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Bank efficiency in CEE

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## **Abstract**

Untersuchungsgegenstand ist die Effizienz von Banken in Österreich, Bulgarien, Kroatien, Serbien und der Türkei im Zeitraum zwischen 2003 bis 2006. Vier dieser Länder gingen in den frühen 80er Jahren von einer Plan- auf eine Marktwirtschaft über. Diese werden mit Österreich verglichen. Zur Sicherstellung einer möglichst vollständigen Stichprobe werden durch die lokalen Aufsichtsbehörden veröffentlichte Daten verwendet.

Bis auf ein Land ergibt die Data Envelopment Analyse für alle Länder höhere Effizienzmaße, wenn Kundeneinlagen als Output modelliert werden. Dies legt nahe, dass Banken Einlagen als Produkte ansehen, die sie ihren KundInnen anbieten und nicht als Input, den es zu minimieren gilt.

Während einige Länder gegenüber periodenübergreifenden nationalen Effizienzgrenzen Effizienzsteigerungen aufweisen, sind diese bei Zugrundelegen einer regionalen Effizienzgrenze nicht ersichtlich. Auch die Ergebnisse des Malmquist Index für die Region sind nicht eindeutig, obwohl für Österreich in 2005 (verglichen mit 2004) technologischer Fortschritt nachgewiesen werden kann.

Bei einer Betrachtung der einzelnen Länder erweisen sich Österreich und Kroatien als am meisten und Serbien und Bulgarien als am wenigsten effizient. Ein interessantes Bild ergibt sich bei einer Betrachtung nach Bankkategorien (Sparkassen, Genossenschaftlicher Sektor und Universalbanken) und Ländern. Hier wird ersichtlich, dass Sparkassen und Mitglieder des Genossenschaftlichen Sektors in Österreich niedrige, in Kroatien und Serbien aber vergleichsweise hohe Effizienzwerte aufweisen. Bei Universalbanken ist das Gegenteil der Fall.

## **Abstract**

The thesis investigates the efficiency of depository institutions in Austria, Bulgaria, Croatia, Serbia and Turkey between 2003 and 2006. Four of these countries switched from a planned to a market economy in the early 1980ies. These are contrasted with Austria. High coverage ratios are ensured by using data published by the relevant regulatory authorities.

Data envelopment analysis yields higher efficiency scores in all but one country when deposits are treated as output. This implies that banks see deposits as products they offer to their customers and which they do not attempt to minimize.

While in some countries improvements in efficiency can be detected against an inter-temporal single-country efficiency frontier, no overall efficiency improvement against a common regional frontier can be identified. Results of a Malmquist Index analysis are also inconclusive for the region as a whole, although technological improvement can be shown for Austria between 2004 and 2005.

When data is grouped by country, Austria and Croatia emerge as most and Serbia and Bulgaria as least efficient markets. An interesting pattern emerges when DMUs are grouped by category (savings, cooperative and universal banks) and country. It can then be seen that savings and cooperative banks show comparably low efficiency in Austria but comparably high scores in Serbia and Croatia. For universal banks, this pattern is reversed

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## Abbreviations Used

BNB	Bulgarian National Bank
BRSA	Banking Regulation and Supervision Agency
BWG	Austrian Banking Law
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DFA	Distribution-free Approach
DMU	Decision Making Unit
FMA	Austrian Financial Market Authority
HNB	Croatian National Bank
IFRS	International Financial Reporting Standards
MI	Malmquist Index
NBS	National Bank of Serbia
OeNB	Austrian National Bank
OeVAG	Österreichische Volksbanken AG
P&L	Profit and Loss Statement
RI	Raiffeisen International
RZB	Raiffeisen Zentralbank
SBM	Slacks-based Model
SFA	Stochastic Frontier Analysis
TFA	Thick Frontier Approach
VBI	Volksbank International
VRS	Variable Returns to Scale

## 1 Introduction

The objective of this thesis is to investigate the efficiency of depository institutions in five countries (Austria, Serbia, Croatia, Bulgaria and Turkey) over the period from 2003 to 2006. To this end, a DEA is applied on data obtained from regulatory authorities. Since this data typically includes all banks in a given country, this approach assures one of the highest coverage ratios found among studies of this region.

In terms of methodology, the paper uses a slacks-based input-oriented DEA model and the Malmquist Index. In terms of modelling the production function, both the intermediation and the service-oriented model are applied. Several issues which came up in previous studies and some points not raised before are addressed in detail.

These issues are:

- The impact the emergence of funds-transfer-pricing and shareholder value theory have on modelling the production function
- Incorporating risk costs and inputs / outputs
- Treatment of outliers
- The need to deflate data
- The presence of cross-guarantees and cross-shareholdings within a sample
- Different leverage levels
- The presence of M&A and different types of bank bail-outs

Where possible, solutions to the above mentioned points are incorporated in the computations. Where this was not possible based on the data available, reasonable assumptions as to their likely impact had to be made.

Initially, two models based on the intermediation and service-oriented approach are applied to country-level data. Subsequently, all DMUs are pooled and analyzed against a common frontier. Finally, in order to test for the presence of technological change, a Malmquist Index analysis is applied.

This outlines how the definition of efficiency and the model selection process can have a major impact on the obtained results.

The structure of the study is therefore as follows:

Chapter 3 describes the tools that will be used for the analysis

Chapter 4 outlines previous research

Chapter 5 focuses on problematic aspects identified in earlier studies and how these will be addressed. It also contains an outline of the model used as well as categories according to which results will be analyzed

In Chapter 6, data for each country is analyzed and interpreted within a national context

Chapter 7 discusses results for a pooled sample

Finally, Chapter 8 summarizes the results

## 2 Methods Used

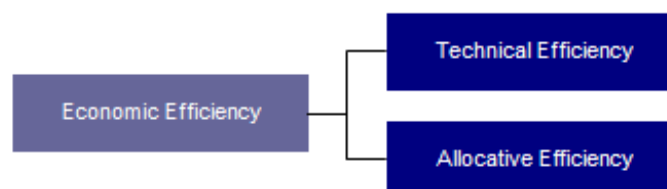
This chapter outlines the theoretical concepts and methods used. After discussing what efficiency is, how it can be measured and which different types can be identified, DEA as a non-parametric frontier efficiency approach is introduced and contrasted with the so-called parametric frontier efficiency approaches and the Malmquist Index.

Efficiency is defined as the ratio of output to input. ‘Relative efficiency’ means the efficiency of a unit as compared against others - the production unit with the highest ratio of output to input is most efficient. Farrell was the first to introduce a quantified measure of relative efficiency (Cooper / Seiford / Tone, 2006, p.66). He stated “*Although there are many possibilities, two [definitions of the efficient production function] at once suggest themselves - a theoretical function specified by engineers and an empirical function based on the best results observed in practice.*” (1957, p. 255) and opted for the second one - comparing each unit against an empirically observed best practice, rather than some hypothetical absolute measure of efficiency. This is also the approach adopted by all concepts mentioned here.

### 2.1 Types of Efficiency

There are various types of efficiency depending on how narrow or wide the production process (and freedom for making decisions associated with it) are defined. Table 1 shows an overview.

*Table 1 - Types of Efficiency*



Technological, or technical, efficiency takes into account the amount of input relative to the level of output. Farrell (1957, p. 259) describes it as a firm’s “*success in producing maximum output from a given set of inputs*”. This can be further understood as input-oriented technical

efficiency if outputs are constant and inputs minimized or output-oriented technical efficiency in the reverse case where inputs are constant and outputs maximized.

Allocative efficiency means that “*optimal inputs and/or outputs are chosen based on both the production technology and the relative prices in the market*” (see Bauer / Berger / Ferrier / Humphrey, 1998). Obviously, price data is necessary for measuring this type of efficiency. Farrell also called this price efficiency. So, while technical inefficiency is reduced by using less input, reducing allocative inefficiency may actually imply using more of a cheaper output.

