

## COMPARATIVE STUDIES OF RISK, CONCENTRATION AND EFFICIENCY IN TRANSITION ECONOMIES

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### Abstract

This paper compares the risk taking behaviour of banks in two groups of early and late transition countries during two periods: the pre-crisis (2000-2006) and the financially turbulent (2007-2012). Using data for 254 banks for the period 2000-2012 we find that during the stable period (2000-2006) the banks with higher concentration and higher technical efficiency take more risks in the late transition countries, while this is ambiguous for the turbulent period (2007-2012). This supports the 'competition-stability' hypothesis during the stable period (2000-2006) for the late transition countries. Although the concentration ratio did not change much in the early transition countries for the periods 2000-2006 and 2007-2012, the banks with higher concentration and higher technical efficiency tend to take less risks during the stable period (2000-2006), but more during the turbulent period (2007-2012).

**Keywords:** Transition Economies, Bank Concentration, Technical Efficiency, Risk

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### 1. Introduction

The presence of a sound banking sector is important for ensuring that the financial system and economy run smoothly and efficiently as banks play a crucial role in channelling funds from lenders to borrowers with productive investment projects. Over the last two decades the financial systems of the former USSR as well as countries in Central and Eastern European (CEE) have undergone substantial reforms and their impact on the overall economy is now established in the literature (Djalilov and Piesse, 2011). In particular, recent studies stress two opposing views regarding the impact of competition on the risk taking behaviour of banks (e.g. Berger et al. 2009b). In particular, the first view ('competition-fragility') states that increased competition reduces the franchise value of banks thus providing incentives to take higher risks (Keeley, 1990), while the second view ('competition-stability') solves the problems related to moral hazard and adverse selection that influence banking sector stability (Boyd and De Nicolo, 2005). Thus, the aim of this paper is to investigate which view dominates for the case of transition economies. The paper uses data from two groups of transition countries. The first includes the early transition economies, which have now progressed sufficiently to become members of the European Union (EU), while the second are late transition countries, that is, the

former Soviet republics. Countries in group one are: Czech Republic, Estonia, Hungary, Latvia, Lithuania and Poland, and those in group two are: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Tajikistan, Ukraine and Uzbekistan.

The contribution of this paper is threefold: Firstly, the paper compares the risk taking behaviour of banks in two different groups of transition countries over two different periods, that is, during the stable (pre-crisis – 2000-2006) as well as during the financially turbulent (2007-2012) periods. This has previously been ignored in the literature. Second, it examines the impact of technical efficiency on bank risk taking behaviour for these countries at different stages of transition. And third, the presence of a nonlinear relationship between risk, the degree of competition and technical efficiency is tested, which is a new departure in the banking literature as previous studies do not assume technical efficiency to have impact on risk taking behaviour of banks. Previous research on risk taking behaviour of banks in the former Soviet countries is limited, for example, Fungacova and Weill (2013) and Pak and Nurmakhanova (2013), and they restrict their study to a single country. Thus, in this paper, panel data is used to allow a more robust analysis.

The structure of the paper is as follows: Section II reviews the existing literature, Section III describes

the data and the methodology, Section IV discusses the results and Section V concludes.

## **2. Literature review**

### **2.1 Why former Soviet republics**

Over the last 25 years, a plethora of studies have focussed on the transition of countries from Central and Eastern Europe from a system of central planning to a market economy. However, the majority of the former Soviet Union republics have been largely ignored due to the paucity of reliable information and these countries are substantially different from the early transition countries in Central and Eastern Europe. There are many reasons for this. Firstly, the former Soviet republics were controlled by the communist regime for more than seventy years. This resulted in the lack of a national collective memory of any other form of economic organisation or institutions in these countries and no experience of managing a domestic market economy prior to the collapse of the Soviet Union in 1991. During the Gorbachev era in the late 1980s, when reforms to establish a market economy took place in the Baltic states of the former Soviet Union and in several countries of Central and Eastern Europe, the other republics of the former USSR did not follow. This provides a sharp contrast to countries such as Hungary, Poland and the former Czechoslovakia, and even to the Baltic states of the former Soviet Union, which only had a system of central planning for the period following the Second World War until the 1990s. This historical legacy has a huge impact on how quickly a market economy can be established and emphasises the importance of the historical background and initial conditions at the beginning of the transition on the direction and speed of financial sector development and its impact on economic growth.

