Safety net, shareholder structure and risk in Central European banks[1]

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Abstract

We study the effects of broadening the safety net on bank risk taking in Central Europe, using individual bank data and time-varying regulatory data. Further, we analyse the shareholder structure and its links with risk, as well as possible modifications it may introduce to the moral hazard incentives produced by the financial safety net. We find that more extensive deposit insurance schemes and state aid granted to the financial sector induce higher levels of risk in individual banks. The shareholder structure does not significantly influence the risk levels, although some evidence for higher risk of government-owned institutions is identified. Majority ownership in the form of other financial institutions not only does not alleviate the moral hazard, but makes it more acute, at least in some risk specifications.

JEL classification: G21, G28, G32
Key words: Bank risk taking, moral hazard, transition economies

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Introduction

Recent experiences gained during the financial crisis indicate that designing an appropriate safety net, which assures banking system stability but does not exacerbate the natural drive of banks towards excessive risk, continues to be a challenging task for regulators worldwide. On the other hand, discussions continue on creating pan-European deposit insurance schemes and bank rescue funds, thus making the question of optimal safety net features quite urgent. In addition, as ten Central European countries are already part of the European Union, their share in potential pan-European safety net schemes is certain. Meanwhile, scarce empirical work specifically targets Central European banks. In addition, these financial institutions have a strikingly different shareholder structure than their Western European counterparts. The dominance of majority ownership in Central European banks certainly affects their policies and may also influence the effects that safety nets have upon their risk taking. Specific literature in that area is also very narrow. The aim of this paper is to fill these gaps.

In our paper, we assess the effect of safety net features and shareholder structure upon bank risk taking in Central Europe in the period 2005-2010. We analyse the regulatory broadening of safety net and analyse its influence upon the level of risk in individual Central European banks, in the light of possible higher moral hazard incentives. If there is such a link, a policy of increasing financial stability in the form of higher deposit insurance or institutional help for ailing banks may be counter effective, with individual banks taking higher risks as a result. The second field of our study relates to shareholder structure – its relationship with bank risk levels and potential adjustments it may cause in moral hazard incentives from the safety net. In case of financial difficulties, banks with more powerful shareholders may rely on support from their owners rather than on institutional help from deposit insurance providers or lender of last resort facilities (be it the central bank or the government). This hypothesis is particularly important for Central European banks, the bulk of which have strong, majority owners in the form of foreign financial institutions.

In order to verify the above hypotheses, we first analyse the safety net features in Central Europe, relying mostly on regulations and annual reports of deposit insurance institutions for 2005-2010. This, in addition to data on institutional help to the financial sector, allows us to create a time-varying database of safety net features for 11 Central European countries. Individual bank year-end data are taken from Bureau van Dijk Bankscope database, regarding both balance sheet data and shareholder structure. As a result, in contrast

to most existing empirical literature[3], we are able to assess the effect of *changes* in safety net features and shareholder structure upon individual bank risk taking. The rest of the paper is organised as follows: Section 1 presents a brief literature review, in Section 2 we describe our methodology and data, Section 3 demonstrates main estimation results, Section 4 includes some robustness tests, followed by the general conclusions.

1. Institutional safety net, bank risk taking and shareholders – literature review

Deposit insurance has in recent years become a widespread policy tool aimed at increasing banking system stability. Numerous state interventions in Western European and US banks during the financial crisis have proven that state aid can also be relied upon in difficult times, regardless of the regulatory framework. Industrialised countries have been using both deposit insurance and state aid in their policies, which implies a positive view of policymakers on these tools. However, conclusions from the literature are not so uniform.

The seminal paper of Diamond and Dybvig (1983) underlines the necessity of deposit insurance schemes, as they diminish the probability of a bank run and enhance banking system stability. Single bank runs and bank failures may feed into larger banking crises, due to contagion effects stemming from e.g. system-wide liquidity shortages (Diamond and Rajan 2005). Generally, banking crises are costly to the economy as a whole, which has been well proven by the recent 2007-2009 crisis, and limiting the probability of such adverse events is seen as a main argument supporting the introduction of deposit insurance schemes.

On the other hand, safety nets are frequently regarded as one of the sources of moral hazard and thus increased risk taking in banks (Demirguc-Kunt and Detragiache 2002). Merton (1977) analyses deposit insurance as a put option on the bank's assets. Bank owners and/or managers are tempted to raise the risk taken by their bank in order to increase their option value. Keeley (1990) demonstrate that fixed-rate deposit insurance systems lead banks to take more risk in order to increase the option value. Deposit insurance is viewed as a subsidy from the insurance providers to the bank and the value of such a subsidy may be maximised through increasing asset risk or decreasing capital (Keeley 1990, Gueyie and Lai 2003).[4] If banks take higher risks because of the sense of security provided by the institutional safety nets, the original aim of these safety nets may be not fulfilled.

[3] See e.g. Laeven and Levine (2009), Angkinand and Wihlborg (2010), Forssbaeck (2011).

[4] On the other hand, Gropp and Vesala (2004) show that deposit insurance may help *decrease* moral hazard, if the non-depositor creditors are left out of the insurance scheme and such an exclusion is credible.

Some authors indicate that the source of moral hazard is not the conflict between bank shareholders and the safety net providers, but between bank shareholders and bank creditors (Barth et al. 2006). Bank owners enjoy limited liability status and increase risk taking at the cost of bank creditors (depositors and debt holders), who suffer losses in case of bank bankruptcy. The wealth transfer in such a case takes place between shareholders and creditors, where increased risk creates the option value of equity.

One of the mechanisms that curb exploiting creditors' interests and bank excessive risk taking is market discipline. It is assumed to be exerted by depositors and bank debt holders, who – institutional safety nets being absent – monitor bank risk and expect higher yield from higher risk banks. Safety nets may distort this process and the bulk of literature studies the effect of introducing or changing safety nets on market discipline and bank risk taking (see among others, Demirguc-Kunt and Huizinga 2004, Nier and Baumann 2006, Barth et al. 2006). Recent studies on cross-country samples of individual banks provide evidence that market discipline leads to lower risk taking and the effect is stronger for banks with increased shareholder control (Forssbaeck 2011). This result depends however on measures of risk used, with the relation valid for asset risk and insignificant for overall default risk.

The potential negative effect of safety nets on moral hazard and excessive risk taking may be diminished by specific policy solutions, proposed in the literature. Deposit insurance may have an implicit or explicit character, with differing implications for the banking system stability and risk taking.[5] Explicit deposit insurance systems usually pre-define the limit on the amount insured, type of depositors covered, currencies and type of deposits. Some include coinsurance, where depositors bear a low share of risk (usually around 10%). Lack of explicit deposit insurance and a high share of non-insured liabilities may result in less aggressive risk taking and higher capital (Nier and Baumann 2006). Explicit deposit insurance may increase the likelihood of banking crises, especially if the coverage is extensive and the system is funded and run by the government (Demirguc-Kunt and Detragiache 2002). On the other hand, explicit deposit insurance may imply visible limits to the safety net and thus market discipline for uninsured depositors persists (Gropp and Vesala 2004). The negative effect of deposit insurance on bank stability may also be curbed by strong institutional and regulatory environment (Demirguc-Kunt and Detragiache 2002). The important effect of credibility of non-insurance and the interplay between explicit and implicit deposit insurance results in a U-

[5] Some authors claim however that there is no difference between explicit and implicit deposit insurance, as in case of a crisis there is usually a bailout in both systems (Hellmann et al. 2000).

shaped relation between explicit deposit insurance and excessive risk taking (Angkinand and Wihlborg 2010).

Despite some differences in specific policy outcomes, the relation between introducing or broadening the safety net and bank risk taking is usually positive. Safety net induces more aggressive risk levels, measured by a variety of indicators. This relation has been demonstrated on both the country level (Demirguc-Kunt and Detragiache 2002, Angkinand and Wihlborg 2010) and in cross-country samples of individual banks (Nier and Baumann 2006, Le 2012). Country-level studies demonstrate that explicit deposit insurance may increase the likelihood of banking crises, especially in institutionally weak environments with feeble regulations (Demirguc-Kunt and Detragiache 2002). The institutional factors in terms of shareholder structure are also used in such country analyses, where Angkinand and Wihlborg (2010) find a U-shaped relationship between deposit insurance and risk. This implies that bank risk taking may be minimised at intermediate levels of protection. In the area of individual bank analyses, a recent study by Le (2012) on c.19,000 individual banks demonstrates that the results may differ significantly between banks. Systemically important institutions and – somewhat surprisingly – institutions close to default are not likely to increase their risk taking after deposit insurance introduction. A rise in risk is more likely to appear in small and sound banks. Gueyie and Lai (2003) analyse the effects of introducing deposit insurance on moral hazard in Canadian banks and find the relationship insignificant. Chernykh and Cole (2011) analyse Russian banks and find that participation in deposit insurance scheme changes the financial structure of the bank, with growth in nominal deposits and in the share of deposits to assets. In addition, the implementation of a deposit insurance scheme leads to higher risk taking by banks in Russia. Cross-country analyses based on individual bank data show that government safety nets diminish bank capital buffers and they reduce the positive effect of market discipline on capital levels (Nier and Baumann 2006).

Safety nets usually weaken market discipline and this result is empirically demonstrated on different bank and country samples. Government guarantees reduce market discipline in Indonesian banks, although the relation may depend on the credibility and delay in payouts of these guarantees (Hadad et al. 2011). In cross-country samples, safety nets in the form of government guarantees also diminish the positive effect of market discipline (Nier and Baumann 2006). In a recent cross-country analysis based on individual bank data, Forssbaeck (2011) proves that market discipline reduces bank risk taking, although the effect is relatively small.

The importance of accounting for shareholder structure has been repeatedly underlined in the literature. Banks with stakes owned by governments are proven to be less efficient (Berger et al. 2005, Iannotta et al. 2007 and Iannotta et al. 2012). On the other hand, the dispersed shareholder structure of the US and Western European banks differs significantly from the strongly concentrated ownership in Central European financial institutions and thus it is particularly important to verify the role of shareholder structure in such a setting.

The relation between insider control and bank risk taking may be U-shaped, although Forssbaeck (2011) demonstrates that the negative effect predominates. This implies that higher ownership concentration may lead to more elevated risk taking, although the results strongly depend on bank leverage. State ownership of banks is associated with relatively high risk taking, as found by Berger et al. (2005) and Forssbaeck (2011). The latter indicates that this effect is associated with high explicit deposit protection. In addition, foreign ownership in this study is also related to higher risk taking in some risk specifications, but not in countries with high explicit deposit insurance. On a country level, Demirguc-Kunt and Detragiache (2002) find that public ownership has no effect on the banking system stability and banking crisis probability. Laeven and Levine (2009) provide evidence for the importance of accounting for shareholder structure in bank risk taking. Their study on individual banks demonstrates that more concentrated and powerful shareholders are associated with higher risk taking and such ownership exacerbates the positive relation between deposit insurance and risk. In addition, powerful shareholders generate a hike in risk following more stringent regulations on capital and bank activities. The results of Laeven and Levine (2009) prove that particular banks may respond to regulations differently and thus it is important to analyse regulatory frameworks in relation to individual bank behaviour rather than on an aggregated (country) level.

