The Fourteenth Dubrovnik Economic Conference

Organized by the Croatian National Bank

HNB

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Measuring Bank Insolvency Risk in CEE Countries

Hotel "Grand Villa Argentina",
Dubrovnik
June 25 - June 28, 2008

Draft version

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CROATIAN NATIONAL BANK

Measuring Bank Insolvency Risk in CEE Countries[*]

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Abstract

This paper investigates the impact of various macroeconomic and bank-specific variables on bank insolvency risk in 7 CEE countries from 1996 to 2006. Estimating separate pooled regression for each country we provide an empirical evidence that bank stability decreases in credit growth, inflation and banking sector concentration. Bank insolvency risk is measured by *z-score*, our *distance-to-insolvency* indicator. Beside actual z, we construct conditional *z-scores* that directly link bank insolvency risk with bank-specific and macroeconomic indicators. Employed insolvency risk measures suggest the rise of bank stability in all CEE countries under consideration.

[*]We are grateful to Ivana Herceg for her invaluable data assistance. We also thank Ivo Krznar, Evan Kraft and Martin Cihak for useful comments. The views expressed in this paper are those of its authors and do not necessarily reflect the view of the Croatian National Bank. All remaining errors are ours.

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1 Introduction

In this paper we study the way macro and micro factors affect bank insolvency risk in Central and Eastern European countries (CEEC). In these countries, the stability of the banking system plays an especially important role as their financial systems are *bank-centric* and largely dominated by commercial banks. Taking into account the remarkable development of CEEC banking sectors since the beginning of the transition process, the question arises what are the factors affecting their stability.

Motivated by related literature (de Nicolo (2000), Cihak and Hesse (2006) and Machler et al (2007)), bank stability is measured by *z-score*. The employed measure is based on Roy (1952), who shown that the probability that current losses would exceed capital is less than or equal to $\frac{1}{z^2}$, so that higher level of z implies lower upper bound of insolvency probability. This indicator has been widely used in recent analyses due to its suggestive *distance-to-insolvency* interpretation - it measures the number of standard deviations returns may drop before they exhaust bank's capital.

De Nicolo (2000) documents the relationship between bank size and measures of charter value and insolvency risk in a sample of publicly traded banks in 21 industrialized countries. With some exceptions, charter values decrease in size and insolvency risk increase in size for most banks in countries considered. He also found that banks operating in countries with more developed financial markets exhibit lower insolvency risk, while bank consolidation is likely to result in an average increase in banks' insolvency risk.

Cihak and Hesse (2006) extended the research on the cooperative banks in 29 OECD countries, analyzing their role in financial stability using the *z-score*. They found that cooperative banks are on average more stable than commercial banks, mainly due to the lower volatility of their returns, which more than offsets their lower profitability and capitalization. Using the regression analysis, they also found that a higher share of cooperative banks increases stability of an average bank in the same banking system.

Boyd, De Nicolo and Al Jalal (2006) explored relationship between concentration and banks' risk of failure, using *z-score* as an empirical risk measure. Their results revealed a positive association between market concentration and risk of failure, driven primarily by a positive association between concentration and volatility of the rate of return on assets.

Bank stability in CEEC has already been studied in the literature using framework similar to that employed in this paper. In contrast to Maechler et al. (2007) who studied aggregated banking stability in the Eastern Europe here we analyse each country separately. Extending beyond the existing literature, together with *distance-to-insolvency* property of our insolvency risk measure we also adopt an intuitive feature of *z-score* as a probability of insolvency indicator. Moreover, we attempt to link probability of insolvency of CEE banks and a number of relevant macro and bank-specific variables. Analysing these *conditional indicators* might be of particular interest in the context of recent global financial turmoil and rising inflation pressures. Finally, after estimating individual banks' insolvency risk we construct systemic risk indicators for each of the CEE countries.

Using extensive knowledge of Croatian banking sector, this paper further investigates whether the usage of more detailed and higher frequency data allows for more precise measure of bank insolvency risk.

The rest of the paper is organized as follows. Section 2 analyses bank insolvency risk in CEEC using regression framework. Section 3 introduces conditional insolvency indicators. Section 4 studies Croatia in more details. Section 5 concludes.

2 Bank insolvency risk decomposition

This section introduces technical framework we follow throughout the paper. First, our insolvency risk measure, namely the *z-score* of individual institution (bank) is defined and its key properties as well as several interpretation issues are discussed in details. After that we attempt to link *z-score* and a number of macro and bank-specific indicators. For this purpose, as in Machler et al. (2007), standard cross-sectional regressions are estimated for each CEE country.

2.1 Z-score definition

We wish to determine the probability that bank losses, that is negative profits, exceed bank's equity. In other words our objective is to estimate individual bank's probability of insolvency - $P\{r \leq -K\}$ where $K = \frac{k}{A}$ and $r = \frac{\pi}{A}$ denote bank's equity capital to asset and return to asset ratios respectively.

Assuming that returns follow a distribution with (finite) first two moments μ and σ_r^2, one can estimate[1] *the upper bound of probability of insolvency*:

$$P\{r \leq -K\} \leq \frac{\sigma_r^2}{(\mu + K)^2}. \quad (1)$$

With definition of our insolvency risk measure *z-score:* $z = \frac{\mu+K}{\sigma_r}$, inequality (1) reduces to:

$$P\{r \leq -K\} \leq \frac{1}{z^2}. \quad (2)$$

Two relations above present adopted insolvency risk measure as an extremely conservative one in the sense that it is being related to the *worst case* scenario. Although (2) provides a fairly rough estimate of bank's probability of insolvency, it does not require strong assumptions (see footnote 1) and therefore presents an appealing indicator from practitioners point of view.

Regarding its interpretation *z-score* can be considered as a version of bank's *distance-to-insolvency* type measure. More precisely z measures the *lower bound* for number of standard deviations returns have to drop below expected in order to exhaust the bank's equity:

$$P\{r \leq -K\} = P\{\frac{r-\mu}{\sigma_r} \leq \frac{-K-\mu}{\sigma_r}\} = P\{\frac{r-\mu}{\sigma_r} \leq -z\} = P\{r \leq \mu - z\sigma_r\} \quad (3)$$

Let us note that terms (2) and (3) ensure the negative relation between *z-score* and probability of bank's failure. Higher z implies a decrease in failure probability and hence more stability for corresponding bank.

[1] By Chebyshev theorem for $\mu \geq -K$ we have $\frac{\sigma_r^2}{(\mu+K)^2} \geq$(Chebyshev)$\geq P\{\mid r-\mu \mid \geq \mu + K\} = P\{r \leq -K\} + P\{r \geq 2\mu + K\} \geq P\{r \leq -K\}$.

So far we have not presumed returns r to follow any specific probability distribution. However, specifying the distribution enables one to determine the exact insolvency probability:

$$P\{r \leq -K\} = (3) = P\{\frac{r-\mu}{\sigma_r} \leq -z\} = \Phi_r(-z), \tag{4}$$

where Φ_r denotes distribution function of bank's standardised returns.

In practice when analysing banking system stability using z indices several technical issues arise. Firstly, although the moments μ and σ_r^2 present *true* parameters they need to be replaced with sample estimates. Hence the reliability of estimated *z-based* bank's stability heavily depends on their precision. This can be particularly important when dealing with short transition countries data sets which often contain many structural breaks. As will be shown later in the paper the data frequency (quarterly vs annual data) used may also strongly affect the results. Finally, one faces a *trade-off* when needs to choose between the approximate (inequality (2)) and the exact (equality (4)) set-up of the insolvency probability estimation. Here we adopted the more robust one and restricted the analysis to the estimation of upper bound of probability (2) only.

2.2 Country regressions

Motivated by de Nicolo (2000), Cihak and Hesse (2006) and Machler et al (2007) we attempt to set a relation between *z-score* and a number of relevant macro and bank-specific indicators. For that purpose we estimate a pooled regression for each CEE country:

$$\ln(z_{it}) = \alpha + \beta_0 \ln(z_{it-1}) + \sum_{j=1}^{J} \beta_j X_{jt} + \sum_{k=1}^{K} \gamma_k Z_{ikt} + \varepsilon_{it},\ i = 1, \ldots, N,\ t = 1, \ldots, T, \tag{5}$$

where $i = 1, \ldots, N$ indexes banks, X_j, $j = 1, \ldots, J$, denote macroeconomic variables which are identical across banks and affect all the banks in the same fashion through β_j, while Z_{ik}, $k = 1, \ldots, K$, denote bank-specific variables with corresponding pooled effects γ_k. We also included lagged z into our specifications as an attempt to capture capital reserves built in previous period.