Second, many former Soviet countries are rich in mineral and energy resources with all the benefits that result in terms of economic growth but also the potential internal conflicts associated with this.

Third, some former USSR countries, especially those located in Central Asia, are geographically very extensive and political instability from neighbours such as Afghanistan can be contagious and therefore ensuring economic growth and financial stability is vital to retain social cohesion and sustained development. Finally, the pace of the transition was much slower in the former Soviet countries, excluding the Baltic states.

### **2.2 Bank efficiency**

An early transition study by Kraft and Tirtiroğlu (1998) shows that new banks were not as efficient as long established ones and that older banks were found to be more profitable. Similar research on the financial sector in Poland used non-parametric methods to

construct a Malmquist Productivity Index (Piesse and Rogowski, 1997), with results suggesting that the quality of bank management and the level of enumeration were important in an assessment of efficiency and competitiveness. Contrary to the earlier study by Kraft and Tirtiroğlu (1998) Jemric and Vujcic, (2002) find that foreign banks were on average most efficient and that new banks were more efficient than long established ones in Croatia for the period 1995-2000. Many studies on the banking efficiency in the transition countries show that banks with majority foreign ownership are more efficient than private and state banks (Fries and Taci, 2005; Tochkov and Nenovsky, 2010; Karas et al., 2010), Bonin et al., 2005; Nikiel and Opiela, 2002; Hasan and Marton, 2003). However, another study by Fang et al. (2011) finds foreign banks to have higher profit, but lower cost efficiency. However, the efficiency gap between foreign, domestic and state banks is also shrinking over time. Finally, in the study on banking efficiency Brissimis et al. (2008) find evidence that reform in the sector reform has a positive impact on efficiency.

### **2.3 Market concentration**

The existing literature assumes that high levels of concentration favours companies' collusive behaviour, which ultimately weakens competition in the market and supports the view of a negative link between concentration and competition. However, there are two dominant views on the impact of competition to banks' risk taking behaviour: 'competition-fragility' and 'competition-stability'. Keeley (1990) shows that greater competition lowers the franchise value of banks, which increases their incentives to take higher risks. By focusing on the deposit market Matutes and Vives (2000) conclude that higher levels of competition increases banks' risk of failure. Thus, these results confirm the view of 'competition-fragility.' However, a contrasting result is found that supports 'competition-stability', suggesting that greater competition may contribute to banking sector stability. Boyd and De Nicolo (2005) argue that the loan rates are lower under higher competition which may reduce incentives to allocate resources to riskier projects taking account of moral hazard and adverse selection problems. However, Martinez-Miera and Repullo (2010) claim that Boyd and De Nicolo (2005) ignore the fact that lower rates (under higher competition) reduce bank revenues from performing loans. Taking this into account Martinez-Miera and Repullo (2010) find a U-shaped relationship between competition and the risk of failure for banks, that is, greater competition increases the risk of bank failure in very competitive markets, while decreasing the risk of failure in highly concentrated markets.

## 2.4 Risk

Many studies address the risk taking behaviour of banks but most focus on developed and developing countries (e.g. Kanas, 2013; Jimenez et al., 2013). However, banks behave differently under different institutional settings (Berger et al., 2001; Berger and Udell, 2002; Haselmann and Wachtel, 2006) which implies that the results obtained for developed and developing countries may not apply to the transition ones. Furthermore, whilst over the last decades various aspects of the banking sector in transition countries (e.g. Grigorian and Manole, 2002; Peresetskiy, 2010; Pruteanu-Podpiera et al., 2008; Weill, 2003) have been studied, risk taking behaviour in the former USSR countries is still limited. Examples of existing studies include Haselmann and Wachtel (2007) who find no indication of excessive risk taking by specific ownership or size categories of banks and Agoraki et al. (2011) who conclude that banks with market power in Central and Eastern Europe tend to take on lower credit risk. Therefore this area provides an opportunity for such research.