Economic efficiency is the widest definition of all. It “*requires technological efficiency as well as allocative efficiency. .... To be economically efficient, a firm has to choose its input and/or output levels and mixes so as to optimize an economic goal, usually cost minimization or profit maximization. It is quite plausible that some firms that are relatively technologically efficient are relatively economically inefficient and vice versa, depending upon the relationship between managers’ abilities to use the best technology and their abilities to respond to market signals.*” (Bauer / Berger / Ferrier / Humphrey, 1998, p.90).

These different efficiency concepts not only require varying granularity of empirical data, they also imply different levels of managerial freedom: In order to derive meaningful results of economic efficiency, one has to assume that each of the units is free to set levels of inputs, outputs as well as prices. This may be a strong assumption in a regulated field such as banking. Table 2 shows an overview of what information is necessary under the various efficiency concepts.

*Table 2 - Information Necessary for Computing Types of Efficiency*

	technical efficiency	allocative efficiency	economical efficiency
input prices		needed	needed
input volumes	needed	needed	needed
cost (price x volume)			
output prices		needed	needed
output volumes	needed	needed	needed
income (price x volume)			
profit (income - cost)			

Both technical and economic efficiency can be further split into subcategories. Cooper / Seiford / Tone (2006, pp. 140) demonstrate how technical efficiency can be subdivided into global technical efficiency, pure technical efficiency, mix and scale efficiency, but this shall not be of primary interest here. What deserves further attention is that different concepts exist of what constitutes economic efficiency, resulting in different results so that studies become incomparable. The two main subtypes of economic efficiency are: cost and profit efficiency.

Cost efficiency means minimizing the costs of producing the same output bundle under the same conditions. Table 3 shows the basic assumptions for the case of a price-taking company with variable input and constant output volumes. Extensions for various more complex cases exist (see Berger / Mester, 1997, for an outline that assumed both variable and fixed costs or Ray, 2004, p. 208ff for short-run and medium-term cost optimization). Cost efficiency is again a relative concept as compared to a best practice unit and is bound between zero and unity. It is important to note, however, that the relative efficiency score captures efficiencies at the current fixed output level, which may or may not be optimal.

Profit efficiency again assumes that input and output prices are constant while the input-output combination (volumes) is optimized within the constraints of the given production possibility set. While cost efficiency can be useful for schools or hospitals, profit efficiency is more likely to capture the economic reality of for-profit companies such as banks. As Berger / Mester (1997, p.900) put it *“Profit efficiency is based on the more accepted economic goal of profit maximization, which requires that the same amount of managerial attention be paid to raising a marginal dollar of revenue as to reducing a marginal dollar of costs. That is, a firm that spends \$1 additional to raise revenues by \$2, all else held equal, would appropriately be measured as being more profit efficient but might inappropriately be measured as being less cost efficient.”* Two things need to be stated: First, profit efficiency scores differ from cost efficiency scores in that they may be negative. And, in order to obtain a finite solution, profit efficiency requires the assumption of variable returns to scale (Ray, 2004, p. 226).

While the assumption of given input prices is not generally disputed, there are attempts to model banks as price setters, rather than price takers, in their output markets. Berger / Mester (1997) take the substantial reported inefficiencies as a reason to investigate its possible



sources based on a panel of 6,000 US banks between 1990 and 1995. They look into three potential reasons: differences in efficiency concept, measurement method and environmental characteristics. They go on to propose a novel efficiency concept which they call alternative profit efficiency. It is measured as “*how close a bank comes to earning maximum profits given its output levels rather than its output prices. ... Thus, instead of counting deviations from optimal output as inefficiency, as in the standard profit function, variable output is held constant as in the cost function while output prices are free to vary and affect profits.*” (ibidem, p.899). They argue that the latter is useful, among others, where unmeasured differences in the quality of banking services must be assumed.

Table 3 gives an overview of the assumptions of all three types of economic efficiency. The simplified cases below can be extended for short-term or long-term optimizations. The different efficiency concepts are not equally demanding and thus influence the efficiency scores obtained. Färe / Grosskopf/ Zelenyuk (2002) refer to the so-called Le Chatelier Principle when they state “... *the technical efficiency measure will be greater than the corresponding cost minimizing efficiency measure which will be equal to or greater than the corresponding profit maximizing efficiency measure*”.

*Table 3 - Optimization Under Various Economic Efficiency Concepts*

	<b>cost efficiency</b>	<b>profit efficiency</b>	<b>adj. profit efficiency</b>
input prices	constant	constant	constant
input volumes	variable; minimized	variable; minimized	variable; minimized
cost (price x volume)			
output prices	constant	constant	variable; maximized
output volumes	constant	variable; maximized	constant
income (price x volume)			
profit (income - cost)			

Historically, DEA was developed to compare volumes of inputs and outputs rather than prices which means that models could not capture allocative efficiency but only technical efficiency. However, extensions that do use prices are now available. For example, Ray, 2004, presents DEA models that can measure both cost and profit efficiency.

Due to the limited data available from publicly accessible sources, the approach used in this study focuses on technical efficiency.

## 2.2 Partial vs. Total Factor Productivity Measures

Two types of productivity measures can be distinguished depending on the number of inputs and outputs used:

### Measures combining one input and one output

In different terminology, this type of measure is referred to as partial productivity measure (PPM). Partial, because it does not capture the impact of all inputs or outputs. This can be illustrated with the Return on Assets (RoA), a popular example of such a measure. This ratio, calculated as net income divided by total assets, could improve after a bank has repaid debt and taken on additional equity (thereby decreasing refinancing expenses as shown in the P&L statement). An analysis of the RoA ratio for two subsequent periods would then show an increase in productivity, and could wrongly attribute this to a cost decrease.

Partial productivity measures often use accounting data such as income or expenses. Other possibilities would be worker hours, full-time equivalents or the number of customers. Zero input values are not permissible, negative ones will typically not lead to meaningful results.

### Measures combining multiple inputs and outputs

These are referred to as total factor productivity measures (TFPM) because they attempt to take the impact of all inputs and outputs into account. The main drawback here is the need to define weights to combine various inputs. Setting up fixed weights beforehand necessitates a thorough argumentation for doing so. In order to avoid that, the method used in this study computes weights from empirically observed data.

This shall be demonstrated with the following examples, which are based on Cooper / Seiford / Tone (2006, pp. 3-9):

In the simplest case, we assume that five units use only one input to produce one output. If the units are shops, the inputs may be employees and the outputs sales. In order not to complicate

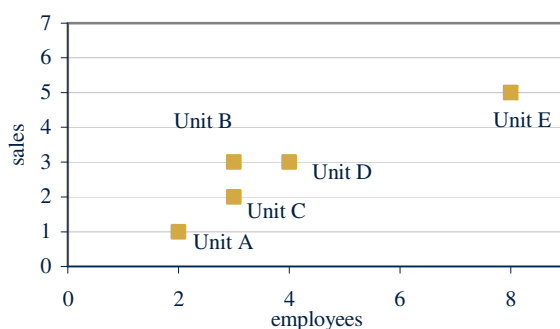
things, we will assume all decision making units (DMUs) are operating under constant returns to scale.

Table 4 shows the data set for the units as well as a graphical representation. The regression line is also shown in order to illustrate that a unit located on the regression line may still show significant inefficiencies. For example, Unit D is located on the regression line, but the empiric evidence shows it is possible to achieve the same level of sales with fewer employees (Unit B). “*These two points of view can result in major differences when used as methods of evaluation. They can also result in different approaches to improvement. DEA identifies a point like B for future examination or to serve as a "benchmark" to use in seeking improvements. The statistical approach, on the other hand, averages B along with the other observations, ... as a basis for suggesting where improvements might be sought.*” (see Cooper / Seiford / Tone, 2006, p.4). Therefore, DEA would suggest Unit D reduce the number of employees to three or increase sales to EUR 4m, as indicated by the arrows.