In a recent analysis of Western European banks, Iannotta et al. (2012) demonstrate that government owned institutions have lower risk than their private owned counterparts, but this lower risk should be attributed to government support, as their standalone financial risk is more elevated. On the other hand, market discipline is more pronounced in listed and foreign banks (Hadad et al. 2011). For European banks, Barry et al. (2011) demonstrate that ownership structure is important in explaining risk differences in privately owned banks. Institutions owned by private individuals/families and by banks are found to have lower asset and default risk.

2. Methodology and data

2.1. Methodology

The first area of our analysis covers the relation between the state safety net and bank risk taking. We want to verify if broadening of the safety net, in the form of either more extensive deposit insurance, or of granting state aid to the financial sector, leads to changes in risk in individual banks. This has powerful policy implications, especially at times of continuing discussions on creating pan-European deposit insurance schemes and strengthening the safety net for European banks. Our first research question can be thus presented in the following form:

> *Hypothesis 1: Broadening of safety net in the form of more extensive or explicit deposit insurance schemes, and/or state aid granted to the financial sector, may lead to higher risk levels in individual banks*

If Hypothesis 1 is confirmed, it provides evidence for the existence of moral hazard incentives and implies adequate regulatory and policy steps that would restrict adverse consequences for individual banks and banking systems as a whole. Basing on the described empirical literature, we use the following empirical specification to verify Hypothesis H1:

$$Bank\ risk_{it} = \alpha + \beta_1 Bank\ control\ variables_{it} + \beta_2 Macroeconomic\ control\ variables_{jt} + \beta_3 Deposit\ insurance_{jt} + \beta_4 State\ aid_{jt} + v_i + \varepsilon_{it} \quad (1)$$

Subscript *i* denotes bank, *j* country and *t* year. *Bank risk* denotes level of risk taken by an individual bank *i* in year *t*, measured by two groups of risk proxies (*ex ante* and *ex post*). *Bank control variables* account for internal bank characteristics, such as loan growth, share of loans in assets, or size. *Macroeconomic control variables* refer to country characteristics such as GDP growth and inflation. *Deposit insurance* and *State aid* reflect features of safety net in a given country and year. All variables are described in detail in Section 2.2.

Equation (1) is a static model with individual bank fixed effects. We assume that all banks possess unobserved individual characteristics (v_i), such as a corporate culture, that are relatively stable over time and are difficult to change. For some independent variables, we introduce time lags, to account for delayed effects they may have on bank risk. Similarly to the general approach in the literature, we use a static model in our estimation. The maximum

number of periods per bank is six, with many institutions displaying less that this maximum and this could limit the effectiveness of a dynamic approach. In the robustness check, we include a random effects specification.

The second part of our study extends and broadens Hypothesis 1, in assuming that the relation between safety net features and bank risk may be amended through shareholder structure in individual banks. As mentioned previously, many Central European banks, and generally banks in other developing countries, have a highly concentrated shareholder structure with one shareholder frequently owning over 50%. Such a corporate governance setting may affect bank risk levels and the sensitivity of banks to modifications in country safety nets. This may be driven by reliance on shareholder – rather than state – support in case of financial difficulties. Thus, our second research question is formulated as follows:

Hypothesis 2: individual bank risk levels are affected by shareholder structure and the latter modifies bank risk sensitivity to changes in the country safety net.

If Hypothesis 2 is confirmed, it implies that corporate governance in Central European banks may change moral hazard incentives generated by broadening of safety net schemes and thus should be accounted for in policy decisions. In order to empirically verify Hypothesis 2, we use the following specification:

$$Bank\ risk_{it} = \alpha + \beta_1 Bank\ control\ variables_{it} + \beta_2 Macroeconomic\ control\ variables_{jt} + \beta_3 Deposit\ insurance_{jt} + \beta_4 State\ aid_{jt} + \beta_5 Shareholder\ Structure_{it} + v_i + \varepsilon_{it} \quad (2)$$

Shareholder Structure includes variables relating to characteristics of the primary shareholder, such as stake size and type of owner, for each bank and year. In addition, it comprises interaction variables, representing sensitivity to safety net changes in conjunction with shareholder characteristics. The details are specified in the following section. Equation (2) is also estimated as a fixed effects, static model, with a robustness check using a random effects approach (Section 4).

2.2. Data

In our estimation we use year-end bank data from 11 countries in Central Europe, for the period 2005-2010, totalling 864 bank-year observations. The raw sample consisted of 1712 bank-year observations from 261 living banks. All financial data are taken from Bureau VanDijk's Bankscope database. Unfortunately, Bankscope includes a considerable number of

faulty inputs and/or serious outliers (such as negative equity of 400% of assets or loan growth of 112,000%). Although this severely reduces our sample, we decide to perform 1/99 centile exclusions on the main variables. [6] Macroeconomic data is taken from the IMF and the World Bank. Regulatory data has been put together basing on deposit insurance fund annual reports and diverse legal acts from the respective countries (see *Regulatory data*, below).

Banks in the sample are primarily commercial banks (over 90%), although a small share of cooperative banks (3.7%), savings banks (3.7%) and real estate and mortgage banks (1%) has also been included. Data is not equally split between countries (Table 1), with a marginal share of Estonian banks (2%) and strong representation from Croatian (17%), Polish (13.5%) and Romanian (12%) financial institutions. In a robustness check, the main models are additionally estimated on a smaller subsample, to account for differences in the economic development and macroeconomic trends in the 2005-2010 period in Central Europe (see Graph 2 and Graph 3).

Table 1. Final sample by country

Country Name	Freq.	Percent
BULGARIA	85	9.84
CROATIA	150	17.36
CZECH REPUBLIC	69	7.99
ESTONIA	19	2.2
HUNGARY	50	5.79
LATVIA	74	8.56
LITHUANIA	45	5.21
POLAND	117	13.54
ROMANIA	104	12.04
SLOVAKIA	68	7.87
SLOVENIA	83	9.61
Total	**864**	**100**

Risk proxies

There is no uniform proxy for bank risk taking in the literature and many authors use several specifications to test parallel risk indicators (see eg. Forssbaeck 2011, Barry et al. 2011 or Laeven and Levine 2009). Nier and Baumann (2006) underline the difference between *ex ante* indicators of risk, which are meant to demonstrate the probability of default of a bank, or its realised and unrealised risk level, and *ex post* risk proxies, representing the realised risk portion. We borrow Nier nad Baumann's (2006) risk division and apply it throughout our paper. Although it falls outside the scope of this analysis, we want to underline

[6] In addition, we restricted the sample in such a way, as to run the estimations of Hypothesis 1 and Hypothesis 2 on the same banks (unless stated otherwise), with full shareholder data availability. This is not always the case in the literature (see e.g.Forssbaeck 2011), but we want to be able to make cross-specification comparisons.

that the decision of choosing risk proxies is fundamental to empirical bank analyses. The empirical literature on bank risk taking and the safety net does not provide a clear indication as to which proxies are the most appropriate, and the wide variety of ratios used confirms the choice problem of bank researchers. In the course of our analysis we find severe differences in results, depending on risk proxies used. Hence our decision of presenting all risk proxies, even if it makes the interpretation not as clear-cut as we would wish.

Table 2. Summary statistics of main variables

Variable	Obs	Mean	Std. Dev.	Min	Max	Source
Risk measures						
Ex ante risk						
Zscore	864	3.34	1.20	-0.61	7.79	Bankscope
ROA volatility	864	0.68	0.95	0.006	12.67	Bankscope
Earnings volatility	864	0.51	0.63	0.004	8.32	Bankscope
Ex post risk						
LLP	864	0.86	1.18	-1.24	7.55	Bankscope
NPL	604	7.68	8.03	0.06	63.86	Bankscope
LLR	813	4.31	3.55	-0.22	27.15	Bankscope
Bank-level control variables						
Equity	864	10.56	4.89	2.27	42.42	Bankscope
Loan growth	864	23.37	36.11	-39.56	319.09	Bankscope
Loan share	864	61.15	13.91	20.20	97.30	Bankscope
Loan deposit ratio	864	114.83	66.36	35.22	519.08	Bankscope
Size	864	4.17	6.55	0.02	42.84	Bankscope
Macroeconomic control variables						
GDP growth	864	2.35	5.71	-17.96	12.23	IMF
GDP per capita	864	9261.44	3560.88	3008.95	18535.35	IMF
Inflation	864	4.18	2.83	-1.71	14.03	IMF
Unemployment	864	8.91	3.52	3.98	18.97	IMF
Deposit insurance variables						
Deposit insurance model	864	0.421	0.494	0	1	Country regulations
Insurance premium	864	0.0033	0.0016	0.000032	0.0075	Country regulations
Premium risk dependence	864	0.188	0.391	0	1	Country regulations
Total insurance limit	864	30750	18296	6412	100000	Country regulations
Full coverage	864	0.752	0.432	0	1	Country regulations
Amount fully covered	864	25833.93	22320.33	0	100000	Country regulations
Coinsurance	864	0.248	0.432	0	1	Country regulations
Total limit/GDP pc	864	3.783	2.696	0.771956	12.61616	Country regulations/IMF
State aid variables						
State aid case (financial sector)	864	0.266	0.442	0	1	European Commission
State aid case in the past	864	0.256	0.437	0	1	European Commission
Total crisis aid (to GDP)	525	0.0093	0.0237	0	0.1038	European Commission

In terms of *ex ante* risk proxies, Zscore remains probably the most popular measure. Zscore is usually defined as a default probability, or the distance of the bank to default. There are many forms of Zscore, but the main version is defined as the relation of the sum of average return on assets (ROA) and level of capital to assets to the standard deviation of the return on assets. Higher values of Zscore indicate lower probabilities of default. The market

version of Zscore uses equity returns instead of return of assets (Forssbaeck 2011), but this requires a set of listed banks, which is not possible for many Central European banks. Zscore is a measure basing on several years, as it includes the mean and standard deviation of ROA. As a result, some analyses are cross-section only, with one value for Zscore for a few years and one period of financial data (Laeven and Levine 2009), or a mean of several years' financial results. Others use three year moving windows to construct Zscore, either for both the average ROA and the standard deviation of ROA (Hadad et al. 2011), or for the standard deviation of ROA only, supplemented with year-end ROA instead of a mean ROA (Le 2012). Zscore is highly skewed and thus the natural logarithm is increasingly applied (Laeven and Levine 2009, Le 2012).

In our estimation we also use Zscore as a primary risk indicator, mostly following Hadad et al. (2011) and Le (2012), with three year moving windows for both the mean ROA and standard deviation of ROA, and natural logarithm of Zscore.