Therefore, it is important to investigate the nature of concentration-competition and their impact on banks' risk taking behaviour in these two groups of transition countries during the stable (2000-2006) and turbulent (2007-2012) periods as this currently a gap in the literature. Further, the literature on risk taking behaviour does not take into account technical efficiency and the impact this may have. Thus, the research on risk taking behaviour of the banking sector in transition economies is still incomplete.

## 3. Method and data

In the first stage of the analysis the variables to represent bank efficiency and market concentration are obtained, the former by estimating a profit function and retrieving the efficiency scores and the

latter by construction. These are then used in the second stage where their impact and the form of their interaction on the risk taking behaviour of banks is determined.

### 3.1 Efficiency

Numerous studies have focused on measuring the efficiency of different sectors and firms in a number of countries, most of which use a production function. Although many different methods have been used, all are based on the transformation function, particularly those that describes a production technology at firm level. The aim is to maximum value under the available technology, prices or other limitations. Assuming a common set of constraints, the efficiency is measured as the distance between individual production units and the best practice frontier. Different methods used to measure the frontier with the two most popular approaches being parametric and nonparametric modelling. Data Envelopment Analysis (DEA) is a non-parametric approach using linear programming, while econometric models estimate deterministic or stochastic frontier (SF) and is a parametric approach. Both allow the calculation of firm level efficiency.

In this paper SF estimation is used as DEA does not take account of measurement errors and other type of statistical noise, assuming all deviations from the frontier are due to technical inefficiency. Profit efficiency is superior as it simultaneously considers both revenue maximisation and cost minimisation so this is the approach here. The profit efficiency of the bank measures how well profits are maximised with respect to a benchmark, or industry best practice. Following the existing literature (e.g. Fries and Taci, 2005) an intermediation approach is used to identify input-output variables for the banks in the estimations. The variables are described in Table 1.

**Table 1.** Input-Output Variables Used for SF

Variables	Description
Total Profit	Dependent variable and equals to Net Profit after Tax
<i>Output</i>	
Total Loans ( $y1$ )	This is Gross Loans
Total Interest Bearing Funds ( $y2$ )	These are the funds banks allocate in other financial institutions' interest bearing accounts
<i>Input Prices</i>	
Total Interest Expenses ( $w1$ )	These are the expenses of banks for attracting funds (i.e. cost of capital)
Overheads ( $w2$ )	Administrative and labour expenses (i.e. cost of labour)
<i>Control</i>	
GDP per capita	This is calculated at constant US dollars (2005) and taken from World Bank Development Indicators (2013)

Source: The bank specific variables are taken from the financial statements of the banks (Bankscope).

The specifying equation to estimate efficiency levels is the widely used translog functional form for the profit function:

$$\ln(\text{Total Profit}/w_2) = \alpha_0 + \sum_j \alpha_j \ln(y_j)_{it} + \frac{1}{2} \sum_j \sum_k \alpha_{jk} \ln(y_j)_{it} \ln(y_k)_{it} + \beta_1 \ln(w_1/w_2)_{it} + \frac{1}{2} \beta_{11} \ln(w_1/w_2)_{it} \ln(w_1/w_2)_{it} + \sum_i \theta_i \ln(y_i)_{it} \ln(w_1/w_2)_{it} + \gamma_t \ln(\text{control})_{it} + v_{it} - u_{it} \quad (1)$$

where  $i$  and  $t$  index the bank and year respectively, and  $\alpha_{jk} = \alpha_{kj}$ . There are two outputs ( $y$ ); *total loans* and *total interest bearing funds*, and two input prices ( $w$ ), namely, *total interest expenses* and *overheads* (Table 1). The profit function is normalised using the input price (overheads) to ensure price homogeneity, following the literature. (e.g. Berger et al., 2009). The model has a control variable (GDP per capita) to account for cross-country heterogeneity.

