank is likely to fail, the depositors may not run on the bank because they are assured of the safety of their funds.

Table 5. Banking instability, deposit insurance coverage, legal environment and administration

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	*bbrun*	*binsolv*	*bbrun*	*binsolv*	*bbrun*	*binsolv*	*bbrun*	*binsolv*
fxcoverd	-0.523	0.26						
	(0.44)	(0.48)						
intbank	0.45	0.774						
	(0.49)	(0.50)						
interven			-0.656	0.695				
			(0.72)	(0.78)				
leglcancel			0.940**	0.314				
			(0.46)	(0.54)				
leglmgr			0.265	-0.417				
			(0.48)	(0.53)				
intervencrgdp					-0.0769**	-0.0314		
					(0.04)	(0.02)		
leglcancelcrgdp					-0.00061	-0.0123		
					(0.01)	(0.01)		
leglmgrcrgdp					0.0157	0.0166		
					(0.01)	(0.01)		
admin							0.138	0.119
							(0.27)	(0.29)
coinsur							0.858	-0.312
							(0.75)	(0.62)
funding							1.372**	-0.732**
							(0.67)	(0.37)
rskadj							0.106	0.0281
							(0.53)	(0.59)
membship							0.126	0.254
							(0.57)	(0.63)
sourcefnd							0.716*	0.780*
							(0.43)	(0.45)
Observations	541	563	455	465	455	465	551	551
No. of countries	41	44	35	37	35	37	41	41

Note: Standard errors given in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Parameter estimates of the macroeconomic variables used as a control for the fundamental banking crisis not included here but available in Tables A4.1–A4.3 in the online appendix.

Legal environment

Estimation results illustrating the importance of the legal environment in explaining banking instability are presented in Table 5, colums 3 and 4. One of the legal environment indicators, *leglmgr*, has insignificant marginal effects, suggesting that whether or not a deposit insurance agency has the mandate to take legal action against bank directors or other bank officials has no bearing on a country's banking stability. The other two legal environment indicators, *interven* and *leglcancel*, are positively related to banking instability and are statistically significant.

This outcome demonstrates that conferring a deposit insurance company with legal powers to intervene in the affairs of a bank or to cancel or revoke deposit insurance for any participating bank increases the likelihood of banking instability. While deposit insurance assures economic agents of the safety of their insured deposits, the speed at which they can get their money in the event of bank failure remains of concern. A deposit insurance agency that has the legal authority to close a bank, therefore, may indeed fuel a bank run on rumours that the bank is on the brink of failure.[7] In this state, economic agents will simultaneously queue to withdraw their funds, not because they doubt the safety of their funds, but because they want to have access to their money when they need it.

Moreover, an explicit deposit insurance scheme founded on a sound legal system with proper enforcement mechanisms is *a priori* expected to command credibility. Banks are likely to be restrained from indulging in certain activities that interfere with banking stability while depositors are reassured of the safety of their funds even in the event of bank failure. The expected outcome, therefore, is stability. This state, however, may also create moral hazard. With a credible deposit insurance scheme, depositors are no longer persuaded to place their deposits in banks chosen on the basis of their financial condition but in accordance with the interest rates they offer; and banks, on their part, may undertake more risky business strategies than they otherwise would (MacDonald 1996). In either case, the probability of banking instability increases.

[7] In countries where deposit insurance membership is compulsory, cancellation of a participating bank's deposit insurance membership implies cancellation of the bank's banking licence. Since deposit insurance membership is compulsory in most countries, we generalise that if a deposit insurance agency has the mandate to cancel or revoke membership for any participating bank, it effectively holds the authority to close the bank.

Administration

Finally columns 7 and 8 of Table 5 present estimation results of the deposit insurance administration indicators. We find that the probability of banking instability characterised by both bank runs and insolvency of banks is not influenced by whether the deposit insurance scheme is administered by the government, the private sector or jointly by both; whether there is co-insurance or not; whether deposit insurance premiums are risk adjusted or not; and whether membership to a deposit insurance scheme is compulsory or voluntary.

We also find that countries with a permanent fund of the deposit insurance scheme are prone to banking instability characterised by bank runs more than countries with a non-funded deposit insurance scheme. In a funded deposit insurance (permanent fund) system, members or the government make periodic contributions to the fund, which are then used as a primary resource base for paying out depositors in the event of bank failure; and in a non-funded system, members pay their contributions to the fund after bank failure has already occurred (Demirgüç-Kunt et al. 2005). Consistent with the theoretical literature and the findings of Demirgüç-Kunt and Detragiache (2002), the marginal effects of funding type are positive and significant for the bank run variable, indicating that deposit insurance schemes with a permanent fund give rise to moral hazard, which in turn leads to banking instability. Deposit insurance schemes with a permanent fund are, however, associated with lower chances of bank insolvency.

