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Bank Efficiency and its Relation to Market Competition: European Perspective

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Prohlášení

Prohlašuji, že jsem diplomovou práci vypracovala samostatně a použila pouze uvedené prameny a literaturu.

Declaration

Hereby I declare that I compiled this master thesis independently, using only the listed literature and resources.

Prague, June 30, 2010 Barbora Malá

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Abstract

Accelerated capital market globalization has led to further deepening of banking sector integration. Wide consolidation of European banking markets resulted in increased competition, however there are still efficiency differences within the global banking sector. Although economic theory postulates that increased competition in financial markets should lead to lower cost and enhanced efficiency, recent studies indicate that the relationship is more complex and not inevitably straightforward. As both banking competition and efficiency is of high relevance for economic development, it is crucial to determine the impact of recent structural changes on the competitive environment and banks' performance. In the theoretical part, we consider different methodological issues in measuring competition and efficiency. Within the empirical section, we employ the SFA to estimate efficiency scores for the selected EU credit institutions and derive corresponding measure of competition based on Panzar-Rosse methodology. By further research, we elaborate on the link between competition and efficiency.

Abstrakt

Postupující globalizace kapitálových trhů má mimo jiné za následek prohlubování integrace bankovního sektoru. Rozsáhlá konsolidace evropských bankovních trhů vedla k zintenzivnění konkurence, nicméně rozdíly v efektivitě řízení bank napříč sektory přetrvávají. Ačkoli ekonomická teorie předpokládá kladný vztah mezi konkurencí na trzích a efektivitou, výsledky studií ukazují značnou komplikovanost tohoto vztahu. Vzhledem k tomu, že konkurence mezi bankami i jejich efektivita jsou významnými faktory ekonomického růstu, je třeba pokusit se definovat důsledky strukturálních změn na trzích pro jejich vývoj. Teoretická část této práce nastiňuje různé metodologické přístupy k měření jak konkurence, tak efektivity, navazující praktická část pak hodnotí míru efektivity vybraného vzorku evropských bank pomocí metody SFA, stupeň konkurence na trhu je určen s použitím Panzar-Rosse přístupu. Následující oddíl se pak zabývá interpretací vztahu obou charakteristik.

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1. Competition and efficiency in banking: Introduction

Competition is generally considered a positive factor in most industries; largely for its potency to stimulate innovation and improve quality of provided goods and services. Higher international competitiveness fostered by free trade deregulation and elimination of entry barriers therefore brings benefits primarily to consumers and clients.

As banks play a fundamental role of financial intermediaries in the economy, banking competition is of high relevance for economic development. Largely, services provided by bank institutions predestinate a corporate life and financial possibilities of each individual in the economic system. Prices of financial services determine the scope of investment activity and economic growth; a higher degree of competition in banking sector therefore comes out as a welfare-driver, since more competition means prices reducing. Those welfare-related implications are foremost given by a net interest margin; its narrowing contributes to an increase in consumer surplus, as the competition pulls deposit rates higher and lowers credit rates. Admittedly, the degree of competition matters for the access of firms and households to financial services and external financing, in turn affecting overall economic growth (Claessens and Laeven, 2004).

Moreover, heightened competition is expected to encourage banks in cost reducing, i.e. lowering their cost inefficiencies (Pruteanu-Podpiera et al., 2007). As well as competition, economic efficiency is widely considered to be another force providing welfare gains. Efficiency improvement can permanently contribute to the banks´ income generating capability, which brings not only stability- but also welfare- related implications (Holló and Nagy, 2006). Those authors highlight the empirical finding that “due to the efficiency surplus an efficiently operating banking sector can charge on average lower credit and higher deposit rates compared to less efficient banking systems” (p. 6).

According to the previous notions, the influence of both competition and efficiency on the national welfare seems to be positive on the first sight. As a first-order effect, one would also conclude that increased competition in the financial sector would lead to

lower cost and enhanced efficiency[1] (Claessens and Laeven, 2004). However, large part of recent research has indicated that the relationship between competition and bank efficiency is not inevitably straightforward. It has proved to be more complex and according to Claessens and Laeven (2004, p. 565), "the view that competition is unambiguously good is more naïve in banking than in other industries."

Through banking industry which is still to a greater or lesser extent influenced by national and international regulation, statesmen are able to influence the real economy. Regulatory changes within the last two decades were mainly aimed towards consolidation, resulting in the massive wave of mergers and acquisitions. Triggered cross-border capital flows and widespread privatization of financial institutions have fostered an increase in market concentration. However, to explicitly define the likely impact of these structural changes on the competitive environment and banks´ performance is a quite complicated issue.

From a policy point of view, increased concentration is expected to intensify market power and therefore hinder both competition and efficiency. But on the other hand, if bank mergers and acquisitions are driven by economies of scale, then higher concentration may foster efficiency improvements (Casu and Girardone, 2006). To enable the regulation powers to successfully support financial flows in the economy, it is therefore crucial to ascertain what the conflicting consequences of increased bank concentration might be, and to define its impact on efficiency, interest rates or bank profits.

The thesis is organized as follows: the next section deals with different methodological issues in measuring competition and outlines the main differences between structural and non-structural approaches; Chapter 3 summarizes existing literature on measuring bank efficiency; in Chapter 4, possible links between efficiency and competition are outlined; Chapters 5 and 6 consist of empirical research on efficiency and competition, respectively. The outcomes are concluded in Chapter 7.

[1] Even allowing for the fact that financial products are heterogeneous

2. Bank competition and concentration in the EU

Deregulation of financial services together with the establishment of the Economic and Monetary Union (EMU) and overall information technology progress have dramatically changed the European banking markets. These changes enabled removing entry barriers and fostering competition within the (inter)national banking industries. Creation of large and transparent euro capital markets has been considered the key progress towards highly competitive European banking industry which would be subject to further consolidation and rationalization.

2.1. Two different concepts introduced

As Bikker and Haaf (2002) acknowledge, the process of concentration may obviously affect competition, in particular on local markets for retail banking services (as the number and power of corporations alter). And the wave of mergers and acquisitions activity within the European banking industry, implemented mainly in the late 90s, has taken effect.

Table 1: Number of credit institutions (1998-2001)

Country		Year			
		1998	**1999**	**2000**	**2001**
BE	**Belgium**	123	117	118	112
DK	**Denmark**	212	210	210	203
DE	**Germany**	3,238	2,992	2,742	2,526
GR	**Greece**	59	57	57	61
ES	**Spain**	402	387	368	367
FR	**France**	1,226	1,159	1,099	1,050
IE	**Ireland**	78	81	81	88
IT	**Italy**	934	890	861	843
LU	**Luxembourg**	212	211	202	194
NL	**Netherlands**	634	616	586	561
AT	**Austria**	898	875	848	836
PT	**Portugal**	227	224	218	212
FI	**Finland**	348	346	341	369
SE	**Sweden**	148	148	146	149
UK	**United Kingdom**	521	496	491	452
MU12	**Monetary Union**	8,379	7,955	7,521	7,219
EU15	**European Union**	9,260	8,809	8,368	8,023

Source: ECB.
End of year figures. The 1998 figures are as of 1 January 1999.

Through the late 90s and the beginning of the 00s, European banking integration developing through cross-border branching and acquisitions was culminating (see Table 1). However, cross-border M&As proceeded still mainly with non-European banks rather than with other European institutions. "In a drive to gain high-margin business, banks are showing a strong interest in expanding into Central and Eastern Europe and Latin America. Some important acquisitions have also been made in the United States" (ECB, 2002).

Table 2: CR5 - Share of the 5 largest credit institutions in total assets (%) 1998-2001

Country		Year			
		1998	**1999**	**2000**	**2001**
BE	**Belgium**	63	76	75	78
DK	**Denmark**	71	71	60	68
DE	**Germany**	19	19	20	20
GR	**Greece**	63	67	65	66
ES	**Spain**	45	52	54	53
FR	**France**	41	43	47	47
IE	**Ireland**	40	41	41	43
IT	**Italy**	26	26	23	29
LU	**Luxembourg**	25	26	26	28
NL	**Netherlands**	82	82	81	82
AT	**Austria**	42	41	43	45
PT	**Portugal**	45	44	59	60
FI	**Finland**	86	86	87	80
SE	**Sweden**	86	88	88	#N/A
UK	**United Kingdom**	28	29	30	30

Source: ECB.
CR5 is on a non-consolidated basis.

In the 00s, the main structural trends in the EU banking industry were in line with what was observed in the previous years. Consolidation continued despite showing signs of deceleration. At the same time, the EU banking landscape continued to be dominated by domestic credit institutions[2], though following the EU enlargement in May 2004 significant differences among member states emerged, with the new member states (NMS) characterized by the prominence of foreign entities (especially those with a EU15 parent). In 2007 the foreign entities in the new member states accounted for slightly more than 70% of total banking assets, while the corresponding figure stood at nearly 28% for the fifteen old member states (ECB, 2008).

While Germany, France and United Kingdom continued to witness a consolidation process up to 2007, the sharp decline in the number of credit institutions in the Netherlands over the past years seems to have run out (see Table 3). Contrary to this

[2] Those having 71.3% of market share, with the remainder equally divided between foreign branches and subsidiaries.

trend, certain old member states, such as Belgium, Spain and Italy have reported an increase in the number of credit institutions for a number of consecutive years. In the majority of the new EU members the number of credit institutions remained on average without any considerable change[3].

Table 3: Number of credit institutions (2003-2008)

Country		Year					
		2003	**2004**	**2005**	**2006**	**2007**	**2008**
BE	**Belgium**	108	104	100	105	110	105
BG	**Bulgaria***	35	35	34	32	29	30
CZ	**Czech Republic***	77	70	56	57	56	54
DK	**Denmark**	203	202	197	191	189	171
DE	**Germany**	2,225	2,148	2,089	2,050	2,026	1,989
EE	**Estonia***	7	9	11	14	15	17
IE	**Ireland**	80	80	78	78	81	501
GR	**Greece**	59	62	62	62	63	66
ES	**Spain**	348	346	348	352	357	362
FR	**France**	939	897	854	829	808	728
IT	**Italy**	801	787	792	807	821	818
CY	**Cyprus***	408	405	391	336	215	163
LV	**Latvia***	23	23	25	28	31	34
LT	**Lithuania***	71	74	78	78	80	84
LU	**Luxembourg**	169	162	155	156	156	152
HU	**Hungary***	222	217	214	212	206	197
MT	**Malta***	16	16	19	18	22	23
NL	**Netherlands**	481	461	401	345	341	302
AT	**Austria**	814	796	818	809	803	803
PL	**Poland***	660	744	730	723	718	712
PT	**Portugal**	200	197	186	178	175	175
RO	**Romania***	39	40	40	39	42	43
SI	**Slovenia***	33	24	25	25	27	24
SK	**Slovakia***	22	21	23	24	26	26
FI	**Finland**	366	363	363	361	360	357
SE	**Sweden**	222	212	200	204	201	182
UK	**United Kingdom**	426	413	400	401	390	391
MU15	**Monetary Union**	**6,623**	**6,427**	**6,271**	**6,157**	**6,128**	**6,569**
EU27	**European Union**	**9,054**	**8,908**	**8,689**	**8,514**	**8,348**	**8,510**

Source: ECB (for the NMS).*

But generally speaking, M&A activity continued to increase in terms of value, reflecting dynamic growth of certain banking groups, which heightened the concentration in terms of both the Herfindahl index and the market share of the five largest institutions (CR5). None the less, the cross-border expansion of EU banks has been still aimed at the emerging markets.

[3] With the remarkable exception of Cyprus, reporting almost 50% drop due to the ongoing consolidation in the cooperative credit sector (ECB, 2008).

Table 4: CR5 - Share of the 5 largest credit institutions in total assets (%) 2003-2008

Country		Year					
		2003	**2004**	**2005**	**2006**	**2007**	**2008**
BE	**Belgium**	83.5	84.3	85.3	84.4	83.4	80.8
BG	**Bulgaria***	#N/A	52.3	50.8	50.3	56.7	57.3
CZ	**Czech Republic***	65.8	64.0	65.5	64.1	65.7	62.0
DK	**Denmark**	66.6	67.0	66.3	64.7	64.2	66.0
DE	**Germany**	21.6	22.1	21.6	22.0	22.0	22.7
EE	**Estonia***	99.2	98.6	98.1	97.1	95.7	94.8
IE	**Ireland**	44.4	43.9	45.7	44.8	46.1	55.7
GR	**Greece**	66.9	65.0	65.6	66.3	67.7	69.5
ES	**Spain**	43.1	41.9	42.0	40.4	41.0	42.4
FR	**France**	46.7	49.2	51.9	52.3	51.8	51.2
IT	**Italy**	27.5	26.4	26.8	26.2	33.1	33.0
CY	**Cyprus***	57.2	57.3	59.8	63.9	64.8	63.9
LV	**Latvia***	63.1	62.4	67.3	69.2	67.2	70.2
LT	**Lithuania***	81.0	78.9	80.6	82.5	80.9	81.2
LU	**Luxembourg**	31.8	29.7	30.7	29.1	27.9	27.3
HU	**Hungary***	52.1	52.7	53.2	53.5	54.1	54.5
MT	**Malta***	77.7	78.5	75.3	71.4	70.1	72.8
NL	**Netherlands**	84.2	84.0	84.5	85.1	86.3	86.8
AT	**Austria**	44.2	43.8	45.0	43.8	42.8	39.0
PL	**Poland***	52.0	50.0	48.5	46.1	46.6	44.2
PT	**Portugal**	62.7	66.5	68.8	67.9	67.8	69.1
RO	**Romania***	55.2	59.5	59.4	60.1	56.3	54.0
SI	**Slovenia***	66.4	64.6	63.0	62.0	59.5	59.1
SK	**Slovakia***	67.5	66.5	67.7	66.9	68.2	71.5
FI	**Finland**	81.2	82.7	82.9	82.3	81.2	82.8
SE	**Sweden**	53.8	54.4	57.3	57.8	61.0	61.9
UK	**United Kingdom**	32.8	34.5	36.3	35.9	40.7	36.5
MU15	**Monetary Union**	**40.5**	**41.6**	**42.6**	**42.8**	**44.1**	**44.7**
	(unweighted avg.)	54.2	54.2	54.9	54.4	54.7	**57.1**
EU27	**European Union**	**39.7**	**40.9**	**42.1**	**42.1**	**44.4**	**44.1**
	(unweighted avg.)	58.8	58.5	59.3	58.9	59.4	**59.6**

Source: ECB (for the NMS).*

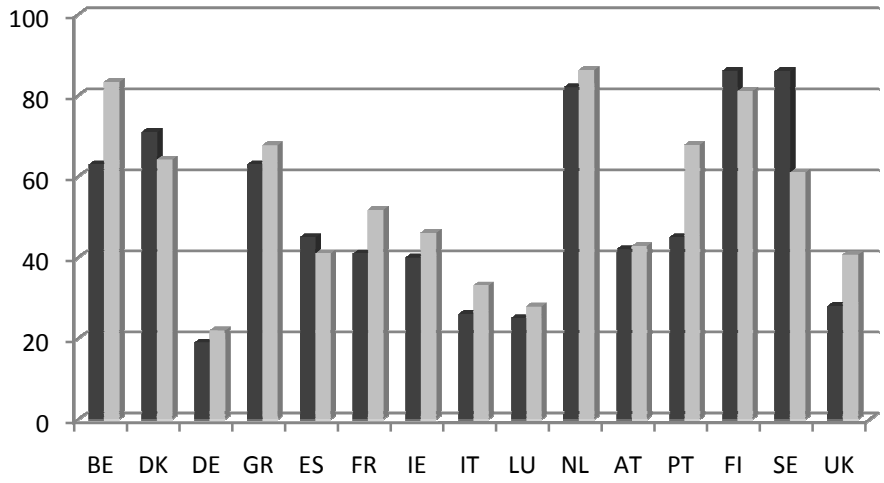
Changes in the CR5 index represent a similar pattern, as it has increased to 44% both at the EU level and within the monetary union (see Table 4)[4]. Smaller countries tend to have more concentrated banking sectors, with the notable exceptions of Austria and Luxembourg, the former having a strong savings and cooperative banking sector, the latter hosting a large number of foreign credit institutions (ECB, 2008). Banking sectors in larger countries, such as Germany, Spain, Italy and United Kingdom, are more fragmented. Regarding the newcomers, rapid credit expansion and intensifying competition exerted a downward pressure on concentration indicators, although they remain significantly above the EU average. However, the banking sectors of Bulgaria, Cyprus, Hungary and Latvia were characterized by slightly opposite developments. The reason for this process was, inter alia, the ongoing consolidation process in the

[4] The cited figures refer to the weighted average.

cooperative credit institution sector and the increased domestic M&A activity among subsidiaries of foreign banks (ECB, 2008).