There are two error terms  $v_{it}$  and  $u_{it}$ , where the first accounts for statistical noise with a symmetric distribution, and the second has non-negative distribution and reflects bank level inefficiency. There are many assumptions regarding the distribution of  $u_{it}$  (e.g. Aigner et al., 1977; Stevenson, 1980; Greene, 1990). We follow Battese–Coelli (1992) parameterization of time effects, where the inefficiency term ( $u_{it}$ ) is modelled as a truncated-normal random variable multiplied by a specific function of time.

The results for the technical efficiency in Table 2 show that two groups of the transition countries do not differ hugely across the research period, however, the variation is higher in the banks of late transition countries. In addition, there is no suggestion that the efficiency has improved in the early transition countries although the opposite is true for the other group of countries.

### 3.2 Concentration

The existing literature use various variables to account for concentration and competition in a banking sector. Considering the heterogeneity nature of the banks in our sample we aim to use Herfindahl-Hirschman Indices (HHI) as a concentration variable in our analyses following the studies by Boyd et al. (2006) and Marques et al. (2013). The index is equal to the squared sum of each banks' market share and thus a higher value implies higher a level of concentration. These are reported in Table 2, where it can be seen that the HHI is relatively higher in the group of late transition economies indicating a more

concentrated market in these countries. In addition, Table 2 shows no significant change in the level of concentration during the turbulent period of 2007-2012.

### 3.3 Bank risk taking

The recent studies use different risk measurements for a banking sector (e.g. credit risk, default risk). Following Boyd et al. (2006) and Marques et al. (2013) we use Z scores as the measure of bank risk as it is monotonically associated with a measure of a bank's probability of failure. Z score is expressed as return on assets (ROA) plus equity-asset ratio (EAR) divided by the standard deviation of return on assets. Since the Z score indicates the distance to insolvency a higher Z score implies that a bank is less risky (Marquez et al., 2013). This represents a more universal measure of bank risk-taking and has been extensively used in the literature of finance and banking. As the Z score is highly skewed we use the natural logarithm form following Marquez et al. (2013). Return on assets is calculated as Net Income divided by Total Assets and is taken from the bank financial statements retrieved using Bankscope. The volatility of the Z score is higher in the group of late transition economies, but banks in the group of the early transition countries take more risks as their Z scores are lower (Table 2). This is consistent with economic theory implying that banks in more advanced markets have better risk assessment expertise and are able to take higher level of risk and still survive and flourish.

### 3.4 Model Specification for the link between risk, concentration and efficiency

Now to test for the presence of a nonlinear relationship between risk, concentration and competition (Jimenez et. al., 2013) the specification is formulated as follows:

$$Z_{b,c,t} = \beta_0 + \beta_1 * Z_{b,c,t-1} + \beta_2 * \text{HHI}_{b,c,t} + \beta_3 * \text{HHI}_{b,c,t-1} + \beta_4 * \text{TE}_{b,c,t} + \beta_5 * \text{TE}_{b,c,t-1} + \beta_6 * \text{HHI}_{b,c,t}^2 + \beta_7 * \text{HHI}_{b,c,t-1}^2 + \beta_8 * \text{TE}_{b,c,t}^2 + \beta_9 * \text{TE}_{b,c,t-1}^2 + \beta_{10} * (\text{TE}_{b,c,t}) * (\text{HHI}_{b,c,t}) + \beta_{11} * (\text{TE}_{b,c,t}) * (\text{HHI}_{b,c,t-1}) + \beta_{12} * X_{b,c,t} + \beta_{13} * X_{b,c,t-1} + \beta_{14} * W_{b,c,t-1} + \beta_{15} * \text{ownership}_{b,c,t} + \epsilon_{b,c,t} \quad (2)$$

where Z, HHI and TE are the variables for the risk, concentration and technical efficiency respectively. X is a control variable (loan loss provisions/total assets) to account for cross bank heterogeneity and W is a vector of control variables to account for cross country differences. The GDP deflator and growth of GDP is used to control for cross country

heterogeneity in first period lagged form, following Marquez et al. (2013). Equation (2) is estimated using random effects based on generalised least squares (GLS) with robust VCE and maximum likelihood (MLE) estimators. The reason for using random effects is that equation (2) has time invariant variables (a bank ownership variable).