All the specifications are estimated applying the ordinary least squares with robust White errors. Given a relatively large number of cross sections within each country in our sample we do not estimate the fixed effects specifications and restrict the analysis to pooled intercepts only.

Furthermore, by projecting z onto lagged predictors:

$$\ln(z_{it}) = \alpha + \beta_0 \ln(z_{it-1}) + \sum_{j=1}^{J} \beta_j X_{jt-1} + \sum_{k=1}^{K} \gamma_k Z_{ikt-1} + \varepsilon_{it},\ i = 1, \ldots, N,\ t = 1, \ldots, T, \tag{6}$$

we aim to define an insolvency forecasting model.

2.3 Data

Our dataset comprises commercial banks from 5 CEE and 2 Baltic countries: Bulgaria, Czech Republic, Croatia, Hungary, Latvia, Lithuania and Slovakia[2]. Time span observed is 9 years (1998-2006). Dependent variable, *z-score* of bank i at time t, is given by:

$$z_{it} = \frac{E(roaa)_{it} + \frac{eq_{it}}{ta_{it}}}{\sigma(roaa)_{it}} \tag{7}$$

where $E(roaa)_{it}$ stands for expected return on average assets, calculated as 3-year average of realized $roaa$ in time t, $t-1$ and $t-2$, $\sigma(roaa)_{it}$ denotes standard deviation of $roaa$, eq_{it} is bank's equity and ta_{it} is bank's assets.

The *z-score* as a measure of bank stability has several limitations, perhaps the most important being that it is based on accounting rather than on market data[3].

Across the countries we obtained 820 observations of *z-score*, most of them falling within the 10-100 range[4]. Table 1 provides some basic descriptive statistics of *z-score* in CEEC.

Table 1. Descriptive statistics of *z-score* across the countries

	Hu	Bu	Cz	La	Li	Sk	Cro
Mean	39.3	33.0	51.7	28.9	68.5	41.8	64.1
Median	26.6	26.8	27.0	21.2	32.2	21.2	35.4
Maximum	532.3	201.4	542.4	185.3	675.1	311.0	888.5
Minimum	0.57	0.88	1.03	0.31	1.85	0.14	0.29
Observations	158	142	119	93	65	76	166

The list of explanatory variables used in regressions incorporates a number of possible risks and banks' characteristics discussed in the literature. They are divided into three groups: 1. bank specific variables from banks' balance sheets and profit and loss accounts, 2. national banking sectors data and 3. macroeconomic variables. Descriptive statistics of explanatory variables is given in Appendix A3.

Bank specific variables from balance sheets and profit and loss accounts Our balance sheets and profit and loss accounts data stem from Bureau van Dijk's Bankscope database. As there was no complete set of data available for some of the variables used, our country by country data sets were reduced to unbalanced panels. Banks' size is captured by the total assets (ta), whereas share of loans to assets describes banks' asset structure (l_a). Banks' credit risk is measured by the annual growth rate of private non-financial sector loans (chg). We had no *a priori* assumptions on the sign of coefficients on these three variables as they can all affect banks' solvency positively or negatively, depending on the quality of assets and

[2] Poland and Romania are not included in our sample since we noticed that Bankscope database's coverage of banks and data in these two countries was too incomplete to represent their banking sectors, especially in 1990s. Slovenia and Estonia are not included due to a small number of banks.

[3] Market data for CEE banks are unreliable even if the bank's shares are publicly traded, since the free float is rather small and turnover is usually insignificantly low.

[4] There are some extreme observations, resulting in the total sample range being from 0.14 to 2760, with an average of 52. To assess the robustness of our results with respect to the outliers, we have done all the regressions both for the full sample and for a sample that excludes the most extreme outliers. As we found no difference in main results for both approaches, we decided to eliminate only two most extreme observations (*z-score*>2000).

loan portfolio. Additionally, credit risk is captured by the ratio of loan loss provisions to net interest income (llp) and we expected that higher ratio would increase the banks' insolvency risk. However, this sign might be ambiguous too as higher loan loss provisions could reflect banks' precautionary reserve building as well as high non-performing loans. Liquidity risk is measured as a ratio of liquid assets to deposits and short-term funding (liqa). In general, liquidity reserves promote banks' financial soundness; on the other hand, excess liquidity undermines banks' efficiency and profitability. In addition, we use the lagged *z-score* as a proxy for profit and capital buffers built up in advance, reflecting bank's credit risk policies.

National banking sectors data Concentration level is measured by the Hirschman Herfindahl index for each county (hhi). We would expect that following the financial liberalization of CEE banking markets increase in concentration in first couple of years in our sample positively affected banks' soundness (since it reflected consolidation and market exit of weaker banks); in the later stage of development this impact is more ambiguous since the existing empirical evidence on this topic is mixed and, theory, too, has produced conflicting predictions.

Macroeconomic variables Macroeconomic environment plays an important role in banking sector performance. We choose several macro variables. First, we use real GDP growth rate (gdp) where we expect higher growth reflects better conditions for financial stability. However, in countries where credit and real economy cycles are highly correlated the opposite might occur[5]. Next, we use inflation rate (cpi) where we assume that price stability contributes to the profitability and stability of the banking sector. Finally, interest rate risk is measured by 6-months LIBOR (libor).

2.4 Regression results

In this section we study to what extent insolvency risk in CEEC measured by *z-scores* can be captured through dynamics of various macroeconomic and bank-specific variables. For each of the CEE countries in our sample we estimate a separate pooled regression (see (5)). This approach to risk decomposition is well known in recent literature. In their studies Maechler et al. (2007) and de Nicolo (2000) adopted similar strategies in order to identify main determinants of bank insolvency risk. Although estimated linear relations do not allow us to draw strong conclusion on causal relations between insolvency risk and various indicators we used, they can still provide useful information on their eventual co-movements.

Another important issue we pay attention here concerns *the stability* of estimated relations. For comparison purpose beside the estimates based on the whole sample data (1996 - 2006) we also report results from *rolling regressions* based on *moving windows* of fixed length of 5 years. While many of our specifications suggest certain level of instability, the analysis of rolling coefficients might provide additional useful information on possible changing nature of estimated relations between the insolvency in CEEC banks and both macro and micro environment.

[5] In countries where the real activity and credit cycles correlate the problem of multicollinearity might occur. Thus we also estimated regressions omitting GDP growth which did not alter our results qualitatively.

Country regression estimates of both the whole sample and moving window specifications can be summarised as follows (for details see Appendix A4).

Z-index is by construction characterised by strong persistence as reflected in high coefficients on its first lag, ranging among the countries between 0.47 and 0.77. As lagged z depicts bank's capital buffers built in the past this result, as expected, confirms its significant positive relationship with present z in all countries observed.

Banks credit risk measured by the annual growth rate of total loans is on average associated with lower stability, which is additionally confirmed with the rolling regression. Thus rapid credit growth as one of the main characteristics of CEE banking sectors exposed banks to higher insolvency risk despite the higher returns derived from such expansion. Comparing to Maechler et al. (2007), who found positive relation with credit growth and negative with credit growth acceleration (measured as growth rate squared), we find no explanatory power of quadratic effect of credit growth, while coefficients with credit growth rate remained negative.

The results for relationship between real output growth and bank insolvency risk are somewhat mixed. Looking at the whole time span, if there exists significant relationship, it is negative as we find for four countries in our sample. In other countries rolling regression with 5-year time intervals showed that in earlier years real economic activity was positively related to bank insolvency risk. This result may be a consequence of the positive relation between output and credit cycles in these countries, where credit growth contributed to higher insolvency risk.

Our assumption that price stability contributes to the stability of banking sector is confirmed for most of the countries. Lithuania is the only exception. This result is mainly driven by the significant negative relation between z and inflation in earlier years in our sample that were characterised by higher inflation rates. Unstable prices in general negatively influence bank profitability. In such conditions it is difficult to forecast real returns which might result suboptimal lending and borrowing decisions.