*Table 4 - Input Data (One Input, One Output, Illustrative Fictional Example); based on Cooper / Seiford / Tone (2006)*

	Unit A	Unit B	Unit C	Unit D	Unit E
employees	2.0	3.0	3.0	4.0	8.0
sales (in mEUR)	1.0	3.0	2.0	3.0	5.0
sales / empl. (in mEUR)	0.5	1.0	0.7	0.8	0.6
relative efficiency score	0.5	1.0	0.7	0.8	0.6

*Graph 1 - Regression vs. Efficiency; based on Cooper / Seiford / Tone (2006)*



The ratio of sales per employee is expressed in Euro millions and thus dependent on the units of measure used. This can be alleviated by dividing the ratio of each unit with that of the best

practice Unit B. The resulting relative efficiency score is then unit invariant and always between 1 (which implies best practice) and 0. In this example, Unit B is the reference set for all inefficient units.

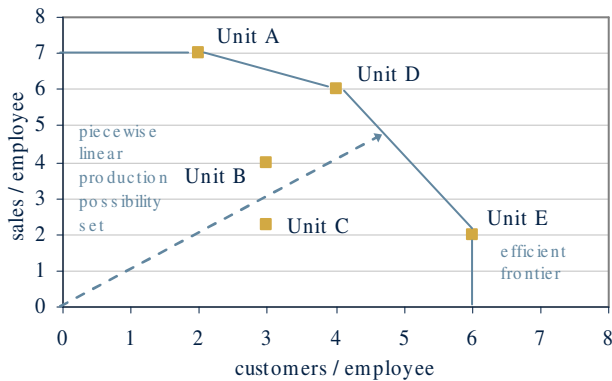
In the case of more than one input or output, a weighting becomes necessary which also means that the chosen weights need to be justified. This is especially difficult where the various indicators are expressed in different units of measurement such as nominal amounts for sales, the number of employees or customer accounts, market shares in percent or even ordinal indicators such as customer satisfaction. The methods used in this analysis approach this problem by calculating weights from the data in such a way that each unit receives the best possible score.

The way such a weighting works can be illustrated with a simple example of one input and two outputs. Table 5 shows data for five units, which now produce both numbers of customers and sales volumes as outputs. Again, the graph shows the efficient frontier which envelops all units. The area between the point of origin and the efficient frontier is referred to as production possibility set, which means that judging from the empirical data, it would be possible to produce any one point within the area. For example, if Unit A is capable of serving two customers per employee, it would have also been capable of serving only one customer per employee. In the below graph, the production possibility set is further assumed to be piecewise linear.

*Table 5 - Exemplary Data (Two Outputs, Fictional Example); based on Cooper / Seiford / Tone (2006)*

	Unit A	Unit B	Unit C	Unit D	Unit E
employees	3.0	3.0	4.0	8.0	8.0
customers	6.0	9.0	12.0	32.0	48.0
sales (in mEUR)	21.0	12.0	9.0	48.0	16.0
employees	1.0	1.0	1.0	1.0	1.0
customers / employee	2.0	3.0	3.0	4.0	6.0
sales / employee (mEUR)	7.0	4.0	2.3	6.0	2.0

*Graph 2 - Deriving Weightings From Empirically Observed Data; based on Cooper / Seiford / Tone (2006)*



Since there is only one input, both outputs can be normalized to values obtained with 1 employee. The resulting values of customers per employee and sales per employee then need to be weighted. Two extreme cases are straight-forward:

- Output 1 weighted with 0% and Output 2 with 100%: In this case Unit E is the best practice unit as it achieves the highest number of customers per employee
- Output 1 weighted with 100% and Output 2 with 0%: In this case Unit A is the best practice unit as it achieves the highest number of sales per employee

This implies that both Unit A and Unit E lie on the efficient frontier. In the graphical representation, we see that Unit D lies above the line connecting A and E and thus must also be efficient. Mathematically, it is the best practice unit at a weighting of e.g. 50% for Output 1 and 50% for Output 2.

As for Units B and C, they are not best practice units, no matter what weighting is applied. In order to become efficient, Unit C would have to move along the arrow until it reaches the efficient frontier at the (not empirically observed) Point P.

Once efficiency is measured, the question of how to reduce inefficiencies immediately pops up. Generally speaking, such improvement can be achieved in one of three ways: In the case of only one input and one output, the only two possibilities are input minimization or output maximization. Where multiple inputs or outputs are combined, their mix may also be altered, for example through innovation.

Mathematically, the relative efficiency score in Table 5 is calculated as Euclidian distance from Point C to the point of origin divided by the distance from point P to the point of origin. Its inverse shows by how much both outputs would need to be increased for the unit to become efficient. Since the ratio of outputs to each other is not changed when doing so, we assume that, based on the data observed, it would be possible for Unit C to reach that level of efficiency without the need to change its output mix by introducing any new technology.

How do results of PPM and TFPM relate to one another? One major drawback of TFPM is that, since weights are derived from empirically observed data, units which are very different from all others can easily become self-identifiers simply because no other empirically units operated with a similar mix of outputs. This means that DEA reacts quite sensitively to outliers.

Several attempts have thus been made to compare relative efficiency scores based on total factor productivity measures with unit rankings according to traditional measures (partial productivity measures such as the CI ratio). The results of two such studies shall be outlined here.

Bikker / Bos (2005) give an overview of nine different models of market power and efficiency as can be applied to banks. Based on a sample of banks from 23 OECD countries (taken from BankScope for the years 1994 to 2003), they also check for any correlation between market power (CR5 as share of the largest 5 banks in terms of total assets), Panzar-Rosse, Bresnahan), efficiency (relative x-efficiency score, average rank according to x-efficiency score) and accounting-based indicators (return on equity, return on assets, cost-income ratio, interest rate margin). The results for correlations between the ten year averages reveal that concentration is uncorrelated with any other measure, the net interest margin is only significantly correlated with the return on assets and both can serve as proxies for the efficiency ranking. The cost income ratio is not correlated with most measures, including efficiency. This would imply that most traditional indicators fail to show a true picture of efficiency levels, perhaps by not taking into account all important aspects of performance.

Hollo / Nagy (2006, p.29) also check for correlation and find that “*Statistical based efficiency indicators are not perfect, but, despite their methodological disadvantages, give a better proxy of efficiency than the so widely used accounting based measures.*”

## 2.3 DEA

Data Envelopment Analysis (DEA) is a method of obtaining total factor productivity measures. As such, it provides a means of comparing the efficiency of Decision Making Units (DMUs) with each other based on several inputs and / or outputs. It derives its name from a theoretical efficient frontier which envelops all empirically observed DMUs.

There are many extensions of the initial model published in Charnes / Cooper / Rhodes (1978) which allow for specifying various assumptions. Two very basic cases are outlined in the introduction to this chapter. Loosening their restrictive assumptions and using different definitions of efficiency can have a significant impact on the resulting efficiency scores.

Table 6 shows an overview of the most important parameters for selected models. The descriptions of the model characteristics are based on Cooper / Seiford / Tone (2006) to which the interested reader is also referred for an exhaustive discussion of their detailed specifications.