**Table 2.** Competition, Risk and Efficiency

Late transition countries					
Competition and risk				Technical efficiency (te)	
Year	HHI	Z score	Banks	scores	Banks
2000	0.55	16.30	42	0.48	33
2001	0.54	20.73	46	0.47	40
2002	0.42	13.36	49	0.45	43
2003	0.47	11.05	60	0.45	52
2004	0.43	12.12	70	0.45	66
2005	0.33	10.31	85	0.45	80
2006	0.31	10.27	89	0.44	84
2007	0.32	11.76	102	0.44	93
2008	0.28	17.98	112	0.42	89
2009	0.30	18.52	119	0.45	76
2010	0.30	17.50	124	0.41	96
2011	0.26	16.91	128	0.41	94
2012	0.29	13.20	108	0.41	93
Early transition countries					
Competition and risk				Technical efficiency (te)	
Year	HHI	Z Score	Banks	scores	Banks
2000	0.34	12.84	39	0.43	36
2001	0.34	12.46	47	0.43	42
2002	0.32	12.81	51	0.46	46
2003	0.30	11.71	58	0.44	55
2004	0.25	13.22	79	0.44	72
2005	0.25	12.23	84	0.42	78
2006	0.24	12.92	92	0.41	84
2007	0.24	11.61	90	0.41	85
2008	0.25	10.71	90	0.43	74
2009	0.24	12.29	103	0.42	63
2010	0.24	13.93	107	0.42	67
2011	0.22	13.27	104	0.42	72
2012	0.22	14.88	96	0.42	76

Source: Authors' calculations

### 3.5. Data

The sample includes only those banks which have at least three years of financial statements in Bankscope for the period 2000-2012. Thus, 254 banks are included. Further data on macroeconomic variables are obtained from World Bank's Development Indicators 2013.

The descriptive statistics show that the mean Z score is higher in the group of early transition countries implying they are less risky for the period 2000-2006. However, the standard deviation is less in the group of late transition economies indicating that the spread is higher, as shown in Table 3. However, the mean Z score is higher in the group of late transition economies for the period 2007-2012. All of this is consistent with the theory that EU member transition economies are more integrated with the

advanced Western countries and the world financial and economic turbulence significantly impacted the banking sectors in these countries.

The mean for the concentration ratio is higher for the group of late transition economies for both periods, 2000-2006 and 2007-2012, indicating that the banking sectors in early transition economies are more competitive. However, the average technical efficiency is similar in both groups of countries for both periods. The group of late transition economies have higher average inflation as well as growth rates for both periods. The mean for loan losses (non-performing loans divided by total assets) is lower in the group of early transition economies for both periods suggesting superior credit assessment methods (Table 3).

**Table 3.** Descriptive statistics for the main variables

<b>Late transition for the period 2000-2006</b>					
Variable	Observations	Mean	Standard deviation	Min	Max
Z score	451	11.217	11.607	-10.136	103.828
HHI	500	0.328	0.208	0.001	0.998
TE	400	0.453	0.219	0.047	0.915
Inflation	502	14.200	18.240	-1.374	185.291
Growth	502	9.771	5.699	-0.176	34.5
Loss	439	0.018	0.062	-0.064	1.227
<b>Early transition for the period 2000-2006</b>					
Variable	Observations	Mean	Standard deviation	Min	Max
Z score	453	13.979	13.310	0.253	76.110
HHI	469	0.227	0.124	0.102	0.606
TE	418	0.432	0.193	0.052	0.853
Inflation	469	4.538	4.320	-0.777	49.464
Growth	469	5.793	2.544	1.205	12.233
Loss	395	0.004	0.008	-0.040	0.049
<b>Late transition for the period 2007-2012</b>					
Variable	Observations	Mean	Standard deviation	Min	Max
Z score	706	15.876	29.688	-6.002	422.374
HHI	739	0.280	0.213	0.099	0.949
TE	550	0.421	0.216	0.032	0.906
Inflation	735	13.454	14.920	-18.930	74.854
Growth	735	5.456	7.427	-14.800	37.485
Loss	682	0.021	0.048	-0.069	0.530
<b>Early transition for the period 2007-2012</b>					
Variable	Observations	Mean	Standard deviation	Min	Max
Z score	592	15.488	18.360	-5.334	126.785
HHI	602	0.167	0.118	0.078	0.682
TE	440	0.419	0.209	0.047	0.847
Inflation	604	4.150	6.659	-3.706	58.001
Growth	604	1.411	5.704	-17.955	9.978
Loss	533	0.013	0.023	-0.044	0.205