Concerning the group of the old member states, the majority increase in the concentration of banking markets over a decade is presented in the Chart 1. There are four exceptions having experienced a slight reduction in the five largest banks´ market power in 2007 compared to 1998; those are Denmark, Spain, Finland and Sweden.

Chart 1: CR5 index of the EU-15



To elaborate on the obvious numbers, Casu and Girardone (2006, p. 441) sum up that "the pro-competitive deregulation process has increased the level of competition, particularly in non-traditional and non-interest bearing areas of banking activity". Moreover they claim that in the early stages, it has pushed banks to become more efficient through cost cutting (i.e. cost-efficient).

Nevertheless, the primary notion that EMU will both increase the degree of competition and concentration is not supported by Bikker and Groeneveld (2000). In their empirical study they acknowledge that EMU leads to further rationalization and consolidation of the banking industry; however they claim it is more likely that the overall environment will become less competitive. This argumentation fuels the orthodox view that increased concentration may eventually result in undesirable exercise of market power by banks, therefore limiting competition. In addition, excessive degree of concentration could also impair the soundness and stability of the financial sector (Bikker and Groeneveld, 2000).

Discrepancy in the existing literature raises several important questions: First of all, what are the links between concentration and competition? Is there any empirical support for the conventional view that concentration impairs competitiveness? It is apparent that banking sector concentration has increased in most European countries between the 90s and the early 00s; but how has the competition evolved during that period and what is the onward trend for the future? Should be the growing concentration of European banks slowed down?

After all, there are less controversial issues speaking surely in favor of the European banks consolidation, apart from the drive for power. It is argued that EMU helped uncover variant starting positions of banking sectors in individual countries; the authors mostly suggest the existence of significantly different competitive conditions across EU countries. Moreover, EMU increases the pressure for further harmonization of regulation across member states, so that the incentives and opportunities for regulatory arbitrage diminish considerably (Bikker and Groeneveld, 2000).

2.2. Methodology

The empirical investigation on competitive conditions and concentration of European banks is neither exhaustive nor full-scale; researchers mostly focus on just one of these factors and frequently interchange them. Few recent studies consider both competitive conduct and degree of concentration and establish a relationship between the two of them. The research on bank competition has consequently evolved in two main directions: structural and non-structural approaches.

Traditional industrial organization theory relies upon market structure which is reflected in concentration indices for the largest firms, such as the Hirschman-Herfindahl index, with higher concentration signaling lower competition and vice versa. The essential assumption included is that concentration weakens competition by fostering collusive behavior among firms – which is in accordance with the structure-conduct-performance (SCP) paradigm proposed by Bain in 1951.[5]

[5] According to SCP paradigm, market structure would influence firm behavior in terms of prices and quantities and therefore firm profits.

The non-structural models have been developed in the context of the new empirical industrial organization literature. They take into account other factors except of market structure and concentration that may affect competitive behavior - such as entry barriers and the general contestability of the market (Rosse and Panzar, 1987). "While tests of market power carried out employing the traditional SCP approach observe the structure of the market (e.g. concentration levels, number of firms) and relate this to the conduct (e.g. pricing policies) and performance (e.g. return on assets; return on equity) of firms, in non-structural approaches empirical studies do not observe the competitive environment but they attempt to measure/infer it" (Casu and Girardone, 2006, p. 444). Hence, the establishment of the relationship between competitive conduct and degree of concentration clearly pose both analytical and methodological questions.

2.2.1. Concentration measures: Possible drawbacks of structural approach

Studies referring to concentration and capacity in the European banking disregard the shape of individual production function. The share of the assets of several largest banks in total bank assets, numbers of banks and their branches are mostly used to proxy concentration. There are two frequently applied types of indices. The so called *k*-bank concentration ratio (CR_k) takes the total market share of a small number (*k)* of the largest banks, ignoring the remaining institutions in the market. The second measure, the Herfindahl-Hirschman index (HHI), stresses the importance of larger banks by assigning them a greater weight. It includes all firms separately[6], summing the squares of their market shares, which makes it sensitive to the share distribution in the industry. The HHI is characterized as follows:

$$HHI = \sum_{i=1}^{n} s_i^2 \qquad (1)$$

where s_i is the market share of firm *i* in the market and *N* is the number of firms. All articles unambiguously agree that practically in every European country a handful of

[6] Or 50 largest firms if there are more than 50.

large banks tends to emerge over time, whether through government encouragement or through market mechanisms (Bikker and Groeneveld, 2000).

However, the commonly used concentration indicators suffer from some methodological drawbacks. Firstly, the indices are highly dependent on the size of a country or banking market and therefore appear to be inversely correlated to the number of banks; the smaller the country or the number of its banks, the larger its measure of concentration (Bikker and Haaf, 2002). Secondly, high degree of concentration in a fragmented national market and an international wholesale market may need a different interpretation. Internationally, competition is expected to be fiercer and may therefore require greater size of operations, while in retail lending, the risk of customers turning to foreign bank may be lower. Also, assessing the level of concentration, one should consider the intermediation activity of other lenders (non-bank institutions) which participate in the market. However, it is difficult to correct for that shortcoming as non-banks compete just in few segments of the banking market (such as mortgage lending, consumer credit etc.).

2.2.2. Determining competition: The non-structural approach

The non-structural approach which has been established in reaction to the theoretical and empirical deficiencies of the structural approach has been recently considered more sophisticated and acknowledged for its relative merits. According to Casu and Girardone (2006), the most important advantage is that it cannot be assumed a priori that concentrated markets are not competitive, because *contestability* may depend on the extent of *potential competition* and not necessarily on the market structure. This was demonstrated in several works; for example Claessens and Laeven (2004) regress competition measure on a number of country characteristics[7] and find that contestability (proxied by an index for regulatory restrictions) rather than structure is the most important for competition.

In addition, when using non-structural models there is no need to specify a geographic market. Analysis of the banks´ competitive conduct gets along without using explicit

[7] Those fall in four categories: market structure, contestability, inter-industry competition and general level of development.

information about the structure of the market; rather the behavior of individual banks gives an indication of their market power.

Non-structural measures of competition are originally based on the Lerner index of monopoly power, formalized by Abba Lerner in 1934 and defined by

$$LI_i = \frac{p_i - MC_i}{p_i} \qquad (2)$$

where P is the market price set by the firm and MC is the firms´ marginal cost. The index ranges between 0 and 1, with higher numbers implying greater market power.[8] However, the need to gather necessary information on prices and costs constitutes the main difficulty with this measure in practice. More specific models have therefore been developed in order to determine the competitive nature of the banking industry empirically, requiring firm-specific data. Generally, there are two modern approaches which have been recently becoming very popular in banking competition research.

One of them was formulated by **Panzar and Rosse (1987)**. They have constructed a test statistic *H* which (under certain assumptions) serves as a measure of competitive behavior of banks. The *H*-statistic is calculated from reduced form revenue equations and measures the sum of elasticities of total revenue of the bank with respect to the bank´s input prices. In other words, P-R methodology investigates the extent to which a change in factor input prices is reflected in (equilibrium) revenues earned by a specific bank.

Specification of the Panzar-Rosse model

In their model, Panzar and Rosse postulate a general banking market model, which determines equilibrium output and equilibrium number of banks by maximizing profits at both the bank level and the industry level. This implies that bank operates on the level where marginal revenue equals marginal cost and the zero profit constraint holds at the market level equilibrium as well.

[8] For a perfectly competitive firm (where P=MC), L=0.

The *H*-statistic, standing for a market power, is measured by the extent to which a change in input prices (dw_{ki}) is reflected in the equilibrium revenues (dR_i^*) earned by bank *i*:

$$H = \sum_{k=1}^{m} \left(\frac{\partial R_i^*}{\partial w_{ki}} * \frac{w_{ki}}{R_i^*} \right) \quad (3)$$

Under perfect competition, an increase in input prices raises both marginal costs and total revenues by the same amount as the rise in costs. The optimal output of any individual firm is not altered, but as some firms exit the industry, the remaining ones face increased demand, leading to a rise in prices. Under a monopoly, a rise in input prices increases marginal costs, reduces equilibrium output and thus reduces total revenues. Concerning the value of *H*, it is negative when the competitive structure is a *monopoly*, or an *oligopoly* (with variant scale of colluding). Under *perfect competition*, the *H*-statistic is unity. If *H* is between zero and unity, the market structure is characterized by *monopolistic competition*. The interpretation of *H* statistics is briefly summarized in the following table:

Table 5 : Interpretation of Panzar-Rosse statistic

H=0	***Collusive oligopoly or a monopoly***: increase in costs causes output decrease and price increase; due to the operating on the price elastic portion of firm's demand function, it reduces its total revenue;
H=1	***Perfect competitive industry***: costs increase makes some firms exit, price increase and survivor' revenue increase proportionally to the increase in costs;
0<H<1	***Intermediate case of monopolistic competition***: increase in costs comes out as increase in revenues at a lower that proportional rate.

Source: Casu & Girardone (2006)

A priori, monopolistic competition is the most plausible alternative to characterize the interaction between banks. Their products are recognizably differentiated, banks tend to differ with respect to product quality and advertising, although their core business is fairly homogeneous (Bikker, 2002). Thereby *H* lying within the (0;1) interval can be thought of as the degree of competitiveness in the industry. If a bank faces a demand with constant elasticity and a Cobb-Douglas technology, the magnitude of *H* can be interpreted as an inverse measure of the degree of monopoly power, or alternatively, as a measure of the degree of competition (Claessens and Laeven, 2004). The *H*-statistic implies the average competitive situation on all segments of the banking market.

The P-R methodology uses bank-level data, allows for bank-specific differences in production function and provides for a study of differences with respect to the type and size of banks. However, it assumes the existence of a long-term equilibrium in banking industry.

The Boone indicator model

An alternative, more recent way to measure competition is the Boone indicator. It is based on the efficient structure hypothesis which assumes that, first, more efficient firms (in terms of lower marginal costs) gain higher market shares and thus higher profits and, second, that this effect is getting stronger with rising competition in the market. The Boone indicator therefore considers a direct link between competition and efficiency, in contrast to the Lerner index for instance.

Boone et al. (2005) consider a banking industry where each bank *i* produces one product q_i (or portfolio of banking products), has constant marginal cost c_i and maximizes its profits. In the banking system with N such banks, competition can increase for two reasons: Fist, competition increases when the produced services of the various banks become closer substitutes, second, competition rises when entry costs decline. And according to the Boone approach, these two circumstances increases market shares of more efficient firms. The model for the market share *s* of the bank *i* can then be characterized by the following two equations:

$$s_j = p_i q_i / \sum_j p_j q_j \qquad (4)$$

$$\ln(s_i) = \alpha + \beta \ln(c_i / \sum_j c_j) \qquad (5)$$

where β is referred to as the Boone indicator.

The market shares of banks with lower marginal costs are expected to increase, so that $\beta < 0$. Thus, an increase in competition raises the market share of a more efficient bank relative to a less efficient bank. The stronger the competition is, the stronger this effect will be and the higher (in absolute terms) the value of β (the more the negative β is, the stronger the competition). For empirical reasons, the log-linear form serves to deal with heteroskedasticity. In addition, the specification represents an elasticity of a market share to a percent change in the Boone indicator. For example, an estimated β

of -5 means that a bank with one percent lower marginal cost than another, less efficient bank would have five percent higher market share than the one with lower efficiency.

With the help of the Boone indicator, Leuvensteijn et al. (2007) argue why the SCP paradigm does not have to be the convenient approach to measure real competition. The most common measure, HHI index, is based on a Cournot model with symmetric banks where a new bank entrance decreases the index. Nevertheless, according to the Boone approach (which is more consistent with reality), the banks differ in terms of efficiency; an increase in a number of market players reallocates output to the more efficient firms that already had higher levels of output. So contrary to the traditional SCP theory, an increase in competition raises the HHI index rather than decreases it (Schaeck & Čihák, 2008).

2.3. Concentration vs. competition: Literature review

Trying to determine the relationship between the competitive structure and level of concentration in banking markets, researchers implicitly test for validity of either the SCP or the contestability/efficiency[9] paradigm in European banking. From the theoretical literature, the nature of this link appears to be ambiguous. Reasoning in line with the traditional SCP paradigm, concentration translates into greater market power, fostering collusion and anti-competitive practices. Nevertheless, the first challenging hypothesis, so called ***contestability theory***, stresses that just the threat of potential entry forces banks with high market power to price their products competitively. Hence, under certain conditions[10], concentrated banking industry allows competitive behavior. On the other hand, according to the ***efficiency hypothesis***, if bank operates more efficiently than its competitors, by reducing prices it can expand its size. In this case, the driving force behind the process of market concentration is efficiency. Thus, both the contestability and the efficiency hypotheses assume that the overall

[9] Since the efficiency hypothesis tests whether it is the efficiency of larger banks that makes for enhanced performance.

[10] The contestability theory supposes no entry barriers, either economic or legal. For European countries, this crucial assumption has been set up through gradual regulatory relaxing and accomplished in 1993 when all formal restrictions regarding the provision of financial services across the European Union were removed. Thanks to the "single banking licence" banks are allowed to service the entire European market.

competitive environment faced by banks does not necessarily depend on the degree of market concentration.

Number of recent studies examining competition in banking markets use non-structural approaches, typically the P-R method, including several papers on European banking systems. Generally, the studies reject both perfect collusion as well as perfect competition and find mostly evidence of monopolistic competition. According to Bikker and Haaf (2002), the structure of the European banking industry has altered during the 80s mostly as in response to domestic deregulation and in anticipation of EU-wide regulatory changes, and one of the key consequences has been increased competition.

According to Molyneux et al. (1994), who tested P-R statistics on a sample of banks in five EU countries, monopolistic competition was discovered in all countries except for Italy where the monopoly hypothesis could not be rejected. Bikker and Groeneveld (2000) provide evidence that European banking sectors can be qualified as monopolistic competitive in most countries, although to varying degrees, and point out that the market structure in individual EU countries also depends on numerous *country-specific features* (e.g. national institutions, government intervention, the sophistication of the financial system etc.). However, despite the wave of deregulation and liberalization between 1989 and 1996, they find hardly any evidence of increasing competition over the years. Moreover, a striking outcome of their study is that the degree of internationalization of national banking systems differs widely[11]. Bikker and Haaf (2002) find monopolistic competition in all 23 examined countries, competition being weaker among small banks operating in local markets and stronger among larger, internationally operating banks. In general, they find higher level of competition in Europe than in the US, Canada or Japan, which they explain as a matter of different funding habits. European banks use the interbank market on average more extensively which might be theoretically explained by more developed financial markets, leading to more intense competition. Weill (2004b) similarly finds monopolistic competition for all the 12 countries in the sample.

[11] With banking systems in Denmark, Greece, Spain, Portugal, Germany and Italy being relatively inward oriented, while banks in Luxembourg, Belgium, the UK, Sweden and the Netherlands being more involved in foreign activities.