*Table 6 - Selected DEA Model Characteristics; Source: Cooper / Seiford / Tone (2006, p. 205)*

model		input-oriented CCR	output-oriented CCR	input-oriented BCC	output-oriented BCC	Additive	Slacks-Based (SBM)
data	inputs	semi-positive	semi-positive	semi-positive	free	free	semi-positive
	outputs	free	free	free	semi-positive	free	free
efficiency type		technical	technical	technical	technical	mix	mix
translation invariance	inputs				X	X	
	outputs			X		X	
units invariance		X	X	X	X		X
(weak) Farrell efficiency value $\theta^*$		[0,1]	[0,1]	[0,1]	[0,1]		[0,1]
returns to scale		constant	constant	variable	variable	constant / variable	constant / variable

CCR means the basic DEA model as introduced by Charnes / Cooper / Rhodes (1997). This was modified by Banker / Charnes / Cooper (1984) and became the BCC model which accommodates variable returns to scale. Tone (2001) introduced the additive and slacks-based models which can accommodate both variable and constant returns to scale and take mix



efficiencies into account. The returns to scale assumptions of the latter two models depend on whether the convexity constraint is included or not.

The term input- and output-oriented relates to the way in which inefficient DMUs are projected onto the efficient frontier. There are three possibilities: input-oriented models aim at reducing the input amounts by as much as possible without reducing present output levels. Output-oriented models maximize output levels without increasing input consumption. The Additive model and the SBM deal with input excesses and output shortfalls simultaneously in a way that jointly maximizes both.

Semi-positive data means nonnegative with at least one positive element for each DMU while free permits negative, zero or positive data. Since the sample of DMUs in this analysis will contain units with, for example, negative profit, data would have to be adjusted for usage with models that require semi-positive data if profit were identified as an output variable. For such modifications, the model needs to be translation invariant, defined as *“Given any problem, a DEA model is said to be translation invariant if translating the original input and/or output data values results in a new problem that has the same optimal solution for the envelopment form as the old one.”* (Cooper / Seiford / Tone, 2006, p.93)

Farrell (also called weak or radial) efficiency means that the optimal solution is one where the same level of output can be guaranteed with a minimal amount of input (or vice versa). Any input excesses and output shortfalls (so-called slacks) which may still exist at that point and which could only be altered through a change in input mix are not taken into account. When an additional constraint is added so that all slacks must be zero, it is not possible to improve any input or output without worsening some other input or output. Such optimization results are called Pareto-Koopmans or strongly efficient (Cooper / Seiford / Tone, 2007, p.45).

The model selection process is of critical importance. The assumptions taken need to match the underlying unit’s business goals, the industries’ technological possibilities and must be in line with the available data. Cooper / Seiford / Tone, 2006, p.106) state *„If the application has important consequences it is wise to try different models and methods, compare results and*

*utilize expert knowledge of the problem, and possibly try other devices, too, before arriving at a definitive conclusion.”.*

Besides this need to carefully examine the implications of a given model, three specific problems are inherent to DEA: The first two are due to the fact that DEA derives weights from empirically observed data: what has already been mentioned, is that outliers may become self-identifiers. The second problem is that using more variables for inputs and outputs always increases the number of technically efficient DMUs and thereby yields higher average efficiency scores. This is a particular issue for countries with a limited number of banks (DMUs). Where this occurs, the application of a system efficiency comparison according to Cooper / Seiford / Tone (2007, pp. 231) can alleviate this problem. Nell-Breuning (2005) used this concept, which loosens the assumption of convexity of the efficient frontier, to analyse the change in efficiency of German, US and UK banks after deregulation and subsequently runs a rank-sum-test developed by Wilcoxon, Mann, Whitley in order to confirm the statistic significance of the results (Cooper / Seiford / Tone, 2007, pp. 234).

The third potential drawback of DEA is caused by it being a non-parametric method: it does not allow for the specification of any random error which means that any random measurement error in accounting data is viewed as inefficiency. Only the so-called parametric methods have the advantage of allowing for measurement error. Their disadvantage is that they require the specification of a functional form on the efficient frontier - again necessitating the need to take and justify a further set of assumptions.

Although the parametric approaches are not applied in this analysis, some studies which rely on parametric methods are included in the outline of the state of the field due to the limited number of prior research on bank efficiency in CEE. For this reason, the characteristics of the three main types of parametric methods shall be outlined. The main difference between them lies in how each tries to separate inefficiency from errors.

- Stochastic Frontier Approach (SFA) starts with the assumption that while inefficiencies can never decrease costs, measurement errors may do so. Accordingly, it assumes that inefficiencies follow an asymmetric and random errors a symmetric distribution (cmp. Lee / Tyler, 1978, and Cooper / Seiford / Zhu, 2004).

- Thick Frontier Approach (TFA) does not use an efficient frontier that would envelop all empirically observed units. Rather, it selects the lowest cost quartile of all units and estimates parameters from these. As Berger / Humphrey (1991) state *“Instead of trying to estimate a precise frontier edge, we estimate a cost function for the lowest average cost quartile of banks. This lowest cost quartile may be thought of as a thick frontier, in which it may be reasonably assumed that the firms are of greater than average efficiency”*. Please note how this argument of greater than average is directly opposed to the one used by other methods: the very idea of evaluating efficiency against efficiency frontiers is to compare against the empirically observed best practice rather than an average.
- Distribution-Free Approach (DFA). DFA assumes that the average efficiency for each firm is constant over time, while random errors average out over time. It is more demanding than the other two approaches in that it requires a panel data set.

How do scores generated by parametric and non-parametric methods relate to each other? Given the outlined methodological differences, the question even begs itself whether efficiency scores obtained under different approaches are comparable at all? Bauer / Berger / Ferrier / Humphrey (1998) argue that it is possible to obtain useful results without having to agree on one single best approach for measuring relative efficiency as long as six consistency conditions are met. Of these, the first three are intended to help identify in how far the approaches are consistent with each other while the latter three attempt to cross-check the results with other indicators such as measures of competition. The first three conditions shall be quoted here:

- “(i) the efficiency scores generated by the different approaches should have comparable means, standard deviations, and other distributional properties;*
- (ii) the different approaches should rank the institutions in the approximately same order;*
- (iii) the different approaches should identify mostly the same institutions as “best practice” and as “worst practice.”*

However, when the authors use data of ~700 US banks (1977-1989) to run analyses with the four major frontier approaches (DEA, DFA, SFA and TFA) they find mixed results. It turns out these first three conditions are met by parametric approaches but not comparable to those

generated by DEA, at least not with the data used. The authors thus conclude *“Rather, the only choice that appears to matter greatly for regulator’s policy considerations is the choice between the parametric and non-parametric methods, at least for this dataset and these techniques.”*

Following the above discussion, the following model is used in this study:

Only DEA as a non-parametric method will be used. This assumes that there is no random measurement error in accounting data. This is justifiable because there is no evidence that would prove that assuming any particular type of distribution of random measurement errors within the given sample is more correct than assuming it to be negligible.

Further, an input-oriented slacks-based model (SBM) based on technical efficiency will be used. SBM yields efficiency scores in line with strong efficiency and is thus the most suitable. The choice of an input-oriented model implies that banks cannot set their outputs at will but are rather faced with a given level of demand for their products. They can also not set the price of their outputs freely: many legislators in the region set strict upper / lower bounds for pricing bank products, particularly those offered to consumers. In the model, banks also cannot decide the price of inputs at will. This is especially true for the cost of personnel where unionization and the existence of collective agreements must be assumed. The model thus assumes that banks aim to produce a certain output with the lowest possible input.

### Comparisons over time

How can one compare the efficiency of units from different time periods? The first possibility is to assume that the production technology did not change. In that case, one common frontier can be computed, against which data from all periods is evaluated. Some have suggested that, when working with this approach, inflation must be taken into account.

The effect of inflation on empirical data is the following: even if the underlying business would remain unchanged, balance sheets, as well as each single P&L item, grow at this rate between periods. In order to compare the growth of absolute values they thus need to be

de/inflated from nominal to real figures. But that does not mean that inputs and outputs would have to be deflated before scores can be computed. DEA uses relative figures (the ratio of inputs to outputs) - and these ratios, as long as they are all expressed in the same currency unit, do not change.