Further, we establish that the source of funding for a deposit insurance scheme has a significant impact on banking instability (both bank runs and bank insolvency). The table reveals that the probability of both bank runs and insolvency of banks is lowest when a deposit insurance scheme is wholly funded by the private sector, increases in cases of joint funding by the government and the private sector, and it is highest when the government is the sole financier.

C. Sensitivity analysis

To ensure that our estimation results are robust we carry out a sensitivity analysis where we re-estimate the regressions using the narrow measures of banking instability *nbrun* and *ninsolv* as new dependent variables. These narrow measures of banking instability capture only the cases when the calculated indices of bank runs and bank insolvency fall within the lowest 5 percent of the standard normal distribution. They capture only around 30% of the episodes identified in the broad measures used in the main analysis. We find that deposit insurance has no significant effect on the probability of bank runs but that it increases the probability of the banking system to suffer from insolvency of banks in countries where the adoption of the deposit insurance has been followed by moral hazard behavior, captured by an increase of the ratio of credit to the private sector (see Tables A3.1–A3.6 in the online appendix for estimation results of the model with narrow measures of banking instability).

We have carried out further robustness checks using dummy variables based on the Caprio et al. (2003) classification of systemic financial crises driven by bank runs and insolvency. Specifically, we have investigated episodes of bank runs and episodes of bank insolvency by Laeven and Valencia (2012) and we have used the Systemic Banking Crisis variable developed by these authors. Using the Laeven and Valencia (2012) dataset, we found that our results about bank insolvency and deposit insurance hold. In fact, 'deposit insurance' and 'deposit insurance guarantee' are positively related to bank insolvency. We also find a positive correlation between the generosity of deposit insurance and bank runs, which is consistent with our earlier results. In contrast to our results, the relation between deposit insurance and bank insolvency is significant at 5%, while ours is not; and surprisingly, the relationship between the generosity of deposit insurance "*guarantee*" and bank insolvency is not significant, while ours is. With this new database, we also find a positive relationship between deposit insurance and bank runs, which is significant at 10% (see Tables A5.1–A5.4 in the online appendix).

The difference between the results obtained using our database and Laeven and Valencia's (2012) database can be explained by the differences in definitions of the variables. The definitions of Laeven and Valencia (2012) differ from ours because they capture those episodes of banking distress that resulted in effective systemic banking crises while our definition is based on the symptoms of financial distress (an excessive contraction in deposits or credit availability) that could result in a systemic banking crisis (in fact the two measures significantly overlap), but also includes episodes of financial distress that didn't result in a systemic banking crisis.

In the final robustness test, we re-estimated the baseline model with lagged valued of deposit insurance to control for endogeneity.[8] We experimented with one, two, three and four lags of deposit insurance and the results remain consistent with the main findings. It is observed that deposit insurance *per se* has no impact on financial instability (see Table A7 in the online appendix).

V. Conclusions

This paper set out to investigate the role moral hazard plays in the effectiveness of deposit insurance in achieving banking stability. Using a new empirical framework that distinguishes banking instability characterised by bank runs from banking instability showing-up as insolvency of banks, the study finds evidence that deposit insurance is associated with moral hazard, which has the consequence of causing bank insolvency that ultimately triggers a run on banks. While our results do not necessarily refute findings in the earlier literature because of differences in measurement of the banking instability variable, we lay claim to having presented more expressive findings following our distinction of bank runs as well as insolvency of the banking system as identifiers of banking instability. In addition to the core findings, the study also establishes that a country is more vulnerable to banking instability when it has a more generous deposit insurance scheme, when the deposit insurance agency has a legal mandate to intervene in a bank's affairs or to cancel or revoke deposit insurance for any participating bank, when the deposit insurance has a permanent fund, and when the scheme is funded jointly by the government and the private sector or solely by the government. We argue that since there are many types of regulations in any given banking system, it may be difficult to study with complete confidence the effect of a given banking regulation alone. Perhaps it is the combination of many types of regulation that matter.

[8] We embarked on a wide search for feasible instruments. Unfortunately the search for a good instrument has been largely unsuccessful as it is difficult to find a homogeneous exogenous institutional determinant of deposit insurance and insurance coverage. We have experimented with a long list of possible instrumental variables. For example we experimented with different measures of institutional quality, from the World Bank Worldwide Governance Indicators, and updated 2012 World Bank measures of political institutions discussed in Beck et al (2001). The reasoning is that deposit insurance and its coverage are related to the sensitivity of political institutions and to savers' need for protection against a financial crisis. We used a measure of the extent of the majority of the ruling party; an indicator of the presence of checks and balances in the political system; and an indicator of the level of polarization in the political system. All three of these variables are weakly linked to the level of coverage of deposit insurance (see Table A6 in the online appendix).