Claessens and Laeven (2004) who include 50 countries in their study of competition and concentration find that greater foreign bank presence and fewer activity and entry restrictions can make for more competitive banking systems. More importantly, they find no empirical evidence that banking system concentration is negatively associated with competitiveness. To the contrary, according to some of their findings, the competitiveness of banking systems might relate negatively to the number of banks in the country which would – in conflict with the SCP theory - make more concentrated banking systems more competitive. Then the contestability rather than a system with low concentration may be more important to assure competitiveness. "The fact that structure matters so little, or even in ways contrary to expectations, may surprise many involved with competition policy in the financial sector" (Claessens and Laeven, 2004, p. 23). They argue that due to the deregulation forces, the pattern of financial markets and services may have changed significantly, and market structure indicators are thus less valuable measures of markets´ competitive nature. To sum up one of the most comprehensive studies on competition, the trade-off need not be inevitably between a more concentrated system and a less competitive system.

None the less, Bikker and Groeneveld (2000) find some negative effect of concentration on competition, though the relationship is rather weak. Bikker and Haaf (2002) test the competition measure against market structure (proxied by concentration indices and the number of banks in the markets) and find support for the conventional view that concentration impairs competitiveness, which is consistent with the traditional SCP paradigm.

Despite the variables used in the estimation of the P-R statistics may differ across the studies, it is possible to generalize that for most EU banking markets monopolistic competition was inferred as the main market environment. However, the empirical findings on the link between concentration and competition remain quite ambiguous.

3. Efficiency in financial markets

Extensive research on bank efficiency offers a large quantum of literature. Efficient management is considered to be essentially important from both a microeconomic and a macroeconomic point of view. While efficiency is a constructive element in enhancing market competition and upgrading institutional frameworks (the micro perspective), it also influences the cost of financial intermediation and the overall market stability. Subsequent improved resource allocation then spurs the growth of the economy (the macro perspective).

The efficiency of bank management differs internationally, resulting in an efficiency gap. *Managerial ability*, which is considered to be the key efficiency driver, is defined in terms of adequate resource allocation along with beneficial utilization of technological opportunities. Apart from the differing managerial abilities, discrepancies in operational environment (e.g. macroeconomic background, structure of financial institutions and other country-specific factors) may also contribute to the efficiency gap. "While operational environment exogenously explains efficiency differences, the executive and professional competence of management endogenously contributes to them," (Holló & Nagy, 2006, p. 5).

3.1. Efficiency measurement

The measurement of efficiency lies in estimation of the *efficient frontier* and assessing deviations from such frontier which corresponds to the loss of efficiency. Assessing frontier efficiency (so called X-efficiency) consists in measuring the distance (in terms of production, cost, revenue or profit) of a decision making unit from the best-practice equivalent (Delis et al., 2009). As Leibenstein (1966) introduced, X-efficiency consists of two elements: technological and allocative. While technological efficiency measures the ability of a firm to establish appropriate production plans (i.e. to maximize output given a set of inputs), develop new products and distribution channels, allocative efficiency reflects the ability to use a given set of inputs in optimal proportions, or in other words, to optimally react to relative input price

changes (assuming the input prices and technology are known). Overall economic efficiency is a joint measure of both the components.

3.1.1. Efficiency measurement methods

There are basically two main methods which have been proposed in the literature to measure efficiency with frontier approaches: *non-parametric* and *parametric* approaches. The non-parametric methods mostly represented by **DEA (Data Envelopment Analysis)** use linear programming techniques. DEA develops a function (efficient production frontier) whose form is determined by the most efficient producers, and consequently benchmarks firms against those producers. The method stems from the assumption that if one firm produces a certain level of output (utilizing specific input levels), another firm of equal scale should be capable of doing the same. A "composite producer" formed by the most efficient firms producing various output levels would therefore supply an efficient solution for each level of input or output (Berg, 2010).[12]

DEA offers the advantage of not requiring a complete specification of the functional form. On the other hand, this method is unable to decompose the deviations of certain firms from the efficient frontier into real inefficiency and random effects independent of management, which is considered the main shortcoming of the DEA technique. Moreover, through requiring general production and distribution assumptions only, inefficiency levels may be systematically underestimated in some cases.

Parametric approaches, considered to be relatively more sophisticated, apply econometric tools to estimate the efficiency, given the underlying assumption of *stochastic optimal frontier* and estimation based on economic optimization. The two most frequent parametric techniques are the **SFA (Stochastic Frontier Approach)** and the **DFA (Distribution Free Approach).** Similar to DEA, DFA does not consider separation of inefficiency from random error by not applying assumptions to the distribution of inefficiency component. The DFA presumes that each firm has a constant efficiency over time and that the random error tends to cancel out over time (Pruteanu-Podpiera et al., 2007). Thus the core inefficiency is distinguished from

[12] Berg, S. (2010). "Water Utility Benchmarking: Measurement, Methodology, and Performance Incentives." International Water Association.

random error (including any temporary fluctuations in efficiency) by assuming that core inefficiency is persistent over time, while random errors average out over time. The DFA may be used when panel data are available.

But it can be argued that while in the long run, the assumption of invariant efficiency level becomes untenable, in the short time horizon the inefficiency proxied by the average of residual over time may be biased, as the random noise may not average out (Holló & Nagy, 2006).

Stochastic Frontier Approach, on the other hand, relies on the distribution assumptions. SFA does not consider all deviations from the frontier to constitute for an efficiency loss, but rather attempts to decompose them into inefficiency and noise, making explicit assumptions about both of them. Considering the following cost function:

$$TC = f(Y, P) + \varepsilon \qquad (6)$$

where *TC* represents total costs, *Y* is the vector of outputs, *P* is the vector of input prices and ε is the error term, the SFA would suppose that:

$$\varepsilon = u + v \qquad (7)$$

where *u* represents cost inefficiencies (dependent on the actual weakness of managerial ability), and *v* stands for random disturbances linked to exogenous shocks that are beyond the control of the bank´s management. While this random component is assumed to be two-sided normally distributed to reflect luck or measurement errors, the inefficiency term *u* is assumed to be one-sided and literature shows various distributional assumptions for it (Pruteanu-Podpiera et al., 2007), but usually truncated normal or half-normal distribution. The parameters of the two distributions are estimated and used to obtain estimates of bank-specific inefficiency. The estimated mean of the conditional distribution of *ln u*, given in *u + v*, i.e.

$$\ln \hat{u} = \hat{E}(\ln u \,|\, \ln u + \ln v) \qquad (8)$$

is usually used to measure inefficiency.

Throughout the literature, neither of the two methods has emerged as the preferred approach. Parametric methods assume particular functional form, which predetermines the shape of the frontier. And just the need to make those premises, in order to "separate the wheat from the chaff", represents the main shortcoming of the SFA. If the functional form is misspecified, the estimated efficiency may be confounded with significant bias (Delis et al., 2000). On the other hand, non-parametric methods do not allow for random error, hence any noise can cause misleading shape or position of the frontier. At the bottom, while the DEA procedure rather focuses on measuring technological efficiency (based on technological optimization), parametric methods use economic optimization and incorporate both input allocative and technical efficiencies (Holló & Nagy, 2006).

3.1.2. The efficiency concepts

Choice of the measurement concept is considered another fundamental decision while measuring efficiency. There are three main economic efficiency concepts for analyzing the efficiency of financial institutions – cost, standard profit, and alternative profit efficiency. All of them are based on economic optimization in reaction to market prices and competition, rather than solely on the technology matter, which is suitable for the parametric methods.

With respect to the different concepts, a bank can pursue more goals: while profit efficiency is naturally its ultimate goal, cost efficiency can be thought of as a key method to reach long-run profit efficiency. They actually need not to be positively correlated for a certain period of time as each of the two estimated functions may incorporate different information (Berger & Mester, 1997). According to these authors, many studies have found large inefficiencies, "on the order of 20 % or more of total banking industry costs and about half of the industry´s potential profits". Nevertheless, there is no consensus on the sources of such significant differences in measured efficiency.

Cost efficiency measures how close a bank´s cost is to what a best-practice bank´s cost would be for producing the same output level under the same conditions. It is derived from a cost function in which variable costs depend on the prices of variable

inputs, the quantities of variable outputs, any fixed inputs or outputs, random error and efficiency component. Such a cost function is written as follows:

$$C = C(w, y, z, u_c, v_c) \quad (9)$$

where C states for variable costs, w is the vector of variable inputs prices, y is the vector of variable outputs quantities, z denotes the quantities of any fixed inputs or outputs[13], u_c indicates an inefficiency factor (that may rise costs above the best-practice level), and v_c denotes the random error that may involve measurement error and temporary luck. When the function is rewritten in natural logs, it can be simplified as follows:

$$\ln C = f(w, y, z) + \ln u_c + \ln v_c \qquad (10)$$

where f denotes some functional form. The particular efficiency measurement methods differ from each other in how they treat the composite error term ($ln\ u_c + ln\ v_c$), i.e. whether they distinguish the inefficiency term from the random error term.
Berger and Mester (1997) define the cost efficiency of a *bank b* as the estimated cost needed to produce *bank b´*s output vector by the best-practice bank in the sample facing the same exogenous variables (w, y, z), divided by the actual costs of *bank b.* The cost efficiency ratio may be therefore thought of as the proportion of costs or resources that are used efficiently.

Standard profit efficiency measures how close a bank is to producing the maximum possible profit given a particular level of input and output prices. In contrast to the cost function, the standard profit function specifies variable profits in place of variable costs and takes variable output prices as exogenous. That is, the profit dependent variable allows for consideration of revenues that can be earned by varying outputs as well as inputs. Accordingly, profit efficiency accounts for inefficiencies on the output side as well as those on the input side.

[13] Which are included to account for the effects of these „netputs“ on variable costs owing to substitutability or complementarity with variable „netputs“ (Berger & Mester, 1997).

Alternative profit efficiency is a more recent concept which measures how close a bank comes to earning maximum profits given its output level rather than its output prices. The alternative profit function employs the same dependent variable as the standard profit function and the same exogenous variables as the cost function: variable output is held constant while output prices are free to vary and affect profits. Alternative profit efficiency may therefore be suitable for the cases when some of the assumptions underlying cost and standard profit efficiency are not met, e.g. when firms exercise some market power in setting output prices (Delis et al., 2009).

4. Bank competition and performance

Not much of theoretical literature has been devoted to the link between competition and efficiency so far. The roots of efficiency research originate from the institutional approach of corporate microeconomics. Recently, the focus has shifted to the financial sector, more particularly on researching the efficiency of banks.

4.1. Theoretical background

The existence of a relation between market structure and firms´ performance was first proposed by John Hicks (1935). His ***quiet life hypothesis*** defines the idea that monopoly power allows managers to grab a share of the monopoly rents through discretionary expenses or reduction of their effort. In other words, monopoly power allows managers a quiet life free from competition and therefore increased concentration should bring about a decrease in efficiency. In its consequences, even if managers do not pay enough attention to cost rationalisation, a company may end up highly profitable thanks to insufficient level of competition or other market distortions.[14] Hicks´ hypothesis indirectly refers to the potential conflict between owners and managers stemming from information asymmetry – the agency problem, which is known in the microeconomic theory.

In one of the complementary theories to the quiet life theorem, Leibenstein (1966) assumes that owners have no means to check the level of effort exerted by managers, since the production function is not known entirely. Leibenstein agrees that the key determinant of a reduction in inefficiencies is an increase in competitive pressures and offers two main reasons for it. First, under the increased competition, managers have to improve their performance if they do not want the firm to leave the market. Thus, they are motivated by their will to avoid the personal costs of bankruptcy. Second, the more firms on the market the better possibilities for owners to assess firm performance relative to other firms and to make changes in the management if necessary (Pruteanu-

[14] The concept of inefficiency as costs deriving from slack management corresponds well to the one of *x-efficiency*.

Podpiera et al., 2007). Thus the positive causality runs from competition to efficiency, which corresponds to the "Structure-Conduct-Performance" paradigm.
Theoretical argumentation by Hicks, Leibenstein and many others[15] support the idea of competition being beneficial to a company performance. "Economists´ vague suspicion that competition is the enemy of sloth can be specifically documented in the effect of competition (and environmental uncertainty) on the decision-making structures and control devices used by firms" (Caves, 1980, p. 88).

Demsetz (1984), however, predicts a reverse causality between competition and efficiency. In the ***efficient structure hypothesis*** he considers that more efficient firms have lower costs and consequently higher profits. The best-managed firms are then able to increase their market share, which leads to a higher level of concentration in industry. If we consider the concentration be an inverse measure of competition, Demsetz finds a negative relationship between cost efficiency and competition with causality running reversely in comparison to the SCP paradigm.

Before introducing another important hypothesis referring to the competition-efficiency relationship, let us remind that banking industry may have some specific characteristics which would modify the shape of the links between competition and efficiency as compared to other markets. As observed in most corresponding studies, banking markets have a structure of imperfect competition as the industry suffers from considerable information asymmetries between the bank and the borrower. To minimize the risks connected with the credit activity, banks try to build a long-term relationship with their customers and by thus gain some information on them. Those costs of monitoring may notably modify the relationship between competition and efficiency in banking. An increase in banking competition may reduce the length of the customer relationship, further decreasing the cost efficiency of banks. And from a different perspective, reduced competition allows banks to benefit from economies of scale in monitoring and from longer customer relationship (Pruteanu-Podpiera et al., 2007). Considering the specificities of banking competition, one can assume that competition negatively influences efficiency; this assumption is usually called the ***banking specificities hypothesis***. According to Pruteanu-Podpiera et al. (2007),

[15] Hart, 1983; Selten, 1986; Scharfstein, 1988, etc.

banking specificities assumption is more relevant for transition countries than for developed countries. They argue that due to the short history of the market economy, banks in transition countries suffer more from accounting information uncertainties or the relative lack of credit risk analysis know-how.

To sum up, the theoretical literature offers quite contradicting arguments and conflicting hypotheses with respect to the direction and sign of a causal relationship between efficiency and competition. Nevertheless, in the empirical studies one should find some more specific conclusions.

4.2. Empirical findings

In comparison with literature on US banking, relatively little empirical research has been done on efficiency in European banking, and even less on cross-country comparisons. Most of the studies accomplished on the relationship between competition and performance regress cost/profit efficiency on a set of variables for market structure; efficiency measured mostly using the stochastic frontier approach and market structure represented by concentration indices. Although the methodology and data sample widely differentiate across the previous research, the quiet life hypothesis does not seem to be well-established, considering the fact that most of the empirical studies reject it.

Casu and Girardone (2009) find no empirical support for Hick´s quiet life hypothesis, however, they do not either conclude in favor of the efficient structure paradigm. Instead, they demonstrate some positive causality running from market power to efficiency. Hence, their conclusions are consistent with the banking specificities paradigm stating that monopoly power may enable banks to operate at lower costs and thus to increase cost efficiency. Moreover, they observe that efficiency is significantly affected by previous years´ efficiency. Pruteanu-Podpiera et al. (2007) who investigate on the relationship between market power and efficiency in the Czech banking sector supplement some other results which are consistent with the banking specificities hypothesis. They indicate a negative causality running from competition to efficiency and thus reject the intuitive quiet life hypothesis.

Those findings cast uncertainty on the view of favoring banking competition from the perspective of reducing prices of financial services. Greater banking competition may hamper the cost efficiency of banks, which can result in higher loan rates (Pruteanu-Podpiera et al., 2007). In this case, increased competition could have negative effects on banking efficiency and therefore financial stability, and consequently negative welfare-related implications.

In keeping with rejecting the quiet life hypothesis and questioning the benefit of competition, Maudos and Fernández de Guevara (2007), who refer to EU15 over the period 1993-2002 and proxy competition with Lerner indices, identify a positive relationship between market power and cost efficiency. Although a reduction in market power decreases the size of social loss, it also decreases the cost efficiency of the banking system, posing the question of its net impact for society. None the less, Maudos and Fernández de Guevara (2007) come up with the conclusion that the welfare gains associated with the fall of market power are much greater than the loss of bank cost efficiency (moreover, they uncover that the welfare loss from the misallocation of resources attributable to market power represented 0.54 % of the GDP of the European Union in 2002).