Although relation is not uniform in all countries, concentration in banking sectors is on average negatively associated with the stability. This is specially pronounced in Lithuania and Bulgaria. All countries, except Hungary and Croatia, recorded a substantial decrease of concentration in banking sectors during the last decade. Together with improved financial stability, it seems that lower concentration with stronger competition contributed to lower insolvency risk. This is in line with some other studies that were exploring same relation on much broader sample of the banks (Boyd et al. 2006). Nonetheless, looking at the movements in rolling coefficients, we found out that in the first period higher concentration contributed to banking sector stability in some countries such as Hungary and Latvia. Although not in line with results of similar researches, this could be explained with the fact that increase in concentration at the end of the 1990s, related to the process of consolidation and restructuring with falling number of banks, actually increased the banking sectors stability. However, as concentration later decreased this relation finally became negative in all countries observed, suggesting that stability goes in line with more strong competitors at the market.

Bank's size proxied by its total assets appears to be associated with greater bank stability in Bulgaria until 2002 and in Czech Republic after 2002. On the contrary, larger banks were in some period less stable in Slovakia (until 2002).

Bank's asset structure, captured by share of loans in total assets can be interpreted as credit risk (since loans in CEE banks are on average the riskiest form of banks' assets) as well as the profitability potential (as the return on loans is in general higher than on the other investments, such as government bonds or deposits). We find that higher share of loans contributed to bank insolvency risk in Bulgaria and Hungary, while the opposite is true for Croatia. Rolling regression confirmed these results and in addition, suggests that higher share of loans after the first couple of years started to contribute to bank stability in Slovakia and Czech Republic. In Lithuania it only gained some importance in the middle of the time span observed when higher loans share negatively influenced bank stability, and later became insignificant.

Ratio of loan loss provisions to net interest income is on average negatively related to bank stability. This might suggest that in CEEC in given period llp reflected non performing loans rather than good risk management practice. However, if we look at the moving window of 5-year periods, in last five years loan loss provisions to net interest income became positively connected to bank stability in Czech Republic and Hungary.

Liquidity risk doesn't explain much variation in *z-index*, so we cannot clearly conclude anything about the association between banks liquidity and stability[6]. Based on the rolling regression we still found that until 2003, higher liquidity contributed to bank stability in Bulgaria, while in Slovakia and Hungary this effect appeared only after 2002.

Interest rate risk measured by 6-months LIBOR, which was included in the model to control for the cost of foreign financing, has somewhat puzzling effect on bank stability. Its significance among countries is very diverse, as well as the direction of relation, where even estimated rolling coefficients change the sign.

In contrast to Maechler et al. (2007) who studied aggregated banking stability in the Eastern Europe here we conduct a coutry-by-country analysis. There is a remarkable degree of heterogeneity among banks in different countries with respect to the relationship between bank stability (*z-score*) and explanatory variables. Although relatively high homogeneity is found in bank stability-credit growth and bank stability-inflation relationships, we believe that given the diverse relationships among other variables, pooling all banks in one sample would provide less precise estimates than country by country regressions.

3 Conditional insolvency risk indicators

In this section, we take advantage of both the introduced regression representation and the fact that the *z-score* is monotonically (i.e. negatively) related to (*the upper bound of)* bank's insolvency probability in order to estimate this probability as a function of a number of both macro and micro indicators.

Another important question we address here concerns the link between the individual banks' risks and likelihood for overall banking sector to experience insolvency problems. Most studies on modelling insolvency probabilities are focused on individual financial institutions, while links between individual institution insolvencies and system-wide crises are still not fully understood.

We employ simple aggregation strategy: systemic indicator is defined as weighted average of individual banks *z-scores* where weights correspond to bank's share in total banking system assets.

[6] Choice of liquidity indicator was constrained as it was the only uniform indicator available in the Bankscope database, so perhaps alternative measure would gain more insight in the relation between liquidity risk and insolvency.

As it is documented in Cihak (2007), any measure of systemic stability should incorporate three elements: probabilities of failure in individual financial institutions, loss given insolvency in financial institutions, and correlation of insolvencies across institutions. He also notes that all the standard measures of financial stability have not proven to be fully successful regarding these requirements. Thus, our systemic risk measure is exposed to Cihak's critique where the inability to deal with the contagion properly is perhaps the most important in this context.

The literature on bank contagion risk in CEE countries is not abundant. To the best of our knowledge, this type of risk has been empirically explored only in Croatia (Krznar, 2008) and Hungary (Lubloy, 2005). Both studies found that bank contagion risk within one country is very low due to the relatively small size of interbank market with bilateral exposures significantly lower than bank tier I capital. These results are not unexpected since majority of banks in both countries is owned by large foreign groups which are their main market counterparts. As high ratio of foreign ownership is common characteristic of all CEE banking sectors that we investigate, we conjecture that ignoring correlations across banks in each country should not significantly alter our results. Of course, contagion risk might materialise in some other scenarios that we do not take into account in this paper.

3.1 Conditional *z-scores*

In order to get more insight into insolvency risk developments in CEEC four systemic *z measures* are constructed for each individual country.

Actual *z-score* Actual *z-scores* are calculated by using individual banks' accounting data (see (7)).

Conditional *z-scores* Since *z-score* dynamics is *well* approximated (in MSE sense, see R^2 statistics in Appendix A.4) by a simple regression equation we calculate two indicators of insolvency risk implied by various macro and micro economic indicators. First conditional *z-score* for each country is constructed using fitted values from country regression estimated on the whole sample data. Furthermore, as we provide evidence of parameters instability in estimated relations we also estimate our second conditional z by using moving window regressions[7].

Forecasted *z-score* By regressing *z-scores* onto lagged explanatory variables we define a suitable insolvency forecasting tool. Thus together with three already defined *z-measures* we also construct one-year-ahead forecasts[8] for 2004-2006.period

Figure 1 summarises insolvency risk developments in CEE countries in the period 1998 - 2006. As a common trend among countries we note a steady growth of banking sector's stability measured by all four *z-scores.* The beginning of observed period covers the second stage of transition process characterised by fairly low GDP growth rates, relatively high inflation and banking sector clean-up programmes while first foreign banks

[7] When calculating z-scores from moving window specifications, the estimate z_t is constructed by using relation (5) on the period from $t-4$ to t.

[8] All the forecasts were produced by using parsimonius specifications where we excluded the variables which do not explain much variation in z (such as LIBOR or total assets).

Due to small amount of available data we could not produce reliable forecasts for Lithuania.

