Moral Hazard, Risk Shifting and Banks' Financial Structure*

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Abstract: This paper analyzes the moral hazard conflict among banks' equity and debt holders. Specifically, we empirically study a straightforward risk shifting problem in banking institutions; that is, a bank's equity (debt) decreases (increases), but the overall risk position of that bank deteriorates. To perform this analysis, we divide the financial structure of banks into three categories: equity, deposits and other funding. This division considerably enriches the empirical analysis of moral hazard: it makes it possible to determine, not just whether shareholders are shifting risk or not, but, if they are, to whom risk is being shifted. Thus, we can establish a taxonomy of the types of moral hazard behavior based on the group of debt holders to which risk is transferred, and hence we can test the type of moral hazard problem that a banking sector is facing. The empirical exercise focuses on the first 15 members of the European Union in 2002-2009. Our main findings suggest that sample banks engaged in moral hazard behavior. The empirical analysis also indicates that the three Pillars of Basel II do not seem to have been effective to control for moral hazard incentives. Nevertheless, in tune with the new rules about conservatory buffers in Basel III, our results suggest that the incentives to engage in moral hazard behavior are weaker in banks holding capital buffers.

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1. Introduction.

It is said that one of Miller's favorite anecdotes was about the baseball player Yogi Berra. Asked by a waiter whether he would like a pizza to be cut in six slices or eight, Yogi answered "I would like eight slices. I am very hungry" (Copeland et al. 2005). This joke helps to illustrate the Irrelevance Proposition (Modigliani and Miller 1958): in a perfect and frictionless economy, a firm's value does not depend on the way in which its financial structure is partitioned -like Yogi Berra's pizza. The Irrelevance Proposition is a keystone of the modern theory of Corporate Finance. Nevertheless, "financing clearly can matter" (Myers 2001: 81). It can matter when frictions or imperfections are present; for instance, in the presence of agency costs associated to conflicts between equity and debt holders (see Harris and Raviv 1991, Myers 2001 for surveys). These conflicts arise because of the moral hazard opportunity that shareholders have to exploit debt holders by substituting riskier assets for safer ones. The rationale for doing so is that, if a risky investment pays off, shareholders keep most of the profits, but limited liability makes debt holders to bear losses in the event of failure (Jensen and Meckling 1976). To put it in terms of a standard moral hazard problem, after agreeing on a (debt) contract, the agent (stockholders) might have incentives to take actions (investing in risky projects) that are aligned with his/her interests but not with the principal's (debt holders'). If this occurs, shareholders would have managed to transfer risk to debt holders.

Moral hazard conflicts between equity and debt holders could be particularly severe in the banking sector, because its leverage is systematically higher than in any other industry (Berger et al. 1995, Gropp and Heider 2010). In addition, the largest proportion of banks' liabilities is in the form of deposits whose owners, to a large extent, have a limited ability to monitor banks (Caprio and Summers 1993). Indeed, since most banks' debt claims are relatively small, debt holders have incentives to free ride on monitoring (Levine 2004). The safety net protecting depositors in particular and the banking institutions in general could also contribute to exacerbate the moral hazard conflict between equity and debt holders (Battachartya and Thakor 1993). Moreover, deposit insurance and what Acharya et al. (2011) call the "implicit bailout assurance of debt" enables banks to transfer the consequences of excessive risk-taking to the taxpayer and softens the market discipline expected from debt holders.

Banking research has studied this conflict extensively, focusing in particular on the effects of deposit insurance, solvency regulation, the lender of last resort and market discipline over moral hazard incentives (see Berger et al. 1995, Stolz 2002, VanHoose 2007, Freixas and Rochet 2008, Degryse et al. 2009 for reviews). In this paper, we attempt to contribute to this

literature on bank moral hazard. In particular, we are interested to empirically analyze situations where the stake of shareholders becomes less and that of debt holders becomes larger, but banks increase their overall risk position. This view entails that we focus on a straightforward problem of risk shifting between equity and debt holders. As King et al. (2006) put it, when equity is a relatively small proportion of a bank's liabilities (i.e., when shareholders have less at stake and debt holders more), stockholders have little to lose and much to win by booking high-risk assets. By contrast, banks with relatively high capital ratios have private incentives to manage themselves prudently.

This risk shifting problem has been at the heart of the financial crisis that started at 2007. Shifting risk to third parties implies, at the end of the day, that banks lack enough equity relative to the risk taken on. Thus, in the event of risk materializing into actual losses, banks would face troubles to honor their debt obligations. In this sense, as Acharya et al. (2011) point out, the emerging evidence from the financial crisis of 2007-09 appears to lead to the conclusion that risk shifting has a key role in understanding bank failures. Furthermore, just doubts about banks' capacity to honor their debt claims because of insufficient equity would generate uncertainty about their solvency, what might contribute to a funding liquidity crisis that can quickly cause a run of the system (Acharya et al. 2009). In tune with this, the Basel Committee of Banking Supervision (2011, p. 3) states that one of the lessons of the financial crisis is the critical need that "banks' risk exposures are backed by a high quality base."

To analyze risk shifting between equity and debt holders, we take into account that banks' liabilities comprise deposits and non-deposit liabilities; indeed, the latter have become increasingly more important in banks' financial structure (Gropp and Heider 2009). Specifically, we divide the financial structure of banks into three broad categories: equity, deposits and other funding sources. To the best of our knowledge, this is the first empirical paper that differentiates between depositors and non-depository debt holders to analyze risk shifting. This differentiations allows us, not just to determine whether shareholders are shifting risk or not, but, it they are, to whom risk is being shifted, i.e., to depositors, to other debt holders or to both. As a result, the empirical analysis of the moral hazard problem between equity and debt holders is considerably enriched. In particular, we can propose a novel taxonomy of moral hazard. Using as a classifying criterion the question about to whom risk is shifted, this taxonomy includes four types of moral hazard behavior in which banks might engage. Hence, our approach makes it possible to test the type of moral hazard problem present in a banking sector.

To carry out this analysis, we take into account that banks do not have absolute control over changes in risk or in any of the three funding sources considered; that is, part of those changes is due to discretionary decisions, but another part is unexpected. To model the discretionary component, and given the imperfect and fractionated nature of the banking market, we use a partial adjustment framework. In addition, we consider that changes in risk are simultaneous to changes in equity, deposits or other funding. Thus, we extend the standard analysis of capital (Shrieves and Dahl 1992) to all the components of banks' financial structure. This enables us to study risk shifting in terms of our taxonomy of the types of moral hazard conflicts. In addition, our analysis makes it possible to find out which variables control for or incentive each type of moral hazard behavior. Accordingly, we can conclude whether a certain type of moral hazard is pushed or repressed by variables such as the size of banks' equity buffer in excess of the minimum legal requirement or the severity of the regulation reflecting the three Pillars of Basel II.

The empirical exercise focuses on the banking systems of the first 15 members of the European Union (EU15) in the period 2002-9. The sample covers individual commercial banks, cooperatives and saving banks. Our main finding is that empirical results support the hypothesis that EU15 banks engaged in moral hazard behavior during the sample period; in particular, in the type that we call "leveraged moral hazard." The separate analysis of banks with and without capital buffer in excess of the minimum legal requirement suggests that supervision and market discipline were not able to control for moral hazard incentives.

Furthermore, implementing the three Pillars of Basel II in a more severe way does not seem to palliate by and large risk shifting. On the contrary, the larger banks' equity buffer is, the weaker are the incentives to engage in moral hazard behavior. This result suggests that banks that behaved prudently (in their capitalization level) will behave prudently (in increasing the capital ratio when risk grows). Although seemingly obvious, it is a result that gives additional support to the agreement of the Basel Committee of Banking Supervision (2011) to introduce in Basel III a framework that forces banks to hold conservation capital buffers.

The rest of the paper is structured as follows. The taxonomy of moral hazard and the model specification are described in Section 2. Section 3 presents the data description. Section 4 discusses the methodology and empirical results. Section 5 concludes the paper.

2. Taxonomy of moral hazard and model specification.

This section explains the taxonomy of the different types of moral hazard that can characterize the relationship among banks' shareholders, depositors and other debt holders. In

addition, we discuss the model specification to empirically examine the type of moral hazard consistent with banks' behavior.