Weill (2004), on the other hand, using the Panzar-Rosse model to determine the level of competition, supports the efficient structure hypothesis, which posits that only the most efficient banks survive and gain market share.

Koetter et al. (2008) deal with the relationship for a sample of 4,000 US bank holding companies between 1986 and 2005, estimating cost and profit frontiers and comparing efficiency-adjusted Lerner indices to conventional Lerner indices[16]. Testing the quiet life hypothesis against the efficient structure hypothesis, the authors consistently find a positive relation between both adjusted and unadjusted Lerner indices and cost efficiency. However, with respect to profit efficiency, they point out that when testing for the relationship between competition and efficiency, it is crucial to control for possible endogeneity (i.e. a loop of causality between the independent and dependent variables). Finally, Koetter et al. (2008) conclude that the efficient structure rather than the quiet life hypothesis holds for the US banking.

[16] The conventional Lerner index assumes that a bank operates fully efficiently. According to Koetter´s findings, efficiency-adjusted Lerner indices yield on average about 20 percent less competition among bank holding companies compared to conventional Lerner indices.

4.3. Banking competition and efficiency in transition countries

The banking industry in transition countries of Central-East European region (CEE) underwent massive structural changes during economic transition period initiated in the 1990s. Under the command economy, the state directed credit allocation with scarce respect for repayment capacity. Inputs used by state banks were not necessarily of the scale and mix that minimized costs, because there was no incentive for profit maximization. After the collapse of the communist regime, banks had to restructure fundamentally both their outputs and use of inputs. The prevailing two-tier banking system has been formed, with the banks been transformed into joint-stock companies and (partially) privatized. Moreover, the licensing requirements for newly engendered banks were minimal at the beginning of the transition reflecting the intent of the governments to create competition in their banking sectors. Hence, many relatively undercapitalized de novo domestic private banks were born under these lax entry requirements (Bonin et al., 2004).

Prior to privatization, banking sectors in the transition economies consisted of some private banks (both domestic and foreign) and state-owned banks. For those banks foreign investors were supposed to stabilize them financially, improve their efficiency and know-how in modern banking. Entry of the transition countries into the European Union has required huge progress in a transition process and liberalization of their financial sector. The number of banks fell in almost all new member states (NMS). Some banks failed, but by far the biggest part of the decline reflects mergers and acquisitions, where especially foreign banks were very active (De Haan et al., 2009). As highlighted earlier, due to foreign entry, concentration of banking markets is relatively high in most NMS compared to the EU-15. In general, the aggregated market share of the five largest banks (CR5 ratio) varies between 50 and 99 per cent. However, according to the ECB report (2005), concentration and profit margins in 2003 were negatively related. The SCP hypothesis has not been therefore supported either for the NMS, suggesting that concentration ratios do not necessarily reflect competitive conditions within the region (De Haan et al., 2009).

Foreign bank[17] presence is very large in most NMS, mainly in the form of subsidiaries of foreign banks; and most of the banks involved in the NMS are viewed as strategic investors[18] with a strong commitment to the local economy, rather than financial investors (ECB, 2005). As was stated in the second chapter, foreign entities in the NMS have been represented predominantly by the EU-15 banks. In general, the presence of non-EU banks in the transition region is rather limited. CEE markets are dominated by banks from Austria, Belgium, Italy, and the Netherlands, while Nordic banks especially entered the Baltic tates (De Haan, 2009).

Table 6: Number of foreign banks in 10 former communist countries (1995-2004)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Bulgaria	3	3	7	17	22	25	26	26	25	24
Czech Rep.	23	23	24	25	27	26	26	26	26	26
Estonia	5	4	4	3	3	4	4	4	4	6
Hungary	21	24	30	28	29	33	31	27	29	27
Latvia	1	14	15	15	12	12	10	9	10	9
Lithuania	0	3	4	5	4	6	6	7	7	6
Poland	18	25	29	31	39	46	46	45	43	44
Romania	8	10	13	16	19	21	24	24	21	23
Slovakia	18	14	13	11	10	13	12	15	16	16
Slovenia	6	4	4	3	5	6	5	6	6	7
Total	103	124	143	154	170	192	190	189	187	188

Source: Naaborg (2007)

Table 6 shows the development of the number of foreign banks between 1995 and 2004 in ten former communist countries which are counted as NMS. The number of foreign banks grew strongly up to 2000, when it reached a peak and since then it has stayed stable or decreased slightly. Table 7 shows the share of foreign banks with respect to total bank assets for the same group of countries. The indicator differs within the group with regard to the timing of foreign bank entry. While in 1997, more than 60 per cent of total bank assets were already owned by foreign banks, the rise came later and more gradually in other countries. The exception is Slovenia, where the foreign share in banking assets grew to just 20 per cent up to 2004.

[17] A foreign bank is usually defined as a bank of which more than 50 % of the shares are owned by non-domestic residents.

[18] Strategic ownership has the advantage of providing both stability and expertise in retail banking and risk management (De Haan, 2009).

Table 7: Share of foreign banks in total bank assets in 10 former communist countries (%) 1995-2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Bulgaria	1	2	18	25	42	72	71	72	82	82
Czech Rep.	17	20	24	27	40	66	89	86	86	85
Estonia	n.a.	2	2	90	90	97	98	98	98	98
Hungary	19	46	62	63	62	67	67	85	84	63
Latvia	n.a.	53	72	81	74	74	65	43	53	49
Lithuania	0	28	41	52	37	55	78	96	96	91
Poland	4	14	15	17	49	73	72	71	72	71
Romania	n.a.	n.a.	n.a.	36	44	47	51	53	55	59
Slovakia	19	23	30	33	24	43	78	84	96	97
Slovenia	5	5	5	5	5	15	15	17	19	20
Median	5	20	24	36	44	67	72	84	84	82

Source: Naaborg (2007)

Most evidence suggests that not only foreign banks in transition markets show higher efficiency than their domestically owned counterparts, but they may also contribute to the quality of banking operations of domestic banks, and therefore more efficient banking practices. They may help improve the quality, pricing, and availability of financial services, both directly as providers of these services and indirectly through increased competition. The spill-over effects may eventually enhance economic growth in transition countries (De Haan, 2009).

However, not all of the empirical results confirm the prevailing expectation that the massive entry of foreign investors would enhance the degree of banking competition and/or efficiency. Pruteanu-Podpiera et al. (2008) who focus on the transition period of the Czech Republic, show the absence of increased competition between 1994 and 2005. Furthermore, they provide evidence in favor of a negative Granger-causality running only from competition to efficiency. Their result is consistent with the *banking specificities* hypothesis, according to which greater competition reduces cost efficiency of banks. This finding is in accordance with a large part of previous empirical research in banking: lack of competition does not necessarily reflect a bad performance development.

Bonin et al. (2004), on the other hand, who investigate the impact of bank privatization on efficiency score for six selected economies[19], indicate that foreign-owned banks are more efficient than government-owned banks. In addition, they

[19] Namely, Bulgaria, the Czech Republic, Croatia, Hungary, Poland and Romania

confirm the previous findings that the entry of a strategic foreign investor in the privatization process has a clearly positive influence on cost and profit efficiency. The authors show that both the method and the timing of privatization matter to performance; first, voucher privatized banks are less profit efficient than both domestic private banks and banks privatized by other methods and, second, early privatized banks are more efficient than later-privatized banks. Bonin et al. (2005) further elaborate on that, finding that foreign-owned banks provide better service, particularly if they have a strategic foreign investor. The conclusion corresponds to the hypothesis that better bank were privatized first in transition countries.

According to Fries & Taci (2005), the overall consolidation of banks in the transition region has contributed to greater cost efficiency in banking. In the initial stages of banking reform, cost efficiency increases significantly, but it then declines as reforms advance further. They acknowledge the forementioned notion that privatized banks with majority foreign ownership are the most cost efficient, followed by newly established private banks, while privatized banks with majority domestic ownership are the least efficient private banks, though they are still more efficient than state-owned banks (Fries & Taci, 2005, p. 79). Furthermore, they conclude that, among other country-level factors (macroeconomic stability, institutional development), competition in banking from foreign entry promotes cost efficiency.

5. Empirical research on efficiency

Since the stochastic frontier approach was independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977), there has been done considerable research to apply and extend the model. The SFA production function presumes the existence of technical inefficiencies of production of firms, i.e. for a given combination of input levels, it is assumed that the realized production of firm is delimited from above by the stochastic frontier production, where the best performer in the industry operates. Notional distance of the realized production from the SF production, representing "best practice", measures the level of technical inefficiency. The inefficiency scores are determined due to the explicit assumptions about the inefficiency component distribution; the SFA tries to decompose the residual of the frontier into inefficiency and noise.

5.1. Model specification

The widest concept of firms' performance measurement is the concept of productive efficiency. The original SFA specification by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) for cross-sectional data assumes the parametric frontier production function

$$y_i = f(x_i, \beta) + \varepsilon_i \qquad (11)$$

where

$$\varepsilon_i = v_i - u_i \qquad (12).$$

Battese and Coelli (1992) modified the function for (unbalanced[20]) panel data with firm effects which are assumed to be distributed as truncated normal random variables, which are also permitted to vary systematically over time. The model can be expressed in the following form:

$$y_{it} = x_{it}\beta + (v_{it} - u_{it}) \quad (13)$$

[20] i.e. the panel of data need not be complete

where y_{it} is the production (or the logarithm of the production) of the i-th firm (i=1,…,N) in the t-th time period (t=1,…,T);

x_{it} is a k×1 vector of (transformations of the) input quantities of the i-th firm in the t-th time period;

β is a vector of unknown parameters;

v_{it} are random variables assumed to be iid. $N(0,\sigma_v^2)$ and independent of the

$u_{it} = (u_i \exp(-\eta(t-T)))$, where

u_i are non-negative random variables which are assumed to account for technical inefficiency in production, supposed to be iid. as truncations at zero of the $N(\mu,\sigma_u^2)$ distribution;

η is a parameter to be estimated.

According to Battese and Corra (1977) parametrization, σ_v^2 and σ_u^2 are replaced with $\sigma^2 = \sigma_v^2 + \sigma_u^2$ (standing for the variance of composite error ε_{it}) and new variable $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$ is defined, so that γ must lie between 0 and 1. This is done with the use of maximum likelihood estimation.[21]

Through imposing various restrictions upon this model number of model specifications has appeared in the literature. For instance, setting η to zero provides the time-invariant model[22] (Battese, Coelli & Colby, 1989), additional restriction of $\mu=0$ reduces it to Pitt and Lee (1981) model[23], and by another restriction of T=1 the model returns to the original cross-sectional formulation of Aigner, Lovell and Schmidt (1977). However, the original specification of production function has been adjusted to the cost functional analogy which will be the key concept of the efficiency research in this paper.

To adjust the production function to the stochastic frontier cost function, the error term is simply adjusted to:

$$\varepsilon_i = v_i + u_i \qquad (14).$$

Now, recalling (9) and (10), the cost function can be defined as:

$$\ln C_i = \ln f(w_i, y_i, z_i, \beta) + \ln u_i + \ln v_i \qquad (15)$$

[21] The corresponding log-likelihood function is to be found in Battese and Coelli (1992).
[22] Meaning, that the efficiency does not change over time
[23] In that case, the SFA approach loses its purpose and the OLS method becomes sufficient.

where C_i represents the total cost of the *i*-th firm;

v_i stands for a two-sided random-noise component;

u_i for a one-sided inefficiency term representing economic inefficiency[24];

$f(w_i, y_i, z_i)$ represents the input variables matrix X so that

$$f(w_i, y_i, z_i, \beta) = X_i\beta \qquad (16)$$

with w_i denoting input prices, y_i output quantities, z_i any fixed netputs such as equity capital, and β stands for a vector of unknown parameters or sensitivity indices.

Employing *(16)* and adding the time dimension the cost function *(15)* can be rewritten as:

$$\ln C_{it} = \beta_0 + \sum_{j=0} \beta_j^y \ln y_{jit} + \sum_{k=0} \beta_k^w \ln w_{kit} + \ln u_{it} + \ln v_{it} \qquad (17)$$

where *j* stands for the number of outputs and *k* for the number of inputs.

In the cost function *(15)*, u_i defines the difference of the real costs of the operating bank from the minimal possible total costs represented by the stochastic frontier $f(w_i, y_i, z_i, \beta)+v_i$, i.e. the costs of the most efficient firm in the sample.

The distributional assumptions of the two disturbance components is the key concept used to disentangle the real inefficiency part from the random error. The SFA assumes that inefficiencies follow an asymmetric distribution: usually a truncated or half normal distribution, but some studies also work with exponential distribution or Gamma distribution.[25] Random errors, on the other hand, follow a symmetric distribution, usually the standard normal distribution. The rationale for this is that bank's inefficiencies cannot be negative, i.e. cannot lower cost, and therefore must have an asymmetric distribution, whereas random error capturing all phenomena beyond the control of management can add or subtract cost and thus it can follow a symmetric distribution. In our work we follow probably the most common

[24] If allocative efficiency is assumed, the u_i is closely related to the cost of technical inefficiency (Coelli, 1996).

[25] However, Greene (2008) finds that regardless the certain distributional assumption the estimates of u_i are almost identical, with just the differing estimates of the cost frontier parameters.

assumptions set applied in the efficiency research: normal-half normal; *v* is normally distributed around the frontier and *u* follows a half normal distribution[26]:

$$v_i \sim iid.N(0,\sigma_v^2) \qquad (18)$$

$$u_i \sim iid.\left|N(0,\sigma_u^2)\right| \qquad (19)$$

with v_i independent of the u_i and both independent of the regressors. Using the density functions applied by Kumbhakar and Lovell (2000):

$$f(v) = \frac{2}{\sigma_v\sqrt{2\pi}}\exp\left\{-\frac{v^2}{2\sigma_v^2}\right\} \qquad (20)$$

$$f(u) = \frac{2}{\sigma_u\sqrt{2\pi}}\exp\left\{-\frac{u^2}{2\sigma_u^2}\right\} \qquad (21)$$

and applying Battese and Corra (1977) parametrization, the density function of the composed error term ε is derived as follows:

$$f(\varepsilon) = \frac{2}{\sigma}\phi\left(\frac{\varepsilon}{\sigma}\right)\Phi\left(\frac{\varepsilon}{\sigma}\sqrt{\frac{\gamma}{1-\gamma}}\right) \qquad (22)$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the cumulative distribution and density functions of the standard normal distribution.[27] This density is asymmetric around zero, with its mean and variance given by:

$$E(\varepsilon) = E(u) = \sigma_u\sqrt{\frac{2}{\pi}} \qquad (23)$$

$$V(\varepsilon) = V(u) + V(v) = \frac{\pi-2}{\pi}\sigma_u^2 + \sigma_v^2 \qquad (24)$$

[26] The half-normal distribution is the probability distribution of the absolute value of a random variable that is normally distributed with expected value 0 and variance σ^2. The truncated normal distribution, on the other hand, is the probability distribution of a normally distributed random variable whose value is bounded below or above.

[27] As denoted before, $\sigma = (\sigma_u^2 + \sigma_v^2)^{1/2}$, and $\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$, based upon Battese and Corra (1977).

Before proceeding maximum likelihood estimation, significancy of γ parameter should be tested since in the case that γ=0, random noise would then account for all the deviations from the stochastic frontier, with zero observed inefficiency.[28]

The particular maximum likelihood estimates of the parameters of the stochastic frontier cost function will be estimated with the use of freely accessible computer program FRONTIER 4.1., designed by Tim Coelli for the purpose of stochastic frontier and cost function estimation (Coelli, 1996). The program follows a three-step procedure. At first, Ordinary Least Squares (OLS) estimates of the function are obtained. Those β parameters are then used in the second step as a base in a two-phase grid search of γ. The values selected in the grid search are consequently used as starting values in an iterative procedure (using the Davidon-Fletcher-Powell Quasi-Newton method) to derive the final ML estimates.