Apart from Zscore, there is a variety of other risk indicators and the final choice is frequently dependent on bank samples and data availability. Some authors use earnings volatilities as an indicator of bank risk, including volatility of market equity returns (Nier and Baumann 2006, Laeven and Levine 2009), the volatility of ROA (Barry et al. 2011) or the volatility of pre-provisioning bank earnings (Laeven and Levine 2009). Using market based data requires listed banks, so it is not frequently applied with samples containing developing country banks. We use both the ROA volatility and the pre-provisioning earnings volatility, in the form of standard deviations constructed for three year moving windows.

Ex post risk proxies generally base on asset risk, and more specifically – on the quality and reserves made for the loan portfolio. In view of massive market risk exposures of many large banks, and the current credit risk exposures inherent within government securities portfolios, the loan quality risk ratios may not be optimal. However, Central European banks are generally not as exposed to market risk as their Western counterparts, due to relatively high profitability of the credit business and potential implicit limitations in local market risk taking, imposed by foreign majority shareholders. As a result, asset quality driven risk proxies may be relatively representative of bank risk in Central European banks. In the existing literature, the most frequent ratios are derived from non-performing loans (Nier and Baumann 2006, Forssbaeck 2011), loan loss provisions (Nier and Baumann 2006), loan loss reserves (Hadad et al. 2011) or even loan to assets ratios (Chernykh and Cole 2011). In our estimation we use loan loss provisions (LLP) as a measure of *ex post* risk, supplemented by non-performing loans (NPL) and loan loss reserves (LLR). LLP is our primary ex post risk proxy,

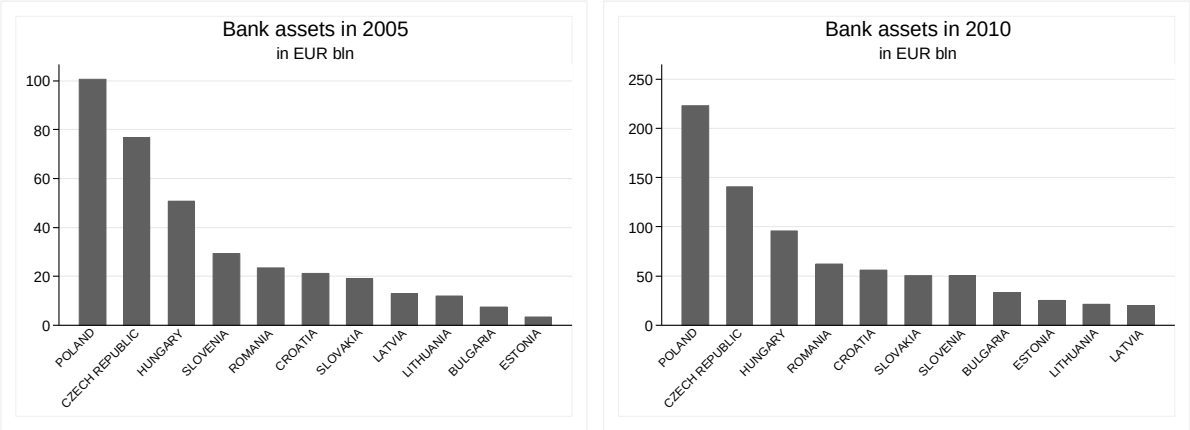
as provisions are an obligatory element of the profit and loss account and are reported by all banks in the sample. They refer not only to the quality of the asset portfolio but also reflect bank policies towards asset risk, whereas non-performing loans are just reported bad loans. In addition, the NPL and LLR reported in Bankscope may not always fully reflect their true levels as revealed to the supervisory authorities, while such discrepancies on the level of LLP are rare. In our estimation, loan loss provisions are used in relation to total assets, while both NPL and LLR refer to total loans.

Control variables

A range of bank-internal and macroeconomic variables is used in our estimation, to control for bank-specific and economic environment factors that may affect bank risk taking. Level of equity relative to assets is used to control for bank leverage (*Equity*). In order to avoid endogeneity of leverage with Zscore, we use a one year lag. Banks with ample capital cushions are prone to approach risk differently than banks with a high leverage. We include loan growth (*Loan growth*) as a control for bank expansion and also – to some extent – market conditions. Some Central European countries witness periods of extensive credit growth and this may shape risk behaviours. Similarly, a share of loans in total assets (*Loan share*) demonstrates the credit-intensity of an individual bank business, which to some extent accounts for banks type. Parallel to this, the ratio of loans to deposits (*Loan deposit ratio*) accounts for the funding part and the degree of using client funding in loan growth and total assets account for size (*Size*). The set of macroeconomic variables is standard, with GDP growth, GDP per capita and inflation controlling for the external environment where banks operate.

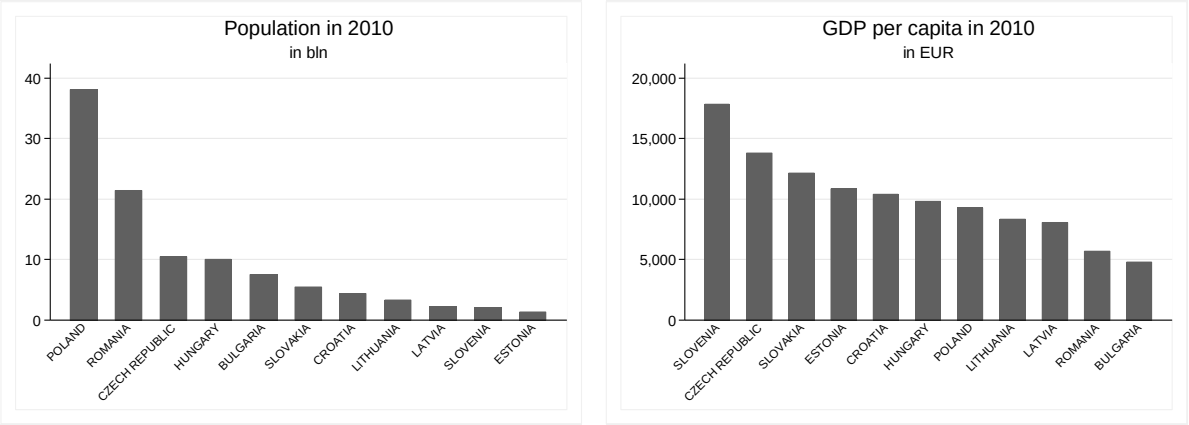
We believe it is important to briefly illustrate the content of our data before moving on to the results. Despite the fact that our sample is relatively homogenous, in comparison to similar work on the subject (see e.g. Forssbaeck 2011 – 47 countries, Laeven and Levine 2009 – 48 countries), important discrepancies between banks and their home countries should be underlined. The size of banking sectors in the 11 countries spreads from EUR 25bln in Estonia to almost tenfold of this in Poland – EUR 223bln in 2010 and such differences have existed for the whole period of our analysis (Graph 1). In addition, the rate of growth in particular banking sectors have also differed, although roughly speaking most sectors have more than doubled within the six year period.

Graph 1. Banking sector size per country



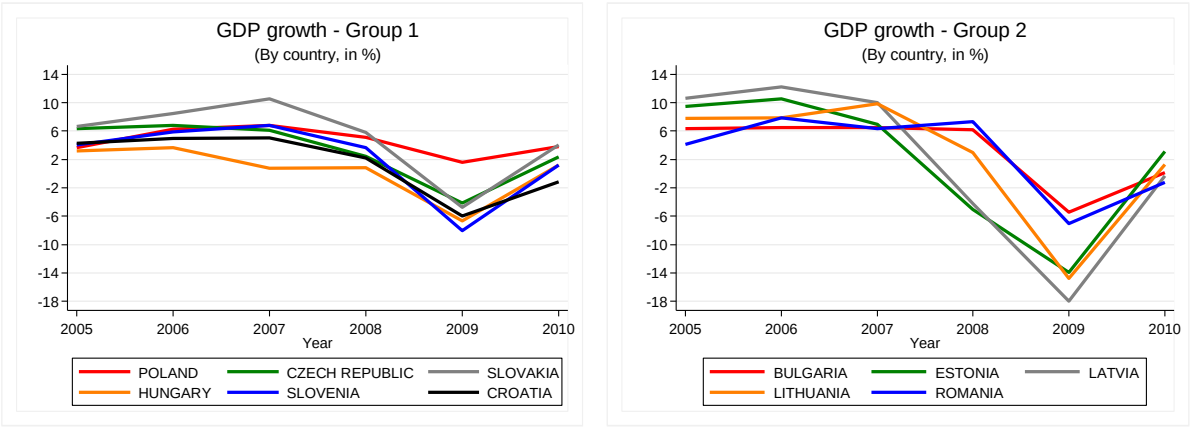
Macroeconomic conditions within Central Europe are also not uniform, even if the region is treated as homogenous by many market participants. Summary statistics demonstrate a high discrepancy of GDP, both in terms of growth and per capita terms. The size of banking sectors primarily corresponds to population levels, rather than to GDP per capita, with the largest banking market in the region (Poland) being only on the seventh place in terms of GDP per capita (Graph 2).

Graph 2. GDP per capita and population per country



The diverse macroeconomic conditions have particularly surfaced during the financial crisis years of 2008 and 2009, with the Baltic countries suffering abrupt and deep recessions and Poland staying around the 2% GDP growth mark in the worst 2009 year (Graph 3). In consequence, despite strong common historical, political and institutional factors the Central European area is not homogenous and individual treatment of banks in the region is particularly important.

Graph 3. GDP growth per country



Although our estimation period is relatively short, countries in the region have witnessed both boom and bust periods during that time. A slowdown in 2008, a painful deterioration across the sample in 2009 and a slow recovery in 2010 (Table 3) indicate that some specifications regarding the relationship between risk and state aid during crisis times should also be included.

Table 3. Macroeconomic developments in Central Europe in the period 2005-2010

Year	GDP growth (mean)	GDP per capita in EUR (mean)	Inflation (mean)	Unemployment (mean)
2005	5.51	7177	4.33	10.40
2006	7.00	8303	3.68	9.00
2007	6.75	9354	6.88	7.17
2008	3.24	10358	4.96	6.58
2009	-6.41	9449	2.11	9.13
2010	1.00	9996	3.36	11.35

Regulatory data

Since the late 1990s, intensive work on revising the Basle capital regulations has brought increased attention to diverging international banking regulations in general. The financial crisis of 2007-2009 has amplified the importance of effective deposit insurance regulations, which should follow certain internationally renowned guidelines. To this aim, the International Association of Deposit Insurers (IADI) has been cooperating with the Basel Committee on Banking Supervision (BCBS) in developing uniform standards for deposit insurance systems. The final set of core principles was published in June 2009 (BCBS IADI 2009) and includes guidelines as to the optimal construction of the deposit insurance system. The guidelines specify the objectives of the system, its mandates and powers, the governance structure, relationships with other safety-net participants and cross border issues, details of

membership and coverage, as well as funding. The document underlines the important role of public awareness and of ensuring an optimal legal environment for the deposit insurance to operate in, while caring for proper reimbursement of depositors and the correct recovery process from the failed banks. The outline of a broadly discussed issue of failure resolution has also been included in the core principles.