Table 7 demonstrates this based on fictional exemplary units: all operate in the same market over 3 periods. There is no change in available technology, inflation equals the relevant GDP deflator and stands at 2%. We deflate the data, and then compute two efficient frontiers from the two sets of data (input-oriented DEA, variable returns to scale, SBM). As can be seen, relative efficiency scores are the same whether data is deflated or not.

This would be different if any non-financial data were included as input or output such as the number of accounts or employees or if data from different regions with different inflation rates were compared.

*Table 7 - Impact of Deflating Nominal Amounts*

Name	Nominal amounts						Deflated amounts					
	{I}Dep.	{I}OpEx	{I}Cap.	{O}Loans	{O}PBT	Score	{I}Dep.	{I}OpEx	{I}Cap.	{O}Loans	{O}PBT	Score
DMU02 2003	2,000	10,000	10,000	10,000	10,000	1.00	2,000	10,000	10,000	10,000	10,000	1.00
DMU03 2003	3,000	10,000	10,000	10,000	10,000	0.94	3,000	10,000	10,000	10,000	10,000	0.94
DMU04 2003	4,000	10,000	10,000	10,000	10,000	0.92	4,000	10,000	10,000	10,000	10,000	0.92
DMU05 2003	5,000	10,000	10,000	10,000	10,000	0.90	5,000	10,000	10,000	10,000	10,000	0.90
DMU06 2003	6,000	10,000	10,000	10,000	10,000	0.89	6,000	10,000	10,000	10,000	10,000	0.89
DMU07 2003	7,000	10,000	10,000	10,000	10,000	0.88	7,000	10,000	10,000	10,000	10,000	0.88
DMU08 2003	8,000	10,000	10,000	10,000	10,000	0.88	8,000	10,000	10,000	10,000	10,000	0.88
DMU09 2003	9,000	10,000	10,000	10,000	10,000	0.87	9,000	10,000	10,000	10,000	10,000	0.87
DMU10 2003	10,000	10,000	10,000	10,000	10,000	0.87	10,000	10,000	10,000	10,000	10,000	0.87
DMU02 2004	2,040	10,200	10,200	10,200	10,200	1.00	2,000	10,000	10,000	10,000	10,000	1.00
DMU03 2004	3,060	10,200	10,200	10,200	10,200	0.94	3,000	10,000	10,000	10,000	10,000	0.94
DMU04 2004	4,080	10,200	10,200	10,200	10,200	0.92	4,000	10,000	10,000	10,000	10,000	0.92
DMU05 2004	5,100	10,200	10,200	10,200	10,200	0.90	5,000	10,000	10,000	10,000	10,000	0.90
DMU06 2004	6,120	10,200	10,200	10,200	10,200	0.89	6,000	10,000	10,000	10,000	10,000	0.89
DMU07 2004	7,140	10,200	10,200	10,200	10,200	0.88	7,000	10,000	10,000	10,000	10,000	0.88
DMU08 2004	8,160	10,200	10,200	10,200	10,200	0.88	8,000	10,000	10,000	10,000	10,000	0.88
DMU09 2004	9,180	10,200	10,200	10,200	10,200	0.87	9,000	10,000	10,000	10,000	10,000	0.87
DMU10 2004	10,200	10,200	10,200	10,200	10,200	0.87	10,000	10,000	10,000	10,000	10,000	0.87
DMU02 2005	2,081	10,404	10,404	10,404	10,404	1.00	2,000	10,000	10,000	10,000	10,000	1.00
DMU03 2005	3,121	10,404	10,404	10,404	10,404	0.94	3,000	10,000	10,000	10,000	10,000	0.94
DMU04 2005	4,162	10,404	10,404	10,404	10,404	0.92	4,000	10,000	10,000	10,000	10,000	0.92
DMU05 2005	5,202	10,404	10,404	10,404	10,404	0.90	5,000	10,000	10,000	10,000	10,000	0.90
DMU06 2005	6,242	10,404	10,404	10,404	10,404	0.89	6,000	10,000	10,000	10,000	10,000	0.89
DMU07 2005	7,283	10,404	10,404	10,404	10,404	0.88	7,000	10,000	10,000	10,000	10,000	0.88
DMU08 2005	8,323	10,404	10,404	10,404	10,404	0.88	8,000	10,000	10,000	10,000	10,000	0.88
DMU09 2005	9,364	10,404	10,404	10,404	10,404	0.87	9,000	10,000	10,000	10,000	10,000	0.87
DMU10 2005	10,404	10,404	10,404	10,404	10,404	0.87	10,000	10,000	10,000	10,000	10,000	0.87

Coming back to the assumption of no technological change - clearly, the longer a time series is taken into account, the less appropriate it becomes, creating a need for a more sophisticated tool. The next subchapter will introduce the Malmquist Index, a tool which can be used where technological change does occur.

## **2.4 Malmquist Index**

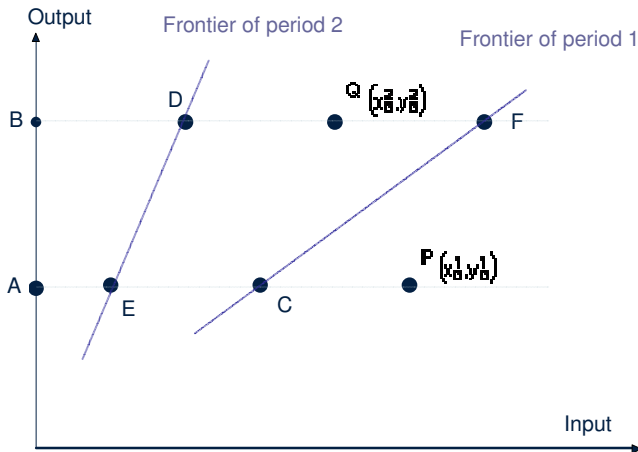
The longer the time series of an investigation, the less appropriate an assumption of no underlying technological change becomes. This creates a need for a more sophisticated tool. The Malmquist Index (MI), as introduced by S. Malmquist (Malmquist 1953), provides a means of comparing the efficiency change of units over time. Rather than using data from one period, it allows for time-dependent comparisons.

It also allows for splitting it in two components: The catch-up (or recovery) term which shows in how far a unit improves (or worsens) its efficiency and the frontier-shift (or innovation) term which reflects the change in the efficient frontiers between two time periods (Cooper / Seiford / Tone 2007, p. 328). The following example is based on Cooper / Seiford / Tone (ibidem) and demonstrates how the method works for an input-oriented single input single output model.

Table 8 - Exemplary data for MI computation; based on Cooper / Seiford / Tone (2006)

	Input	Output
Period 1	5	1
Period 2	4	2

Graph 3 – Frontier-shift and Catch-up effect; based on Cooper / Seiford / Tone (2006)



In the graph, the relative efficiency of a DMU in period 1 equals its input (AP) compared against the smallest empirically observed input (AC). A DMU thus needs to minimize the distance to the efficient frontier of a given period. Please note that the DMU is only evaluated against the frontier for the same period - the two separate frontiers are not compared.

Mathematically, the catch-up effect of the DMU between two periods can be expressed as:

$$\text{Catch - up} = \frac{\text{Efficiency of } (x_0, y_0)^2 \text{ with respect to period 2 frontier}}{\text{Efficiency of } (x_0, y_0)^1 \text{ with respect to period 1 frontier}} = \frac{\frac{BD}{BQ}}{\frac{AC}{AP}}$$

A score above 1 indicates improved relative efficiency between periods.

In order to evaluate the impact of innovation and technological change, the shift of frontiers needs to be compared. In the example shown in Graph 3, this would be the shift from point C to E. Where C input had been necessary in period 1, technological improvement(s) made it possible to produce the same output with only E amount of input.