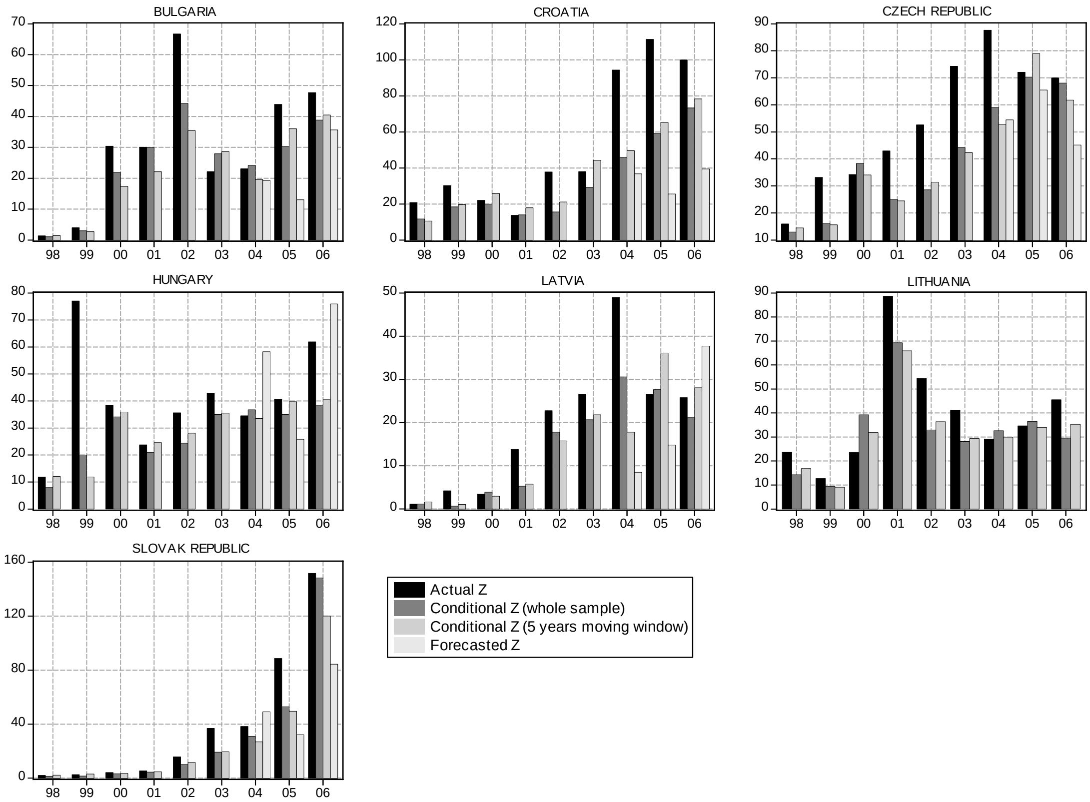


Figure 1: Z-scores for seven CEE Countries (1998 -2006). Conditional *z-indicies* are fitted values from panel regressions (5). The country aggregate is defined as weighted average of individual bank's *z-scores* weighted by corresponding bank's share in total assets.

were entering the CEE markets. Under these conditions banks were having relatively low and volatile returns which according to its definition resulted in low *z-scores.* Later, as Central and Eastern Europe experienced more favourable economic conditions followed by the rapid development of banking sectors, *z-scores* increased in all countries (see Appendix for details).

Regarding the reliability of two alternative regression based indicators of insolvency risk, figure 1 suggests that both of them capture dynamics of actual z fairly well. In contrast to actual z these indicators directly link insolvency risk with actual broader economic and bank - specific environment which might provide a valuable contribution to financial stability assessment.

3.2 Conditional probabilities of insolvency

In this section we propose the way to estimate *upper bound of probability of insolvency implied by macro and micro indicators.*

Related literature (de Nicolo (2000), Cihak and Hesse (2007) and Machler et al. (2007)) almost exclusively exploits *distance-to-insolvency* property of *z-score* only and

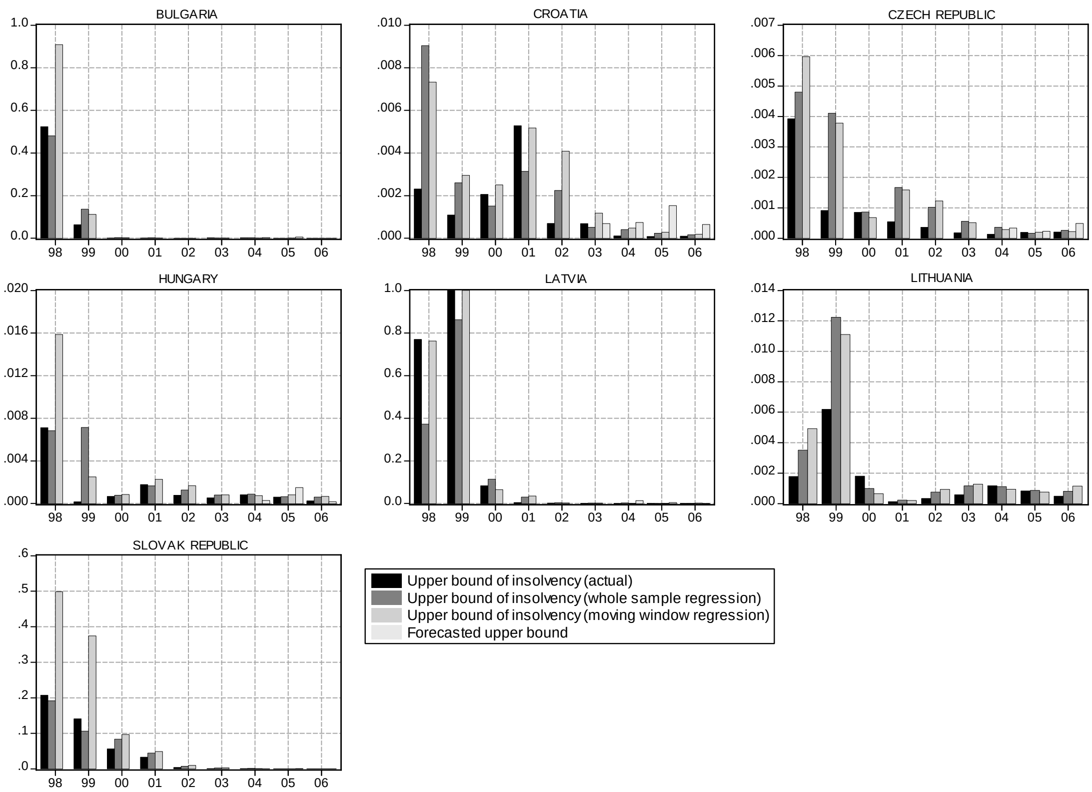


Figure 2: Upper bounds of insolvency probabilities for seven CEE Countries (1998 - 2006).

thus ignores underlying probabilities. Such practice is motivated by several reasons. The most important one concerns a very strong requirement that probability distribution for returns needs to be defined explicitly. Yet this is necessary only if exact probability of insolvency is of interest. Relaxing this condition enables us to estimate conservative or *safety first* version of insolvency probability, i.e. its upper bound. In context of measuring insolvency risks in transition economies we do not find conservativity property to be (too) restrictive[9]. In our opinion, using probability of insolvency instead of *the number of standard of deviations returns have to fall below the expected in order to exhaust bank's equity*, provides easier interpretation of z.

[9] Let us note that if distance to default, i.e. z drops bellow unity, Chebyshev theorem only ensures probability of insolvency to be less than one which is of very limited help in this context.

Combining regression fit from (5) and relation (2) it is possible to estimate:

$$\begin{aligned} P\{r_t \leq -K_t | X_t, Z_t\} &\leq \frac{1}{z(X,Z)^2} = \\ &= \left(\frac{1}{e^{\alpha+\beta_0 \ln(z_{it-1})+\sum \beta X_t + \sum \gamma Z_t + \varepsilon_{it.}}}\right)^2 = \\ &= \left(\frac{1}{e^{\alpha+\beta_0 \ln(z_{it-1})+\sum \beta X_t + \sum \gamma Z_t}}\right)^2 \left(\frac{1}{e^{\varepsilon_{it.}}}\right)^2 \approx \\ &\approx \left(\frac{1}{e^{\alpha+\beta_0 \ln(z_{it-1})+\sum \beta X_t + \sum \gamma Z_t}}\right)^2, \text{ for } \varepsilon_{it.} \textit{ close to } 0. \end{aligned}$$

Similarly, by using panel (6) a forward-looking version of implied probability can be estimated - $P\{r_{t+1} \leq -K_{t+1} | X_t, Z_t\}$.

Figure 2 compares probabilities of insolvencies implied by actual *z-score,* two conditional indicators introduced in the previous section and *one-year-ahead* forecast of z. The upper bounds of systemic insolvency probabilities on figure 2 are calculated as $\frac{1}{z^2}$ for given indicator z (see (2))[10]. Time series of probabilities clearly reflect the differences in *z-scores* among CEE Countries. At the beginning of the observed period estimated upper bounds of insolvency probabilities were on average much higher than they were in the later period. Bank stability in CEEC substantially increased after 2003 since when estimated systemic probabilities of insolvency remained below 0.1%. However, if macroeconomic conditions would resemble those from the 1990s one might expect a rise of bank insolvency risk. Even though these conditions were to the great extent unique as being related to transition process, other events might trigger similar macro scenarios with negative impact on bank stability.

4 Case study: Croatia

For comparison purpose, in the previous section we employed the same regression specification for all countries. In practice, when assessing insolvency risk of an individual banking sector more attention should be paid to the selection of explanatory variables. In line with this we attempt to estimate appropriate regression for Croatia taking advantage of more detailed and reliable accounting and supervisory bank data.