#### 4. New Evidence on Risk Taking Behaviour

##### 4.1. Correlation

The correlation matrix (Table 4) shows that the concentration ratio has a significant positive correlation with the Z score in the group of late transition economies, but this is negative for the group of early transition countries for both periods. Technical efficiency is only significantly correlated with the Z score for the late transition countries for the period 2007-2012. Table 4 also indicates that there is a non-linear relationship between the Z score and technical efficiency and the concentration ratio. Moreover the product of the concentration ratio and technical efficiency is significant in most cases although with different signs, in particular, this correlation is negative and significant for the late transition economies for the period 2000-2006, but is significant and positive for the period of 2007-2012. This indicates that the banks with higher concentration and technical efficiency are likely to have a higher risk appetite in the late transition economies for the period 2000-2006 although this group of highly concentrated and technically efficient

banks are inclined to behave differently during the turbulent period, 2007-2012. However, the correlation results also show that the banks in the group of early transition economies take less risk in both time periods (Table 4). We will check whether the link based on the correlation results are consistent with those of the regressions in the following sections.

##### 4.2 Modelling the Determinants of Risk Taking Behaviour

The results in Table 5 and 6 are considered to be robust only if they are the same when applied two methods, namely, GLS and MLE random effects and only these will be discussed. Table 5 indicates that the product of the concentration ratio with the technical efficiency has a significant impact on the risk taking behaviour of the banks although the signs are different between the groups for the period 2000-2006. This implies that the highly concentrated and technically efficient banks take higher risks in the late transition economies for the period 2000-2006 when the level of competition was quite low in these countries. However, the banks with higher concentration and technical efficiency in the early transition economies take less risks during the stable

(2000-2006), but the opposite is true for the turbulent period (2007-2012).

Standard errors are in parentheses. We delete statistically not significant variables one by one from the equations starting from the most insignificant one thus keeping only significant ones at the end. All variables, except ownership, are used in natural logarithm. Particularly, HHI – Herfindahl-Hirschman index for concentration, TE – technical efficiency, Inflation – GDP deflator (annual %), Growth – GDP growth (annual %) and Loss - loan loss provisions divided by total assets.

Moreover, inflation decreases risk taking behaviour of banks in the early transition countries, while growth increases the level of risk for the period 2000-2006. Foreign and private ownership only in the

group of late transition economies increases risk compared to the state owned banks. This suggests there is a difference in performance and the ability to manage resources efficiently between the banks with foreign, private and state ownership in the group of late transition economies for the period 2000-2006. Additionally, higher risk in foreign and privately owned banks may result from better credit assessment practices compared to that of state owned banks in the period 2000-2006. The implication is that the banks with foreign, state and private ownership have already converged in terms of performance in early transition economies for the period 2000-2006, but this only happens later in the late transition countries in the latter period (Table 6).