Although the scope of the BCBS IADI core principles is large, they are not constructed as specific regulations that may be adopted by national deposit insurance funds. Instead, the principles indicate main areas where regulators should consider available options and implement own policies. Nonetheless, they provide a sound base for a uniform international approach to the construction of the deposit insurance system, even if they are just the first step on the way to implementing detailed national regulations.

In the aftermath of the financial crisis, the European Union has taken legal steps to harmonise deposit insurance across its member countries. The European Commission has introduced regulations setting deposit insurance limits. All member countries, including all countries in our sample, have introduced these EU limits in their respective regulations, with some members imposing higher limits in advance (Lithuania). As a result, larger heterogeneity as to nominal deposit insurance in the region only lasted until 2008. On the other hand, taking into account the earlier described divergence in the macroeconomic and banking environment in the region, some doubts about setting a uniform nominal deposit insurance limit could be voiced. Apart from deposit insurance limit, all countries in our sample converged towards the full insurance model, with earlier co-insurance eliminated in the whole sample by the end of 2008.

Regulatory data regarding deposit insurance in our sample has been hand-collected, basing on annual reports from deposit insurance funds and other safety-net institutions, current and historical legal acts, and supplemented by data received directly from respective deposit insurance funds. Data on state aid is based on European Commission reports and databases.

Table 4. Safety net variables in the final sample

Variable	Observations	Variable = 0	Variable = 1
Deposit insurance model	864	500	364
Premium risk dependence	864	702	162
Coinsurance	864	650	214
State aid case (financial sector)	864	634	230
State aid case in the past	864	643	221

The general descriptive statistics of safety net data is shown in Table 2. The more detailed description of dummy variables is shown in Table 4 and their annual values in Table 5. *Deposit insurance model* defines whether the country system is a pay-box type (dummy = 0) or risk-minimiser type (dummy = 1). Risk minimiser systems assume aid to ailing banks, to avoid their bankruptcy, while pay-box systems theoretically only pay out deposits in case of bank defaults. However, the financial crisis raised serious doubts about the credibility of pay-box systems, as many banks have received government help, without the formalised risk-minimiser systems in Western Europe. Nonetheless, this variable is meant to demonstrate if there is a relationship between the explicit deposit insurance system and individual bank risk taking. *Insurance premium* shows the fee paid by banks to the deposit insurance fund (as a % of total insured deposits). If the premium is regarded by banks as costly, its changes should affect risk levels in different years. *Premium risk dependence* is a dummy variable, taking the value of 1 if premiums paid to the deposit insurance fund depend on the risk taken by a given bank (and not only on deposit volume). *Total insurance limit* demonstrates the nominal amount of deposits insured in a given year. *Total limit/GDP pc* relates the nominal amount to the GDP per capita level, as we indicated that the macroeconomic conditions in countries in the sample differ significantly. *Coinsurance* is a dummy variable (if coinsurance exists then dummy = 1), as all the nominal amounts of coinsurance in our sample were mostly 10%. *Amount fully covered* shows the nominal value of the 100% insured deposits, as in systems with coinsurance the structure usually included a lower deposit insurance limit, where full coverage was available, and a higher limit with 10% coinsurance. Only Czech Republic and Slovakia had coinsurance for the whole deposit amount.

Table 5. Safety net features in Central Europe in the period 2005-2010

Year	Insurance premium (mean)	Total DI limit (mean in EUR)	Total DI limit / GDPpc (mean)	State aid to non-fin sect. (mean)	Crisis aid fin. sect. (mean)
2005	0.0039	16477.52	2.520	0.8175	0
2006	0.0032	17898.54	2.411	0.7426	0
2007	0.0031	19198.91	2.360	0.9432	0
2008	0.0031	20135.57	2.193	0.7890	0.0052
2009	0.0032	48623.09	6.139	0.8150	0.0149
2010	0.0032	51328.11	5.962	0.7703	0.0158

The most important state aid variables are dummy variables, indicating if state aid was granted to the financial sector in a given year or in the recent past (the previous three years). Extending state aid in the current year is denoted by *State aid case* (dummy = 1), while past cases are shown in *State aid case in the past*. Some countries have granted extra aid to their

financial sectors in the period 2008-2010 and the amount of this aid (in relation to GDP) is demonstrated by *Total crisis aid*.

Shareholder data

All shareholder data in our sample comes from the Bankscope database. We have hand-checked the primary shareholder stakes in all available annual reports and found existing data in Bankscope (both current and historical) as reliable. Shareholder data in our sample is year-end data for every year, even if generally changes between years are not frequent or large. The details of the shareholder structure in the sample are shown in Table 6.

Table 6. Shareholder structure variables in the final sample

Variable	**Number of observations**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
primary shareholder	864	73.98821	28.79738	0.01	100
Variable ownership	*variable ownership =1*		*variable ownership =0*		
full ownership (>95%)	362		502		
majority owner (>50%)	660		204		
bank majority owner	496		368		
government majority owner	16		848		
government share min. 10%	41		823		

Primary shareholder denotes the stake held by the largest shareholder in a given year. Holding majority stakes is the main ownership model in Central European banks, as demonstrated in Table 6. Studies on developed country bank samples reveal a radically different picture, with a much more dispersed shareholder structure. Laeven and Levine (2009) study banks in 48 countries (without Central Europe) and assume that a shareholder stake above 10% indicates concentrated and powerful ownership. In our study, only 24% of banks have the largest shareholder below the 50% mark. On the basis of the *Primary shareholder* and data on shareholder type from Bankscope, we construct dummy variables relating to full- and majority ownership and single out banks with bank owners and government owners. In addition, we account for a possible government influence upon bank activities even if the stake is not a majority one, and assume a 10% government share to this aim. However, the amount of banks with government participation is very small (under 5%).

Among banks which are majority owned, three quarters have bank owners, in a form of a direct or indirect stake of a large, Western European financial institution.[7]

Table 7. Shareholder structure in the final sample, by country (2010)

Country Name	Majority ownership (% of banks)	Full ownership (% of banks)	Bank ownership (% of banks)
BULGARIA	83	39	50
CROATIA	60	37	40
CZECH REPUBLIC	87	53	67
ESTONIA	60	40	40
HUNGARY	91	64	64
LATVIA	77	31	62
LITHUANIA	89	56	44
POLAND	86	23	55
ROMANIA	88	53	82
SLOVAKIA	92	50	58
SLOVENIA	50	38	44

Some differences in shareholder models are visible across countries in the region (Table 7), but no country displays a shareholder share below the 50% mark. Slovakia and Hungary have the most concentrated ownership, while the presence of bank majority shareholders is the most pronounced in Romania. Summing up, all countries in the region display striking differences in relation to their Western European and US counterparts. Dominance of majority ownership models indicates that the power of secondary owners and other investors is limited and banks possibly strongly follow their – largely bank – owners lead. This implies different corporate governance mechanisms and poses questions on possible intragroup relations, which remain however outside the scope of this text.[8]

3. Results

Hypothesis 1

We start our estimation by verifying Hypothesis 1, stating that broadening of the elements inducing moral hazard in the form of the safety net, may have an effect on individual bank risk taking. Tables 8 and 9 present results of estimating Equation (1), in different specifications. The first estimation series (Table 8) uses the *ex ante* risk proxies, mainly ZScore, but also the volatility of ROA and the volatility of pre-provisioning income (both calculated as standard deviations with three year moving windows).

[7] Sometimes, Western European banks hold indirect stakes, through a fully owned subsidiary in another Central European state, but the ultimate shareholder and control does not change.

[8] For a detailed study of intragroup transactions between European parent banks and their foreign subsidiaries see Allen et al. (2011).

Table 8. Estimation results for Equation (1), *ex ante* risk measures

Variable	**Zscore** *Spec.1*	**Zscore** *Spec.2*	**Zscore** *Spec.3*	**Zscore** *Spec.4*	**Zscore** *Spec.5*	**ROA volatility**	**Earnings volatility**
Equity	0.01147296	0.03074481	0.01395189	0.01237555	0.01526429	0.01300341	0.01089139
Loan growth	-.00216253*	0.00045865	-0.00190605	-0.00165683	0.00014701	.00196801*	.00214513***
Loan share	0.0090042	0.00309227	0.00782769	0.00806094	-0.00003142	-0.00676051	-0.00136416
Loan deposit ratio	0.00082721	0.00245582	0.00049407	0.00053746	0.00070233	0.00097897	-0.0000217
Size	-0.00519611	0.05121309	-0.01018858	-0.0093177	0.0190005	-.03562576*	0.00238789
GDP growth	0.00973353	-0.00435451	0.01630059	0.01124983	-0.01203686	-0.00867832	0.00344829
GDP per capita	.00045773**	.0008373**	.00044169**	.00045399**	.0008515***	-.00055377***	-.00020374*
Inflation	-0.00215301	0.03886118	0.00092719	0.00062634	0.00865831	-0.00159789	-0.01077633
Deposit insurance model	-0.2064459		-0.23258156	-0.23910373		-0.05815003	0.04652478
Insurance premium	72.380466*	78.247491	76.766028*	74.328311*	171.42409*	-39.097672	19.585849
Premium risk dependence	0.30148622		0.182436	0.21713209		-0.07554127	-0.19472628
Deposit insurance limit	-.07641772***	-.05912732*	-.09018864***	-.08454987***	-.08796572***	.07651042***	0.00588772
Coinsurance	.52829737***	.63918454***	.5359497***	.54300152***	.52825188***	-.43572827***	-.18196174***
State aid case	-.42020944***	-.69565556***	-.46592294***	-.49460748***	-.62488022***	0.15511073	0.08712291
State aid in the past	-.19575828*	-.29355182**			-.29216756**	0.06983155	0.00524235
Limit change	-0.04064539	0.16424256		-0.00488474	-0.03330877	0.11278297	-0.07636596
Limit change past	-0.14305297					0.05202049	-0.03162621
Limit change in *t-1*		0.04292133					
Limit change in *t-2*		0.07160202					
Date of limit change			0.01664198			-0.02351071	0.0089118
Total crisis aid					3.1590213		
Constant	0.73177684	-1.7619111	0.78425235	0.75429882	-0.95087453	3.4062625***	1.3797651***
F-statistics	10.868889	9.2735621	11.991095	11.900231	10.175831	8.0537788	2.1035094
No of obs.	864	486	864	864	525	864	864

Notes: *Equity* is bank equity divided by total assets, lagged by 1 year, *Loan growth* is current year loan expansion (in %), *Loan share* is total loans to total assets, *Loan deposit ratio* is total loans to total client deposits, *Size* is total assets (divided by 1mln), *GDP growth* is GDP growth in constant 2000 prices, *GDP per capita* is in constant 2000 USD converted to EUR, *Inflation* is year-end price growth, *Deposit insurance model* is dummy variable (0 for paybox, 1 for risk minimiser), *Insurance premium* is premium paid to deposit insurance fund (as % of total deposits), *Premium risk dependence* is a dummy variable (1 for risk dependent premiums), *Deposit insurance limit* is the nominal limit divided by GDP per capita, *Coinsurance* is a dummy variable (1 if coinsurance exists), *State aid case* is a dummy variable (1 if state aid was granted to the financial sector in the given country and year), *State aid in the past*, dummy lagged variable (1 for state aid in any of the years between *t-1* and *t-3*), *Limit change* a dummy variable (1 if limit change takes place in current year), *Limit change past* dummy for past limit changes ((1 for change in any of the years between *t-1* and *t-3*) *Date of limit change* interaction term of Limit change*Deposit insurance limit, *Total crisis aid* – total aid to fin. Sector granted during the financial crisis.