As the program produces estimates of σ^2 and γ, the estimates of σ_u^2 and σ_v^2 are indirectly produced as well, so as to get evidence on the relative sizes of v_i and u_i. According to Coelli (1996), we can imply that the measure of cost efficiency relative to the cost frontier is defined as:

$$EFF_i = \frac{E(C_i^* \mid u_i, x_i)}{E(C_i^* \mid u_i = 0, x_i)} \sim \exp\{u_i\} \quad (25)$$

where C_i^* is the cost of the i-th firm, which will be equal to $\exp(C_i)$ if the dependent variable is in logs. The EFF_i score will take a value between one and infinity in this case. The above expression relies upon the value of the unobservable u_i being predicted. This is achieved by deriving expressions for the conditional expectation of the function of the u_i, conditional upon the observed value of $(v_i + u_i)$.[29] The stochastic frontier estimation technique uses outputs and input prices as the inputs into the model, deriving scalar measure of efficiency scores. By modest modification of this measure, detailed in the expression *(25)*, we obtain the efficiency scores that take values from 0 to 1. Higher value means higher efficiency; thus a firm A with an efficiency score of 0.6 is wasting 40 % of resources since it could produce the exactly

[28] We test the null hypothesis H_0: $\gamma=0$ (i.e. inefficiency effects are absent) against H_A: $\gamma>0$ with the use of the generalized likelihood-ratio test. The test statistic is calculated as: $LR=-2[\ln(L(H_0))-\ln(L(H_A))]$ and has a chi-square distribution, the degrees of freedom equal to the number of parameters assumed to be equal to zero in the null hypothesis (in our case it is one).

[29] For the detailed expressions, see results in Jondrow et al. (1982) and Battese & Coelli (1988; 1992; 1993; 1995).

same output while employing just 60 % of its actual inputs set. Explained in the context of the stochastic frontier, a perfectly cost-efficient firm (approaching the value of 1) would produce the same output as firm A with the use of 60 % of costs compared to firm A's costs.

5.2. Functional form specification

To estimate the stochastic cost efficiency frontier, we use the ML procedure of Battese and Coelli (1992). The specific form used for the cost function is a standard translog specification, which can be written as:

$$\ln TC_i = \alpha_0 + \sum_l \alpha_l \ln w_{li} + \frac{1}{2}\sum_l \sum_h \alpha_{lh} \ln w_{li} \ln w_{hi} + \sum_k \beta_k \ln y_{ki} + \frac{1}{2}\sum_k \sum_j \beta_{kj} \ln y_{ki} \ln y_{ji} + \sum_k \sum_l \delta_{kl} \ln w_{li} y_{ki} + \ln v_i + \ln u_i \qquad (26)$$

where TC_i assigns for the total costs of the i-th bank, w_l denotes the input prices (l=1,…,3) and y_k the outputs (k=1,2). To ensure that the estimated cost frontier is well behaved, standard symmetry and homogeneity restrictions are imposed (Kumbhakar and Lovell, 2000):

$$\beta_{kj} = \beta_{jk};\ \alpha_{lh} = \alpha_{hl};\ \sum_l \alpha_l = 1;\ \sum_h \alpha_{lh} = 0;\ \sum_l \delta_{lk} = 0. \qquad (27)$$

In order to achieve the linear homogeneity, the total costs and the input prices are being normalized by the price of physical capital (which is the third input price: w_3). In addition, the total costs and the outputs are being normalized by the bank equity (z), which serves as protection against heteroskedasticity, disparities stemming from differences in banks' size and other estimation imperfections (Stavárek, 2005)[30]. We therefore end up with the specification:

[30] The capital has been incorporated for several reasons. First, the model then captures different risk preferences of management when solving optimization problems; risk averse managers may conserve higher level of capital in the firm than needed in order to absorb financial shocks. Omitting the risk preferences issue could lead to evaluating an optimally managed bank as ineffective. Secondly, higher capital commonly signals lower risk of bankruptcy, which consequently displays in bank's expenses and profits through risk premium. This was particularly characteristic for the transition countries with high rates of classified loans implying increased insolvency risk (Stavárek, 2005). Berger and Mester (1997) also point out that bigger banks usually much more depend on not-own capital than their smaller

$$\ln\left(\frac{TC}{w_3 z}\right)_i = \alpha_0 + \sum_l \alpha_l \ln\left(\frac{w_l}{w_3}\right)_i + \frac{1}{2}\sum_l\sum_h \alpha_{lh} \ln\left(\frac{w_l}{w_3}\right)_i \ln\left(\frac{w_h}{w_3}\right)_i + \sum_k \beta_k \ln\left(\frac{y_k}{z}\right)_i + \frac{1}{2}\sum_k\sum_j \beta_{kj} \ln\left(\frac{y_k}{z}\right)_i \ln\left(\frac{y_j}{z}\right)_i + \sum_k\sum_l \delta_{kl} \ln\left(\frac{w_l}{w_3}\right)_i \ln\left(\frac{y_k}{z}\right)_i + \ln v_i + \ln u_i \quad (28)$$

To estimate cost inefficiency from the above equation, we estimate equation coefficients and the error term ε_{it}, and then calculate efficiency score for each observation in the sample.

5.3. Data and Variables

The data used in this study are based on balance sheets and income statements for a chosen sample of European commercial banks for the period 2004 – 2008. We selected a sample of commercial banks operating in four transition countries: the Czech Republic, Slovakia, Poland and Hungary, as the Visegrad group can be considered to be representative sample of the European post-communist markets. Another sample of selected banks represents European "developed" markets, namely United Kingdom, Germany, France and Italy. The data were obtained exclusively from the Bureau van Dijk Bankscope Database. We focus on commercial banks as they represent considerable segment of depository institutions in European banking and their services are reasonable homogeneous and comparable across countries. We work with an unbalanced data panel[31] consisting of 108 European banks. Moreover, as we deal with the data of accounting character, we choose to use broad variable definitions (presented by IBCA Bankscope) to minimize possible bias arising from different accounting practices in various countries. In addition, where banks report according to both local and international accounting standards, we use data in international accounting standards (IFRS). The detailed list of surveyed bank institutions can be found in the Appendix. Concrete variables will be further specified.

By including just certain part of the banking sector in each chosen country, we are aware that the estimated efficiency scores do not necessarily determine the mean

peers. Since capital is assumed to be the most expensive source of assets financing, its omitting might benefit the more capital-dependent banks, awarding them higher efficiency scores.

[31] The unbalanced panel is justified mostly to account for mergers and acquisitions during the period.

efficiency of the industry. With respect to the dataset selection, the estimation results are representative not of the entire population of banks, but rather of the relatively larger and well-established top tier of commercial banks in chosen countries. The scores are defined on the relative basis within the sample, the measures thus rather indicate the institutions ranking than the exact absolute figures. Nevertheless, as Podpiera & Podpiera (2005) and many others denote, it is deedful to realize that the crucial dependence of the mean efficiency on the choice of the sample of banks complicates the comparison of efficiency development across studies and any exact comparison is not advisable.

5.3.1. Inputs and outputs employed

There are generally two approaches proposed in the banking literature for the definition of inputs and outputs, most significantly differing in the placement of *deposits* within the input-output framework. The *intermediation approach*, first proposed by Sealey & Lindley (1977), views the financial institutions as mediators between the supply and the demand of funds. It assumes that the bank collects deposits to transform them, using labor and capital, into loans (i.e. deposits are considered as inputs and provided loans as outputs). *Production approach*, on the other hand, assumes deposits and loans to be the two main bank products, and labor and capital are used to produce them. The absence of consensus among researchers on the most convenient approach has led to various variables sets defined across the existing papers, mainly as a result of different perceptions of nature and functions of financial intermediaries. But so far, traditional view of deposits as a source of funding has slightly prevailed; the intermediation approach is used for instance by Pruteanu-Podpiera et al. (2007) and Delis et al. (2009). Podpiera & Podpiera (2005), who research on relation of cost efficiency and stability of banks, consider demand deposits as outputs and hence represent the production approach.[32]

We decided for the use of traditional intermediation approach since we consider banks as institutions receiving various types of client deposit to transfer them, with the use of labor and capital, into loans provided to different economic subjects. In our cost function we adopt two outputs and three inputs. The two outputs are total loans and

[32] As Berger & Mester (1997) have shown, the choice of approach to define the input and output variables has an impact on efficiency scores but does not imply strong modifications in their rankings.

other earning assets, both measured in absolute money value. As inputs we include labor, physical capital and borrowed funds, which is common approach in vast majority of bank efficiency studies.[33] The price of labor is measured by the ratio of personnel expenses to total assets; the price of physical capital is defined as the ratio of expenses for physical capital to fixed assets; the price of borrowed funds is defined as the ratio of interest expenses to borrowed funds/deposits. Total costs are then the sum of operating expenses and expenses for borrowed funds. For linear homogeneity and homoskedasticity reasons explained earlier, we normalize total costs *(TC)*, price of labor (w_1) and price of borrowed funds (w_2) by the price of physical capital (w_3). Equity capital *(z)* stands for a fixed netput in our cost function and normalizes *TC* and the outputs y_1, y_2. The used variables are defined in the Table 8 and the descriptive statistics of input prices and output quantities used in the SFA model for the full sample of 8 countries are summarized in the Table 9.

Table 8: Definition of variables used in the formula (28)

Variables		**Description**
Dependent variable		
▪ *Total costs*	TC	Operating expenses + Interest expenses
Explanatory variables		
Input prices		
▪ *Price of labor*	w_1	Personnel expenses/Total assets
▪ *Price of borrowed funds*	w_2	Interest expenses/(Total deposits + Total other funding)
▪ *Price of physical capital*	w_3	(Operating expenses-Personnel expenses)/Fixed assets
Outputs		
▪ *Loans*	y_1	Total customer loans
▪ *Other earning assets*	y_2	Total other earning assets
Fixed netput		
▪ *Equity*	z	

[33] Weil (2004), Podpiera & Podpiera (2005), Holló & Nagy (2006), Pruteanu-Podpiera et al. (2007), Koetter et al. (2008)

Table 9: Descriptive statistics of Input prices and Output quantities – Full sample

	Year	Price of borrowed funds %	Price of labor %	Price of physical capital %	Loans mil. USD	Other earning assets mil. USD
MEDIAN	2008	3.37%	0.62%	258.99%	19882	9720
	2007	4.19%	0.69%	145.65%	12029	9041
	2006	2.75%	0.69%	138.61%	12494	8755
	2005	2.65%	0.89%	172.57%	6736	6817
	2004	2.58%	0.87%	259.80%	5740	5882
AVERAGE	2008	4.03%	0.49%	171.78%	96751	143585
	2007	4.15%	0.63%	129.86%	99163	130625
	2006	3.52%	0.69%	126.15%	76675	105823
	2005	2.95%	0.61%	122.07%	60898	86182
	2004	2.80%	0.69%	130.15%	52857	72023
S.D.	2008	3.61%	0.49%	118.44%	179115	345235
	2007	3.94%	0.65%	95.42%	193062	290577
	2006	3.51%	0.74%	93.40%	141779	227794
	2005	2.78%	0.60%	93.35%	114207	186653
	2004	2.74%	0.70%	104.23%	99674	169825

5.4. Estimation of efficiency scores

The cost efficiency frontier was estimated first for the overall panel data set of 108 banks for the 5-year period 2004-2008. The common cost efficiency frontier is usually derived in order to imply some international comparison[34]. When executing the model, we considered time-varying efficiency ($\eta \neq 0$) to allow for the relative efficiency to shift between the surveyed years as a result of possible technical changes etc. The mean cost efficiency, which denotes the percentage of the resources of the average bank to produce the same output if it were on the estimated frontier, projects quite low level of efficiency scores, corresponding with poor performance in terms of cost management. According to the means stemming from the whole sample regression, the efficiency measure moves around 32 % in 2004 and shows no dramatically upward or downward trend, retaining the 33% level in 2008. The obtained results therefore indicate high backlog of inquired banks with respect to cost management. For instance, the score of 0.33 in 2008 indicates that the average bank was in that year wasting 67 % of its

[34] This approach follows Weill (2004a), Bonin et al. (2005), Fries & Taci (2005), Stavárek (2005) etc.

resources, relative to the best-practice bank. The descriptive statistics of estimated efficiency scores obtained by the SFA methodology for the full sample are presented in the Table 10. Apart from the generally low levels of efficiency, from the upward development of the standard deviation we cannot support the notion of convergence forces across the markets.

Table 10: Descriptive statistics of estimated efficiency scores: Full Sample

year	sample of banks	mean	median	S.D.	min
2004	92	0.3238	0.267526757	0.184927207	0.105155295
2005	100	0.3181	0.255111711	0.190631683	0.10518894
2006	104	0.3364	0.245657461	0.217436196	0.109481317
2007	104	0.3149	0.232601126	0.203448626	0.100471362
2008	102	0.3319	0.226230376	0.228618447	0.102509546

Our evidence of poor cost management efficiency in the first model quite differs from the core results of the existing literature which mostly conclude on significantly higher efficiency scores. Holló & Nagy (2006) estimate the X-efficiency scores on sample of 2459 banks from the 25 EU member states and arrive at the average level of efficiency of 0.67 for EU-10 and 0.85 for EU-25, respectively. Weill (2004), who investigates on differences between frontier techniques with the use of sample consisting of five European countries, arrives at the SFA levels of efficiency ranging between 0.65 and 0.84.

However, as Podpiera & Podpiera (2005) notify, the size of mean efficiency scores is crucially dependent on the individual choice of the sample, hence, any comparison of efficiency development across studies is highly complicated. In their research on Czech banking sector between years 1994 and 2002, they demonstrate on different samples of banks that the mean efficiency appears to be about 20 per cent lower for the full sample than in the case of an alternative sample excluding entries and exits; moreover, the conclude that mean efficiencies for the different samples differ not only in the level but more crucially, even in their trend.

As our full sample consists of four post-communist countries and four traditionally democratic countries, we can assume the data to be inequable. Most likely, heterogeneity of the data sample accounts for the large part of inefficiencies in the case of the single European-wide frontier. Further on, we support the empirical evidence that a sample with higher level of data homogeneity, i.e. the research on a

sample including countries with similar banking systems, implies higher levels of measured efficiency scores. The reasoning is that the more heterogeneous sample the more banks will be far-off the efficiency frontier, which represents the best-practice units.

In the second step, we separated the data into two subsamples: CEE[35] - standing for the group of the so called Visegrád four (Czech Republic, Slovakia, Hungary and Poland); and WE[36] - identifying group of four European countries with long tradition of democracy and free market. Employing SFA to estimate a stochastic cost frontier for each of the samples, we correct for data heterogeneity since the countries within the two subgroups and for the examined period of time are expected to have similar market settings and institutional framework. The descriptive statistics of estimated cost efficiency for the CEE sample and WE sample are summarized in Table 11 and Table 12, respectively.