2.1. Taxonomy of moral hazard.

Equity has the payoff structure of a call option over the value of a firm that is exercised if the value of the assets is larger than the value of the debt claim. Accordingly, losses would be mainly absorbed by creditors, whereas higher risk increases the stockholders' chance to get larger payoffs. Therefore, to maximize the value of equity, banks' shareholders have incentives to increase risk and leverage (Jensen and Meckling 1976) (see Harris and Raviv 1991, Myers 2001 for reviews). As Merton (1977) pointed out in the inaugural paper of the *Journal of Banking and* Finance, those incentives are strengthened if the safety net gives banks the possibility to be subsidized by taxpayers, in particular through the so-called deposit insurance subsidy (Kane 1986, Keeley 1990).

The incentives that banks' shareholders have to increase the amount of risk that they take but do not internalize might give rise to a risk shifting problem. This problem is our research objective; that is, we analyze those situations in which banks' shareholders (debt holders) decrease (increase) the amount of wealth at stake, and, nevertheless, banks' overall risk grows. Yet our aim is not just to determine whether risk is shifted, but also to whom is transferred. In this sense, as Freixas and Rochet (2008: 336), we find it convenient to consider three types of liabilities: equity, deposits and non-deposit debt claims. The latter type of liability includes senior long term debt, subordinated debt and other debenture notes (Gropp and Heider 2010). Note that this category includes deposits from other banks.

In tune with this division of banks' financial structure, equity holders could be transferring risk to depositors, to other debt holders or to both. Depending on the group of agents to which risk is transferred, a different type of moral hazard conflict occurs. Therefore, the complete study of these potential problems of risk shifting provides a taxonomy of the moral hazard relations between equity and debt holders.

Note that a condition that our method requires for moral hazard behavior to take place is that risk-increasing changes are positively related to decreasing changes of the equity-to-assets ratio, i.e., shareholders have less at stake, but their banks become riskier. If this condition holds, we propose a classification that includes four different types of moral hazard conflicts. The first type is the "double-sided moral hazard." In this case, risk shifts from shareholders to both depositors and other debt holders. Accordingly, banks that reduce their equity-to-assets ratio and increase the deposits-to-assets ratio and the ratio of other funding

to assets are expected to increase their overall risk. We have called the second type "leveraged moral hazard," where risk shifts from shareholders to non-depository debt holders. Hence, changes that increase risk and reduce the equity-to-assets ratio will be jointly observed with changes that increase the ratio of other funding to assets. As regards the deposits-to-assets ratio, it either decreases or has a non-significant relation with risk changes. The third type is the "deposit-based moral hazard." Under this version, shareholders transfer risk to depositors. This entails that increasing-risk changes follow reductions of the equity-to-assets ratio and increases of the deposits-to-assets ratio, whereas the ratio of other funding to assets either decreases or is insignificant. The fourth type, the "unclassified moral hazard," refers to a situation in which the group of agents to whom risk is shifted is unknown. Specifically, banks that reduce their equity-to-assets ratio increase their overall risk, but their deposits and other funding ratios do not change in a significant way.

To complete our classification, moral hazard is not observed when banks increase their capital-to-assets ratio and their overall risk, but the deposits-to-asset ratio and the ratio of other funding to assets do not change in a significant way, or both (or one) of them increase(s). For other situations in which both the capital ratio and overall risk increase, our method does not allow us to obtain clear conclusions about whether banks engage or not in moral hazard behavior.

2.2. Model specification.

Building on the pioneering papers by Peltzman (1970), Marcus (1983), Wall and Peterson (1988), and Shrieves and Dahl (1992), we take into account that the observed changes in risk and funding sources have two components. The endogenous or discretionary one reflects banks' decision, whereas the exogenous component results from unanticipated and randomly distributed events such as an unexpected shock.

Let FS be the ratio of any of the three funding sources considered to total assets. A partial adjustment model is used to capture the endogenous component of the changes in risk and FS (Marcus 1983, Shrieves and Dahl 1992). Accordingly, for bank *j* and period *t*, the discretionary adjustments in risk (FS) are proportional to the difference between *j*'s target risk (FS) value and the value of risk (FS) in *t-1*; that is,

$$\Delta RISK_{j,t}^{M} = \alpha \cdot \left(RISK_{j,t}^{*} - RISK_{j,t-1} \right),$$

$$\Delta FS_{j,t}^{M} = \beta \cdot \left(FS_{j,t}^{*} - FS_{j,t-1} \right),$$

where, for bank *j* and period *t*, $\Delta RISK_{j,t}^{M}$ and $\Delta FS_{j,t}^{M}$ are the endogenous components of the observed change in risk and FS respectively, $RISK_{j,t}^{*}$ and $FS_{j,t}^{*}$ are the target risk and FS values respectively, and $RISK_{j,t}$ and $FS_{j,t}$ are the observed risk and FS values respectively. The coefficients α and β are proportionality factors. Note that they reflect the speed of adjustment of risk and FS respectively; that is, the speed to which observed values converge to target values.

We take also into account that changes in banks' risk and in their funding sources take place in a simultaneous and interrelated way. Hence, the model to be estimated is a simultaneous equation model where, for bank *j* and period *t*, changes in risk depend on changes in FS, and vice versa.[1] Hence, for the funding source associated to FS, our benchmark model is,

$$\begin{aligned} \Delta RISK_{j,t} &= \alpha \cdot \left(RISK_{j,t}^{*} - RISK_{j,t-1}\right) + u_{j,t} \\ \Delta FS_{j,t} &= \beta \cdot \left(FS_{j,t}^{*} - FS_{j,t-1}\right) + e_{j,t} \end{aligned} \qquad [1]$$

where $u_{j,t}$ and $e_{j,t}$ are error terms standing for the exogenous component of the changes in risk and FS respectively. These terms are assumed to be freely correlated, but independent over time and across banks.

Model [1] is used to extend the standard analysis about the relation between changes in risk and capital (Shrieves and Dahl 1992). Specifically, our aim is to include in the analysis additional funding sources, what allows us to study the existence and typology of moral hazard conflicts in the banking sector. In this sense, for bank *j* and period *t*, $E_{j,t}$ stands for the equity-to-assets ratio, $D_{j,t}$ for the deposits-to-assets ratio, and $OF_{j,t}$ for the ratio of non-depository funding sources to total assets. These three types of liabilities cover the whole financial structure of a bank. Indeed, equity, deposits and other funding complement each other in the task of financing banks' assets, so that, by definition, $\Delta E_{j,t} + \Delta D_{j,t} + \Delta OF_{j,t} \equiv 1$. For our empirical analysis to be consistent with this identity, [1] is used to separately analyze the relationship between changes in risk and in each of these funding sources; that is, three equation systems like [1] are to be estimated, one per each of the funding sources considered.

[1] Note that we analyze the relationship between changes in risk and funding sources, rather than the relationship between the levels of these variables. The main reason for using changes instead of levels is that a negative cross-sectional correlation between the levels of risk and funding sources could result from the distribution of risk preferences and not from moral hazard incentives (Shrieves and Dahl 1992, Heid et al. 2004).

For this analysis to be sound, the speed to which observed risk values converge to target risk values (i.e., α in [1]) must be about the same in these three equation systems. Satisfying this requirement would indicate that the relation between changes in risk, $\Delta RISK_{j,t}$, and the target risk level, $RISK^{*}_{j,t}$, does not depend in a crucial way on the funding source that we consider. If this is the case, separately analyzing the funding sources (in order to be consistent with the identity $\Delta E_{j,t} + \Delta D_{j,t} + \Delta OF_{j,t} \equiv 1$) is not expected to have a substantial impact on our results.

To measure banks' risk level, we use the Z-score. It provides an overall risk measure that reflects banks' probability of failure, i.e., how close to insolvency they are (Altman 1968). The Z-score of bank *j* in period *t*, $ZS_{j,t}$, is defined as follows,

$$ZS_{j,t} = \frac{E_{j,t} + ROA_{j,t}}{\sigma_{j}^{ROA}},$$

where $ROA_{j,t}$ is the return on total assets of bank *j* at period *t*; and σ_{j}^{ROA} is bank *j*'s standard deviation of the rate of return on total assets over the sample period. The Z-score increases in capitalization ($E_{j,t}$) and profitability ($ROA_{j,t}$) and decreases in the instability of profits (σ_{j}^{ROA}). Thus, the Z-score is an indicator of financial stability at the firm level that inversely proxies a bank's probability of failure; that is, a higher Z-score indicates more bank stability and larger distance to default.