**Table 4. Correlation Matrix**

<b>Late Transition Countries for the period 2000-2006</b>						
Variables	Z score	HHI	TE	HHI^2	TE^2	HHI*TE
Z score	1.000					
HHI	0.1487 (0.002)**	1.000				
TE	0.0713 (0.158)	0.0622 (0.217)	1.000			
HHI^2	-0.063 (0.189)	-0.908 (0.000)***	-0.019 (0.712)	1.000		
TE^2	-0.082 (0.104)	-0.0722 (0.152)	-0.948 (0.000)***	0.017 (0.731)	1.000	
HHI*TE	-0.194 (0.000)***	-0.675 (0.000)***	-0.688 (0.000)***	0.587 (0.000)***	0.676 (0.000)***	1.000
<b>Early Transition Countries for the period 2000-2006</b>						
Variables	Z score	HHI	TE	HHI^2	TE^2	HHI*TE
Z score	1.000					
HHI	-0.197 (0.000)***	1.000				
TE	-0.046 (0.349)	0.116 (0.180)	1.000			
HHI^2	0.217 (0.000)***	-0.978 (0.000)***	-0.1040 (0.034)**	1.000		
TE^2	0.0380 (0.4389)	-0.0958 (0.051)*	-0.9438 (0.000)***	0.0886 (0.077)*	1.000	
HHI*TE	0.105 (0.032)**	-0.489 (0.000)***	-0.892 (0.000)***	0.480 (0.000)***	0.857 (0.000)***	1.000
<b>Late Transition Countries for the period 2007-2012</b>						
Variables	Z score	HHI	TE	HHI^2	TE^2	HHI*TE
Z score	1.000					
HHI	0.0794 (0.039)**	1.000				
TE	-0.156 (0.000)***	0.007 (0.864)	1.000			
HHI^2	-0.069 (0.071)*	-0.973 (0.000)***	0.020 (0.646)	1.000		
TE^2	0.1939 (0.000)***	-0.028 (0.508)	-0.949 (0.000)***	0.010 (0.816)	1.000	
HHI*TE	0.0256 (0.5517)	-0.498 (0.000)***	-0.809 (0.000)***	0.466 (0.000)***	0.787 (0.000)***	1.000
<b>Early Transition Countries for the period 2007-2012</b>						
Variables	Z score	HHI	TE	HHI^2	TE^2	HHI*TE
Z score	1.000					
HHI	-0.282 (0.000)***	1.000				
TE	-0.004 (0.927)	0.152 (0.001)**	1.000			
HHI^2	0.304 (0.000)***	-0.974 (0.000)***	-0.146 (0.0022)**	1.000		
TE^2	0.065 (0.177)	-0.132 (0.006)*	-0.962 (0.000)***	0.130 (0.007)*	1.000	
HHI*TE	0.147 (0.002)**	-0.461 (0.000)***	-0.921 (0.000)***	0.466 (0.000)***	0.897 (0.000)***	1.000

p-values are in parentheses. All variables are in natural logarithm.

**Table 5.** Risk, Concentration and Efficiency for the period 2000-2006

Variables	Late Transition		Early Transition	
	Random Effect (GLS)	MLE Random Effect	Random Effect (GLS)	MLE Random Effect
Constant	0.501 (.090)***			
Z score(-1)	0.862 (0.028)***	0.944 (0.017)***	0.933 (0.044)***	0.978 (0.016)***
HHI				0.429 (0.254)*
HHI(-1)				-0.465 (0.269)*
TE				
TE(-1)				
HHI^2	0.005 (0.002)*			
HHI^2(-1)				
TE^2				
TE^2(-1)				
HHI*TE	-0.0713 (0.021)**	-0.053 (0.018)**	0.415 (0.215)*	0.415 (0.214)*
HHI*TE(-1)	0.046 (0.017)**	0.049 (0.024)**	-0.445 (0.226)**	-0.452 (0.227)**
Inflation(-1)			0.042 (0.022)*	0.046 (0.025)*
Growth(-1)	-0.052 (0.031)*		-0.134 (0.041)**	-0.118 (0.034)
Loss				
Loss(-1)				-0.027 (0.011)**
Foreign ownership	-0.118 (0.050)**	-0.194 (0.116)*		
Private ownership	-0.168 (0.042)***	-0.232 (0.116)**		
State ownership				
Observations	278	231	200	200
R squared	0.928		0.953	

The banks with higher technical efficiency in the late transition economies tend to take higher levels of risks during the turbulent period (2007-2012) and the relationship between technical efficiency and Z score is non-linear (Table 6). In contrast to the previous results (Table 5), the banks with higher technical efficiency and concentration ratios take higher risks in

the early transition countries during the financially turbulent period (Table 6). Moreover, the previous period's losses (loan loss provision divided total assets) decrease the level of risk taking in the banks of early transition economies over the turbulent period (2007-2012).