The second estimation series (Table 9) uses the *ex post* risk proxies, based on asset quality, so mainly loan loss provisions level, but also ratios of non-performing loans and loan loss reserves (both in relation to total loans).

Our main results provide evidence for a strong relationship between level of individual bank default risk and safety net features (Table 8). *Ex ante* risk increases (Zscore falls) when deposit insurance limits are raised, a relationship that is strongly significant and very stable through all specifications and on different sample sizes. The feature of partial coinsurance, borne by depositors, also leads to lower risk taking, which again is very significant statistically and stable throughout various specifications. Thus, it seems that the current policy direction of abolishing depositor coinsurance is not optimal. A statistically weaker, but also quite robust relationship between deposit insurance premia and risk (as measured by Zscore) indicates that higher costs of deposit insurance schemes are associated with lower risk levels. Increasing the cost of deposit insurance results in lower risk, which provides an argument for the supporters of risk-dependent premia. If aggressive risk takers are faced with much higher deposit insurance fees, their risk appetite could be curbed.

The second part of the safety net system, state aid, also appears as a substantial risk driver. The instances of state aid in the current year and in the recent past raises banks' risk levels. Current year cases provide stronger incentives for risk taking, and their statistical significance and stability is higher than that of aid granted in the past. On the other hand, "current year" is defined as the year of actual help being delivered to ailing financial sector institutions. Some information on required and forthcoming government or central bank help may be available before the moment of actual aid granting, so other financial institutions may act upon such government willingness to help even before actual help is paid out. This may imply that "current year" may in fact encompass years *t* and *t-1*, while past state aid relates to years *t-1*, *t-2* and *t-3*. State aid does not affect risk measured as the volatility of pre-provisioning earnings and of ROA, so the relation between volatility and leverage is crucial. Control variables indicate that bank default risk is higher in countries with worse macroeconomic conditions, while the most important internal driver of ex ante bank risk is loan growth.

In general, the broadening of the safety net leads to higher *ex ante* or default risk in banks and thus strong moral hazard implications exist. Deposit insurance scheme features, such as high deposit insurance limits and lack of depositor coinsurance (and low insurance premia paid by banks in some specifications) are positively related to bank risk taking. In

addition, granting state aid to ailing financial institutions in a given country increases the risk of other national institutions, which has both a current and lagged effect.

Table 9. Estimation results for Equation (1), *ex post* risk measures

Variable	**LLP** *Spec.1*	**LLP** *Spec.2*	**LLP** *Spec.1*	**NPL** *Spec.1*	**NPL** *Spec.2*	**LLR** *Spec.1*	**LLR** *Spec.2*
Equity	-.02455633**	-0.02870725	-.07595595***	-0.1348542	-.30331315*	-0.05358579	-.1930084***
Loan growth	-.00237407**	-.00433153**	-.0029148*	-.0244193**	-.02217277*	-.00764769**	-.00945518**
Loan share	-0.00748262	-0.01075955	-0.00109675	-.10942975***	-.13261666**	-.09162595***	-.08647853***
Loan deposit ratio	0.00028951	-0.00247849	-0.00071648	-.01647586**	-.03623871***	-0.00124633	-.00694945*
Size	0.00486548	-0.00936858	0.02069417	-0.03345822	-0.3821209	-0.0497641	-0.14603455
GDP growth	-.05870789***	-.03683622**	-.04998791***	0.04681369	-0.016434	0.00937142	.0649976*
GDP per capita	-0.00008174	-0.00045642	-0.00021395	-0.0011521	0.00015104	-0.00041391	-0.00069911
Inflation	0.00938313	0.02687193	0.03374969	-0.01227307	0.02406078	-0.03927576	-0.01413983
Deposit insurance model	-0.24316678	0	0	-0.46690245	0	-0.54735441	0
Insurance premium	-61.672609*	-42.883952	-65.527236	-280.31119	-78.687692	-262.14885***	-46.202735
Premium risk dependence	0.2149705	0	0	-7.108388***	0	-4.4518203***	0
Deposit insurance limit	.15711756***	.16418168***	.17620824***	1.3614381***	1.1123852***	.70307969***	.68874219***
Coinsurance	-0.14366829	0.02308318	-0.14707329	-1.3428446*	-1.4765813	-.86262906***	-.91625443**
State aid case	0.14122347	.79120796***	0.18542935	3.7981072***	2.4143896	1.4524324***	1.3996648**
State aid in the past	0.1005511	.27143561*	0.00654368	1.4266712**	0.57278142	.57855516**	0.10826218
Limit change	0.05093361	0.14690494	-0.02461246	1.1145502	0.35969044	0.3153795	-0.1250402
Limit change past	0.0413971		-0.07358834	0.277441	0.05762342	0.12686318	-0.53166194
Date of limit change	-0.03668218	0.00186332	-0.0233856	-.40582035***	-.35171325*	-.23872557***	-.1601546**
Limit change in *t-1*		0.27663032					
Limit change in *t-2*		-0.21978454					
Total crisis aid			7.6079725		49.299924*		35.783482***
Constant	1.7244463**	3.368937**	2.2765234	19.702314***	20.31315**	12.275569***	13.693551***
F-statistics	30.735129	13.534147	19.115545	21.783732	16.266856	33.131411	31.577943
N	864	486	525	604	406	813	490

Notes: *Equity* is bank equity divided by total assets, lagged by 1 year, *Loan growth* is current year loan expansion (in %), *Loan share* is total loans to total assets, *Loan deposit ratio* is total loans to total client deposits, *Size* is total assets (divided by 1mln), *GDP growth* is GDP growth in constant 2000 prices, *GDP per capita* is in constant 2000 USD converted to EUR, *Inflation* is year-end price growth, *Deposit insurance model* is dummy variable (0 for paybox, 1 for risk minimiser), *Insurance premium* is premium paid to deposit insurance fund (as % of total deposits), *Premium risk dependence* is a dummy variable (1 for risk dependent premiums), *Deposit insurance limit* is the nominal limit divided by GDP per capita, *Coinsurance* is a dummy variable (1 if coinsurance exists), *State aid case* is a dummy variable (1 if state aid was granted to the financial sector in the given country and year), *State aid in the past*, dummy lagged variable (1 for state aid in any of the years between *t-1* and *t-3*), *Limit change* a dummy variable (1 if limit change takes place in current year), *Limit change past* dummy for past limit changes ((1 for change in any of the years between *t-1* and *t-3*) *Date of limit change* interaction term of Limit change*Deposit insurance limit, *Total crisis aid* – total aid to fin. Sector granted during the financial crisis.

The relationship between *ex post* risk – based on asset quality – and the safety net is weaker, but is maintained and remains of the same sign (Table 9). The deposit insurance limit continues to have a stable and significant effect on risk throughout all asset quality specifications. Increasing this limit leads to higher loan loss provisions, higher non-performing loans and higher loan loss reserves. On the other hand, the link between insurance limits and risk weakens in the year when the change of limit is introduced. This implies that it may take time for bank risk proxies to reflect the change in risk attitudes, and literature confirms the prevailing lag effect in asset quality ratios (see e.g. Foos at al. 2010). Higher insurance premia paid by banks and lack of coinsurance also increase risk taking, but not in all specifications.

State aid granted to financial institutions has both a contemporary and lagged effect upon risk, mainly visible in the non-performing loans and loan reserves levels. Additional financial support granted to banks during the financial crisis (*Total crisis aid*) has a positive effect on risk measured by non-performing loans and loan loss reserves, while the relationship was insignificant for risk measured by Zscore and volatilities. In conclusion, the relationship between safety net features and risk is confirmed in the *ex post* risk specification, but it strongly depends on the risk proxy used and the overall stability of the relationship is weaker.

Hypothesis 2

In order to assess if the relationship between safety net features and individual bank risk depends on the shareholder structure (Hypothesis 2), we estimate Equation 2 on the full bank sample.

Bank default risk (Table 10) remains dependent on both deposit insurance features and state aid risk, if we control for the stake held by the largest shareholder, and the relation becomes only marginally stronger in economic terms. The level of default risk of government-owned banks is higher and these banks' reactions to changes in deposit insurance limits are enormous, in comparison to privately owned institutions (almost four times larger). Majority ownership by other financial institutions does not increase default risk, but leads to higher volatility of asset returns. In addition, for these banks raising the deposit insurance limit increases volatility of ROA, the sensitivity being two times larger than that of the remaining institutions. The effect does not materialise for Zscore, however, which implies that maybe there is an adequate equity cushion to cover for the more elevated ROA volatility.

Table 10. Estimation results for Equation (2), *ex ante* risk measures

Variable	**Zscore** *Spec.1*	**Zscore** *Spec.2*	**Zscore** *Spec.3*	**ROA volatility** *Spec. 1*	**ROA volatility** *Spec. 2*	**Earnings volatility** *Spec. 1*	**Earnings volatility** *Spec. 2*
Equity	0.0107139	0.013088	0.010611	0.014462	0.01362508	0.01070763	0.01078184
Loan growth	-.0021379*	-0.00202	-0.0021	.00197396*	.00213241**	.00221334***	.00212453***
Loan share	0.00874938	0.009426	0.008983	-0.00659	-0.0073275	-0.00135235	-0.00083599
Loan deposit ratio	0.00086425	0.000725	0.00083	0.000818	0.00087439	-0.00002834	-0.00002984
Size	-0.01278888	-0.0057	-0.00982	-0.03194	-.03275684*	0.00256516	0.00384745
GDP growth	0.00943816	0.008503	0.009529	-0.00578	-0.00548773	0.00233996	0.00217997
GDP per capita	.00045796**	.00045115**	.00046433**	-.00054533***	-.00055248***	-.00020932*	-.00020422*
Inflation	-0.00232042	0.000968	-0.00237	-0.00169	-0.00092313	-0.01156824	-0.01134099
Deposit insurance model	-0.20038617	-0.21572	-0.14231	-0.05688	-0.04611207	0.0481692	0.03162069
Insurance premium	70.01013*	67.13392	72.951311*	-35.8595	-41.042954	18.64002	20.850425
Premium risk dependence	0.31741972	0.288758	0.286275	-0.11073	-0.11555032	-0.17591168	-0.19475712
Deposit insurance limit	-.07696817***	-.07540735***	-.06615472**	.06507393***	.04009002*	0.00925393	.02451874*
Coinsurance	.54869917***	.53493582***	.54198894***	-.46761671***	-.45351401***	-.18638708***	-.16916373**
State aid case	-.42995354***	-.43606312***	-.41123277***	0.179753	0.18010624	0.07489822	0.0782027
State aid in the past	-.20363078*	-.18585387*	-.20738146*	0.056409	0.07451919	0.00298431	0.00703464
Limit change	-0.03813704	-0.02916	-0.03779	0.014314	0.02257295	-0.0434339	-0.04319557
Limit change past	-0.13047838	-0.13142	-0.1413	0.045999	0.06024059	-0.03525062	-0.03640165
Primary shareholder	0.0020972	0.005274	0.001146	0.000416	0.00178181	0.00043702	0.00111054
Bank maj. shareholder	-0.1640117			.35087046**		0.04896291	
Government maj. shareholder	-.86277632*			0.120149		-0.01250227	
Full ownership		-0.35717					
Majority ownership		-0.20986					
Government min. share (10%)			-0.07309		0.33792033		0.00734038
DI limit*bank ownership			-0.01357		.04319963**		-.02639321*
DI limit*government ownership			-.19080985**		-0.00985407		0.00520822
Constant	0.73417853	0.647027	0.621705	3.1503674***	3.3075574***	1.3455577***	1.2613067**
F-statistics	9.4211179	9.362095	9.04675	7.512076	7.1577329	1.8904121	1.980836
No. of observations	864	864	864	864	864	864	864