Target risk and target levels of the three funding sources considered are not observable. Therefore, we assume that those target levels depend linearly upon a set of explanatory variables and a stochastic disturbance term. In tune with standard practice in the analysis of the simultaneous relation between changes in risk and capital, the explanatory variables that we consider are size, profitability and capital buffer (Shrieves and Dahl 1992, Jacques and Nigro 1997, Aggarwal and Jacques 2001, Rime 2001, Bichsel and Blum 2004, Heid at al. 2004, Jokipii and Milne 2009). We also include a control variable that captures the generosity of deposit insurance schemes as well as regulatory and supervisory variables that reflect the three pillars of Basel II.

Size affects the target level of risk and the target financial structure because it is a key factor of bank diversification and in the too-big-to-fail doctrine. In addition, size is relevant to define banks' investment opportunity set, the capacity to access financial markets, or the capacity to raise funds through deposits. To proxy bank *j*' size at period *t*, we use the natural log of total assets, $SIZE_{j,t}$.

Profitability of bank *j* in period *t* is captured by the return on assets, $ROA_{j,t}$. Profits are relevant for target risk because they help to define banks' viability; indeed, ROA and its variability are included in the definition itself of the probability of failure as measured by the Z-score. As regards the relation between profits and funding decisions, the pecking order theory establishes that retained earnings, which have no issuing costs or information problems associated, are the preferred funding option (Myers and Majluf 1984). Therefore, profits are at the core of the decision concerning banks' target financial structure.

In relation to target risk, maintaining a capital buffer to prevent a breach of capital requirements is a sign of bank solvency and stability. Indeed, it allows a banking institution to absorb losses on its assets and remain solvent, thereby protecting its creditors (Brunnermeir et al. 2009). The relevance of capital buffer for target financial structure lies in the fact that, in principle, banks have decision-making capacity over their funding sources just if capital is above regulatory requirements. Bank *j*'s buffer in period *t*, $BUF_{j,t}$, is defined as the difference between *j*'s equity-to-assets ratio in period *t* and the regulatory capital ratio at *t* in *j*'s country.

Deposit insurance schemes have been at the heart of the standard analysis of moral hazard in the banking industry (Merton 1977, Keele 1990); especially, because they reduce depositors' incentives to monitor banks and can imply shifting risk from shareholders to depositors and taxpayers. Accordingly, to capture the generosity of the deposit insurance scheme, our analysis includes $DII_{j,t}$. Following Demirgüç-Kunt and Detagriache (2002), $DII_{j,t}$ is the result of summing up the values assigned to the answers to eight questions. As a result, the larger $DII_{j,t}$ is the more generous is the deposit insurance protecting bank *j*'s depositors.[2]

The regulatory and supervisory variables of concern in this study are related to the three pillars of Basell II. Thus, for bank *j*'s country at period *t*: capital requirements, $CAP_{j,t}$, captures Pillar 1; official supervisory power, $SUPERV_{j,t}$, reflects Pillar 2; and market discipline, proxied by private monitoring, $PRIMON_{j,t}$, is associated to Pillar 3. In addition, we

[2] The questions used to construct $DII_{j,t}$ are the following (in parentheses the values assigned to the possible answers): [1] Is there coinsurance? (No = 2, yes = 1, implicit = 0); [2] Explicit coverage limit? (Coverage limit divided by gross domestic product per capita, implicit = 0); [3] Are foreign currency deposits covered? (Yes = 2, no = 1, implicit = 0); [4] Are interbank deposits covered? (Yes = 2, no = 1, implicit = 0); [5] Type of fund? (Funded = 2, unfunded = 1, implicit = 0); [6] Source of funding? (Government = 3, joint = 2, private = 1, implicit = 0); [7] Fund management? (Public = 3, joint = 2, private = 1, implicit = 0); and [8] Membership? (Compulsory = 2, voluntary = 1, implicit = 0).

include a control variable that proxies restrictions on banks' activities, $REST_{j,t}$. To build these four variables, we follow Barth et al. (2001, 2008).[3] The larger the value of any of them is, the more strict is the regulatory or supervisory aspect which that variable measures.

According to the discussion above, the model to be estimated is obtained by just substituting a polynomial that linearly depend on the set of explanatory variables considered

[3] To construct $CAP_{j,t}$, the following questions are used (in parentheses the values assigned to the possible answers): [1] Is the minimum required capital-asset ratio risk-weighted in line with Basle guidelines? (Yes = 1, no = 0); [2] Does the minimum ratio vary as a function of market risk? (Yes = 1, no = 0); [3-5] Before minimum capital adequacy is determined, which items are deducted from capital: (a) Market value of loan losses (Yes = 1, no = 0), (b) Unrealized securities losses (Yes = 1, no = 0), (c) Unrealized foreign exchange losses (Yes = 1, no = 0); [6] Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (Yes = 1, no = 0); [7] Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? (No = 1, yes = 0); and [8] Can initial disbursement of capital be done with borrowed funds? (No = 1, yes = 0). For $SUPERV_{j,t}$: [1] Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank? (Yes = 1, no = 0); [2] Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud, or insider abuse? (Yes = 1, no = 0); [3] Can supervisors take legal action against external auditors for negligence? (Yes = 1, no = 0); [4] Can the supervisory authority force a bank to change its internal organizational structure? (Yes = 1, no = 0); [5] Are off-balance sheet items disclosed to supervisors? (Yes = 1, no = 0); [6] Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? (Yes = 1, no = 0); [7-9] Can the supervisory agency suspend director's decision to distribute: (a) Dividends (Yes = 1, no = 0), (b) Bonuses (Yes = 1, no = 0), (c) Management fees (Yes = 1, no = 0); [10] Can the supervisory agency supersede bank shareholder rights and declare bank insolvent? (Yes = 1, no = 0); [11] Does banking law allow supervisory agency or any other government agency (other than court) to suspend some or all ownership rights of a problem bank? (Yes = 1, no = 0); [12-14] Can supervisory agency or any other government agency do the following?: (a) Supersede shareholder rights (Yes = 1, no = 0), (b) Remove and replace management (Yes = 1, no = 0), (c) Remove and replace directors (Yes = 1, no = 0); [15] Frequency of onsite inspections conducted in large and medium size banks (Annually = 1, every two years = 0); [16] Does the law establish pre-determined levels of solvency deterioration which forces automatic actions such as intervention? (Yes = 1, no = 0); [17] Must infraction of any prudential regulation found by a supervisor be reported? (Yes = 1, no = 0); and [18] Any mandatory actions in these cases? (Yes = 1, no = 0). For $PRIMON_{j,t}$: [1] Is subordinated debt allowable (required) as part of capital? (Yes = 1, no = 0); [2] Are consolidated accounts covering bank and any non-bank financial subsidiaries required? (Yes = 1, no = 0); [3] Are off-balance sheet items disclosed to public? (Yes = 1, no = 0); [4] Must banks disclose risk management procedures to public? (Yes = 1, no = 0); [5] Are directors legally liable for erroneous/misleading information? (Yes = 1, no = 0); [6] Is an external audit compulsory? (Yes = 1, no = 0); and [7] Does income statement contain accrued but unpaid interest/principal while loan is non-performing? (No = 1, yes = 0). For $REST_{j,t}$: [1-3] Restrictions on trading with (a) Securities (Prohibited = 4, restricted = 3, permitted = 2, unrestricted = 1), (b) Insurance (Prohibited = 4, restricted = 3, permitted = 2, unrestricted = 1), (c) Real estate(Prohibited = 4, restricted = 3, permitted = 2, unrestricted = 1); and [4] Regulatory restrictiveness of bank ownership of nonfinancial firms (Prohibited = 4, restricted = 3, permitted = 2, unrestricted = 1).