Table 11: Descriptive statistics of estimated efficiency scores: CEE Sample

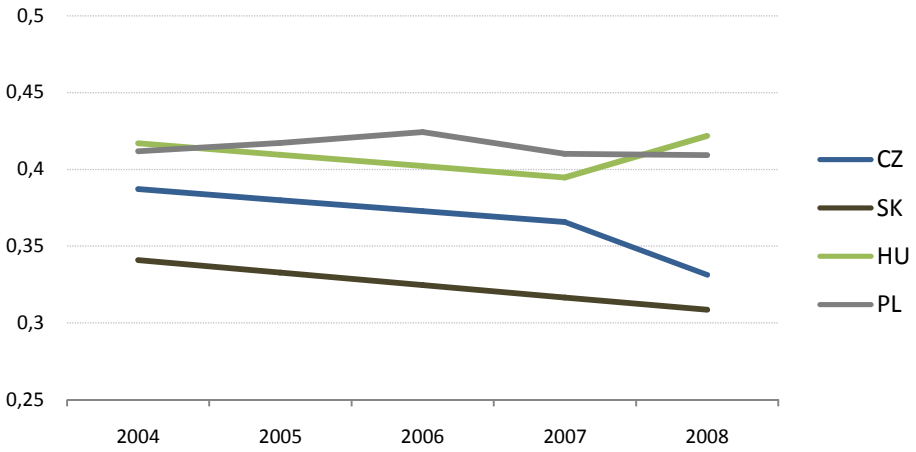
year	sample of banks	mean	median	S.D.	min
2004	48	0.3946	0.340332787	0.165556	0.137205
2005	48	0.3917	0.340996474	0.167389	0.131112
2006	49	0.3900	0.328998255	0.175167	0.12516
2007	50	0.3807	0.315486494	0.174771	0.11935
2008	49	0.3797	0.312467396	0.18580	0.113686

In the case of the Visegrád countries, the mean efficiency scores are slightly better than those derived from the first regression, nevertheless, still poor. The observed banks in the CEE markets demonstrate nearly 40% cost efficiency in the year 2004, referring to 60 % of resources to be wasted. And again, we observe practically no obvious increasing or decreasing trend thereafter; the mean efficiency score terminates at 0.38 in 2008. When we examine for the banks' efficiency development in individual countries (see Chart 2), the highest scores appear for Polish credit institutions (with the mean of 0.42) and the lowest for Slovak banks (with the mean of 0.32), although the scale of variation among all four countries is minimal. Marginally decreasing trend in time can be seen for all markets except Hungary during 2008. In general terms, our

[35] CEE denoting for the Central-East Europe
[36] WE serves us as an abbreviation for Western Europe, although it is not geographically correct for Italy.

empirical results indicate low cost efficiency of banks' management and no evidence of improvement during the last years.

Chart 2: Development of banks' efficiency in the Visegrád Group



Nonetheless, our findings in the case of the CEE-sample are reasonably closer to the outcomes of former empirical researches. Fries & Taci (2005) measure cost efficiency of 289 banks from 15 post-communist countries for the years 1994-2001 and find mean efficiency to range between 0.4 and 0.8. They also conclude that cost efficiency increased significantly in the initial stages of banking reform, but it then declined as reforms advanced further. Stavárek (2005), who measures efficiency of the Visegrád countries for the years 1999-2003, finds on the other hand increasing trend of the average efficiency values. According to his results, the level of efficiency rises from 0.59 in 1999 as far as to 0.71 in 2004. However, it is convenient to remark that Stavárek based his research upon a different sample during different time period. The data for 1999-2003 may possibly have somewhat a different background or interpretation compared to more recent period due to the reverberation of transformation process. Moreover, due to the inadequate information politics of banks in transition countries and the ongoing process of mergers and acquisitions, the individual data are not available for every year and thus the sample size differs in time (Stavárek, 2005). The number of available observations used in our model is listed in the Table 11.

In the case of the WE sample, consisting of 56 commercial banks from UK, Germany, France and Italy, the mean efficiency scores are surprisingly comparable, and even slightly lower, to the efficiency levels in the observed CEE countries for the same

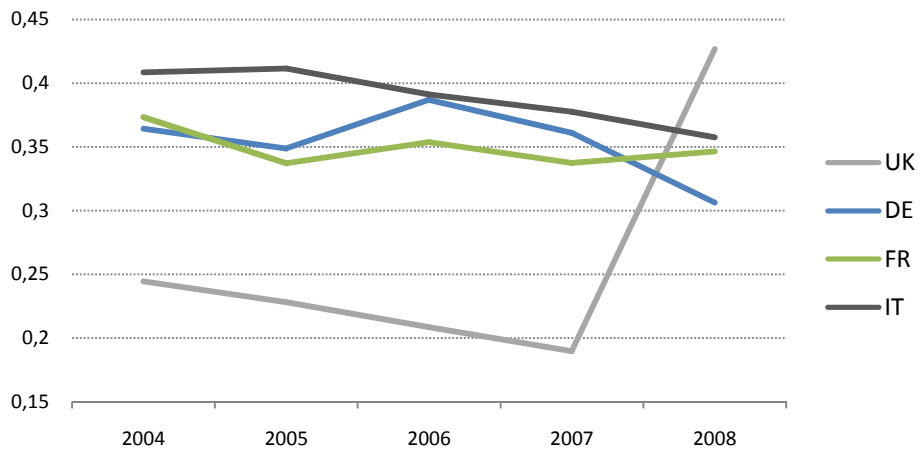
period of time. As denoted in the Table 12, the efficiency measure reaches for just 0.35, where its remains practically without any considerable change up to 2008. And again, the increasing tendency of standard deviations does not give us any signal of efficiency convergence among particular countries.

Table 12: Descriptive statistics of estimated efficiency scores: WE Sample

year	sample of banks	mean	median	S.D.	min
2004	44	0.3486	0.301293	0.180957	0.12934
2005	52	0.3336	0.284655	0.176848	0.113876
2006	55	0.3432	0.284232	0.209596	0.10725
2007	54	0.3233	0.264096	0.198694	0.107004
2008	53	0.3529	0.275314	0.236074	0.111761

Evaluating efficiency development in individual countries (see Chart 3), the scores appear to be very similar, with the highest represented by Italy and the lowest by United Kingdom[37].

Chart 3: Development of banks' efficiency in the selected group of developed countries



[37] The British sample shows strong increase between 2007 and 2008 which can be explained by closer look at the data: three institutions experienced a leap raise in efficiency during that year by approximately 0.8 points. Those were Abbey National Treasury Services Plc, Bank of Scotland Plc and Northern Rock Plc.

According to our evidence, bank cost efficiency appears rather worse compared to most of the studies evaluating cost efficiency with the use of stochastic frontier approach. The primary objective argument lies in the choice of banks' sample with respect to size and selection criteria, and also in use of different sets of assumptions. The literature on banks efficiency, despite significant research effort over the last few years, still gives us no consensus or comprehensive information on the sources of the substantial variation in measured efficiency.

6. Empirical research on competition

Panzar and Rosse (1987) developed methodology to distinguish competitive, monopolistically competitive and oligopolistic markets (introduced in chapter 2.2.2.). When applying the non-structural Panzar-Rosse measure of the competition level of the banking sector we need to characterize bank's production process first, i.e. to define its input and output items.

6.1. Model and variables specification

We follow the intermediation approach again, which is used for instance by Casu & Girardone (2006). In this approach we define loans and other earning assets as outputs, whereas deposits along with labor and capital are inputs. Thereby, we also ensure consistency of the competition research with the methodology used earlier to derive efficiency scores, with the use of parallel data.

To derive the sum of elasticities of total revenue of the firm with respect to the firm's input prices, denoted by *(3)*:

$$H = \sum_{k=1}^{m} \left(\frac{\partial R_i^*}{\partial w_{ki}} * \frac{w_{ki}}{R_i^*} \right)$$

we estimate the following reduced-form revenue equation:

$$\ln TR_{it} = \alpha + \beta_1 \ln P_{1,it} + \beta_2 \ln P_{2,it} + \beta_3 \ln P_{3,it} + \gamma_1 \ln EQAS_{it} + \gamma_2 \ln AS_{it} + \gamma_3 \ln LOAS_{it} + \varepsilon_{it} \qquad (29)$$

where T is the number of periods observed (t=1,…,T) and I is the total number of banks (i=1,…,I). TR denotes total revenue[38] over total assets[39], P_1 is the average cost

[38] According to Casu & Girardone (2006), the reason for using the total revenue rather than only the interest revenue is the recent evidence of dramatic increase of non-interest income. Additionally, the different accounting practices are another argument in favor of using a comprehensive measure of bank revenues.

[39] Normalization by TA serve to account for size differences.

of labor (personnel expenses/total assets), P_2 is the average cost of borrowed funds (interest expenses/borrowed funds), and P_3 is the average cost of fixed capital (capital expenses/fixed assets). All prices are taken in the logarithm form, which enables us to interpret the estimated coefficient in terms of elasticities. Following Casu & Girardone (2006), we then incorporate set of other bank-specific variables to increase the reliability of regression results. The additional regressors are *ln EQAS*, i.e. total equity over total assets; *ln AS*, i.e. total assets; and *ln LOAS*, i.e. the ratio of total loans to total assets. The EQAS ratio is included to control for differences in risk propensity[40], AS controls for the size of the bank and can be considered a proxy for scale economies, and LOAS ratio is expected to be a positive factor in determining the total revenues. The employed variables are summarized in the following table:

Table 13: Definition of variables used in the formula (28)

Variables		**Description**
Dependent variable		
▪ *Total revenue*	***TR***	Total revenue/Total assets
Explanatory variables		
Input prices		
▪ *Price of labor*	$\boldsymbol{P_1}$	Personnel expenses/Total assets
▪ *Price of borrowed funds*	$\boldsymbol{P_2}$	Interest expenses/(Total deposits + Total other funding)
▪ *Price of physical capital*	$\boldsymbol{P_3}$	(Operating expenses-Personnel expenses)/Fixed assets
Bank-specific variables		
▪ V_1	***EQAS***	Total equity/Total assets
▪ V_2	***AS***	Total assets
▪ V_3	***LOAS***	Total loans/Total assets

[40] The coefficient can be expected to be negatively related to the total revenue as lower capital ratios should lead to higher bank revenue.

6.2. Empirical results on European banks competition

Consistently with previous studies, we run the panel data set using fixed effects, as Casu & Girardone (2006) suggest that the error term includes a systematic and bank specific component[41]. The fact that our panel comprises observations on a fixed and relatively small set of units of interest is in favor of using fixed effects. We estimate the regression coefficients both at the whole EU-8 level as well as at each individual country level.

After we receive the regression results, the *H* statistic is calculated as the sum of the three derived input price coefficients:

$$H = \sum_{k=1}^{3} \beta_k \qquad (30).$$

H statistic can be then interpreted as a continuous measure of the level of competition, in particular between 0 and 1, in the sense that higher values of *H* indicate stronger competition than lower values (Bikker & Haaf, 2002).[42] The two extreme cases of monopoly and perfect competition are here identified by *H*=0 and *H*=1, respectively.

To validate the results, we conduct the equilibrium test on observations to find out if the banking system is in long-run equilibrium. The empirical test is suggested by the fact that competitive capital markets will equalize risk-adjusted rates of return across banks such that, in equilibrium, rates of return should not be correlated statistically with input prices (Molyneux et al, 1994). The equilibrium test can be performed by newly-made regression, with the dependent variable of *TR* being replaced by the logarithm of *ROAA* (net income over average total assets) and recalculating the Panzar-Rosse *H* statistic, as demonstrated in the following equation[43]:

[41] Along with the random effects models, the fixed effects models decompose the unitary pooled error term, u_{it}, yielding $y_{it} = X_{it}\beta + \alpha_i + \varepsilon_{it}$, where α_i is a unit-specific and time-invariant component and ε_{it} an observation-specific error.

[42] According to Bikker & Haaf (2002) and as underlined by Casu & Girardone (2006), under stronger assumptions (above all a constant price elasticity of demand across bank-size markets and countries) this 'continuous' interpretation of *H* and the comparison between countries of bank-size markets is correct.

[43] Following Claessens & Laeven (2004) and Casu & Girardone (2006), the measure of ROAA included in *(30)* is equal to ln(1+ROAA) and thus is adjusted for small negative values due to banks' losses in any year.

$$\ln ROAA_{it} = \alpha + \beta_1 \ln P_{1,it} + \beta_2 \ln P_{2,it} + \beta_3 \ln P_{3,it} + \gamma_1 \ln EQAS_{it} + \gamma_2 \ln AS_{it} + \gamma_3 \ln LOAS_{it} + \varepsilon_{it} \quad (31)$$

The findings will be interpreted as follows: H<0 indicates disequilibrium and H=0 indicates equilibrium.

First, we execute the fixed effects panel data regression[44], where estimators are carried out at the EU-8 level. We get the following results, reported in Table 14.

Table 14: Panel data estimates on the reduced-form revenue equation[45]

	coefficient	std. error	t-ratio	p-value	
const	1.41623	0.172443	8.213	2.61E-015	***
lnP1	0.314626	0.0248534	12.66	2.13E-031	***
lnP2	0.486394	0.0177956	27.33	9.64E-096	***
lnP3	0.0210806	0.010438	2.02	0.0441	**
lnEQAS	0.0772892	0.0247285	3.126	0.0019	***
lnAS	-0.0774898	0.0182438	-4.247	2.66E-05	***
lnLOAS	0.0823893	0.0225584	3.652	0.0003	***
Adjusted R-squared = 0.95293					

The estimated *H*-statistic for the whole sample is 0,822, thus indicating monopolistic competition. Moreover, relatively high number indicates that the degree of market competition is closer to perfect competition than monopoly/oligopoly. An analysis of the sign and significance of the regression coefficients indicates that all the price of labor, price of funds and price of capital are positive and statistically significant. However, the impact of cost of physical capital is much lower compared to the other input prices. These results are consistent with previous studies (Molyneux et al., 1994; Bikker and Haaf, 2002; Casu & Girardone, 2001; 2006), finding the impact of the capital factor input price being the least important component of *H*. According to Casu & Girardone, this might be due to the poor quality of capital expenses and fixed assets data. The bank-specific variables report less intuitive results. The variable EQAS is positive, proposing that a high capital ratio may possibly suggest a highly risky loan

[44] We use the Gretl software

[45] We check the results of an F-test for the null hypothesis that the cross-sectional units all have a common intercept, i.e. all the α_is are equal. We can reject the null hypothesis (p-value = P(F(107, 426) > 21,6517) = 1,0629e-120), and therefore confirm that the use of pooled OLS model, with a column of 1s included in the *X* matrix, would not be adequate.

portfolio, thus suggesting a positive coefficient (Bikker & Groeneveld, 2000). The negative coefficient for AS variable in our case contradicts the scale economies argumentation; and the variable LOAS is positive, confirming the expectation that higher loans provision generates greater revenue. Although all the bank-specific variables proved to be statistically significant, they report mixed results and their participation in explanation of total revenues is relatively much lower, compared to price of labor and price of funds.

Further, we perform the equilibrium test which is detailed in the equation *(31)* with the ROAA as the dependent variable; the regression outcome is summarized in Table 15. The resulting value of *H* is -0,002, which is, although of negative sign, very close to zero.[46] We can conclude that banking systems are in long-run equilibrium.

Table 15: Panel data estimates: the equilibrium test

	coefficient	std. error	t-ratio	p-value
const	0.0376971	0.009163	4.114	4.67E-05 ***
lnP1	0.000616161	0.00132062	0.4666	0.641
lnP2	-0.00142083	0.000945594	-1.503	0.1337
lnP3	-0.00158114	0.000554638	-2.851	0.0046 ***
lnEQAS	0.00648494	0.00131398	4.935	1.15E-06 ***
lnAS	-0.00100974	0.000969408	-1.042	0.2982
lnLOAS	6.17E-05	0.00119867	0.0515	0.959
Adjusted R-squared = 0.74266				

Under the assumption of constant elasticity of demand across markets, the model specification is consistent with a continuous interpretation of *H*, and hence, the comparison between countries is acceptable. We thus carry out the estimations at each individual country level to support the EU-8 results. Table 16 reports the regression results. To validate the results on the individual country levels, we conducted the equilibrium test for all the banking markets. According to the results we conclude again that the markets are in long-run equilibrium, and thus it is adequate to use the Panzar-Rosse methodology to derive the level of competition.

[46] Using an F-test, we test whether H=0. If rejected, the market is assumed not to be in equilibrium.