Let  $\phi_1$  denote the frontier-shift effect at this point  $(x_o, y_o)$  of the frontier:

$$\phi_1 = \frac{\text{Efficiency of } (x_o, y_o)^1 \text{ against period 1 frontier}}{\text{Efficiency of } (x_o, y_o)^1 \text{ against period 2 frontier}} = \frac{\frac{AC}{AP}}{\frac{AE}{AP}} = \frac{AC}{AE}$$

The shift at point  $(x_1, y_1)$  can be expressed in a similar fashion

$$\phi_2 = \frac{\text{Efficiency of } (x_o, y_o)^2 \text{ against period 1 frontier}}{\text{Efficiency of } (x_o, y_o)^2 \text{ against period 2 frontier}} = \frac{\frac{BF}{BQ}}{\frac{BD}{BQ}} = \frac{BF}{BD}$$

The overall frontier shift effect can then be expressed as the geometric mean of the frontier-shift effects of both data points.

$$\phi = \sqrt{\phi_1 \phi_2} = \sqrt{\frac{AC}{AE} * \frac{BF}{BD}}$$

Where the result equals zero, indeed no technological change has taken place. A result larger than one would indicate that technological improvement made it possible, in this case, to produce more from less. A result smaller than one implies technological regression.

By combining the two formulas, we arrive at the definition of MI as product of catch-up and frontier-shift:

$$MI = \frac{\frac{BD}{BQ}}{\frac{AC}{AP}} * \sqrt{\frac{AC}{AE} * \frac{BF}{BD}} = \frac{AP}{BQ} * \sqrt{\frac{BF}{AC} * \frac{BD}{AE}}$$

An MI higher than one indicates an improvement in the total factor productivity of a DMU from the first to the second period. A result of one means no change has taken place and a result lower than one means efficiency has decreased.

As for the limitations of MI, one is immediately obvious: the method requires panel data (as it computes technological change unit by unit and not for "the market" as a whole). In practice,



this means that any newly established, liquidated or merged units must be excluded from the sample for the period in which the change occurred as well as the ones preceding and following it.

In the given context of banking markets in transition one would generally assume the innovation component to be particularly pronounced. However, several studies have shown that this is not always the case, particularly where restrictions on lay-offs and restructuring measures are put in place by privatisation agencies. It will be interesting to see the results for the given sample.

## 2.5 Production Functions of Banks

In order to conduct a DEA, inputs and outputs need to be defined. Such a definition means that assumptions regarding the bank's production function and aims are taken. In light of the impact both implicit and explicit assumptions may have on scores obtained, it is crucial to make this step as transparent as possible.

There are numerous ideas as to what banks do and why they do it, but unfortunately, no general agreement exists. The most notable attempts at outlining various approaches include Sealey / Lindley (1977), Colwell / Davis (1992) and Berger / Humphrey (1997).

Classifications of approaches often distinguish between those best suited for comparing bank branches (production approach) and banks (intermediation approach) with each other (cmp. Varmaz, 2006, pp.209 and Porembski, 2000, pp. 227). Leightner / Lovell (1988) and Tomova (2005) use a different split and distinguish between regulatory goals and the goals of the bank. Colwell / Davis (1992, p. 113) distinguish the possibility to use macroeconomic data but add that *“Most banking studies do not use national accounts measures, but instead have tended to adopt either the ‘production’ or the ‘intermediation’ approach.”* Using either approach based on micro-economic data is generally considered superior as *“... it is likely that the use of aggregated data over regions disguises inefficiency, since efficient and less efficient firms tend to offset one another within regions.”* (Lee / Tyler, 1978, p. 385).

The following subchapter discusses the merits of each of these statements and goes on to outline which of these aspects are particularly relevant for CEE.

### Micro or Macro level?

Macroeconomic studies of financial market efficiency use different methodology and more detailed definitions of efficiency (cmp. Haiss / Fink / Mantler, 2004) and are thus rarely comparable to DEA studies. However, that is not the only problem which occurs when microeconomic data (on bank level) is used: very rarely do DEA analyses want to find out how one particular bank performs. The overwhelming number of studies wants to use DEA in

order to judge whether and how efficiency in a given banking market has changed. This makes it necessary to aggregate individual scores into one measure which is then taken to represent the market as a whole.

Most of the sampled empirical studies compute the arithmetic mean of the sampled units' efficiency scores and attempt to judge efficiency changes within the banking system based on it. Ali / Gstach (2000) compute the geometric mean instead while some weigh the efficiency score of each bank with its asset size or exclude outliers before computing the mean (Schure / Wagenvoort, 2000). The first problem with this approach is clearly selection bias - how can scores represent the total market if not all banks are covered? The second is the use of the mean.

The impact of both problems shall be demonstrated based on an exemplary, random data as outlined in Table 9. In this example, there are five banks which use input (expenses) to produce output (assets) during two periods. Data for the first period is always the same while three different scenarios are set up for the second period. DMUs are then evaluated against three frontiers (one for both periods of each scenario, therefore abstracting from technological change).

*Table 9 - Market Scenarios And Their Impact on Efficiency Scores*

Name	Base (T <sub>0</sub> )			Scenario 1 (T <sub>1</sub> )			Scenario 2 (T <sub>1</sub> )			Scenario 3 (T <sub>1</sub> )		
	Input	Output	Score	Input	Output	Score	Input	Output	Score	Input	Output	Score
DMU 1	30	100	100%	50	100	80%	42	100	86%	100	200	100%
DMU 2	70	100	71%	50	100	80%	42	100	86%			
DMU 3	50	100	80%	50	100	80%	50	100	80%	50	100	80%
DMU 4	50	100	80%	50	100	80%	50	100	80%	50	100	80%
DMU 5	50	100	80%	50	100	80%	50	100	80%	50	100	80%
Sum	250	500		250	500		234	500		250	500	
<b>Mean</b>			<b>82.3%</b>			<b>80.0%</b>			<b>82.3%</b>			<b>85.0%</b>
<b>Weighted Mean</b>			<b>82.3%</b>			<b>80.0%</b>			<b>82.3%</b>			<b>88.0%</b>
<b>Median</b>			<b>80.0%</b>			<b>80.0%</b>			<b>80.0%</b>			<b>80.0%</b>

In period T<sub>0</sub>, Bank 1 is the most efficient while DMU 2 lags behind.

Under Scenario 1, the overall intermediation and cost level in the market stay the same during the second period but DMU 1 deteriorates while DMU 2 improves. Both the weighted and the arithmetic average show the same result: that efficiency decreased. This is erroneous, however. The banking system still uses the same inputs to produce the same outputs. The

change in the average efficiency score does not correspond to any improvement in the macroeconomic efficiency of the banking system.

This is a very basic problem that occurs when sampled units become too similar. The only alternative would be to compare against some hypothetical absolute efficiency level rather than the units against each other (cmp. Farrell, 1957). It is easy to see how this problem takes on another dimension where sample bias occurs: The more homogenous the selected units are (for example, large foreign-owned banks are more likely to get selected), the more likely this type of artefact is to emerge. Choosing units that are more similar to one another inflates the resulting average efficiency score.

In Scenario 2, DMU 2 has managed to lower its inputs - but DMU 1 worsened. While overall market output remained the same, the banking system as a whole uses less input. However, neither the arithmetic nor the weighted mean would tell - they are all the same as for period  $T_0$ .

In Scenario 3, the least efficient DMU 3 has been liquidated. DMU 1 was able to win all the business. Overall, the banking system is still producing the same outputs from the same inputs - only that the number of market participants has decreased. However, the arithmetic and weighted mean indicate a significant improvement in efficiency: from 5 percent based on the arithmetic to 8 percent based on the weighted mean. In this example:

- a macroeconomic analysis would not yield a change
- based on the arithmetic mean, one author could deduct the average bank in the market improved its efficiency by c. 3% percent
- another author could find the average level of efficiency increased by as much as 5 percent (change of weighted mean).