plus a stochastic disturbance term for the target risk and FS values in [1]. The resulting model is formed by three systems of two simultaneous equations. The first system refers to changes in risk and equity:

$$\begin{aligned}\Delta ZS_{j,t} &= \alpha_0^E + \alpha_1^E \Delta E_{j,t} + \alpha_2^E SIZE_{j,t} + \alpha_3^E ROA_{j,t} + \alpha_4^E BUF_{j,t} + \alpha_5^E DII_{j,t} + \alpha_6^E CAP_{j,t} \\ &\quad + \alpha_7^E SUPERV_{j,t} + \alpha_8^E PRIMON_{j,t} + \alpha_9^E REST_{j,t} - \alpha_{10}^E ZS_{j,t-1} + u_{j,t}^E \\ \Delta E_{j,t} &= \beta_0^E + \beta_1^E \cdot \Delta ZS_{j,t} + \beta_2^E SIZE_{j,t} + \beta_3^E ROA_{j,t} + \beta_4^E BUF_{j,t} + \beta_5^E DII_{j,t} + \beta_6^E CAP_{j,t} \\ &\quad + \beta_7^E SUPERV_{j,t} + \beta_8^E PRIMON_{j,t} + \beta_9^E REST_{j,t} - \beta_{10}^E E_{j,t-1} + e_{j,t}^E\end{aligned} \qquad [2i]$$

where $u_{j,t}^E$ and $e_{j,t}^E$ are i.i.d. error terms.

The second equation system relates risk and deposits changes:

$$\begin{aligned}\Delta ZS_{j,t} &= \alpha_0^D + \alpha_1^D \Delta D_{j,t} + \alpha_2^D SIZE_{j,t} + \alpha_3^D ROA_{j,t} + \alpha_4^D BUF_{j,t} + \alpha_5^D DII_{j,t} + \alpha_6^D CAP_{j,t} \\ &\quad + \alpha_7^D SUPERV_{j,t} + \alpha_8^D PRIMON_{j,t} + \alpha_9^D REST_{j,t} - \alpha_{10}^D ZS_{j,t-1} + u_{j,t}^D \\ \Delta D_{j,t} &= \beta_0^D + \beta_1^D \cdot \Delta ZS_{j,t} + \beta_2^D SIZE_{j,t} + \beta_3^D ROA_{j,t} + \beta_4^D BUF_{j,t} + \beta_5^D DII_{j,t} + \beta_6^D CAP_{j,t} \\ &\quad + \beta_7^D SUPERV_{j,t} + \beta_8^D PRIMON_{j,t} + \beta_9^D REST_{j,t} - \beta_{10}^D D_{j,t-1} + e_{j,t}^D\end{aligned} \qquad [2ii]$$

where $u_{j,t}^D$ and $e_{j,t}^D$ are i.i.d. error terms.

The last system of simultaneous equations reflects the relationship between adjustments in risk and other funding:

$$\begin{aligned}\Delta ZS_{j,t} &= \alpha_0^{OF} + \alpha_1^{OF} \Delta OF_{j,t} + \alpha_2^{OF} SIZE_{j,t} + \alpha_3^{OF} ROA_{j,t} + \alpha_4^{OF} BUF_{j,t} + \alpha_5^{OF} DII_{j,t} + \alpha_6^{OF} CAP_{j,t} \\ &\quad + \alpha_7^{OF} SUPERV_{j,t} + \alpha_8^{OF} PRIMON_{j,t} + \alpha_9^{OF} REST_{j,t} - \alpha_{10}^{OF} ZS_{j,t-1} + u_{j,t}^{OF} \\ \Delta OF_{j,t} &= \beta_0^{OF} + \beta_1^{OF} \Delta ZS_{j,t} + \beta_2^{OF} SIZE_{j,t} + \beta_3^{OF} ROA_{j,t} + \beta_4^{OF} BUF_{j,t} + \beta_5^{OF} DII_{j,t} + \beta_6^{OF} CAP_{j,t} \\ &\quad + \beta_7^{OF} SUPERV_{j,t} + \beta_8^{OF} PRIMON_{j,t} + \beta_9^{OF} REST_{j,t} - \beta_{10}^{OF} OF_{j,t-1} + e_{j,t}^{OF}\end{aligned} \qquad [2iii]$$

where $u_{j,t}^{OF}$ and $e_{j,t}^{OF}$ are also i.i.d. error terms.

Recall that this specification requires the speed of adjustment of risk to be close in the three systems above, i.e. α_{10}^E, α_{10}^D and α_{10}^{OF} must have similar values.[4]

3. Data description.

Our sample consists of EU15 commercial banks, cooperative and saving banks in the period 2002-2009. The set of countries includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom.

[4] Note that these coefficients are equivalent to α in [1].

We collect information from several sources. All bank-specific data were obtained from the annual financial statements of banks provided by Fitch-IBCA's Bankscope database of Bureau van Dijk. To ensure an adequate level of reliability, data from Bankscope requires considerable editing. Following the reasons given by Bonin et al. (2005), we focus on unconsolidated accounting data to the extent possible. We use reports prepared under International Accounting (or International Financial Reporting) Standards when available; otherwise, reports following Generally Accepted Accounting Principles are used. Banks that have missing, negative or zero values for the relevant variables of our empirical analysis are excluded. To have a sound measure of σ_j^{ROA}, banks whose data covers less than a four-year period have also been deleted. After cleaning the database, the sample has been reduced to 16.378 observations.

In addition, for any sample year, our analysis just considers banks that increase their overall risk. Note in this regard that our taxonomy of moral hazard relies on the signs of the relations between changes in risk and changes in equity, deposits or other funding. Let us focus, for instance, on the relation between changes in risk and equity in bank *j*. If our sample is not restricted to risk-increasing banks and we find that changes in risk and equity in *j* are negatively related, there are two possible explanations. The first one is that *j* has decreased equity and has increased risk. The second one is that *j* has increased equity and has decreased risk. Just the first explanation is consistent with risk shifting: shareholders have less at stake and bank *j* becomes riskier, so that risk is being transferred to a third party. The second explanation cannot be considered a case of moral hazard, since *j* reduces its risk position. Therefore, to conclude whether our results are consistent with moral hazard behavior, our sample is restricted to risk-increasing banks. This type of banks amounts to 44 percent of the cleaned sample, i.e., 7,171 observations.

Information about deposit insurance schemes is taken from the World Bank's "Deposit Insurance around the World Dataset", elaborated by Demirgüç-Kunt and Sobaci (2001) and Demirgüç-Kunt et al. (2005). Data concerning regulation and supervision is taken from the World Bank database developed by Barth et al. (2001) and updated by Barth et al. (2004, 2008).[5]

[5] The "Deposit Insurance around the World Dataset" is a cross-country database that provides information on deposit insurance schemes up to 2003. The bank regulation and supervision database of the World Bank just covers three points in time, 1998-2000, 2002 and 2005-2006. Consequently, we have to work under the assumption that the scores of variables $DII_{j,t}$, $CAP_{j,t}$, $SUPERV_{j,t}$, $PRIMON_{j,t}$, and $REST_{j,t}$ remain constant in some windows of time. More precisely, $DII_{j,t}$ is assumed to be constant since 2003. For the other four variables, we use data referring to 2002 for 2003-2004, and information as of

Table 1 displays the descriptive statistics of the variables used in the econometric analysis. For a given period *t*, changes in variables are calculated as the difference between the value in *t* and the value at *t-1*.

Table 1

4. Methodology and empirical results.

This section presents the results obtained in the analysis of the type of moral hazard in which EU15 banks engaged in 2002-2009. For the sake of clarity, before proceeding to discuss those results, we show how our empirical analysis allows us to identify the different types of moral hazard behavior included in our taxonomy.

4.1. The moral hazard taxonomy in empirical terms.

Overall, the type of moral hazard depends on the signs of the coefficients of $\Delta E_{j,t}$, $\Delta D_{j,t}$ $OF_{j,t}$ in the first equation of [2i-2iii], i.e. α_1^E, α_1^D and α_1^{OF}. According to those signs, Table 2 shows the taxonomy of moral hazard problems. Recall that the Z-score is an inverse measure of the probability of bankruptcy, so that the larger $\Delta ZS_{j,t}$ is the lower is the risk level of bank *j* in *t*. This implies that we focus on Z-score-decreasing banks, i.e. risk-increasing banks.