**Table 6.** Risk, Concentration and Efficiency for the period 2007-2012

Variables	Late Transition		Early Transition	
	Random Effect (GLS)	MLE Random Effect	Random Effect (GLS)	MLE Random Effect
Constant			0.716 (0.171)***	
Z score(-1)	0.902 (0.022)***	0.923 (0.017)***	0.789 (0.059)***	0.804 (0.034)***
HHI			-0.656 (0.338)*	
HHI(-1)			0.647 (0.339)*	
TE	-201.404 (111.136)*	-201.757 (115.164)*	-3.396 (1.657)**	
TE(-1)	204.539 (112.943)*	204.951 (117.019)*	3.554 (1.777)**	
HHI^2				
HHI^2(-1)				
TE^2	-72.197 (34.634)**	-67.524 (35.155)*		
TE^2(-1)	74.524 (35.759)**	69.698 (36.293)*		
HHI*TE			-0.998 (0.369)**	-0.579 (0.156)***
HHI*TE(-1)			1.093 (0.361)**	0.607 (0.157)***
Inflation(-1)		0.032 (0.019)*		
Growth(-1)				
Loss		-0.0179 (0.019)*		
Loss(-1)			0.038 (0.015)**	0.026 (0.013)**
Foreign ownership				0.409 (0.143)**
Private ownership				0.459 (0.140)**
State ownership				
Observations	279	284	243	243
R squared	0.922		0.9211	

Standard errors are in parentheses. We delete statistically not significant variables one by one from the equations starting from the most insignificant one

thus keeping only significant ones at the end. All variables, except ownership, are used in natural logarithm. Particularly, HHI – Herfindahl-Hirschman

index for concentration, TE – technical efficiency, Inflation – GDP deflator (annual %), Growth – GDP growth (annual %) and Loss - loan loss provisions divided by total assets.

## 5. Conclusion

This paper first constructed efficiency scores using a SF estimating equation and then used these in an analysis of risk, market concentration and efficiency in a sample of early and late transition economies. During the stable period (2000-2006) the banks with higher concentration and higher technical efficiency take more risks in the late transition countries, while this is ambiguous for the turbulent period (2007-2012). However, the banks with higher concentration and higher technical efficiency of the early transition countries tend to less risks during the stable period (2000-2006), but more during the turbulent period (2007-2012). Moreover, the previous period's losses decrease the level of risk taking in the banks of early transition economies over the turbulent period (2007-2012).

Additional findings show that the ownership structure impacts on risk taking behaviour only in banks in late transition during the period 2000-2006, that is, banks with foreign and private ownership take more risks. This may be due to the performance differences between the banks in late transition countries for the period 2000-2006, but ownership is not found to impact risk taking during the period 2007-2012. Moreover, the results in Table 6 indicate that more efficient banks in the late transition countries take higher risks over the turbulent period (2007-2012) and this relationship is non-linear.

These results support the 'competition-stability' hypothesis during the stable period (2000-2006) for the late transition countries, indicating that higher competition favours less risk taking behaviour in the banking sector, consistent with Boyd and De Nicolo (2005). The banking sectors in these countries are quite concentrated during this period (2000-2006) and this is consistent with the argument proposed by Martinez-Miera and Repullo (2010) that higher competition reduces risk taking behaviour in highly concentrated markets. Although the concentration ratio did not change much in the early transition countries for the periods 2000-2006 and 2007-2012, the risk taking behaviour of the highly concentrated and more technically efficient banks is different between stable and turbulent periods, that is, they take more risks during the turbulent period (2007-2012). This different risk taking behaviour over the stable and turbulent periods with similar concentration ratios was not distinguished by Martinez-Miera and Repullo (2010).

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