In the last quarter of 1998 in Croatia entered in a reccession caused by three main factors: unresolved structural problems in economy, unfavourable international environment and so called *second banking crisis* which led to bankruptcy and market exit of several small to medium-sized banks. This banking crisis started in the first quarter of 1998 following the end of rapid credit growth period. It was mainly caused by new, fast growing banks with agressive market strategies and imprudent bank practices, as a consequence of typical market and regulation failures. In this period non-performing loans significantly increased while banks' credit activity sharply declined, as illusttrated in Figure 3. The reccession and banking crisis were deeply interrelated, exacerbating each other. By the end of 1999 the crisis was resolved with the aid of the new *Banking Law*, and an emphasis was laid on the banking system restructuring and its recapitalisation,

[10] Employing the root mean squared error statistics, we measured the distance between actual *upper bound of insolvency probability* and its two regression based estimates. For four out of seven countries (Czech Republic, Croatia, Litva, Lithuania) in our sample the moving window specifications outperformed the whole sample counterpart. The most significant gain was in Lithuania (around 60%).

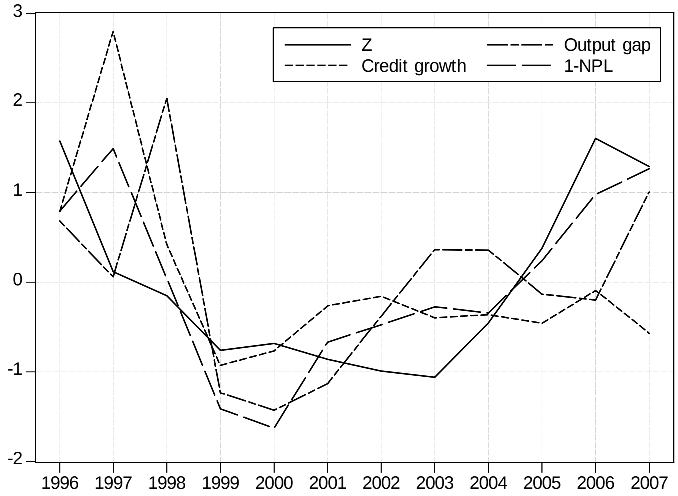


Figure 3: Average z, output gap, credit growth and *performing loans* (1-NPL) in Croatia (1996 - 2007). All series are standardised.

foremost by attracting foreign strategic investors. In 2000 economic growth recovered, interest rates substantially declined while credit growth accelerated again. Banks' loan portfolio quality gradually improved as well as the overall banking sector stability.

The dataset for Croatia used here comprises banks in the period from 1996 to 2007 obtained from the central bank's monetary statistics. We restricted our sample to 24 banks that were active during the whole period analysed. This made our sample biased towards more solid banks, as others that have left the market were either acquired by another bank, liquidated or went bankrupt.

We calculated new *z-score* for Croatia (z*) using annualised quarterly data from banks' reports. This way we take into account intra-annual variation of returns which resulted in significantly higher standard deviation of ROAA than the former formula where we used only annual data. As a consequence, new *z-score* for Croatia is substantially lower. New *z-score* implies more realistic probabilities of insolvency as it correctly identifies those banks that underwent rehabilitation programmes in 1990s (Figure (4)).

The set of explanatory variables corresponds to the one in CEE pool. In addition we employed some new indicators. Having in mind that Croatia is the most euroised country in our sample we study the impact of the change in nominal exchange rate on bank stability[11]. Credit risk is alternatively measured by non-performing loans as a percent of total loans (npl) while dependency on the foreign sources of financing is measured by the ratio of foreign liabilities to total assets (open). Finally, we constructed a set of dummy variables describing bank ownership through time (government owned - gd, domestic private banks – dd and foreign owned banks - fd) and bank's primary business orientation (on households financing, dom_h or on corporate lending, dom_c).

Regression results provide several key findings. Coefficients on real output growth were positive and significant in the beginning of the period analysed. At that time bank

[11] On the other hand due to frequent changes of exchange rate regimes in other countries in our sample, this variable was not included in pertaining specifications.

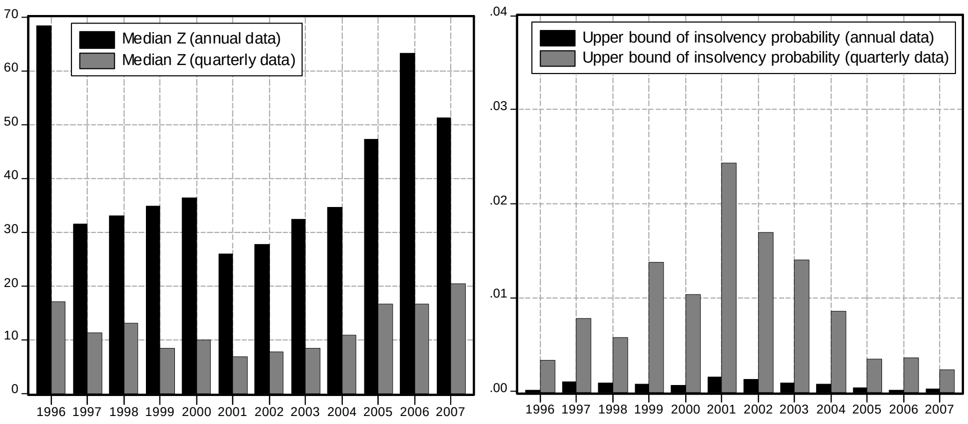


Figure 4: Comparison between *z-scores* and corresponding insolvency probabilities for Croatia calculated from quarterly and annual data.

stability indicator moved in line with output gap and credit growth. After economic recovery and banking system restructuring and consolidation, credit growth became negatively related to bank stability. Since credit and output growth continued to move simultaneously, this alludes a negative relationship between bank stability and output which is confirmed by significant negative coefficients on real GDP growth in moving window regressions after 2001.

Bank insolvency risk increases in consumer prices inflation. In context of high level of eurisation exchange rate stability plays a particularly important role in financial stability. In general, domestic currency depreciation leads to lower bank stability as shown by its significant negative coefficient on the whole sample. Given the high level of eurisation in Croatia, this is an expected result since depreciation exposes banks to indirect credit risk arising from possible higher proportion of loan insolvencies.

Higher level of concentration in Croatia is positively associated with stability. This result is opposite with findings in other CEE countries, but it is not unexpected. While in other CEE countries in our sample concentration decreased, in Croatia it recorded sharp increase during 1999 and 2000 after which it remained relatively stable in the following years. Initial increase in HHI in Croatia was primarily driven by market exit of numerous (usually small) unsound banks that contributed to the higher stability of the more consolidated and healthier banking sector.

Share of loans in total assets over the whole sample does not affect bank stability. On the other hand moving window regression coefficients became positive and significant after 2004 to present. This result is probably driven by higher profitability of loans in comparison to other forms of assets. Whereas this relationship in earlier model was unclear, here we find that bank stability increases in size (measured by total assets).

As a measure of credit risk, instead of ratio of loan loss provisions to net interest income that has an ambiguous impact on bank stability, we use non-performing loans (NPL) ratio. As oppose to the first measure whose impact on bank stability in Croatia was not significantly different from zero, bank stability is decreasing in NPL ratio over the whole sample. However, moving window regression coefficients and their significance are decreasing over time, suggesting that the negative impact of NPLs on bank stability is weakening.

In addition to these variables, we investigated the impact of dependency on foreign financing, business orientation and ownership on bank stability. We find that bank insolvency risk increases with higher share of foreign liabilities in total assets, especially after 2003. Banks oriented towards corporate lending as oppose to household financing are on average less stable than the other banks, which is not surprising taking into account that households loans in Croatia have on general higher interest margins while bad loans ratio to total loans is lower. Finally, we find that private domestic banks tended to be more stable than foreign and government owned banks until 2004, when this relationship became insignificant. This result is direct consequence of higher capitalization rates of domestic, mainly smaller, banks.

Overall, this model better explains variations in z compared to the model described in Section 2.2. We benefited from the studious selection of banks included in the sample based on the availability and reliability of their historical data, as well as from the adding additional explanatory variables.

5 Conclusion

In this paper we studied banking sector stability in Central and Eastern European countries. Estimating country regressions we examined the impact of a number of variables on insolvency risk. Beside this, using the estimated relations we constructed an indicator of bank insolvency risk conditioned on various bank-specific and macroeconomic variables.

Our main findings may be summarised as follows.