While Lee / Tyler (1978) are right about pointing out the potential shortcomings of macroeconomic analyses, the examples shown the difficulty of inducing macroeconomic trends from unit-level data. For this reason, both approaches shall be contrasted in this study.

### Variable and Constant Returns to Scale

As mentioned before, the assumption of constant returns to scale (CRS) has the pleasant side-effect that input- and output-oriented efficiency become equal and there are no scale efficiencies (see Ray, 2004, p19). The CRS and variable returns to scale (VRS) frontiers coincide at the most productive scale size (MPSS) (Ray, 2004, p. 65). Unfortunately, CRS are a rather restrictive assumption which does not apply to many markets.

Cooper / Seiford / Tone (2006, pp. 104) suggest the following approach as to defining assumptions: *“The CCR model is based on the assumption that constant returns to scale prevails at the efficient frontiers, whereas the BCC and Additive models assume variable returns to scale frontiers, i.e., increasing, constant and decreasing returns to scale. If preliminary surveys on the production functions identify a preferable choice by, say, such methods as linear regression analysis, (e.g., a Cobb-Douglas type) or expert opinions, then we can choose a DEA model that fits the situation. However, we should bear in mind that conventional regression-based methods deal with single output and multiple input cases, while DEA models analyze multiple outputs and multiple inputs correspondences.”*

It is usual to observe that average efficiency scores under the CRS assumption are lower than if VRS is assumed. For example, Färe / Grosskopf / Zelenyuk (2002) stated *“Nonparametric and econometric efficiency scores will tend to increase as we make less restrictive assumptions on the underlying technology; i.e. a quasi-concave technology set is less restrictive than a convex technology set, which in turn is less restrictive than a convex technology set, which in turn is less restrictive than a constant returns to scale convex technology set. Index number estimates of efficiency remain unchanged as we change our assumption on the technology”*. Either way, assuming CRS does not seem appropriate for the sample or period.

### Optimizing social or private benefits?

Another way of categorizing production approaches is according to whose benefits are maximized: social or private ones. Social benefits of banks refer to their specific function

within an economy, which is to provide credit to the private sector. The private benefit of banks is to make a profit and pay dividends to shareholders.

However, such a distinction is not very clean-cut in practice. Regulators, charged with overseeing banks stability and ability to maintain their function as financial intermediaries, face various trade-offs and conflicts of interest.

In overseeing the money creation process, one of their goals is to deepen financial intermediation. That is, citizens shall feel comfortable to deposit their savings with banks who can lend them on to the real economy (e.g. for “mattress money” to come out). On the other hand, an overly high level of liquidity may lead to speculative bubbles or increase inflation. Further, regulators must feel ambiguous about banks’ profitability: On the one hand, the stability of the financial system can only be ensured if banks operate profitably and prudently - at the same time, more wide-spread usage of bank services is fostered if bank services are cheap (cmp. Varmaz 2006, p. 135).

Notwithstanding these limitations, the abovementioned categorization would label the following two approaches as viewing banks as maximizers of social benefits (e.g. providers of financing and services):

### **2.5.1 Intermediation Approach**

The intermediation approach, which can also be referred to as asset approach, was introduced by Sealey / Lindley (1977) - although various modifications have been proposed since - and assumes that the banks’ main aim is to transform liabilities (deposits) into loans (assets).

In their article, Sealey / Lindley (1977) do identify three categories of services, which are payment transfers, services to depositors and borrowers, and other services. However, they argue that only the second activity regarding earning assets generates income. *“The services received by depositors of financial firms are more appropriately associated with the acquisition of economic inputs since these services require the financial firm to incur positive costs without yielding any direct revenue”* (Sealey / Lindley, 1977, p.1253). Clearly, this

argumentation follows an accounting view on income and expense which is understable given that the concept of funds transfer pricing (FTP) was only popularized later.

Only once FTP is employed does the profitability of deposits come to light. *“Likewise, liabilities provide a stable interest margin contribution based on their coupon spread to the pricing curve. The contribution measure is irrespective of how the funds are actually employed. ... Funds transfer pricing hereby assigns a profit contribution value to funds provided and used. The profit contribution is the difference between the customer's interest rate and the transfer rate multiplied by the amount of funds.”* (AMIFs Research Committee, 2001, p. 10). However, even after funds transfer pricing became a popular and widely accepted concept, no efficiency study has employed it. This may be due to the limited amount of data about banks' asset and liability structures available to outsiders.

The approach, as published by Sealey / Lindley (1977, p.1254) defines the production function of a bank in the following way: *“...the production process of the financial firm, from the firm's viewpoint, is a multistage production process involving intermediate outputs, where loanable funds, borrowed from depositors and serviced by the firm with the use of capital, labour and material inputs, are used in the production of earning assets.”* It thus uses labour and material input, physical capital and funding as inputs which should be minimized and earning assets (loans and securities) as outputs which should be maximized.

Over thirty years after Sealey / Lindley's article this remains the most commonly used approach - although modifications have been proposed - particularly in order to take into account the role of risk as well as increasing off-balance sheet volumes.

### **2.5.2 Production Approach**

The Service-oriented Approach, which can also be referred to as value-added or production approach, focuses on the services banks provide to their clients. It assumes that the banks' aim is to produce liabilities (deposits) as well as loans (assets) and other services.

One of the first studies under this approach was Benston (1965). The aim here is to investigate which bank can produce services at the lowest cost. Expert estimates and

timesheets are used to break down operating expenses of six types of services (which are demand deposits, time deposits, mortgage loans, instalment loans, business loans, and securities) on the average number of deposit or loan accounts. Interest expenses are not taken into account (neither is profit).

Berger / Hanweck / Humphrey (1987) follow Benston's approach in principle but add an alternative specification under the intermediation approach. They use functional cost analysis to allocate costs to five types of deposits and loans. These, together with capital, are their inputs and the average account size of loan and deposit accounts are outputs - this differs from Benston who used the number of accounts. Although Berger / Hanweck / Humphrey (1987) is often cited as one of the most notable studies under the production approach, it is interesting to note the authors themselves preferred the intermediation approach "*The intermediation approach is preferred to the production approach for competitive viability analysis because it is inclusive of both operating and interest costs - a competitive firm would minimize the sum of these for any given output.*" (ibidem, p. 508)

The production approach thus has two main disadvantages: First, it does not take interest costs into account and second, it requires information about the number of accounts and cost allocation.

### **2.5.3 Profit Approach**

The profit approach is the newest of the presented approaches. It is based on Berger / Mester (2003) who stated that "*use of the profit approach may help take into account unmeasured changes in the quality of banking services by including higher revenues paid for the improved quality, and may help capture the profit maximization goal by including both the costs and revenues*". Such changes are expected to occur, in particular, following any significant changes in the disposable income of citizens. Graph 4 illustrates this from the point of view of one internationally active banking group.