Table 16: Results - H-statistics

Variables	**CZ**	**SK**	**HU**	**PL**	**UK**	**DE**	**FR**	**IT**
P1	0.285**	0.297**	0.168**	0.466***	0.362***	0.285***	0.253**	0.658***
P2	0.178***	0.380***	0.483***	0.385***	0.515***	0.519***	0.530***	0.343***
P3	0.045	0.117***	0.116***	0.032	0.096**	0.004	-0.042	-0.049
EQAS	0.196	0.142*	0.024	0.195**	0.170***	0.164**	-0.007	-0.340**
AS	0.042	-0.020	-0.121***	-0.041	-0.176**	-0.069	-0.168***	0.159
LOAS	-0.076	-0.039	-0.084**	0.083	-0.228	0.165*	0.181***	0.122**
H	**0.509**	**0.794**	**0.767**	**0.883**	**0.972**	**0.808**	**0.741**	**0.952**

The estimated individual *H*-statistics confirm the existence of monopolistic competition in the banking sectors of all examined countries. The value of the *H*-statistics ranges between 0.972 in the United Kingdom (close to perfect competition) and 0.509 in the Czech Republic. All the results indicate high competition forces present in the markets and, except for the CR, all countries show the value of *H*-statistics higher than 0.7. We can therefore observe some convergence across European countries, which would be in line with the pursuing integration of financial markets. Along with the UK, the competition seems to be the highest in Italy (0.952), Poland (0.883) and Germany (0.808).

Although our results indicate on average slightly higher competition compared to other studies, they are consistent with their primary conclusion of monopolistic competition to be the prevalent market structure in Europe (see, among others, Molyneux et al., 1994; Bikker and Haaf, 2002, Claessens & Laeven, 2004; Casu & Girardone, 2001; 2006). Besides, the Panzar-Rosse methodology is still quite a novel concept and the number of studies, which are employing this non-structural measure of competition, is very limited. It therefore remains for future research to be elaborated on. Moreover, we are aware that our banks' sample is bounded and that it is necessary to interpret the results with guardedness.

Analyzing the sign and significance of the regression coefficients from Table 16, we see again that the price of labor and price of funds are positive and statistically significant for all countries. However, P_3, cost of fixed capital, is mostly insignificant (with the exception for Slovakia, Hungary and UK) and its effect on the dependent variable is mixed and minimal compared to the other input prices. We believe that this finding is due to the poor quality of data on capital expenditure and fixed assets, as

Casu & Girardone (2006) propose. The impact of the three bank-specific variables is relatively smaller compared to the input prices, with the mixed sings of the impact. Unlike in the case of the whole pooled sample, the bank-specific variables are statistically insignificant in the half of results.

6.2.1. Bank efficiency involved

In the existing empirical literature, there is a lack of evidence on the relationship between competition and efficiency so far, neither does the literature provide a clear-cut conclusion in favor of a positive effect of heightened competition on efficiency in banking. In the vast majority of researches on the link between competition and efficiency, the relationship is examined using Granger-type causality estimation on dynamic panel data (see, among others, Pruteanu-Podpiera et al., 2007; Casu & Girardone 2001; 2009). In that autoregressive-distributed linear specification, competition is measured by the Lerner index of monopoly power, which is defined as the difference between price and marginal cost divided by price, and provides for the use of both cross-sectional and panel data. However, as denoted earlier, the need to gather necessary information on prices and costs constitutes the main difficulty with this measure in practice.

As we chose to employ the Panzar-Rosse measure of competition, which has recently become one of the most popular methods used to assess competition in the banking industry, the Granger-type causality estimation is not suitable for our purpose. The *H*-statistics allows for a quantitative assessment of the competitive nature of banking markets and is rather an indicator of the average competitive situation in the market, where each bank' decision is dependent on the interaction with other institutions present in the banking industry.

Beyond the measures of competition, efficiency estimates are frequently related to many various aspects of the banks and their markets. In this section, we follow Casu & Girardone (2006) to explore the relation between efficiency and competition in an alternative manner. We include the estimated SFA efficiency scores in the reduced-

form revenue equation as one of the bank-specific factors. Using this method, we consider efficiency as a bank-specific variable, capturing managerial ability[47].
Hence, efficiency estimates are included in the revenue function that is used to calculate the Panzar-Rosse H statistic, adjusting the formula as follows:

$$\ln TR_{it} = \alpha + \beta_1 \ln P_{1,it} + \beta_2 \ln P_{2,it} + \beta_3 \ln P_{3,it} + \gamma_1 \ln EQAS_{it} + \gamma_2 \ln AS_{it} + \gamma_3 \ln LOAS_{it} + \gamma_4 \ln EFF_{it} + \varepsilon_{it} \quad (32)$$

As illustrated in Table 17, the overall results are not affected, i.e. the outcome suggests monopolistic competition in the banking sector with the *H* statistics for the whole sample being 0.817. All the regression coefficients are significant and retained the same sign from the original regression without the SFA scores. The efficiency measure is positive and statistically significant for the whole sample. The positive sign indicates that banks with the highest efficiency scores generate the highest total revenues per Dollar or Euro of assets. Our result may be explained by the fact that the most cost-efficient institutions are the best-managed banks, hence, enjoying the largest market shares. However, analogous to the other bank-specific variables, the coefficient of the EFF variable indicates quite low influence on total revenues compared to price of labor and price of borrowed funds. Accordingly, the found relationship is rather weak.

Table 17: Panel data estimates - SFA efficiency scores included in the reduced-form revenue equation

	coefficient	std. error	t-ratio	p-value	
const	1.47573	0.177033	8.336	1.37E-015	***
lnP1	0.305731	0.0255197	11.98	2.46E-028	***
lnP2	0.48867	0.0182719	26.74	6.73E-090	***
lnP3	0.0222874	0.0104206	2.139	0.0331	**
lnEQAS	0.093971	0.0247882	3.791	0.0002	***
lnAS	-0.0762446	0.0187082	-4.075	5.58E-05	***
lnLOAS	0.103898	0.0234365	4.433	1.21E-05	***
lnEFF	0.0342214	0.0172204	1.987	0.0476	**
Adjusted R-squared = 0.95499					

[47] The inclusion of efficiency as one of the regressors is motivated theoretically, since it can be considered as one of the exogenous variables that shift the bank's costs (Bikker & Haaf, 2002).

Table 18 summarizes results of particular regressions for each country specifically.[48] An explicit impact upon the *H* statistic is not present as the values move very close to the original level. More importantly, all of them suggest presence of monopolistic competition in the inquired markets, and thus confirm the general consensus of previous research. The efficiency variable is only significant in the case of United Kingdom and varies in its sign of impact on total revenues across the countries. In this case, we do not conclude on any clear influence of the bank's management cost efficiency on the degree of competition in the market.

Table 18: Results – H-statistic with efficiency scores included

Variables	**CZ**	**SK**	**HU**	**PL**	**UK**	**DE**	**FR**	**IT**
P1	0.351***	0.322**	0.141*	0.489***	0.360***	0.271***	0.290***	0.443*
P2	0.184***	0.380***	0.436***	0.417***	0.649***	0.515***	0.564***	0.523***
P3	0.070	0.120***	0.140***	0.035	0.089***	0.004	-0.058	-0.035
EQAS	0.210	0.140*	0.029	0.278***	0.192***	0.152*	-0.047	-0.335**
AS	0.045	0.006	-0.051	0.039	-0.254***	-0.086	-0.197***	0.120
LOAS	-0.080	-0.032	-0.023	0.118	-0.165	0.183**	0.115	0.121*
EFF	0.058	0.125	0.359	0.290	0.059***	-0.012	-0.007	0.906
H	**0.605**	**0.822**	**0.717**	**0.942**	**0.963**	**0.790**	**0.796**	**0.931**

6.3. Efficiency as one of the determinants of *H*-statistics

As an additional part of our research on the link between competition and efficiency, we regress the derived *H* statistics on a number of country-specific characteristics. Hereby, we take advantage of the fact that Panzar-Rosse methodology, as well as other non-structural models for purpose of measuring competition, do not assume that high concentration of institutions in a market leads to unfavorable competitive behavior. Following Casu & Girardone (2006), we derive a cross-sectional model where H statistic is explained by the set of country-specific factors:

$$H_i = \alpha_0 + \alpha_1 \ln EFF_i + \alpha_2 \ln DEPP_i + \alpha_3 \ln LODEP_i + \alpha_4 BANKP_i + \alpha_5 \ln CR5_i + \varepsilon_i \quad (33)$$

[48] The equilibrium test is carried out again, and we conclude that banking sectors of most countries are in long-term equilibrium.

where H_i is the H statistic for country i, estimated using equation *(29)*[49]; EFF is the estimated efficiency; DEPP denotes for the density of demand, measured as total deposits per million inhabitants; LODEP is the ratio of total loans to total deposits; BANKP indicates number of banks per million inhabitants; and CR5 is the measure of market concentration, measured by the total market share of the five biggest institutions[50]. The employed variables are summarized in the following table:

Table 19: Definition of variables used in the formula (33)

Variables		Description
Dependent variable		
▪ *Competition*	***H***	*Panzar-Rosse statistics*
Explanatory variables		
▪ *Efficiency*	***EFF***	SFA scores
▪ *Density of demand*	***DEPP***	Total deposits/mil. inhabitants
▪ *Intermediation ratio*	***LODEP***	Total loans/total deposits
▪ *Density of banks*	***BANKP***	Number of banks/mil. inhabitants
▪ *Concentration ratio*	***CR5***	Share of 5 largest banks in total assets

The EFF measure for each country is calculated as the average of the individual financial institutions' efficiency scores. Concentration ratio and the density of banks are used to proxy for the structure of the banking system. A negative coefficient for CR5 would imply that high concentration in the market indicates low competition, which would support the conventional view conformable with the structure-conduct-performance paradigm. A positive value for density of banking system (BANKP) would indicate positive relationship between number of banks (relative to the population) and competition. Total deposits per million inhabitants and loans-over-deposits ratio are included as proxy for competition in the market. Negative coefficient for the LODEP variable can be expected[51], whereas no obvious expectation about the influence of the DEPP variable is predetermined.

[49] i.e. the *H* statistics derived without the inclusion of SFA efficiency scores as the explanatory variable
[50] As measured by total assets
[51] Low quantity of deposits needed to produce loans mean low cost of intermediation, thus low competition (Casu & Girardone, 2006).

The results of our cross-sectional model are summarized in the Table 20. All variables except for the intermediation ratio are negative, suggesting that the influence of efficiency, density of demand, number of banks and concentration ratio on market competition might be negative. However, no explanatory variable appears to be significant, which rather limits us in making any conclusions. The poor validity of the model is primarily due to the low number of degrees of freedom, i.e. the number of observations counts only two more than the number of parameters.

Table 20: Results - H statistic regressed on country-specific variables

	coefficient	std. error	t-ratio	p-value
const	0.980304	2.52595	0.3881	0.7354
lnEFF	-0.236352	0.503057	-0.4698	0.6847
lnDEPP	-0.0457254	0.200854	-0.2277	0.8411
lnLODEP	0.285924	0.553221	0.5168	0.6567
lnBANKP	-0.121940	0.417431	-0.2921	0.7977
ln_CR5	-0.331532	0.68373	-0.4849	0.6757
Unadjusted R-squared = 0.457				

After the most insignificant variables are successively omitted from the model, we end up with the two-variable regression which was found the most suitable in explaining dependent variable (see Table 21). Both efficiency and concentration ratio are negatively related to competition, although the relation is still weak due to the relatively high p-values. CR5 variable is significant approximately on 80% level of significance, whereas the EFF variable denotes significance level lower that 60 %. The model has therefore still very limited explanatory potential and its results must be interpreted with high guardedness. However, with respect to the fact that the sample consists of just 8 observations, the results could be barely more favorable.

Table 21: Results - H statistics regressed on CR5 and efficiency

	coefficient	std. error	t-ratio	p-value
const	0.330318	0.372976	0.8856	0.4164
lnEFF	-0.275477	0.316314	-0.8709	0.4236
ln_CR5	-0.200505	0.138621	-1.446	0.2077
Unadjusted R-squared = 0.36976				

We find slight evidence that a structure of banking system is related to measured competitiveness. The negative sign of CR5 reports in favor of the traditional SCP notion that higher concentration of banks in the market lowers the competition pressures, even though the link remains rather statistically unfounded. From the different point of view, the results incline to the previous findings (Claessens & Laeven, 2004) that the degree of competition is not necessarily related to market structure, as H statistic and bank concentration measures mirror different concepts. Finally, we find no empirical evidence that efficiency of banking system boosts competitiveness, as the EFF coefficient is negative and statistically insignificant. Although the negative sign, if supported by lower p-value of the coefficient, would give support to the efficient structure hypothesis, out of our sample of banks, we cannot acknowledge either of the existing hypotheses.

7. Conclusion

This thesis deals with the issues of efficiency and competition in the European banking markets. Banking competition is of high relevance for economic development, as the degree of competition matters for the access of firms and households to financing, in turn affecting overall economic growth. Competition within the market is expected to be closely related to the bank performance through encouraging banks in cost reducing, leading to minimizing of cost inefficiencies. Efficiency improvement influences profitability of banks and is generally supposed to reflect in stability- and welfare- related implications. Economic theory thus postulates that increased competition in financial markets should lead to lower cost and enhanced efficiency. However, recent studies indicate that the link between competition and efficiency is more complex and not inevitably straightforward. Through altering rules and regulations, which the banking industries face to, statesmen may influence the real economy. From a policy point of view, it is therefore crucial to ascertain conflicting consequences of recent structural changes and to provide for their impact on the competitive environment and banks' performance.

In the theoretical part, we consider different methodological issues in measuring competition and outline the main differences between structural and non-structural approaches. Among the non-structural measures, the Panzar-Rosse H statistic is highlighted as a modern approach to assess the degree of competition pressures present in the market. Further on, we summarize extensive research on bank efficiency in European markets and gather the main hypotheses on its relationship to competition, which occur across the empirical literature.

Within the empirical section, we first estimate efficiency scores for the selected EU credit institutions. With the use of stochastic frontier approach method we employ the concept of cost efficiency on the sample of 108 commercial banks, both from developed and transitional countries, for the time period 2004 - 2008. Concretely, we focus on banks in United Kingdom, Germany, France, Italy; and the Visegrád Group, consisting of the Czech Republic, Slovakia, Hungary and Poland. In general, our empirical results indicate low cost efficiency of banks' managements and no evidence

of improvement during the examined period. Additionally, we do not prove any appreciable evidence of efficiency convergence forces across the markets.

In the following section, empirical research on competition is performed, using the Panzar-Rosse model. To save for consistency of research, we follow the intermediation approach, which views the financial institutions as mediators between the supply and the demand of funds. The calculated H statistics indicate the degree of competition in all examined countries corresponding to monopolistic competition, which is broadly in line with previous empirical research. To elaborate on the link between competition and efficiency, we follow a two-step procedure. First, the estimated SFA efficiency scores are included in the reduced-form revenue equation as one of the bank-specific factors, and the P-R statistic is recalculated. As a result, we again confirm the monopolistic competition to be the prevalent market structure in Europe. Further, we gain some evidence that banks with the highest efficiency scores generate the highest total revenues. This might be explained by the fact that the most cost-efficient institutions are the best-managed banks, hence, enjoying the largest market shares. Such interpretation speaks in favor of the efficient structure hypothesis, none the less, found relationship is rather weak.

As an additional part of our research, we regress the derived H statistics on a number of country-specific characteristics in order to explore, if any, power of particular factors in explaining the competition measure. Although the model has very limited explanatory potential, the results incline to the previous findings that the degree of competition is not necessarily related to market structure. Finally, we find no evidence that efficiency of banking system boosts competitiveness. Resulting negative sign of efficiency parameter, if supported by better significancy indicator, would rather motivate the alternative theory expressed by efficient structure hypothesis.

8. References

Bain, J. (1951): *Relation of Profit Rate to Industry Concentration*. Quarterly Journal of Economics 65, 293-324.

Battese, G.E. & Coelli, T.J. (1993): *A Stochastic Frontier Production Function Incorporating a Model for Technical Inefficiency Effects*, Working Papers in Econometrics and Applied Statistics, No.69, Department of Econometrics, University of New England, Armidale, pp.22.

Berger, A. N. & Mester, L. J. (1997): *Inside the black box: What explains differences in the efficiencies of financial institutions?* Journal of Banking & Finance, vol. 21, pp. 895-947.