Bank stability in CEEC is on average increasing in last years, mainly as a consequence of more favourable macroeconomic environment and banking sector consolidation that resulted in higher and less volatile bank returns.

Regression results suggest that bank stability in CEE countries is on average negatively related to credit growth. This result emphasizes the problem of rapid credit expansion associated with a number of micro (loosening of credit policies and underestimation of risks) and macro (building of domestic and external imbalances) risks.

Rise in loan loss provisions have negative impact on bank stability mainly through lower profitability indicators. This finding might imply that building loan loss provisions in CEE banks during the period observed was more a reflection of the loans quality than a precautionary risk management.

We also document that price stability contributes to lower insolvency risk. This result is mainly driven by the significant negative relation between bank stability and inflation in earlier years in our sample that were characterised by higher inflation rates. In such conditions it is difficult to forecast real returns which might result suboptimal lending and borrowing decisions.

In this analysis we employed *z-score* as bank's *distance-to-insolvency* measure. In addition to analysing the actual *z-score*, we propose the estimation of conditional *z-scores* that we find to capture observed *z-score* dynamics fairly well. In contrast to the actual z, these conditional indicators directly link bank insolvency risk with broader macro and micro environment. Thus, conditional *z-scores* might be useful in identifying the impact of possible shocks on banking sector stability. This may be especially interesting in the context of recent global financial turmoil and rising inflation pressures.

Bank stability in CEEC substantially increased after 2003. In that period estimated systemic probabilities of insolvency remained below 0.1%. However, if macroeconomic conditions would resemble those from the 1990s one might expect a rise of bank insolvency risk. Even though these conditions were to the great extent unique as being related to transition process, other events might trigger similar macro scenarios with negative impact on bank stability.

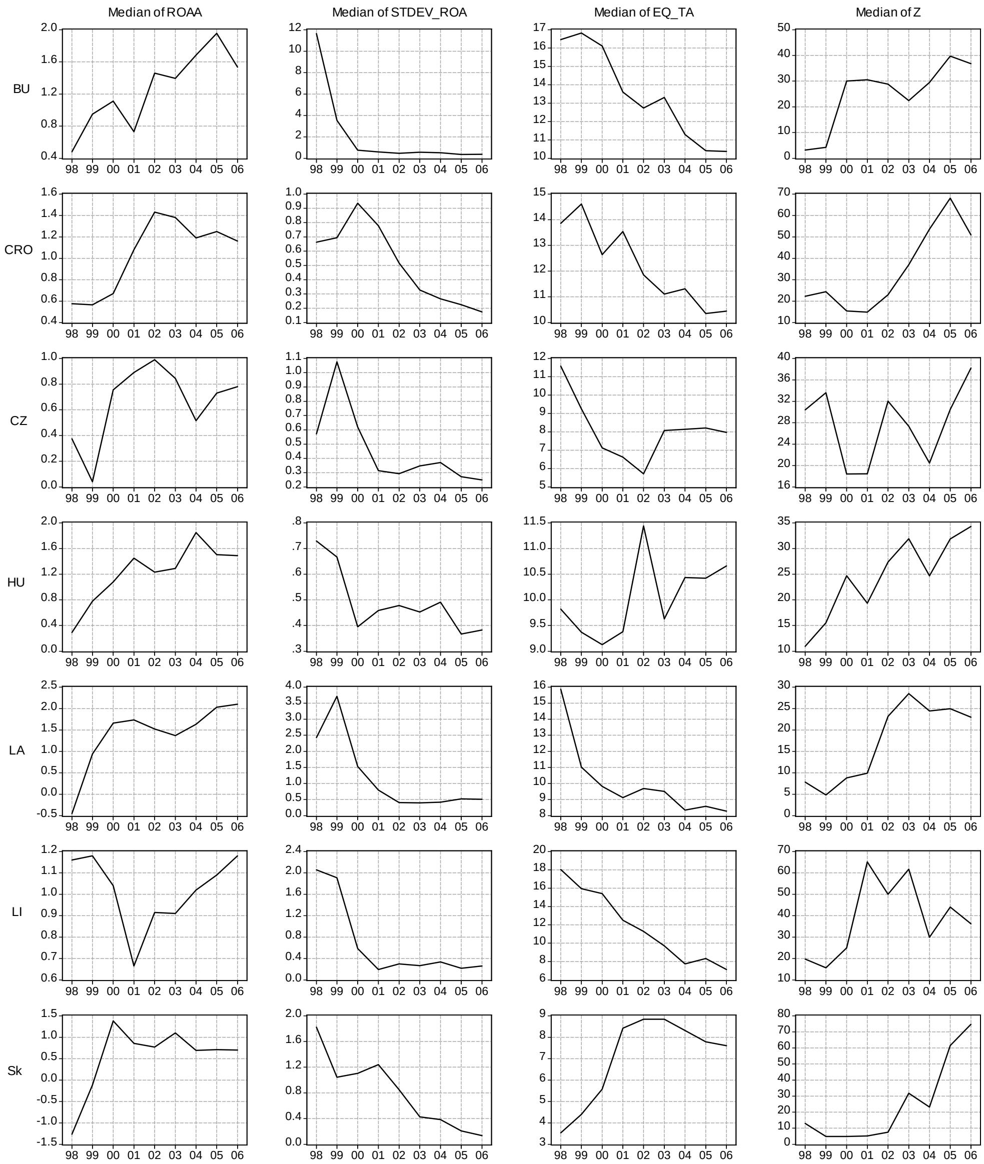
A Appendix

A.1 Data description

Variables		Name	Description	Source
Dependent variable				
	z-score	log(z)		Bankscope
	z-score*	log(z*)	Calculatation based on quarterly data	CNB
Explanatory variables				
Bank specific	Credit growth	chg	Annual percentage change in total credits	Bankscope, CNB
	Total assets	ta	Total bank assets, in USD mil	Bankscope, CNB
	Credit growth to households*	chg_h	Annual percentage change in total credits to households	CNB
	Credit growth to corporates*	chg_c	Annual percentage change in total credits to corporates	CNB
	Assets structure	l_a	Share of total credits in bank assets	Bankscope, CNB
	Credit risk	llp	Loan loss provisions to net interest income	Bankscope
	Non performing loans*	npl	Non performing loans in percent of total loans	CNB
	Liquidity risk1	liqa	Liquidit assets as percentage of customer and short term funding	Bankscope
	Liquidty risk2*	liq	Liquid assets as percentage of short term liabilities	CNB
	Foreign financing*	open	Ratio of foreign liabilities to total assets	CNB
Macro variables	Output growth	gdp	Annual rate of change in real output	IFS, CBS
	Inflation	cpi	Average annual rate of change in consumer price index	IFS, CBS
	Interest rate risk	libor6	6-months LIBOR	Bloomberg
	Exchange rate risk*	hrkeur	Average annual exchange rate of HRK/EUR	Eurostat, CNB
Banking sector	Concentration	hhi	Hirschman-Herfindal index	Bankscope, CNB
Dummy variables*	Bank ownership	dd fd gd	Private domestic banks Foreign owned banks Government owned banks	CNB
	Credit structure	dom_h dom_c	Share of credits to households > 55% Share of credits to corporates > 55%	CNB

*variables used only in Section 4 Case study: Croatia

A.2 Z - score components over time



A.3 Mean values of explanatory variables over time

Bulgaria	gdp	cpi	hhi	ta	l_a	llp	liqa	chg
1998	4.0	17.11	0.177	180,988	0.30	-7.86	22.51	103.07
1999	2.3	2.55	0.186	146,915	0.38	19.46	18.51	15.64
2000	5.4	9.82	0.160	151,829	0.41	27.55	15.14	40.25
2001	4.1	7.10	0.147	164,878	0.40	22.87	52.29	55.50
2002	4.5	5.65	0.121	234,291	0.47	35.66	25.34	92.31
2003	5.0	2.13	0.112	347,985	0.54	9.01	21.40	92.93
2004	6.6	6.15	0.106	607,661	0.57	16.63	26.09	63.85
2005	6.2	4.92	0.095	757,194	0.55	11.74	23.69	27.23
2006	6.3	7.01	0.096	1,170,187	0.54	-1.45	19.26	50.42