Table 2

According to Table 2, the taxonomy of moral hazard entails the following estimated relationships for risk-increasing banks:

(1) Double-sided moral hazard: The equity-to-assets ratio decreases ($\alpha_1^E > 0$), but the deposits-to-assets ratio and the ratio of other funding to assets increase ($\alpha_1^D < 0$ and $\alpha_1^{OF} < 0$).

(2) Leveraged moral hazard: The equity-to-assets ratio decreases ($\alpha_1^E > 0$), but the ratio of other funding to assets increases ($\alpha_1^{OF} < 0$). Changes in the deposits-to-assets ratio are positive ($\alpha_1^D > 0$) or are not statistically significant (n.s.).

2005-6 for the period 2005-2009. This shortcoming is not expected to have a significant impact on our results. Indeed, similar assumptions are common in studies that use the same databases (e.g., Demirgüç-Kunt et al. 2004, Fernandez and Gonzalez 2005, Beck et al. 2006, Pasiouras et al. 2008).

(3) Deposit-based moral hazard: The equity-to-assets ratio decreases ($\alpha_1^E > 0$), but the deposits-to-assets ratio increases ($\alpha_1^D < 0$). Changes in the ratio of other funding to assets are positive ($\alpha_1^{OF} > 0$) or are not statistically significant.

(4) Unclassified moral hazard: The equity-to-assets ratio decreases ($\alpha_1^E > 0$), but changes in the deposit and other funding ratios do not have a statistically significant effect over risk.

(5) Not moral hazard: The equity-to-assets ratio increases ($\alpha_1^E < 0$), whereas changes in the deposit and other funding ratios are not statistically significant, or one of them ($\alpha_1^D > 0$ and $\gamma_{1,1}$ is n.s., or α_1^D is n.s. and $\alpha_1^{OF} > 0$) or the two of them ($\alpha_1^D > 0$ and $\alpha_1^{OF} > 0$) are positively related to risk.

(6) Unclear situations: Other possible results cannot be clearly characterized as a type of moral hazard behavior by our method.

To estimate [2i-2iii], we use the three stage least square estimator. Thus, besides taking into account endogeneity, cross-equation correlation of the disturbance terms is exploited, so that the results are asymptotically more efficient than those generated by 2SLS. As Shrieves and Dahl (1992), Jacques and Nigro (1997), Aggarwal and Jacques (2201) or Rime (2001), we pool the cross-sectional data over all the sample period. In addition, to control for time and country specific effects, we introduce a time trend and dummy variables for country in [2i-2iii]. For the sake of clarity, these variables are not explicitly shown in the model.

4.2. Results.

The goal of this paper is to study risk shifting from banks' shareholders to debt holders in the EU15. To meet this aim, we estimate [2i-2iii] using data that refers to risk-increasing EU15 banks in 2002-09. The results obtained are displayed in Table 3.

A key assumption of our analysis is that changes in risk and in the funding sources are simultaneous. To check for this assumption, we test the null that these changes are not mutually related. To reject this hypothesis, the pairs of coefficients α_1^E and β_1^E, α_1^D and β_1^D, and α_1^{OF} and β_1^{OF} in [2i-2iii] must be significantly different from zero. Since these coefficients are significant in all the regressions performed, the results seem to provide support to the simultaneity of changes in risk and in the funding sources considered.

Let us focus now on the speed of adjustment in risk, i.e., the parameters α_{10}^E, α_{10}^D and α_{10}^{OF} in [2i-2iii]. Panel A of Table 3 shows that the speeds of adjustment are barely the same for the three funding sources considered. Specifically, these speeds are -0.0005, -0.0008 and -

0.0008 for the decisions that refer to $\Delta E_{j,t}$, $\Delta D_{j,t}$ and $OF_{j,t}$ respectively. This suggests that the relation between changes in risk and in the target risk value is similar regardless of the funding source taken, what gives support to our model specification.

A first requirement of moral hazard is that decreases in the capital-to-assets ratio are followed by increases in risk. Since the coefficient of $\Delta E_{j,t}$ is significant and positive in Panel A of Table 3, this requirement is satisfied.[6] In tune with our taxonomy of moral hazard, the concrete type of risk shifting in which risk-increasing banks engaged is given by the coefficients of $\Delta D_{j,t}$ and $\Delta OF_{j,t}$ in the first equations of [2ii-2iii]. The positive coefficient of $\Delta D_{j,t}$ and the negative one of $\Delta OF_{j,t}$ in Panel A of Table 3 suggest that banks transferred risk to non-depository debt holders. That is, banks seem to have engaged in leveraged moral hazard.

Table 3

To obtain further conclusions about the effects of banking supervision, market discipline and the current economic crisis on risk shifting, we also analyze the type of moral hazard that characterizes some subsamples. As Shrieves and Dahl (1992), we split the sample into risk-increasing banks with and without capital buffer. If supervision and market discipline are effective in controlling moral hazard incentives, banks included in these two subsamples are expected not to engage in moral hazard practices. Specifically, we expect supervision to prevent risk-increasing banks without buffer from shifting risk to debt holders, whether depositors or non-depository investors. However, authorities are expected to relax the monitoring of risk shifting by banks with buffer. For these banks, the question is whether market discipline is able to control for moral hazard incentives.

Results of this additional analysis are presented in Table 4. According to Panel A of this table, the coefficients of $\Delta E_{j,t}$ are significant and positive for banks with and without buffer, the coefficients of $\Delta OF_{j,t}$ are significant and negative for banks with and without buffer, and the coefficients of $\Delta D_{j,t}$ are not significant for banks without buffer, but positive and significant for banks with buffer. Hence, banks with and without buffer seemed also to engage in leveraged moral hazard; that is, splitting the sample in these two groups of banks does not have any effect on the type of moral hazard observed. This result suggests that supervision failed to control for risk shifting in EU15 during the sample period. It also entails that market

[6] Recall that the Z-score is an inverse measure of a bank's probability of failure.

discipline did not seem to mitigate or change the incentives to engage in moral hazard behavior.

Table 4

In addition, we focus on risk-increasing banks' moral hazard behavior in the pre-crisis period 2002-2007.[7] The main insight that we get from restricting the sample to this period is that risk-increasing banks engaged in leveraged moral hazard also in the pre-crisis period. Furthermore, the type of moral hazard observed does not change when banks are divided into banking institutions with and without buffer. The empirical evidence giving support to the existence of risk shifting during the pre-crisis period might help to explain the distrust of European banks during the crisis and the collapse of the European interbank system even before the sovereign debt crisis started.

Table 5 summarizes the type of moral hazard behavior followed by the banks in each of the subsamples considered.

Tables 5

Once we know the type of moral hazard that characterizes banks' behavior in the sample period, we can analyze which variables contribute to motivate or demotivate risk shifting. This information is provided by Panels B in Tables 3 and 4. Before proceeding, a brief explanation about how to read this information is worthwhile. Panels B in Tables 3 and 4 show how the variables defining the target values of the three funding sources considered affect, in a simultaneous framework, the changes in these funding sources. Let $Var_{j,t}$ be one of these variables. Recall also that each type of moral hazard requires that the ratios of the three funding sources considered change in a particular way. For instance, double-sided moral hazard requires $\Delta E_{j,t}$ to decrease, and $\Delta D_{j,t}$ and $\Delta OF_{j,t}$ to increase. Therefore, $Var_{j,t}$ would favor this type of moral hazard if it caused these effects. In terms of the coefficients of our model, this would entail that β_2^E is significant and negative in [2i], whereas β_2^D and β_2^{OF} are significant and positive in [2ii-2iii]. On the contrary, $Var_{j,t}$ would contribute to control for moral hazard incentives if β_2^E is significant and positive, whereas β_2^D and β_2^{OF} are either significant and negative or non-significant. There are also situations where the effect of a variable like $Var_{j,t}$ over moral hazard might be unclear. They occur if β_2^E, β_2^D or β_2^{OF} are significant and

[7] Results are available upon request.

positive; or if β_2^E and β_2^D (β_2^{OF}) are significant and positive, whereas β_2^{OF} (β_2^D) is insignificant or significant and negative.