Bikker, J.A. & Groeneveld, J.M. (2000): *Competition and Concentration in the EU Banking Industry.* Kredit und Kapital, Vol. 33, pp. 62-98.

Bikker, J.A. & Haaf, K. (2002): *Competition, Concentration and Their Relationship: an Empirical Analysis of the Banking Industry.* Journal of Banking and Finance, Vol. 26, pp. 2191-2214.

Bonin, J. & Hasan, I. & Wachtel, P. (2004): *Privatization Matters: Bank Efficiency in Transition Countries*. Working Papers 04-06, New York University, Leonard N. Stern School of Business, Department of Economics.

Bonin, J. & Hasan, I. & Wachtel, P. (2005): *Bank performance, efficiency and ownership in transition countries*. Journal of Banking & Finance, Elsevier, vol. 29(1), pages 31-53, January.

Bureu Van Dijk (2009), Bankscope Database.

Campbell, R. & Rogers, K. & Rezek, J. (2008): *Efficient frontier estimation: a maximum entropy approach.* Journal of Productivity Analysis, Springer, vol. 30(3), pages 213-221, December.

Casu, B. & Girardone, C. (2009): *Testing the relationship between competition and efficiency in banking: A panel data analysis.* Economics Letters, vol. 105, pp. 134-137.

Casu, B. & Girardone, C. (2006): *Bank competition, concentration and efficiency in the Single European market.* The Manchester School Vol. 74 No. 4, pp. 441-468.

Casu, B. & Girardone, C. (2001): *Does Competition Lead to Efficiency? The Case of EU Commercial Banks*. University of Essex, Discussion Paper No. 07-01.

Caves, R. (1980): *Industrial Organization, Corporate Strategy and Structure*. Journal of Economic Literature 18, 64-92.

Claessens, S. & Laeven, L. (2004): *What Drives Bank Competition? -Some International Evidence.* Journal of Money, Credit and Banking 36, 3, 563-583.

Coelli, T.J. (1996): A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation, Working Paper No. 7/96, CEPA Working Papers.

De Guevara, J.F. & Maudos, J. & Perez, F. (2005): *Market Power in European Banking Sectors.* Journal of Financial Services Research 27, 2, 109-137.

De Haan, J. & Oosterloo, S. & Schoenmaker, D. (2009): *European Financial Markets and Institutions*. Cambridge University Press, New York.

Delis, M. & Koutsomanoli-Fillipaki, A. & Staikouras, C. & Gerogiannaki, K. (2009): *Evaluating cost and profit efficiency: a comparison of parametric and nonparametric methodologies.* Applied Financial Economics, Taylor and Francis Journals, vol. 19(3), 191-202.

European Central Bank (2002): *Structural Analysis of the EU Banking Sector: Year 2001*. http://www.ecb.int. ISBN: 92-9181-331-1.

European Central Bank (2005): *Banking Structures in the New EU Member States*. ECB, Frankfurt am Main.

European Central Bank (2008): *EU Banking Structures*. http://www.ecb.europa.eu. ISSN 1830-1878.

Fries, S. & Taci, A. (2005): *Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries*. Journal of Banking and Finance 29, 2005/1, pp. 55–81.

Goddard, J. & Molyneux, P. & Wilson, J.O.S. (2001): *European Banking: Efficiency, Technology and Growth*. Wiley Finance, ISBN: 0-471-49449-6.

Griffith, R. & Boone, J. & Harrison, R. (2005): *Measuring Competition*. Advanced Institute of Management, Research Paper No. 022.

Holló, D. & Nagy, M. (2006): *Bank Efficiency in the Enlarged European Union*. MNB Working Papers 2006/3, Budapest, ISSN: 1585-5600.

Koetter, M. & Kolari, J. & Spierdijk, L. (2008): *Efficient competition? Testing the "Quiet Life" of US Banks with Adjusted Lerner Indices*. Working Paper, Groningen University.

Van Leuvensteijn, M. & Bikker, J.A. & Van Rixtel, A. A.R.J.M. & Kok-Sørensen, Ch. (2007): *A new approach to measuring competition in the loan markets of the euro area*. CPB Discussion Papers 84, CPB Netherlands Bureau for Economic Policy Analysis.

Maudos, J. & J. Fernández de Guevara (2007). *The cost of market power in banking: Social welfare loss vs. cost ineffciency*. Journal of Banking & Finance 31, 2103-2135.

Molyneux, P. & Lloyd-Williams, D.M. & Thornton, J. (1994): *Competitive Conditions in European Banking*. Journal of Banking and Finance, Vol. 18, pp. 445-459.

Naaborg, I.J. (2007): *Foreign Bank Entry and Performance with a Focus on Central and Eastern Europe.* PhD thesis, University of Groningen.

Panzar, J.C. & J.N. Rosse (1987): *Testing for "Monopoly" Equilibrium.* Journal of Industrial Economics, vol. 35, pp. 443-456.

Podpiera, A. & Podpiera, J. (2005): *Deteriorating Cost Efficiency in Commercial Banks Signals an Increasing Risk of Failure.* CNB Working Paper Series 6/2005.

Pruteanu-Podpiera, A. & Weill, L. & Schobert, F. (2007): *Market Power and Efficiency in the Czech Banking Sector*. CNB Working Paper Series 2007/6, Prague.

Pruteanu-Podpiera, A. & Weill, L. & Schobert, F. (2008): *Banking Competition and Efficiency: A Micro-Data Analysis on the Czech Banking Industry*. Comparative Economic Studies 6/2008, Volume 50, Number 2, pp. 253-273.

Stavárek, D. (2005): *Restrukturalizace bankovních sektorů a efektivnost bank v zemích visegrádské skupiny.* Vědecké monografie Slezské univerzity v Opavě, ISBN: 80-7248-319-6.

Schaeck, K. & Čihák, M. (2008): *How Does Competition Affect Efficiency and Soundness in Banking? New Empirical Evidence*. ECB Working Paper No. 932.

Weill, L. (2004a): *Measuring Cost Efficiency in European Banking: A Comparison of Frontier Techniques.* Journal of Productivity Analysis, vol. 21, pp. 133-153.

Weill, L. (2004b): *On the Relationship between Competition and Efficiency in the EU Banking Sector.* Kredit und Kapital, Vol. 37, No. 3, pp. 329-352.

Appendix

	Bank Name	Country Code	Total Assets th USD (Last avail. Yr)	Country rank by Assets
1	Ceska Sporitelna a.s.	CZ	44568904	1
2	Ceskoslovenska Obchodni Banka A.S.- CSOB	CZ	42617855	2
3	Citibank a.s.	CZ	7222115	7
4	CMSS as-Ceskomoravska Stavebni Sporitelna as	CZ	8039750	6
5	GE Money Bank as	CZ	5094402	9
6	Hypotecni banka a.s.	CZ	7142407	8
7	J&T Banka as	CZ	1998811	17
8	Komercni Banka	CZ	36133775	3
9	Stavební Sporitelna Ceské Sporitelny as	CZ	5078466	10
10	Unicredit Bank Czech Republic AS	CZ	14405097	4
11	Banque de Financement et de Trésorerie - BFT	FR	27448610	40
12	Banque Fédérative du Crédit Mutuel	FR	591779263	12
13	Banque PSA Finance	FR	36698907	34
14	Banque Scalbert Dupont- CIN	FR	23308050	47
15	BNP Paribas	FR	2888526820	1
16	Caisses d'Epargne Participations	FR	662527295	10
17	Calyon	FR	1193335158	6
18	Crédit du Nord	FR	56698764	27
19	Crédit Immobilier de France Développement - CIFD	FR	53658337	28
20	Crédit Industriel et Commercial - CIC	FR	350241450	17
21	Crédit Lyonnais	FR	136993943	21
22	Credit Mutuel - IFRS	FR	809559509	8
23	Dexia Crédit Local SA	FR	576522148	13
24	HSBC France	FR	370224749	15
25	La Banque Postale	FR	155793195	20
26	Lyonnaise de Banque	FR	46762086	30
27	Natixis	FR	773446504	9
28	Newedge Group	FR	76047594	23
29	RCI Banque	FR	32102149	36
30	Société Générale	FR	1572615644	5
31	SOFINCO	FR	72587572	24
32	Aareal Bank AG	DE	57280633	23
33	Bayerische Hypo-und Vereinsbank AG	DE	638232535	3
34	BHF-Bank AG	DE	30302692	40
35	Commerzbank AG	DE	870080000	2
36	Deutsche Bank AG	DE	3126269491	1
37	Deutsche Kreditbank AG DKB	DE	66528977	18
38	Deutsche Postbank AG	DE	321873209	7
39	Dresdner Bank AG	DE	585847873	n.a.
40	HSBC Trinkaus & Burkhardt AG	DE	30903484	39
41	ING-DiBa AG	DE	114057474	13
42	Maple Bank GmbH	DE	67136377	20
43	Santander Consumer Bank AG	DE	32533297	37
44	SEB AG	DE	83763828	15
45	UBS Deutschland AG	DE	54999097	26
46	Volkswagen Bank GmbH	DE	42958179	32

47	CIB Bank Zrt-CIB Bank Ltd	HU	16171608	3
48	Commerzbank Zrt	HU	1489713	14
49	Deutsche Bank Zártköruen Muködo Részvénytársaság-Deutsche Bank ZRt	HU	871859	16
50	Erste Bank Hungary Nyrt	HU	14030967	5
51	K&H Bank Zrt	HU	16936251	2
52	KDB Bank (Hungary) Ltd	HU	774222	17
53	Magyar Cetelem Bank Rt	HU	506004	19
54	MKB Bank Zrt	HU	15355223	4
55	OTP Bank Plc	HU	49914511	1
56	Porsche Bank Hungaria	HU	388420	20
57	Raiffeisen Bank Zrt	HU	13678835	6
58	UniCredit Bank Hungary Zrt	HU	9375706	7
59	WestLB Hungaria Bank Rt	HU	283572	23
60	Banca Aletti & C. SpA-Aletti & C. Banca di Investimento Mobiliare SpA	IT	35414236	24
61	Banca Carige SpA	IT	44515203	18
62	Banca IMI SpA	IT	113697580	8
63	Banca Italease SpA	IT	31463782	27
64	Gruppo Monte dei Paschi di Siena-Banca Monte dei Paschi di Siena SpA	IT	297538090	3
65	Capitalia SpA	IT	180602800	n.a.
66	CREDEM-Credito Emiliano SpA	IT	41925681	20
67	Intesa Sanpaolo	IT	885300931	2
68	UniCredit Banca	IT	83174028	11
69	UniCredit SpA	IT	1455169575	1
70	AIG Bank Polska SA	PL	2732122	19
71	Bank BPH SA	PL	5343372	14
72	Bank Handlowy w Warszawie S.A.	PL	14366365	7
73	Bank Millennium	PL	15907521	6
74	Bank Pekao SA-Bank Polska Kasa Opieki SA	PL	44547502	2
75	Bank Pocztowy SA	PL	913532	29
76	Bank Polskiej Spoldzielczosci SA	PL	3805557	16
77	Bank Zachodni WBK S.A.	PL	19528023	5
78	BRE Bank SA	PL	27890202	3
79	Deutsche Bank Polska S.A.	PL	2158856	22
80	DZ Bank Polska SA	PL	962354	28
81	Fortis Bank Polska SA	PL	6708420	13
82	GE Money Bank SA	PL	7862077	11
83	Getin Bank SA	PL	6210472	12
84	Gospodarczy Bank Wielkopolski S.A.	PL	1947194	23
85	ING Bank Slaski S.A. - Capital Group	PL	23502768	4
86	Kredyt Bank SA	PL	13076743	8
87	Nordea Bank Polska SA	PL	5322473	n.a.
88	Raiffeisen Bank Polska SA	PL	5285449	9
89	RBS Bank (Polska) SA	PL	2725741	20
90	Dexia banka Slovensko a.s.	SK	3778721	6
91	Komercni Banka Bratislava a.s.	SK	504606	13
92	OTP Banka Slovensko, as	SK	2296923	8
93	Privatbanka, as	SK	592939	12
94	Slovak Savings Bank-Slovenska sporitel'na as	SK	17689127	1
95	Tatra Banka a.s.	SK	14863731	3
96	UniCredit Bank Slovakia a.s.	SK	6553729	5

97	VOLKSBANK Slovensko, as	SK	2163063	9
98	Vseobecna Uverova Banka a.s.	SK	15823521	2
99	Abbey National Treasury Services Plc	GB	355522827	14
100	AIB Group (UK) plc	GB	42080556	26
101	Bank of Scotland Plc	GB	938784469	6
102	Barclays Bank Plc	GB	2992884447	1
103	Clydesdale Bank Plc	GB	75539037	22
104	HSBC Bank plc	GB	1347334395	4
105	Lloyds TSB Bank Plc	GB	635874729	8
106	National Westminster Bank Plc - NatWest	GB	468269737	9
107	Northern Rock Plc	GB	152114520	18
108	Ulster Bank Limited	GB	101586072	20

Master Thesis Proposal

Author	Bc. Barbora Malá
Supervisor	PhDr. Adam Geršl PhD.
Proposed Topic	Analysis of the European banking system: Efficiency and competition

Topic characteristics

Accelerated capital market globalization leads to further deepening of banking sector integration. European banking system is being largely consolidated and the competition becomes more intensive. Despite this clear development there are still efficiency differences within the global banking sector. During the recent financial turmoil what proved to be highly relevant (and in many cases fatal) for financial stability of the bank was the managerial ability to proceed efficiency measures.

But the likely absence of competitive pressures may result in a lesser effort on the part of managers. Therefore, insufficient level of competition (followed by other market distortions) may lead to high profitability even though managers may not pay enough attention to cost optimalisation; which is suggested as the "Quiet life" hypothesis.

As in the long term, efficiency differences caused by market distortions will probably disappear and only the efficiency improvements may contribute to the income generating capability. Those improvements may have not only stability- but also welfare- implications.

Hypotheses, research questions

H: Poorer competition in terms of the market concentration leads to less efficient bank, i.e. competition positively influences efficiency ("Quiet life" hypothesis).

Is the level of market competition across different states converging? Does it imply greater efficiency pressures?

Methodology

On a sample of commercial banks of selected European countries, I would like to demonstrate a relationship between competition in the banking sector and efficiency of financial institution´s management.

Firstly, I would like to use parametric method (stochastic frontier approach) for efficiency data estimation. Secondly, I will apply one of the known methods of market concentration measure to determine the degree of competition in each of the chosen bank markets. Finally, I will execute the regression to find out the relationship between competition and efficiency in my sample of banks.

Outline

1. Introduction, literature review
2. Measuring bank efficiency
3. Market concentration as a measure of banking system competition
4. Analysis of the relationship between efficiency and market competition in banking
5. Conclusion

Core Literature

- Holló, D. & Nagy, M. (2006): *Bank Efficiency in the Enlarged European Union*. MNB Working Papers 2006/3, Budapest, ISSN: 1585-5600.

- Pruteanu-Podpiera, A. & Weill, L. & Schobert, F. (2007): *Market Power and Efficiency in the Czech Banking Sector*. CNB Working Paper Series 2007/6, Prague

- Bikker, J. A. (2004): *Competition and Efficiency in a Unified European Banking Market*. Edward Elgar Publishing, ISBN: 1-84376-110-6.

- Bikker, J. A. & Groeneveld, J. M. (1998): *Competition and Concentration in the EU Banking Industry.* Research Series Supervision no. 8, De Nederlandsche Bank.

- Koetter, M. & Kolari, J. W. & Spierdijk, L. (2008): *Efficient Competition? Testing the ´Quiet Life´ of U.S. Banks with Adjusted Lerner Indices.* University of Groningen.

- Berger, A. N. & Mester, L. J. (1997): *Inside the black box: What explains differences in the efficiencies of financial institutions?* Journal of Banking & Finance, vol. 21, pp. 895-947.

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