Czech Republic	gdp	cpi	hhi	ta	l_a	llp	liqa	chg
1998	-0.8	10.10	0.286	5,448,951	0.38	60.64	14.89	15.60
1999	1.3	2.12	0.254	3,298,618	0.29	69.74	22.26	22.62
2000	3.6	3.83	0.233	4,110,290	0.31	8.95	17.17	126.06
2001	2.5	4.60	0.227	4,679,935	0.36	19.50	17.60	79.40
2002	1.9	1.77	0.217	6,363,683	0.37	5.91	15.26	62.13
2003	3.6	0.09	0.220	7,560,156	0.45	14.94	20.09	76.24
2004	4.5	2.80	0.210	7,741,083	0.45	3.14	12.91	54.07
2005	6.4	1.82	0.217	8,751,003	0.48	31.75	25.92	11.53
2006	6.4	2.51	0.213	11,259,602	0.51	7.69	36.41	40.89

Latvia	gdp	cpi	hhi	ta	l_a	llp	liqa	chg
1998	4.7	4.56	0.503	97,539	0.43	-17.90	13.71	377.75
1999	3.3	2.34	0.303	119,603	0.43	28.58	11.39	82.53
2000	6.9	2.61	0.238	175,337	0.30	95.30	14.61	-12.53
2001	8.0	2.46	0.189	284,208	0.34	-10.57	8.65	91.05
2002	6.5	1.92	0.176	460,283	0.39	6.16	22.64	180.49
2003	7.2	2.88	0.143	633,454	0.41	13.40	21.83	39.62
2004	8.7	6.01	0.142	837,322	0.42	21.83	26.55	57.29
2005	10.6	6.54	0.164	1,014,180	0.48	-0.15	28.44	32.80
2006	12.2	6.35	0.184	1,862,201	0.57	5.19	31.29	69.19

Lithuania	gdp	cpi	hhi	ta	l_a	llp	liqa	chg
1998	7.5	4.95	0.471	231,075	0.45	-2.28	26.90	23.50
1999	-1.5	0.75	0.559	336,478	0.47	23.45	24.75	27.52
2000	4.1	1.01	0.464	329,008	0.47	29.69	25.27	48.20
2001	6.6	1.29	0.391	371,389	0.44	20.72	23.70	25.47
2002	6.9	0.30	0.361	444,631	0.53	18.87	21.12	88.61
2003	10.3	-1.19	0.258	706,408	0.53	-1.94	20.21	69.63
2004	7.3	1.19	0.238	1,274,225	0.58	9.45	13.74	61.74
2005	7.9	2.62	0.223	1,695,332	0.61	10.85	17.50	44.20
2006	7.7	3.76	0.222	2,675,187	0.66	11.73	16.89	74.77

Hungary	gdp	cpi	hhi	ta	l_a	llp	liqa	chg
1998	4.8	13.31	0.136	2,614,547	0.41	13.77	20.48	32.53
1999	4.2	9.53	0.150	2,484,260	0.46	21.92	18.30	31.70
2000	5.2	9.34	0.158	2,473,057	0.57	4.82	16.20	32.10
2001	4.1	8.82	0.159	2,316,934	0.59	7.22	11.24	21.66
2002	4.4	5.13	0.196	2,825,696	0.67	5.51	17.67	83.84
2003	4.2	4.53	0.216	3,358,255	0.67	5.89	8.54	49.85
2004	4.8	6.56	0.228	5,108,780	0.72	11.54	35.24	64.87
2005	4.1	3.49	0.315	5,148,624	0.74	11.21	72.66	0.02
2006	3.9	3.81	0.332	7,804,021	0.72	16.19	51.47	31.05

Slovak Republic	gdp	cpi	hhi	ta	l_a	llp	liqa	chg
1998	4.4	6.47	0.247	1,558,586	0.45	111.83	12.94	5.34
1999	0.0	10.06	0.270	1,425,614	0.39	160.10	19.15	-16.07
2000	1.4	11.36	0.279	1,265,801	0.42	-42.29	21.92	-12.44
2001	3.4	7.07	0.227	1,302,672	0.37	9.55	31.73	-8.48
2002	4.8	3.27	0.220	1,661,436	0.39	8.90	24.32	89.06
2003	4.8	8.20	0.214	1,913,712	0.43	7.98	30.06	45.27
2004	5.2	7.28	0.206	2,629,704	0.39	3.52	18.96	31.78
2005	6.6	2.67	0.201	2,548,109	0.47	8.88	16.20	25.20
2006	8.5	4.38	0.204	3,433,220	0.48	13.99	18.27	42.67

Croatia	gdp	cpi	hhi	ta	l_a	llp	liqa	chg
1998	2.8	5.54	0.102	676,521	0.55	71.48	15.34	21.40
1999	-0.9	3.92	0.119	551,495	0.51	91.24	18.01	-23.02
2000	2.9	4.50	0.136	638,265	0.47	36.55	14.84	-4.60
2001	4.4	3.73	0.130	748,427	0.48	2.05	14.77	25.84
2002	5.6	1.69	0.124	1,063,001	0.53	25.36	10.02	57.29
2003	5.3	1.78	0.127	1,448,483	0.55	14.16	9.43	36.00
2004	4.3	2.08	0.136	1,533,306	0.57	15.46	13.21	28.00
2005	4.3	3.25	0.136	1,409,316	0.56	8.33	11.88	13.70
2006	4.8	3.15	0.130	2,307,614	0.59	5.17	10.36	57.83

A.4 Regression results

These tables provide regression coefficients from both whole sample and moving window specification. In first five rows of the table for each country the results from moving window regressions are reported where given year denotes a final observation in the window (2002 row is related to 1998 - 2002 window, 2003 with 1999 - 2003 and so on). The first table summarises results from section 4. while results for seven CEE countries are reported in second table. For both tables (*) i (**) denote significance at 10% and 1% respectively.

Croatia	z*(-1)	gdp	cpi	hrkeur	hhi	chg	npl	open	l_a	ta	dom_c	dd	Adjusted R^2	S.E.
2000	0.77(**)	-1.5(*)	0.68(**)	2.34(**)	0.9(**)	-0.04(*)	-2.64(*)	0.39	-2.12(**)	-0.11	0.32(**)	0.21(*)	0.68	0.80
2001	0.76(**)	-47.84(**)	0.59(**)	-73.13(**)	19.02(**)	-0.04(*)	-2.26(*)	0.50	-1.1(*)	-0.06	0.27(**)	0.21(*)	0.69	0.76
2002	0.67(**)	22.02(**)	0.36(**)	28.57(**)	-5.84(**)	-0.18(**)	-2.75(**)	0.13	-0.26	0.00	0.04	0.31(**)	0.64	0.74
2003	0.58(**)	5.60(**)	-0.47(**)	17.86(**)	2.41(**)	0.07	-1.68(*)	-0.43	0.02	0.05	-0.03	0.4(**)	0.52	0.74
2004	0.55(**)	44.45(**)	-1.20(**)	32.8(**)	17.61(**)	0.09	-1.52(*)	-1.17(**)	0.97(*)	0.15(**)	-0.01	0.27(**)	0.58	0.62
2005	0.63(**)	36.67(**)	-0.11(**)	-4.43(**)	9.98(**)	-0.04	-0.61(*)	-0.69(*)	1.66(**)	0.17(**)	-0.05	0.15	0.69	0.52
2006	0.63(**)	-38.94(**)	-0.07(**)	-1.29(*)	-1.38	-0.49(**)	-0.41	-0.89(**)	1.29(**)	0.15(*)	-0.19(*)	0.01	0.66	0.55
2007	0.61(**)	-12.59(**)	-0.14(**)	-4.51(**)	2.44(**)	-0.53(**)	0.07	-0.74(**)	1.37(*)	0.13(*)	-0.15(*)	-0.08	0.67	0.52
1996-2007	0.70(**)	1.86(*)	0.19(**)	-6.74(**)	1.90(**)	-0.32(**)	-1.41(**)	-0.07	0.43	0.03	-0.10(*)	0.04	0.68	0.66