Notes: *Primary shareholder* is the stake held by the largest shareholder (in %), *Bank majority shareholder* is a dummy variable (1 for banks that have "Bank" as majority shareholder type in Bankscope), *Government majority shareholder* is a dummy variable (1 for banks that have "Public authority, State, Government" as majority shareholder type in Bankscope), *Full ownership* is a dummy variable (1 if primary shareholder owns over 95%), *Majority ownership* is a dummy variable (1 if primary shareholder owns over 50%). For description of remaining variables see notes under Table 8.

Table 11. Estimation results for Equation (2), *ex post* risk measures

Variable	**LLP** *Spec. 1*	**LLP** *Spec. 2*	**LLP** *Spec. 3*	**NPL** *Spec. 1*	**NPL** *Spec. 2*	**LLR** *Spec. 1*	**LLR** *Spec. 1*
Equity	-.02339952**	-.02356125**	-.0239619**	-0.11044374	-0.11520271	-0.04403098	-0.04759544
Loan growth	-.00257995**	-.00258891**	-.0022247*	-.02611543***	-.02678419***	-.00848384***	-.00787963**
Loan share	-0.00750894	-0.0077155	-.00925418*	-.10304562**	-.10076162**	-.09024212***	-.09308404***
Loan deposit ratio	0.00023919	0.00024533	0.00025147	-.01884395**	-.01914648**	-0.00200686	-0.00180697
Size	0.00434748	0.00409832	-0.00109033	-0.02133719	-0.02293255	-0.03904649	-0.05900261
GDP growth	-.05426451***	-.05413588***	-.05340319***	0.09979676	0.09409812	0.04148161	0.04187494
GDP per capita	-0.00006275	-0.00006339	-0.00007008	-0.00097407	-0.00103091	-0.0003065	-0.00033929
Inflation	0.01142858	0.01154082	0.01132091	0.02721827	0.03432077	-0.02290736	-0.02477419
Deposit insurance model	-0.24387562	-0.23831979	-0.17552074	-0.47396305	-0.29481755	-0.59859617	-0.30665231
Insurance premium	-57.825879	-57.70138	-63.987092*	-184.33132	-155.88366	-234.18702**	-250.84883**
Premium risk dependence	0.15504698	0.1515812	0.19298959	-8.4060873***	-8.5132342***	-5.0147537***	-5.0177396***
Deposit insurance limit	.14189828***	.14209088***	.09342327***	1.1839149***	1.2578068***	.60428439***	.54777803***
Coinsurance	-0.14957361	-0.14535113	-0.18338794	-1.3137523	-1.2611003	-.88303448***	-.91764538***
State aid case	0.18411549	0.19105485	0.18638306	4.4383075***	4.4428264***	1.7989227***	1.802242***
State aid in the past	0.09480282	0.09961005	0.09127256	1.4207109**	1.4363637**	.60905109**	.55691113**
Limit change	-0.09120399	-0.09238076	-0.08526789	-0.60962469	-0.6219644	-.59981651***	-.58628605***
Limit change past	0.04923275	0.04934274	0.06004888	0.41446162	0.40132585	0.19848684	0.21599163
Primary shareholder	-0.00132685	-0.00028023	-0.00204898	0.02486646	0.02466848	0.00099625	0.00183499
Bank maj. shareholder	0.0687942			-0.17884809		-0.00238499	
Government maj. Shareholder	-0.06554749			-1.7727547		0.49899362	
Full ownership		0.03397498					
Majority ownership		-0.09133304					
Government min. share (10%)			-0.42113363		3.3929589		1.3851011
DI limit*bank ownership			.08706299***		-0.13891839		.1076058*
DI limit*government ownership			-0.05535193		-0.71042118		-.69155337***
Constant	1.7194928*	1.746533**	1.9692194**	16.889679***	16.699608***	11.674798***	11.929541***
F-statistics	27.397914	27.404294	27.511038	19.041668	18.283335	28.522915	28.22658
No. of observations	864	864	864	604	604	813	813

Notes: For variable descriptions, see notes under Table 10.

For the *ex post* risk specifications (Table 11), results indicate that the safety net effects are sustained after accounting for shareholder structure. Deposit insurance features and state aid are again significant in the non-performing loans and loan loss reserves risk ratios, even if the economic effect is slightly lower.

On the other hand, shareholder structure and the kind of shareholder do not affect the level of *ex post* risk in any specification. This again proves the difference between both types of risk measures and indicates that asset risk ratios may be additionally shaped by other elements. Conversely, there is again evidence for a higher risk sensitivity towards safety net changes on the side of banks owned by other financial institutions. They prove more sensitive to deposit insurance limit changes in terms of risk measured by provisioning and reserve levels. In other words, broadening the safety net increases the risk of these banks more than that of other financial institutions. They are thus confirmed to be more susceptible to moral hazard factors.

In contrast to the *ex ante* risk setting, in *ex post* risk government owned banks tend to be *less* sensitive to changes in insurance limits, but this is significant only for the loan loss reserves measures.

Financial crisis effects

As shown in Section 2, Central Europe has been under macroeconomic stress during the financial crisis, even if some regions have suffered less and generally the scope of the deterioration was narrower than in some Western European countries and the US. We extend our both hypotheses and verify if during financial crises the relationship between safety net, shareholder structure and risk is modified. In order to carry out the empirical test, we introduce dummy variables for the crisis, equalling 1 for years 2008 and 2009, which allows to estimate changes in the level of bank risk. In addition, we introduce interaction terms with the crisis dummies, relating to the sensitivity towards deposit limit changes (crisis limit sensitivity), representing overall attitude to modifications in safety net, and to the shareholder structure (crisis shareholder structure), representing the potentially different role of primary shareholders during recessions.

Results reported in Table 12 provide evidence that default risk is visibly higher during the crisis, but other *ex ante* risk measures do not display sensitivity towards the crisis period. This may be caused by the fact that pure volatilities of earnings are not sufficient to capture the crisis effects and only after accounting for the equity levels, does the full extent of risk become visible. Among the *ex post* ratios, only loan loss provisioning levels prove sensitive to

Table 12. Estimation results for Equation (2), accounting for the financial crisis – *ex post* and *ex ante* risk measures

Variable	Zscore	ROA volatility	Earnings volatility	LLP	NPL	LLR
Equity	0.01079999	0.01445756	.01260854*	-.02672402**	-0.178916	-.06836628**
Loan growth	-.00274598**	.00206108*	.0023647***	-.00239176**	-.03237188***	-.01073493***
Loan share	.01104419*	-0.0071246	-0.00258778	-0.00541932	-.07798432*	-.07918536***
Loan deposit ratio	0.00095634	0.00086147	-0.00010058	-0.00016661	-.01390188*	0.00074416
Size	-0.00716769	-.03305449*	0.00249951	0.00281785	-0.02879166	-0.03740771
GDP growth	0.00789378	-0.0060226	0.00663794	-.05664206***	-0.0126391	-0.02401468
GDP per capita	0.00025365	-.00050543***	-0.00015181	-0.00009636	-0.00234394	-0.00091397
Inflation	0.00333106	-0.00322154	-0.0098287	0.01023961	-0.05100071	-0.05882736
Deposit insurance model	-0.13380357	-0.0684353	0.02874803	-0.24344875	-0.13378509	-0.35693273
Insurance premium	56.916039	-33.64838	14.854559	-44.623993	-72.52398	-190.97148*
Premium risk dependence	0.34461155	-0.10787754	-0.25186492	0.20864361	-6.216482***	-3.8773004***
Deposit insurance limit	-.11730763***	.07272283***	0.01172168	.15205582***	1.1321036***	.58675332***
Coinsurance	.51586524***	-.46052948***	-.17953974***	-0.15638839	-1.3669042*	-.90802368***
State aid case	-.39128081**	0.17064725	0.1184815	0.11137509	3.3071136***	1.1845981***
State aid in the past	-.20550019*	0.05225022	0.00966908	0.1205947	1.0719301	0.42883003
Limit change	-0.07502822	0.02514119	-0.0624378	-0.07703583	0.13553989	-0.29320829
Limit change past	-0.09300109	0.03946375	-0.04047023	0.04011831	0.48541596	0.2365674
Primary shareholder	0.00208216	0.00057975	0.00085121	-0.00331861	0.0192783	-0.00129134
Bank maj. shareholder	-0.14903928	.34722238**	0.03321381	0.09649555	0.25621008	0.17465573
Government maj. shareholder	-.86640521*	0.12031488	-0.00268618	-0.07656613	-1.9123899	0.34053825
Crisis	-.43689059**	0.12681763	0.13556373	-.42750986**	-1.8838035	-0.80962882
Crisis* DI limit	.05495988**	-0.0124263	0.01289106	-0.02501635	-.39630309**	-.21665961***
Crisis* primary shareholder	0.00119026	-0.00081012	-0.00142993	.00669343***	0.0185438	0.00766652
Constant	1.6866127	2.9574926***	1.0941815**	1.9034709**	22.831136***	14.221909***
F-statistics	8.4913766	6.5329743	1.8428854	24.614981	18.103468	27.241166
No. of observations	864	864	864	864	604	813

Notes: *Crisis* is a dummy variable, taking the value of 1 for years 2008 and 2009. *Crisis*DI limit* denotes bank risk sensitivity to deposit insurance changes during the financial crisis, *Crisis*primary shareholder* denotes bank risk sensitivity to shareholder changes during the financial crisis. For the remaining variable descriptions, see notes under Table 8 and Table 10.

the economic recession, but with a negative sign. This implies that during the first phase of the crisis provisioning levels are lower, as banks fight to sustain bottom line profits through less generous reserve policies. Again, the already mentioned lag effect in asset quality ratios is to be considered here.