Table 6 shows the effect on moral hazard incentives of the set of variables used to define the target values of the three funding sources considered. "Yes" ("No") indicates that the corresponding variable contributes (does not contribute) to moral hazard. Unclear situations are represented by a question mark. Finally, "n.s." stands for those cases where β_2^E is not statistically significant, so that the basic condition to start discussing the possibility of moral hazard behavior does not hold.

Tables 6

Table 6 suggests some stylized facts. First, very few variables seem to contribute overall to control for moral hazard incentives. This is extreme for banks without buffer, where just $CAP_{j,t}$ mitigates moral hazard. For banks with buffer, a set of three variables ($BUF_{j,t}$, $DII_{j,t}$ and $SUPERV_{j,t}$) affect negatively moral hazard behavior.

Second, the variables standing for the three Pillars of Basel II seem to have a very limited capacity to weaken moral hazard incentives. Just $SUPERV_{j,t}$ in the sample of banks with buffer and $CAP_{j,t}$ in the sample of banks without buffer seem to have the capacity of doing so. Furthermore, for the three samples in Table 6, the more severe private monitoring is, the larger seem to be the incentives to engage in moral hazard behavior.

Third, and related to the last point, $ROA_{j,t}$ and $PRIMON_{j,t}$ favor moral hazard behavior for both banks with and without buffer. This suggests that being profitable and having strict private monitoring rules seem to be powerful signals of strength that allow banks (even with no equity buffer) to transfer risk to debt holders; specifically, to non-depository debt holders.

Fourth, for both the whole sample and the subsample formed by banks with buffer, the larger the capital buffer is, the lower are banks' incentives for risk shifting. This result strengthens the rules in Basel III to promote the build-up of capital buffers above the minimum legal requirement. The main argument given by the Basel Committee on Banking Supervision (2011: 6) to agree on these rules is the need to address a market failure: at the onset of the crisis, to avoid sending a signal of weakness, "a number of banks continued to make large distributions in the form of dividends, share buy backs and generous compensation payments even though their individual condition and the outlook for the sector were deteriorating." The

negative relation between the buffer size and moral hazard incentives found by our analysis provides an additional reason for the conservative buffer promoted by Basel III.

To a certain extent, the observed relation between capital buffers and risk shifting qualifies the conclusion above about the effects of market discipline on moral hazard. Recall in this regard that the type of moral hazard found in the subsample of banks with buffer is the same that that in the whole sample and in the subsample of banks without buffer. This similarity has led us to conclude that market discipline seems unable to mitigate moral hazard behavior. However, no rule forced banks to hold a capital buffer up to Basel III; that is, banks held a capital buffer, if they did, because of private incentives, such as adjustment and bankruptcy costs avoidance (Fonseca and Gonzalez 2010). Given that $BUF_{j,t}$ seems to demotivate moral hazard practices according to our results, it seems that those private incentives that lead banks to have a capital buffer control also for banks' incentives to engage in moral hazard behavior.

The idea that “good” banks (because of their capitalization level) will behave in a “good”way (in risk shifting) is also consistent with previous findings. In particular, those that have pointed out that banks with large capital buffers increased their capital ratio relatively more as a result of the introduction of risk-based capital standards (Haubrich and Wachtel 1993, Jacques and Nigro 1997).

Fifth, returning to the Pillars of Basel II, a more strict supervision does not weaken the incentives of banks without buffer to engage in moral hazard practices, although these banks are expected to be those that are closely monitored by supervisory authorities. This result is aligned with the conclusion pointed out above that there seem to have been flaws in the EU15 supervisory architecture that have not stopped risk shifting.

Sixth, flaws in supervision have even far-reaching implications if risk is finally transferred to taxpayers. Note in this sense that the more generous the deposit insurance scheme is, the larger are the incentives of banks without buffer to engage in moral hazard. Moreover, as Table 6 shows, the generosity of deposit insurance schemes in EU15 countries favored deposit-based moral hazard among banks without buffer. This implies that the generosity of these schemes motivated shareholders to transfer risk to depositors, who, in turn, shifted risk to taxpayers. This effect of insufficient supervision and generous deposit insurance on risk shifting is consistent with Demirgüç-Kunt and Detragiache (2002). They conclude that opportunities for moral hazard are more limited when, due to an adequate institutional framework, prudential regulation and supervision offset the adverse incentives created by deposit insurance.

Seventh, as regards its effect on moral hazard, $SIZE_{j,t}$ is just relevant for banks without buffer. Specifically, larger banks without buffer seem to engage in risk shifting at a relatively higher scale.

Table 6 does not only show whether the variables defining $FS^{*}_{j,t}$ contribute to moral hazard, but also to which type of moral hazard they contribute. Nevertheless, this information can be rearranged as in Table 7. This table clearly shows that the large majority of variables that contribute to moral hazard behavior motivate the leveraged type. Indeed, just $DII_{j,t}$ favor other types. This evidence provides an explanation of why the leveraged type of moral hazard is observed in the empirical analysis of all the samples considered.

Table 7

Turning our attention to how the variables helping to define the target values of our analysis affect target risk, recall that Panel A of Table 3 shows results that refer to simultaneous decisions about changes in risk and in the three funding sources considered. The overall results for EU15 banks suggest that larger banks pursue higher target risk levels. In addition, more stringent capital requirements seem to reinforce the substitutive nature that leverage and risk can have, i.e., reductions in leverage induced by regulatory increases in capital seem to lead to more risk (Koehn and Santomero 1980, Kim and Santomero 1988). Finally, more severe supervision does not reduce target risk level, whereas more generous deposit insurances and more demanding private supervision do.

4. Conclusion.

Equity can be thought of as a call option over firm value. This entails that shareholders' payoff distribution is truncated on the negative side, because, in the event of failure, debt holders will shoulder most of the losses. Accordingly, shareholders will prefer assets that are risky but have some probability of getting large returns.

This brief description synthesizes the incentive scheme underlying the moral hazard conflict between equity and debt holders. To analyze this conflict in the banking industry, we have divided banks' financial structure into three types of liabilities: equity, deposits and other funding. If risk shifting occurs, this division allows us to determine the group of debt holders to which shareholders are transferring risk. Then, using as a classifying tool whether risk is transferred to depositors or non-depository debt holders, a taxonomy of the possible types of moral hazard is obtained. This classification includes four kinds of moral hazard: double-sided

moral hazard (risk is shifted to both depositors and non-depository debt holders), leveraged moral hazard (risk is shifted to non-depository debt holders), deposit-based moral hazard (risk is shifted to depositors) and unclassified moral hazard (the group of debt-holders to which risk is shifted is uncertain).

This paper has empirically studied the type of moral hazard present in EU15 during 2002-2009. We have also tested whether there are any differences in the moral hazard behavior of banks with and without buffer. Finally, the pre-crisis period 2002-2007 has been analyzed in order to shed some light on whether risk shifting shares any responsibility in the current financial crisis. Our results suggest that risk-increasing EU15 banks engaged in leveraged moral hazard behavior regardless of the sample used.

If supervisory authorities fulfill their task adequately, risk-increasing banks without buffer are expected to not have the opportunity to engage in risk shifting practices. Since our empirical analysis indicates that banks followed these practices, there seem to have been flaws in the EU15 supervisory governance. Similarly, finding that moral hazard was present in banks' behavior in the pre-crisis period helps to explain the financial crisis: banks' shareholders were not taking on the risk level assumed, so that banks' financial structure did not reflect adequately the level of risk taking. Thus, a time bomb was being built behind banks' financial structure.

Our analysis allows us also to determine whether the variables that define the target values of our study favor or hamper moral hazard. In this sense, the three Pillars of Basel II have overall a limited capacity to weaken moral hazard incentives. Indeed, private monitoring even favor risk shifting. Nevertheless, the incentives that lead banks to have a capital buffer above the legal minimum motivate banks to not transfer risk to debt holders. Accordingly, the new regulation in Basel III that promotes the build-up of conservative buffers could help to mitigate risk shifting.