Bulgaria	z(-1)	gdp	cpi	hhi	libor	ta	l_a	llp	liqa	chg	Adjusted R^2	S.E.
2002	0.51(**)	67.37(**)	-12.63(**)	-0.11	15.67	0.13(**)	-0.81(*)	-0.49(**)	1.12(*)	-0.17	0.71	0.63
2003	0.5(**)	13.36(**)	-1.78	-3.8(**)	21.87(*)	0.05	-0.82(**)	-0.53(**)	1.02(*)	-0.20(**)	0.66	0.56
2004	0.72(**)	11.05(**)	-2.75(*)	-3.73(**)	36.37(**)	0.01	-0.99(**)	-0.37(**)	0.00	-0.19(**)	0.54	0.60
2005	0.52(**)	27.26(**)	3.99(*)	-5.00(**)	-25.63(*)	0.01	-0.45(*)	-0.27(*)	0.75	-0.26(**)	0.40	0.65
2006	0.51(**)	3.48	5.42(*)	-2.49(**)	0.59	0.03	-0.55(**)	-0.20(**)	0.11	-0.29(**)	0.35	0.66
1998-2006	0.54(**)	6.49(*)	-8.96(**)	-4.22(**)	36.61(**)	0.03	-0.58(**)	-0.25(**)	0.48	-0.24(**)	0.52	0.69

Czech Republic	z(-1)	gdp	cpi	hhi	libor	ta	l_a	llp	liqa	chg	Adjusted R^2	S.E.
2002	0.85(**)	14.64	-4.04	-2.58	-7.88	-0.10	-0.56	0.01	-0.75	0.01	0.67	0.82
2003	0.80(**)	11.51	-4.77(*)	0.60	-5.22	0.02	-0.11	0.28	-0.33	0.10	0.72	0.73
2004	0.73(**)	7.43(**)	-4.26(*)	2.11	0.84	0.12	0.21	0.31	-0.16	0.08	0.66	0.73
2005	0.65(**)	12.04(**)	-0.60	-1.77	-33.37(**)	0.17(*)	0.98(*)	0.23	-0.42	0.14	0.62	0.70
2006	0.57(**)	10.92(*)	-5.75	-4.14	-27.23(**)	0.27(**)	1.43(**)	0.44(**)	0.30	0.16	0.63	0.65
1998-2006	0.77(**)	6.60(*)	-6.57(**)	0.01	-3.66	0.02	-0.35	0.14	-0.25	0.09	0.63	0.74

Latvia	z(-1)	gdp	cpi	hhi	libor	ta	l_a	llp	liqa	chg	Adjusted R^2	S.E.
2002	0.34(*)	16.03(**)	-64.03(**)	2.87(**)	-3.90	0.03	0.72	-0.43(*)	-0.34	-0.05(*)	0.41	1.13
2003	0.35(*)	-1.24	47.35	5.54(*)	-17.6(**)	-0.05	0.69(*)	-0.47(**)	-0.33	-0.07(*)	0.49	1.04
2004	0.43(**)	-7.03	-2.79	2.33(**)	-22.69(*)	0.03	0.37	-0.37(**)	-0.40(*)	-0.04(**)	0.50	0.89
2005	0.40(*)	-23.18(**)	5.07	0.64	7.83	0.00	0.34	-0.13	-0.29	-0.04(**)	0.20	0.84
2006	0.27(*)	-13.62(**)	3.70	-0.39	20.60(*)	-0.03	-0.03	-0.14	-0.53(**)	-0.04(**)	0.13	0.63
1998-2006	0.48(**)	14.45(*)	-24.2(*)	1.66(*)	-26.11(**)	0.04	0.29	-0.29(**)	-0.18	-0.07(**)	0.51	0.82

Lithuania	z(-1)	gdp	cpi	hhi	libor	ta	l_a	llp	liqa	chg	Adjusted R^2	S.E.
2002	0.74(**)	-6.70(*)	25.55(**)	-3.71(**)	5.35	0.01	-2.59	-1.01	-0.35	-0.97(**)	0.61	0.98
2003	0.74(**)	-9.26(*)	28.60(**)	-4.59(**)	0.79	-0.03	-0.97	-0.96	-2.29	-0.99(**)	0.71	0.88
2004	0.67(**)	24.02(*)	51.30(**)	-2.16(*)	34.69(**)	-0.22(*)	-0.94(*)	-1.18	-0.41	-0.96(**)	0.62	0.99
2005	0.63(**)	-6.65	23.86(**)	-5.36(**)	74.57(*)	-0.18(*)	-0.31	-0.92	-1.07	-0.93(**)	0.60	0.94
2006	0.66(**)	-250.25(**)	186.8(**)	-44.50(**)	-31.04(**)	-0.10	-0.15	-1.07	0.20	-0.6(**)	0.56	0.86
1998-2006	0.65(**)	-3.65	26.37(**)	-3.73(**)	-1.03	-0.06	-0.15	-0.47	-0.64	-0.86(**)	0.60	0.87

Hungary	z(-1)	gdp	cpi	hhi	libor	ta	l_a	llp	liqa	chg	Adjusted R^2	S.E.
2002	0.62(**)	-380.35(**)	33.02(**)	13.68(**)	155.24(**)	0.05	-1.24(*)	-1.95(*)	-2.79(*)	-0.02	0.39	0.94
2003	0.68(**)	342.12(**)	23.34(**)	3.10(**)	-160.48(**)	0.11	-0.38	-1.85(*)	-3.49(**)	-0.19	0.45	0.90
2004	0.60(**)	-27.25	-15.11(**)	0.51	31.07(*)	0.03	0.13	2.02(*)	0.18	-0.29	0.62	0.60
2005	0.62(**)	74.28(**)	-4.38(*)	1.34(*)	-32.65(**)	-0.01	0.04	0.57	0.10(**)	-0.25(**)	0.51	0.63
2006	0.54(**)	-5.66	4.81	0.50	-7.45(*)	0.04	-0.50	0.97(**)	0.06(*)	-0.21(**)	0.37	0.68
1998-2006	0.56(**)	22.80	-12.63(**)	0.23	-3.61(*)	0.03	-0.81(*)	-0.76	0.02	0.00	0.42	0.82

Slovak Republic	z(-1)	gdp	cpi	hhi	libor	ta	l_a	llp	liqa	chg	Adjusted R^2	S.E.
2002	0.64(**)	-261.28(*)	-181.03(*)	-13.92(*)	247.74(*)	-0.58(*)	-3.00(**)	-0.97(**)	0.15	-0.24	0.54	1.03
2003	0.74(**)	50.89(**)	-1.18	1.43	6.19	-0.02	-3.06(**)	-0.63(**)	-2.55(*)	-0.69	0.38	1.11
2004	0.57(**)	29.58(*)	-4.12(*)	3.56(*)	-11.25	-0.16	-1.96(*)	-0.69	0.34	-0.68	0.35	1.10
2005	0.56(**)	-7.18	-3.92	5.95(*)	8.73	0.09	0.33	-0.79	1.10	-0.78	0.35	1.07
2006	0.73(**)	9.91	-0.80	-9.56	23.42(**)	0.12	2.14(**)	2.50(*)	4.20(**)	-0.19	0.51	0.92
1998-2006	0.69(**)	20.79(*)	-3.14	2.66(**)	-1.74	-0.10	-0.23	-0.80(*)	1.71(**)	-0.35	0.55	1.06

Croatia	z(-1)	gdp	cpi	hhi	libor	ta	l_a	llp	liqa	chg	Adjusted R^2	S.E.
2002	0.66(**)	-256.83(**)	-125.64(**)	-63.33(**)	336.67(**)	-0.08	-0.42	-0.32(*)	0.73	-0.27	0.33	1.15
2003	0.58(**)	0.62	-32.5(**)	1.99(*)	0.47	-0.11(**)	-0.65	-0.34(*)	0.55	-0.18	0.31	1.12
2004	0.59(**)	-69.12(**)	-74.25(**)	-2.56(**)	-11.46(*)	-0.12(**)	-0.23	0.18	1.07	-0.51(*)	0.39	1.06
2005	0.47(**)	69.56(*)	22.00	7.41(*)	59.36(*)	-0.03	0.88	0.31	-0.39	-0.22	0.36	0.96
2006	0.46(**)	-25.44(*)	-20.16(*)	-0.33	12.32(*)	0.07	1.65(*)	0.8(*)	-1.24	-0.35(*)	0.30	0.98
1998-2006	0.57(**)	2.19	-18.49(**)	-0.12	6.52	0.06	1.24(*)	0.04	-0.75	-0.31(*)	0.39	1.03

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