Appendix

A . Country sample

Countries with explicit deposit insurance: Argentina, Austria, Bahamas, Bahrain, Bangladesh, Brazil, Canada, Chile, Congo, Cyprus, Denmark, Dominican Republic, Ecuador, El Salvador, Finland, Germany, Greece, Guatemala, Honduras, Iceland, India, Indonesia, Ireland, Italy, Jamaica, Japan, Jordan, Kenya, Republic of Korea, Kuwait, Malaysia, Malta, Mexico, Netherlands, Nicaragua, Nigeria, Norway, Oman, Paraguay, Peru, Philippines, Portugal, Spain, Sri Lanka, Switzerland, Tanzania, Thailand, Trinidad and Tobago, Turkey, Uganda, United Kingdom, and Zimbabwe.

Countries with implicit deposit insurance: Antigua and Barbuda, Australia, Barbados, Belize, Benin, Bhutan, Bolivia, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, China, Costa Rica, Cote d'Ivoire, Dominica, Egypt (Arab Republic), Equatorial Guinea, Ethiopia, Fiji, Gabon, Gambia, Ghana, Grenada, Guyana, Iran (Islamic Republic), Israel, Lesotho, Libya, Madagascar, Malawi, Macao China, Maldives, Mali, Mauritius, Morocco, Nepal, New Zealand, Niger, Pakistan, Papua New Guinea, Samoa, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Solomon Islands, South Africa, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Swaziland, Sweden, Togo, Tonga, Tunisia, Uruguay, Vanuatu, Venezuela (Bolivarian Republic of), Yemen (Republic), and Zambia.

B. Definitions and measurement of deposit insurance variables

admin: Administration of deposit insurance. It takes the value 1 if administration is official, 2 if it is joint and 3 if it is private.

coinsur: Coinsurance. It takes the value 1 if there is coinsurance of the deposit insurance scheme and zero otherwise.

crgdp: Ratio of domestic private sector credit to GDP.

dinsur: Deposit insurance. It takes the value 1 when a country has explicit deposit insurance and zero otherwise.

funding: Permanent fund. It takes the value 1 if the deposit insurance is funded and zero otherwise. In a funded deposit insurance system, members or government make periodic contributions to the fund, which is then used as the main source for paying out depositors in the event of bank failure (Demirgüç-

Kunt et al. 2005). In a non-funded system, on the other hand, members pay their contributions to the fund after a bank failure has already occurred. As at 2003, only 14 countries out of 88 had unfunded deposit insurance, 11 of which were European and Chile was the only country with the government as a sole contributor to the fund (Demirgüç-Kunt et al. 2005).

fxcoverd: Foreign currency deposits covered. The variable takes the value 1 if foreign currency deposits are covered by the deposit insurance and zero otherwise.

gdpgr: GDP growth.

guarantee: Deposits guaranteed coverage. The variable takes the value 2 in the case of unlimited guarantee (full coverage), 1 in the case of limited guarantee (partial coverage) and zero otherwise.

inflatn: Inflation measured by year on year percentage changes in the all items national composite consumer price index.

intbank: Interbank deposits covered. The variable takes the value 1 if interbank deposits are covered by the deposit insurance and zero otherwise.

interven: Does the deposit insurance authority make the decision to intervene a bank? The variable takes the the value 1 if yes and zero otherwise.

legalcancel: Does the deposit insurance authority have the legal power to cancel or revoke deposit insurance for any participating bank? The variable takes the value 1 if yes and zero otherwise.

legalmgr: Can the deposit insurance agency/fund take legal action against bank directors or other bank officials? The variable takes the value 1 if yes and zero otherwise.

m2fxres: Ratio of M2 to foreign exchange reserves.

membship: Membership takes the value 1 if affiliating to a deposit insurance scheme is compulsory and zero if it is voluntary. In most countries (almost 90 percent as of 2003), membership to a deposit insurance is compulsory.

rir: Real interest rates.

rskadj: Risk adjusted premiums. It takes the value 1 in cases where premiums vary according to riskiness of the assessment base and zero otherwise. The number of countries with risk adjusted premiums has risen from only the United States in 1995 to 20 as at 2003 (Demirgüç-Kunt et al. 2005).

sourcefnd: Source of funding. It takes the value 2 if the deposit insurance is solely funded by the government, zero if it is privately funded and 1 if funded jointly by the government and the private sector.

xrdepr: Exchange rate depreciation.

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