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Tables

Table 1. Summary statistics				
Variable	**Mean**	**SD**	**Min**	**Max**
$\Delta ZS_{j,t}$	0.919	0.097	0.063	1.000
$\Delta E_{j,t}$	0.951	0.082	0.236	1.743
$\Delta D_{j,t}$	0.998	0.107	0.016	1.946
$\Delta OF_{j,t}$	1.030	0.199	0.036	1.999
$ZS_{j,t}$	33.001	22.343	0.190	157.409
$E_{j,t}$	0.076	0.031	0.032	0.190
$D_{j,t}$	0.647	0.194	0.003	0.959
$OF_{j,t}$	0.278	0.191	0.005	0.961
$SIZE_{j,t}$	13.732	1.627	8.780	20.814
$ROA_{j,t}$	0.005	0.008	-0.062	0.070
$BUF_{j,t}$	-0.004	0.031	-0.048	0.110
$DII_{j,t}$	1.583	1.415	0.386	4.585
$CAP_{j,t}$	5.312	1.349	2.000	8.000
$SUPERV_{j,t}$	10.196	1.725	7.000	16.000
$PRIMON_{j,t}$	5.672	0.673	4.000	7.000
$REST_{j,t}$	1.966	0.475	1.000	3.000
N. obvs.	7.171	7.171	7.171	7.171

This table reports descriptive statistics of the variables used to test the type of moral hazard behavior exerted by sample banks. For bank *j* and period *t*, $\Delta ZS_{j,t}$ ($ZS_{j,t}$): change over the previous period in (level of) the Z-score; $\Delta E_{j,t}$ ($E_{j,t}$): change over the previous period in (level of) the equity-to-assets ratio; $\Delta D_{j,t}$ ($D_{j,t}$): change over the previous period in (level of) the deposits-to-assets ratio; $\Delta OF_{j,t}$ ($OF_{j,t}$): change over the previous period in (level of) the ratio of other funding to assets; $SIZE_{j,t}$: natural log of total assets; $ROA_{j,t}$: return on assets; $BUF_{j,t}$: difference between the equity-to-assets ratio and the regulatory capital ratio; $DII_{j,t}$: generosity of the deposit insurance scheme; $CAP_{j,t}$: strictness of the legal capital requirements; $SUPERV_{j,t}$: strictness of the supervisory policy; $PRIMON_{j,t}$: strictness of private monitoring; $REST_{j,t}$: strictness of the restrictions on banks' activities.

Table 2. Taxonomy of moral hazard			
Moral hazard type	**Coefficients**		
	[2i] $\Delta E_{j,t}$	[2ii] $\Delta D_{j,t}$	[2iii] $\Delta OF_{j,t}$
Double-sided	$\alpha_1^E > 0$	$\alpha_1^D < 0$	$\alpha_1^{OF} < 0$
Leveraged	$\alpha_1^E > 0$	$\alpha_1^D > 0$ (or n.s.)	$\alpha_1^{OF} < 0$
Deposit-based	$\alpha_1^E > 0$	$\alpha_1^D < 0$	$\alpha_1^{OF} > 0$ (or n.s.)
Unclassified	$\alpha_1^E > 0$	n.s.	n.s.
Not moral-hazard	$\alpha_1^E < 0$	$\alpha_1^D > 0$ (or n.s.)	$\alpha_1^{OF} > 0$ (or n.s.)
Unclear	Other combinations		

Table 3. Moral hazard			
Panel A. Dependent variable: $\Delta ZS_{j,t}$			
	System 2i [$\Delta E_{j,t}$]	System 2ii [$\Delta D_{j,t}$]	System 2iii [$\Delta OF_{j,t}$]
Intercept	-0.0503* (0.0154)	0.7162* (0.0226)	0.8378* (0.0208)
$\Delta E_{j,t}$	0.8966* (0.0085)	--	--
$\Delta D_{j,t}$	--	0.0538* (0.0094)	--
$\Delta OF_{j,t}$	--	--	-0.0644* (0.0049)
$SIZE_{j,t}$	-0.0008*** (0.0005)	-0.0006 (0.0007)	-0.0007 (0.0007)
$ROA_{j,t}$	4.9577* (0.0956)	5.5744* (0.1468)	5.6061 (0.1463)
$BUF_{j,t}$	-0.2754* (0.0289)	0.1198* (0.0442)	0.1063** (0.0440)
$DII_{j,t}$	0.0022 (0.0061)	0.0222** (0.0093)	0.0197** (0.0093)
$CAP_{j,t}$	-0.0036* (0.0015)	0.0015 (0.0022)	0.0015 (0.0022)
$SUPERV_{j,t}$	-0.0064* (0.0011)	-0.0010 (0.0017)	-0.0011 (0.0017)
$PRIMON_{j,t}$	0.0286* (0.0027)	0.0091** (0.0042)	0.0097** (0.0042)
$REST_{j,t}$	-0.0018 (0.0078)	-0.0141 (0.0120)	-0.0114 (0.0119)
$ZS_{j,t-1}$	-0.0005* (0.0001)	-0.0008* (0.0001)	-0.0008* (0.0001)
Panel B. Dependent variables: $\Delta E_{j,t}$, $\Delta D_{j,t}$ and $\Delta OF_{j,t}$			
	System 2i [$\Delta E_{j,t}$]	System 2ii [$\Delta D_{j,t}$]	System 2iii [$\Delta OF_{j,t}$]
Intercept	1.1594* (0.0121)	0.9776* (0.0317)	1.2896* (0.0575)
$\Delta ZS_{j,t}$	0.3806* (0.0059)	0.0897* (0.0167)	-0.3981* (0.0316)
$SIZE_{j,t}$	0.0004*** (0.0003)	0.0897* (0.0167)	0.0052** (0.0020)
$ROA_{j,t}$	-2.1658* (0.0617)	-0.8801* (0.2183)	2.8907* (0.4136)
$BUF_{j,t}$	6.4032* (0.0669)	-0.0731 (0.0598)	-0.0316 (0.1114)
$DII_{j,t}$	-0.0079** (0.0035)	0.0017 (0.0125)	-0.0286 (0.0237)
$CAP_{j,t}$	0.0012 (0.0008)	0.0005 (0.0029)	0.0003 (0.0057)
$SUPERV_{j,t}$	0.0045* (0.0006)	0.0058** (0.0023)	-0.0047 (0.0044)
$PRIMON_{j,t}$	-0.0192* (0.0016)	-0.0234* (0.0057)	0.0297* (0.0107)
$REST_{j,t}$	0.0143* (0.0045)	-0.0100 (0.0161)	0.0405 (0.0306)
$\Delta E_{j,t-1}$	-0.0059* (0.0006)	--	--
$\Delta D_{j,t-1}$	--	-0.0039 (0.0089)	--
$\Delta OF_{j,t-1}$	--	--	-0.0014* (0.0006)

***, **, and * represent significance at the 1%, 5%, and 10% levels respectively. This table reports the results obtained from the estimation of [2i-2iii] for EU15 in 2002-2009. Panel A shows the results associated to the equations where $\Delta ZS_{j,t}$ is the dependent variable. Panel B refers to the equations where $\Delta E_{j,t}$, $\Delta D_{j,t}$, or $\Delta OF_{j,t}$ are the dependent variables.