The key result in the financial crisis specification is however the stable and robust effect of *decreased* sensitivity of bank risk towards changes in safety net elements (represented by deposit insurance limit). This may indicate that during financial crises banks' risk levels become *less* dependent on formal safety net features and moral hazard declines. In other words, increasing deposit insurance limits during a crisis has a less detrimental effect on bank risk taking than during normal times. Banks may be aware of financial pressure on governments, which display a reduced ability of helping ailing banks, especially in developing countries of Central Europe. This cannot be attributed to a different position of primary shareholders in bank risk taking during recessions, as the interaction term Crisis Shareholder Structure appears significant only in the loan loss provisioning setting. Generally, the financial crisis estimation has proven that – in Central European banks – moral hazard incentives coming from the safety net have decreased during the crisis and the shareholder structure was rather irrelevant in this process. On the other hand, we are not able to measure the lagged effects of broadening the safety net during crisis times, as the recession took place at the end of our sample period. This possibility is not to be ignored, as moral hazard incentives may appear with delays, as shown earlier.

4. Robustness tests

We check robustness of our results through two additional specifications. In the first robustness test, we re-estimate both equations on a modified bank sample. In the second test, we perform a random effects estimation on both equations.

In order to verify the strength of our main results, we re-estimate Hypothesis 1 on a modified bank sample. As the descriptive statistics on macroeconomic conditions (Section 2.2.) demonstrate, although the general homogeneity of Central European countries is high (in comparison to some other international samples), some outliers exist. We decide to modify our bank sample by deleting all banks from the three Baltic states. Trouble that the economies and banks in these countries experienced during the financial crisis may distort the remaining sample and drive the results for the rest of the region. We reduce our main sample by 138

Table 13. Estimation results for Equation (1), on a reduced bank sample, *ex post* and *ex ante* risk measures

Variable	Zscore	ROA volatility	Earnings volatility	LLP	NPL	LLR
Equity	0.01651907	.01854327*	0.00280578	-0.0178825	-0.04562947	-.06101449*
Loan growth	-.00287504**	.00210528**	.00285578***	-.00331556***	-.02131927*	-.00613096**
Loan share	0.00678763	-0.00276353	-0.00165909	-0.00186493	-0.02125951	-.05728662***
Loan deposit ratio	0.00058878	.00200599*	-0.00020219	0.00103741	-.03422625***	-0.00121612
Size	-0.01610214	-.03142087*	0.00308438	0.00574503	-0.05012802	-0.03723407
GDP growth	0.01739943	-0.01911574	-0.00680469	-0.01476097	0.03609472	-0.0128088
GDP per capita	0.00021884	-0.00022701	-0.00014914	-0.00025566	-0.00010778	0.00030056
Inflation	0.011599	0.01878448	-0.01213725	.05230984***	0.12538964	.15488161***
Deposit insurance model	-0.21000895	-0.04994389	0.04277362	-0.22642523	-0.95497287	-.85543593*
Insurance premium	43.690788	-15.804771	27.33587	-79.6931**	-109.52302	-286.48496***
Premium risk dependence	0.1022405	-0.06508058	-0.12182016	0.13025782	-7.9839018***	-4.1436858***
Deposit insurance limit	-0.02866451	0.01718313	-0.00429756	.19508826***	1.1395149***	.61212693***
Coinsurance	.4394987***	-.36646641***	-.16667481*	-.34762682***	-1.2730578	-1.2759755***
State aid case	-0.20687697	0.03664449	0.02706363	0.07927147	3.935073***	0.55857441
State aid in the past	-0.13507507	-0.04013241	-0.01930516	0.00707429	0.94624611	-0.25523139
Limit change	0.02779727	-0.00095928	-0.07006963	-.2012443***	-1.1045443*	-1.0305898***
Limit change past	-0.14445691	0.06863883	-0.0311659	-0.02821722	-0.0789755	-0.23913136
Constant	1.8889758	1.5477292	1.2856455*	1.8206912*	10.413759	7.3045106**
No. of observations	726	726	726	726	496	679
F-statistics	3.9202411	2.9812724	1.9224223	21.382363	10.847449	22.350576

Notes: *Equity* is bank equity divided by total assets, lagged by 1 year, *Loan growth* is current year loan expansion (in %), *Loan share* is total loans to total assets, *Loan deposit ratio* is total loans to total client deposits, *Size* is total assets (divided by 1mln), *GDP growth* is GDP growth in constant 2000 prices, *GDP per capita* is in constant 2000 USD converted to EUR, *Inflation* is year-end price growth, *Deposit insurance model* is dummy variable (0 for paybox, 1 for risk minimiser), *Insurance premium* is premium paid to deposit insurance fund (as % of total deposits), *Premium risk dependence* is a dummy variable (1 for risk dependent premiums), *Deposit insurance limit* is the nominal limit divided by GDP per capita, *Coinsurance* is a dummy variable (1 if coinsurance exists), *State aid case* is a dummy variable (1 if state aid was granted to the financial sector in the given country and year), *State aid in the past*, dummy lagged variable (1 for state aid in any of the years between *t-1* and *t-3*), *Limit change* a dummy variable (1 if limit change takes place in current year), *Limit change past* dummy for past limit changes ((1 for change in any of the years between *t-1* and *t-3*).

observations and run the estimations for both *ex ante* and *ex post* risk proxies. The results of verifying Hypothesis 1 on a restricted sample are presented in Table 13.

In general, our conclusions regarding the relationship between safety net and bank risk are confirmed. However, the relationship changes for the restricted sample size. For the *ex ante* risk, the previously robust relationship between risk and deposit insurance limit weakens or disappears and only lack of coinsurance remains a stable risk driver. In addition, state aid granted to financial institutions does not affect current or lagged levels of default risk. On the other hand, for *ex post* risk proxies the relationship between deposit insurance and bank risk visibly strengthens, both in terms of the economic and statistical significance. State aid remains meaningless for *ex post* risk levels in this sample.

In order to verify the conclusions on Hypothesis 2, we re-estimate the Equation 2 on the restricted bank sample. The results are mixed, as in case of Hypothesis 1 re-estimation. The relationship between safety net impulses and *ex ante* risk visibly weakens, with the coinsurance feature again playing a role in risk taking. Risk measured through *ex post* proxies remains dependent on the safety net, mostly through deposit insurance features however, which again proves that state aid effects may be strongly driven by the Baltic country banks in our total sample.

As far as the relationship between shareholder structure, risk and the safety net is concerned, results are mixed. Government owned banks in the non-Baltic CE countries no longer display higher risk levels, but their high sensitivity to deposit limit changes persists, while privately owned banks seem immune to deposit limit changes. On the other hand, increasing deposit insurance limits results in lower loan loss reserves in government banks, which may not necessarily be a sign of lower asset risk. These institutions may decide to create lower reserves, when news about an anticipated deposit limit increase surface, relying on an increased governmental propensity to cover bank losses.

In the reduced sample, bank ownership is confirmed to result in higher absolute risk levels, as measured through ROA volatility, and their higher sensitivity to deposit limit changes is again mirrored in the loan loss provisioning levels. Thus, increased sensitivity towards moral hazard incentives in bank owned financial institutions persists.

Table 14. Estimation results for Equation (2), on a reduced bank sample, *ex post* and *ex ante* risk measures

Variable	**Zscore** *Spec.1*	**Zscore** *Spec.2*	**ROA volatility**	**LLP** *Spec.1*	**LLP** *Spec.2*	**NPL**	**LLR**
Equity	0.01557213	0.01500363	.01837193*	-0.01777248	-.01809576*	-0.05302727	-.06525883**
Loan growth	-.00283286**	-.00275354**	.00229478**	-.00345074***	-.00319032***	-.02091003*	-0.00505577
Loan share	0.00661638	0.00629686	-0.00219196	-0.00222446	-0.0041665	-0.01846824	-.05776192***
Loan deposit ratio	0.00065718	0.0005922	0.00181212	0.00110628	0.00102949	-.03461***	-0.00152633
Size	-0.02348378	-0.022055	-0.02811308	0.00307157	-0.00121981	-0.05352036	-0.04423728
GDP growth	0.01766759	0.01794921	-0.02055072	-0.01469588	-0.01251017	0.03614438	-0.01068673
GDP per capita	0.00020266	0.00020568	-0.00020841	-0.00025932	-0.00026678	-0.00010921	0.0002409
Inflation	0.01163332	0.01011272	0.01853701	.05223378***	.04830411**	0.12841714	.14732764***
Deposit insurance model	-0.20608722	-0.1338896	-0.05261592	-0.21747934	-0.15256158	-0.97862655	-0.62215398
Insurance premium	40.461514	41.985241	-12.976804	-81.044075**	-86.220321**	-101.75677	-294.14728***
Premium risk dependence	0.13064733	0.10738399	-0.06651746	0.14975981	0.19014472	-8.1226798***	-4.2599766***
Deposit insurance limit	-0.02749515	-0.0268378	0.01311181	.19556384***	.15554775***	1.1359467***	.5851369***
Coinsurance	.44778216***	.43859828***	-.38569868***	-.35518516***	-.3774145***	-1.2604585	-1.2958036***
State aid case	-0.22935512	-0.2023933	0.03175624	0.07873202	0.0939488	3.9119569***	0.57746787
State aid in the past	-0.14345187	-0.1470266	-0.05930625	0.00015245	0.00326603	0.87417934	-0.29181872
Limit change	0.02684992	0.02872551	-0.00659472	-.2019667***	-.19369653***	-1.0942752*	-1.0232226***
Limit change past	-0.13502611	-0.1443453	0.05851069	-0.02950626	-0.01886385	-0.05820097	-0.23985109
Primary shareholder	0.00152015	0.00023759	0.00268715	-0.00214017	-0.00321985	0.01523552	0.00946124
Bank maj. shareholder	-0.15992362		.32194743*	0.0581189		0.10437957	
Government maj. shareholder	-0.77824436		0.010238	-0.09346103		-1.4903005	
Government min. share (10%)		-0.0270661			-0.59157385		1.0245924
DI limit*bank ownership		0.00496291			.06951923***		0.06055146
DI limit*government ownership		-.20186757**			-0.02896278		-.68354671***
Constant	2.0072112	1.9816263	1.0763235	1.9934352*	2.3006312**	9.2385536	6.9387152**
F-statistics	3.486611	3.4658379	2.9683666	18.149831	18.264316	9.2004791	19.175534
No. of observations	726	726	726	726	726	496	679

Notes: For variable description see Table 9 and Table 10.

Although the results of the Hausman test on our estimation implies using the fixed effects approach, we decide to run a random effects estimation as a robustness check. The results of estimating Equation (1) in a random effects specification are shown in Table 15, while Equation (2) is presented in Table 16.

In general, the random effects specification confirms both robustness and direction of the relationship between safety net and bank risk. Broadening of the deposit insurance schemes and state aid boost risk incentives for banks, although the effect differs again for various risk proxies. The sensitivity towards moral hazard incentives coming from the deposit insurance appears with a lag, as the interaction term between the year of changing the deposit limit and the limit itself implies a decreased sensitivity if the change took place in the current year. On the other hand, the random effects model displays lack of link between past state aid and present level of risk, an effect that surfaced strongly and consistently in the fixed effects estimation. Last but not least, a strong procyclicality of risk towards the economic cycle becomes visible, with periods of high growth accompanied by decreasing risk proxies.

Estimation of Hypothesis 2 through the random effects specification does not change conclusions on the safety net versus risk debate. However, some conclusions regarding the role of shareholder structure in risk taking should be treated with caution. The random effects model reveals no link between government owned banks and risk, neither regarding its absolute level nor special risk sensitivity of government banks towards safety net changes. On the other hand, a higher default risk appears on the side of bank owned financial institutions, and their sensitivity towards safety net modifications differs from the rest of the sample in some settings. In general, these effects are not very stable however and are not sufficient to override the conclusions from the fixed effects specification.

Conclusions

The aim of this analysis was to analyse moral hazard incentives that the broadening of country safety nets may produce for bank risk taking in Central Europe. Furthermore, we intended to establish if shareholder structure characteristics may modify the moral hazard framework produced by the safety net in the region. Both hypotheses were estimated using a c.200 bank sample from eleven Central European countries, encompassing the period 2005-2010, supplemented by a hand-collected database of regulatory factors.

We find a strong, stable and adverse effect that the broadening of financial safety net may have on individual bank risk levels in Central Europe. The moral hazard effect materialises on current risk and is maintained with a lag of up to three years. The results are

confirmed using various specifications, both on the risk side and on the sample size. On the other hand, we find that the adverse influence of broadening the safety net may decrease during financial crises. During recessions, banks' risk levels become *less* dependent on formal safety net features and moral hazard declines. Banks may realise a decreased importance of explicit safety net features during such periods and no longer adjust their risk levels to the declared scope of a safety net. It is important to keep in mind however that it is too early to analyse the full moral hazard effects of the financial crisis era, as lagged effects may still surface and our estimation period finishes in 2010.

Shareholder structure does not fundamentally change the relationship between bank risk and safety net features in Central Europe. We find higher *ex ante* risk levels for government owned banks and their sensitivity to changing safety net characteristics is also stronger in some settings. These results are however not stable for all risk specifications.

More robust findings are demonstrated for financial institutions owned by banks. In some settings, they prove more risky than their peers. More importantly, however, there is stable evidence for their higher risk sensitivity towards safety net changes, so broadening the safety net increases the risk of these banks more than that of other financial institutions. Bank-owned institutions in Central Europe seem thus to be more susceptible to moral hazard factors, although again the result is not universal for all risk proxies.

Our results highlight that introducing broader safety net schemes in Central Europe has important costs in terms of bank risk levels. In addition, some banks react to such changes more aggressively than others and shareholder structure may play an important role. Surprisingly, having a majority shareholder in the form of a (usually powerful) bank does not alleviate the moral hazard problem and indicates that such banks still refer to country safety nets as their financial backup. In consequence, we believe that broadening of the financial safety net in Central Europe should be accompanied by a well-designed regulatory framework, which curbs excessive bank risk taking that could lead to financial stability problems.

Table 15. Estimation results for Equation (1), random effects specification, *ex post* and *ex ante* risk measures

Variable	**Zscore** *Spec.1*	**Zscore** *Spec.2*	**Zscore** *Spec.3*	**ROA volatility**	**Earnings volatility**	**LLP**	**NPL**	**LLR** *Spec.1*	**LLR** *Spec.2*
Equity	0.01016405	0.01126143	0.01064519	.03431602***	.02904075***	-0.00483453	0.10244275	0.04188476	0.02475238
Loan growth	-.00387199***	-.00384417***	-.00355643***	.00363341***	.00285635***	-.00288697***	-.03408009***	-.01448216***	-.0140772***
Loan share	0.00615636	0.00531329	0.00541372	-.00660123**	-.00596086***	0.00264854	-.1040062***	-.07114347***	-.03330155**
Loan deposit ratio	-0.00030249	-0.00044674	-0.00036819	0.00080755	-0.00014468	0.00079062	-0.00076318	9.87E-06	-0.00235407
Size	0.01285976	0.01212588	0.01185843	-0.01146808	-0.00784626	-0.00273935	-.15070334**	-0.04515676	-0.01373187
GDP growth	.02994298***	.03733974***	.03159493***	-.02833573***	-0.00092912	-.06007995***	-0.0125606	-0.01719006	.07888171***
GDP per capita	0.00003378	0.00003265	0.00003379	-0.00004982	-.0000367*	-0.0000305	-0.00017498	.00027102**	-0.00005745
Inflation	-0.00059494	0.0007922	-0.00037891	-0.00532566	-0.00733659	0.01287457	-0.06933913	-.11218755**	0.0287101
Deposit insurance model	-0.12989798	-0.11708008	-0.11995171	-0.1091332	0.0451012	-0.18828736	-0.08550045	0.12232314	-1.6250708
Insurance premium	81.742002***	86.506781***	86.043301***	-50.533387**	-9.7982437	-73.27975**	-548.61564**	-280.48395***	-440.25157***
Premium risk dependence	0.12986197	0.06385856	0.09517873	0.01398492	-0.11788907	0.24293681	-4.2092522***	-1.8988134***	-0.12088632
Deposit insurance limit	-.07595658***	-.09687866***	-.0823393***	.07429814***	0.01024108	.1643343***	1.2709825***	.61509524***	.7131217***
Coinsurance	.42883439***	.43877705***	.444184***	-.28036978***	-.16490327***	-0.14998573	-1.1715934*	-.63635479**	-.75035091**
State aid case	-.40043398***	-.4225545***	-.46127229***	.18725352*	.16718723**	0.14098267	3.5884634***	1.2992928***	2.1240591***
State aid in the past	-0.13762143			0.06503959	0.01922675	0.07974968	0.98436229	0.20861559	0.27086719
Limit change	0.05283693		0.07193329	0.02275812	-0.08694228	0.0342759	1.4275702*	0.49987507	-0.44569947
Limit change past	-0.11449258			0.00526276	-0.0305243	-0.02399208	-0.03474765	-0.05432357	-.77093995**
Date of limit change		.03302664**		-0.02092857	0.01371446	-.04508077*	-.532083***	-.29927168***	-0.10160128
Total crisis aid									38.854094***
Constant	2.8149958***	2.7986484***	2.7809325***	.87625299***	.79816156***	.70126197**	12.921877***	7.1149506***	5.724566***
No. of observations	864	864	864	864	864	864	604	813	490

Notes: For variable description see Table 9.

Table 16. Estimation results for Equation (2), random effects specification, *ex post* and *ex ante* risk measures

Variable	**Zscore** *Spec.1*	**Zscore** *Spec.2*	**ROA volatility**	**Earnings volatility**	**LLP** *Spec.1*	**LLP** *Spec.2*	**NPL** *Spec.1*	**NPL** *Spec.2*	**LLR** *Spec.1*
Equity	0.00804694	0.00947176	.03587531***	.02827349***	-0.00589479	-0.0050771	0.11728964	0.11534758	.0454198*
Loan growth	-.003791***	-.00386046***	.00352146***	.0028455***	-.00308721***	-.00296779***	-.03725663***	-.0377055***	-.01623119***
Loan share	.00710611*	0.00650301	-.00714614**	-.00513816**	0.00284247	0.00109574	-.09807201***	-.09705564***	-.0688978***
Loan deposit ratio	-0.00026282	-0.00029187	0.00069503	-0.00012411	0.00074101	0.0006759	-0.00286694	-0.00326378	-0.0000745
Size	0.01421432	0.01256264	-0.01219719	-0.00640474	-0.00223084	-0.00363903	-.14523083**	-.15843238**	-0.04380171
GDP growth	.02973084***	.02958467***	-.02581225***	-0.00283845	-.05474226***	-.0543357***	0.05177879	0.04473451	0.02056726
GDP per capita	0.00003139	0.00003219	-0.0000489	-0.00003645	-0.00003604	-0.00002964	-0.00022039	-0.00026489	.00023611**
Inflation	-0.00026975	-0.00051938	-0.00458563	-0.00762232	0.01529702	0.01433064	-0.01105383	-0.00831636	-.09149163**
Deposit insurance model	-0.12328547	-0.11659528	-0.11392436	0.05428244	-0.18837525	-0.16918651	-0.14423315	-0.11333434	0.06225031
Insurance premium	80.633583***	82.215485***	-47.888243*	-9.1430285	-72.690675**	-71.012727**	-520.21704**	-500.97388**	-279.77275***
Premium risk dependence	0.11164688	0.11601144	0.0090514	-0.12706413	0.20870229	0.21983531	-4.8252375***	-4.8738226***	-2.085783***
Deposit insurance limit	-.07698441***	-.06712839***	.06427866***	.0357452***	.14281084***	.12306857***	1.0227587***	1.089121***	.48005103***
Coinsurance	.4496967***	.43689698***	-.29656654***	-.15320419***	-0.14450578	-.16515166*	-1.1941096*	-1.1887367*	-.63698051**
State aid case	-.4137804***	-.40319479***	.21038337**	.15544164**	0.16782455	0.17961667	4.1719744***	4.1458999***	1.5656236***
State aid in the past	-0.12900578	-0.14048298	0.05825954	0.01967077	0.08118801	0.07155177	1.0507267	1.0208746	0.24669232
Limit change	0.0545938	0.05318856	-0.05615374	-0.03549088	-.13511081**	-.13342108**	-0.81561781	-0.83500711	-.63953628***
Limit change past	-0.10878276	-0.11432395	0.0112457	-0.03832597	-0.00503702	-0.00735946	0.21863772	0.22383219	0.06570427
Primary shareholder	0.0021894	0.00050358	-0.00048305	0.00131451	0.00047798	-0.00174229	0.00958802	0.0096283	-0.00559394
Bank maj. shareholder	-.24864768*		0.14209496		-0.12165015		-0.79135293		-0.37635269
Government maj. shareholder	-0.21402738		0.03475486		-0.2812923		0.92543592		0.69726038
Government min. share (10%)		0.15708609		-0.086137		-0.15682796		3.1097108	
DI limit*bank ownership		-0.01453984		-.03501773***		.04000902**		-0.13640511	
DI limit*gov. ownership		-0.07939087		-0.00791783		-0.08901135		-0.35954292	
Constant	2.760642***	2.7624664***	.87858067***	.64003478***	.81228097**	.97713839***	12.954261***	12.663569***	7.9711312***
No. of observations	864	864	864	864	864	864	604	604	813

Notes: For variable description see Table 9 and Table 10.

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