Table 4. Moral hazard with and without buffer						
Panel A. Dependent variable: $\Delta ZS_{j,t}$						
	System 2i [$\Delta E_{j,t}$]		System 2ii [$\Delta D_{j,t}$]		System 2iii [$\Delta OF_{j,t}$]	
	With buffer	**Without buffer**	**With buffer**	**Without buffer**	**With buffer**	**Without buffer**
Intercept	0.1292** (0.0601)	-0.2362* (0.0436)	0.7129* (0.0836)	0.8766* (0.0704)	0.7797* (0.0817)	0.9908* (0.0695)
$\Delta E_{j,t}$	0.7310* (0.0153)	1.0134* (0.0083)	--	--	--	--
$\Delta D_{j,t}$	--	--	0.0144 (0.0129)	0.0624* (0.0128)	--	--
$\Delta OF_{j,t}$	--	--	--	--	-0.0646* (0.0067)	-0.0660* (0.0067)
$SIZE_{j,t}$	-0.0019** (0.0008)	0.0007 (0.0006)	-0.0034* (0.0011)	0.0007 (0.0009)	-0.0032* (0.0011)	0.0006 (0.0009)
$ROA_{j,t}$	3.6644* (0.1285)	6.6177* (0.1357)	4.4121* (0.1782)	7.2928* (0.2216)	4.4456* (0.1771)	7.3115* (0.2209)
$BUF_{j,t}$	-0.2052* (0.0478)	--	0.0089 (0.0667)	--	-0.0075 (0.0661)	--
$DII_{j,t}$	0.0065 (0.0179)	0.0148** (0.0079)	0.0331 (0.0251)	-0.0239** (0.0129)	0.0298 (0.0249)	-0.0197 (0.0129)
$CAP_{j,t}$	-0.0022 (0.0020)	-0.0054** (0.0021)	0.0018 (0.0028)	0.0073 (0.0034)	0.0012 (0.0028)	0.0068** (0.0035)
$SUPERV_{j,t}$	-0.0143* (0.0021)	-0.0028** (0.0014)	-0.0114* (0.0029)	-0.0014 (0.0023)	-0.0122* (0.0029)	-0.0007 (0.0023)
$PRIMON_{j,t}$	0.0374* (0.0053)	0.0306* (0.0034)	0.0419* (0.0074)	-0.0005 (0.0055)	0.0441* (0.0073)	-0.0000 (0.0056)
$REST_{j,t}$	0.0038 (0.0122)	-0.0145 (0.0104)	-0.0282** (0.0170)	-0.0470* (0.0170)	-0.0149 (0.0169)	-0.0476* (0.0169)
$ZS_{j,t-1}$	-0.0006* (0.0000)	-0.0003* (0.0000)	-0.0006* (0.0001)	-0.0008* (0.0000)	-0.0006* (0.0001)	-0.0008* (0.0001)
Panel B. Dependent variables: $\Delta E_{j,t}$, $\Delta D_{j,t}$ and $\Delta OF_{j,t}$						
	System 2i [$\Delta E_{j,t}$]		System 2ii [$\Delta D_{j,t}$]		System 2iii [$\Delta OF_{j,t}$]	
	With buffer	**Without buffer**	**With buffer**	**Without buffer**	**With buffer**	**Without buffer**
Intercept	1.4098* (0.0253)	0.3296* (0.0420)	1.2151* (0.1436)	0.7904* (0.0872)	1.1773* (0.2712)	1.2072* (0.1633)
$\Delta ZS_{j,t}$	0.0722* (0.0083)	0.8949* (0.0078)	0.0349 (0.0366)	0.0866* (0.0187)	-0.6529* (0.0693)	-0.3299* (0.0351)
$SIZE_{j,t}$	-0.0001 (0.0003)	-0.0012** (0.0005)	-0.0064* (0.0021)	0.0012 (0.0011)	0.00857** (0.0040)	0.0039*** (0.0022)
$ROA_{j,t}$	-0.5664* (0.0577)	-5.8312* (0.1448)	-0.4611 (0.3451)	-0.8028* (0.3039)	3.5206* (0.6562)	2.5731* (0.5736)
$BUF_{j,t}$	7.0283* (0.0652)	--	-0.3574* (0.1145)	--	-0.1080 (0.2151)	--
$DII_{j,t}$	0.0125*** (0.0069)	-0.0163** (0.0076)	-0.0019 (0.0428)	0.0299** (0.0158)	-0.0027 (0.0814)	0.0204 (0.0298)
$CAP_{j,t}$	-0.0012 (0.0008)	0.0055* (0.0020)	0.0045 (0.0047)	0.0006 (0.0042)	-0.0107 (0.0091)	-0.0041 (0.0080)
$SUPERV_{j,t}$	0.0041* (0.0008)	0.0027** (0.0014)	0.0071 (0.0049)	0.0223*** (0.0028)	-0.0184** (0.0094)	-0.0079 (0.0053)
$PRIMON_{j,t}$	-0.0083* (0.0021)	-0.0296* (0.0033)	-0.0283** (0.0127)	-0.0164** (0.0068)	0.0619** (0.0242)	0.0218** (0.0128)
$REST_{j,t}$	0.0154* (0.0047)	0.2522* (0.0431)	-0.0792* (0.0289)	0.0344*** (0.0207)	0.1973* (0.0552)	-0.0547 (0.0391)
$\Delta E_{j,t-1}$	-0.0067* (0.0006)	-0.0008* (0.0000)	--	--	--	--
$\Delta D_{j,t-1}$	--	--	0.0027 (0.0162)	-0.0082 (0.0108)	--	--
$\Delta OF_{j,t-1}$	--	--	--	--	-0.0014* (0.0003)	-0.0013* (0.0002)

***, **, and * represent significance at the 1%, 5%, and 10% levels respectively. This table reports the results obtained from the estimation of [2i-2iii] for EU15 banks with and without buffer during 2002-2009. Panel A shows the results associated to the equations where $\Delta ZS_{j,t}$ is the dependent variable. Panel B refers to the equations where $\Delta E_{j,t}$, $\Delta D_{j,t}$, or $\Delta OF_{j,t}$ are the dependent variables.

Table 5. Summarized results	
Sample	**Moral hazard type**
Complete sample	Leveraged
With buffer	Leveraged
Without buffer	Leveraged
Pre-crisis period	Leveraged
Pre-crisis with buffer	Leveraged
Pre-crisis without buffer	Leveraged

Table 6. Variables that contribute or not to moral hazard (by sample)			
	All	**Buffer**	**No buffer**
Observed moral hazard	Leveraged	Leveraged	Leveraged
$SIZE_{j,t}$	?	n.s.	Yes
$ROA_{j,t}$	Yes	Yes	Yes
$BUF_{j,t}$	No	No	--
$DII_{j,t}$	Yes [unclassified]	No	Yes [deposit-based]
$CAP_{j,t}$	n.s.	n.s.	No
$SUPERV_{j,t}$	?	No	?
$PRIMON_{j,t}$	Yes	Yes	Yes
$REST_{j,t}$	No	?	?

This table reports whether the variables helping to define the target values of the three funding sources considered contribute or not to moral hazard, and if they do, the type of moral hazard to which they contribute. The table is organized using as a criterion the sample used, i.e., the whole sample ("All"), banks with buffer ("Buffer") and banks without buffer ("No buffer"). The type of moral hazard found in each sample is shown in the file "Observed moral hazard". "Yes" ("No") implies that the corresponding variable affects the financial structure of the banks in the sample analyzed in such a way that this variable contributes (does not contribute) to the type of moral hazard found in this sample. For instance, the variable $Var_{j,t}$ contributes to deposit-based moral hazard if the coefficient of $Var_{j,t}$ is negative in the second equation of [2i], and positive in the second equations of [2ii-2iii]. If $Var_{j,t}$ contributes to a different type of moral hazard than that found in the sample analyzed, the type to which $Var_{j,t}$ contributes is explicitly mentioned between brackets. "?" indicates that the effect of $Var_{j,t}$ on banks' financial structure does not lead to a clear conclusion about moral hazard. "n.s." means that the coefficient of $Var_{j,t}$ in the second equation of [2i] is not significant. For bank *j* and period *t*, the variables considered are $SIZE_{j,t}$: natural log of total assets; $ROA_{j,t}$: return on assets; $BUF_{j,t}$: difference between the equity-to-assets ratio and the regulatory capital ratio; $DII_{j,t}$: generosity of the deposit insurance scheme; $CAP_{j,t}$: strictness of the legal capital requirements; $SUPERV_{j,t}$: strictness of the supervisory policy; $PRIMON_{j,t}$: strictness of private monitoring; $REST_{j,t}$: strictness of the restrictions on banks' activities.

Table 7. Variables that contribute or not to moral hazard (by type)					
	Moral hazard type				
	Double-sided	Leveraged	Deposit-based	Unclassified	Not moral hazard
SIZE	--	1/3	--	--	--
ROA	--	3/3	--	--	--
BUF	--	--	--	--	2/2
DII		--	1/3	1/3	1/3
CAP	--	--	--	--	1/3
SUPERV	--	--	--	--	1/3
PRIMON	--	3/3	--	--	--
REST	--	--	--	--	1/3

This table reports the same information as Table 6, but the criterion used to organize the table is the type of moral hazard to which the variables considered contribute. The ratio X/Y means that the corresponding variable has contributed to the corresponding type of moral hazard in X out of Y samples.