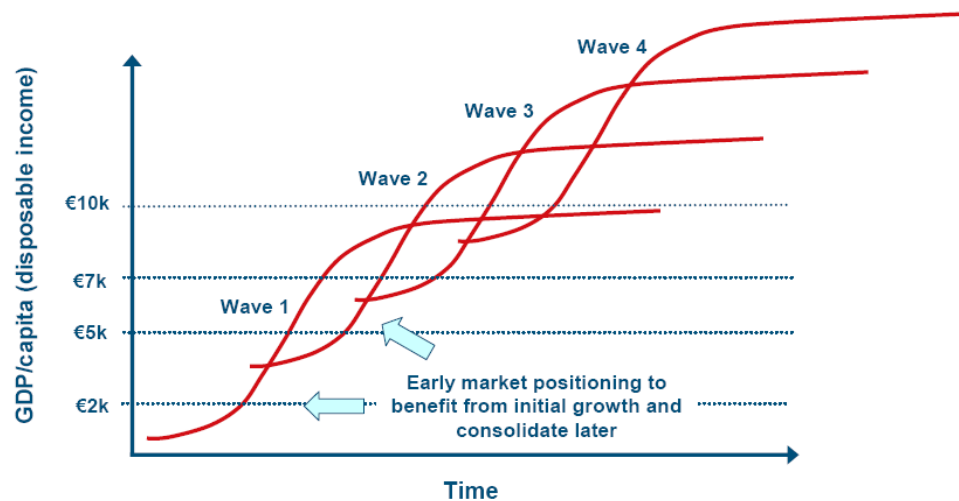
Graph 4 - Market Development And Product Mix; Source: Erste Bank (2005)

**Wave 1: Savings, payment transfers**

**Wave 2: Current accounts, debit cards, mortgages**

**Wave 3: Credit cards, consumer finance**

**Wave 4: Wealth management – asset management, pensions, insurance**



Drake / Hall / Simper (2006) pick up on this idea with their specification. They use employee expenses, other non-interest expenses and income / expenses from allocations to / release of loan loss provisions as inputs and net interest income, net commission income and total other income as outputs. Since no according volumes are specified, the paper is understood to investigate technical efficiency only.

Since this approach is relatively new, there is no consensus yet as to whether these positions are the most meaningful. Not surprisingly, one of the most disputed questions is how to adequately take the bank's credit risk into account. Hahn (2005) also applies the profit approach, but uses risk-weighted assets as an input rather than the P&L category mentioned above. This, of course, makes the approach less versatile as risk-weighted assets are not always disclosed and may be calculated in various ways.

What is relevant for CEE?

In how far do the outlined assumptions, advantages and drawbacks of each approach apply to the specific situation of the Central and Eastern European region?

The economic situation in CEE countries is characterized by specific circumstances: First, most of the sampled economies are - or were at least at times - characterized by significant mandatory reserve requirements. These effectively place a limit on financial intermediation between retail deposits and onward lending. Second, a lack of trust in the banking system has led to significant amounts of banknotes being stored at home and not as bank deposits (so-called “mattress money”). This impacts financial intermediation in the whole economy as well as on the single bank level. Third, inflation and, following that, interest levels have and still do differ greatly over time and between countries. Fourth, data availability is rather modest. Fifth, the product mix offered has developed rapidly in many of these countries.

As for the possible approaches, the intermediation approach does not necessarily define profitability as the primary objective of banks - neither profit nor prices are taken into account. On a single unit level, this assumes that management aims to increase market share and grow business as much as possible, rather than to achieve outstanding profitability. This seems a reasonable characterization of banks’ business strategy in CEE during the sample period. Such an assumption is also consistent with the efficiency thesis under the SCP (Structure - Conduct - Performance) paradigm which says that although efficient banks have lower costs, rather than increasing profits, these can be passed on to customers, thereby increasing market share and business volumes (Varmaz, 2006, p.142). Interestingly, it would also align the interests of managers and the regulator.

However, it does not take into account the goal of profit maximization and does not explain the dynamic emergence of new product offerings in CEE.

In their discussion of requirements that production functions should meet, Tortosa-Ausina (2002) state *„As a result, some banking companies could be choosing different and less regulation-conditioned product mixes. In such circumstances, the output definitions should be*

*able to capture these trends.*“ The profitability approach was developed specifically to capture such changes in output quality. However, its original setup does not take any indicators of business volumes or market share into account.

This study will therefore apply two slightly modified production functions based on the intermediation and service-oriented approach, respectively.

Under the first, profit before tax is added as an additional output. This helps to avoid distortions from different tax rates (for example due to possible tax benefits obtained for foreign direct investments) and exceptional one-off items. Rather than using earning assets as output, only customer loans are included. This is because it is not always clear why higher interbank business volumes or securities held would increase credit supply to the real economy (at least within Europe's predominantly lending based financial systems).

In the second model, deposits are used as output rather than input. This seems to be the best possible approximation given the limited data available

Due to the possible artefacts outlined in Table 9, results will also be compared with macroeconomic data.

### **3 State of the Field**

This chapter outlines the state of the field regarding bank efficiency research in CEE and explains the reasoning behind the methodological approach taken in the following statistical part. It includes an overview of the levels of efficiency previous studies have identified for these markets. Further, a review of the design, assumptions and parameters these studies have used is conducted.

Given the large variance in results, the main question addressed is whether the average relative efficiency score, as published in most studies, can actually be compared across publications.

The structure of the chapter is as follows:

First, a systematic approach for reviewing the previously conducted research is set up. To that end a list of journals and institutions that publish working paper series is set up and the content of each reviewed.

The second part establishes which aspects of a study's design, assumptions taken and parameters chosen are likely to impact the result of a DEA of bank efficiency and why. These aspects are:

- a) the source of data
- b) the assumed production function
- c) how the units are grouped and
- d) the relative efficiency scores.

To this end, the resulting publications are split into two main groups: cross-country studies which compare relative efficiency scores against a common frontier and single-market studies which only compare DMUs from one single country. All are reviewed with particular focus on the before mentioned parameters.

Additionally, previous research regarding bank efficiency not directly linked to the CEE region is reviewed with the aim of identifying any best practices, known pitfalls or other topics of interest. Building on that analysis, conclusions for how a study of bank efficiency in

CEE should best be designed are drawn. The chapter concludes with an outline of the model specifications to be used in the statistical part of this study.

### **3.1 Publications in Journals and Working Paper Series**

By all accounts, efficiency research is a dynamic area of research. For example, Tavares (2002) conducts a literature review of DEA and its uses until 2001 and finds more than 3,600 papers on the topic. Although these do not all concern themselves with banks, it is clearly necessary to limit the literature review in this analysis to only the most relevant studies.

To this end, a list of 59 journals and 27 institutions that publish working paper series is set up and the content of each reviewed on a case by case basis for studies on bank efficiency published since the year 2000. Of the journals surveyed, 14 are chosen based on their ‘A+’-ranking awarded by the Association of University Professors of Management e.V. (VHB) in 2008. 45 additional ones from the fields of Banking, Accounting and Economics are added by the author. The following table shows the number of relevant studies:

Table 10 - Relevant Publications Since 2000

<b>Journal</b>	<b># of articles</b>	<b>Working Paper Series</b>	<b># of articles</b>
Academy of Management Journal	-	Austrian National Bank (OeNB)	1
Academy of Management Review	-	Austrian Institute of Economic Research (WIFO)	2
Accounting Organizations and Society	-	Bank for International Settlements (BIS)	1
Administrative Science Quarterly	-	Banco de Espana	1
American Economic Review	-	Centre for European Policy Studies (CEPS)	-
Applied Economic Letters	2	Centre for North South Econ. Research (CRENOS)	-
Applied Financial Economics	3	Centre of Economic Policy Research (CEPR)	-
Central Bank Review	1	Czech National Bank	1
Comparative Economic Studies	1	Deutsche Bundesbank	1
Contemporary Economic Policy	1	Europ. Bank for Rec. and Development (EBRD)	1
Eastern European economics	1	European Central Bank (ECB)	1
Economics of Transition	2	European Investment Bank (EIB)	2
Emerging Markets Review	1	Federal Reserve Bank	3
Empirica	1	Hungarian Central Bank (MNB)	1
European Economic Review	1	INSEAD	-
European Journal of Finance	1	International Monetary Fund (IMF)	2
Financial Stability Review	1	Materialy i studia	2
Information Systems Research	-	Money Macro and Finance Research Group	1
International Economic Review	-	National Bureau of Economic Research (NBER)	-
International Journal of Finance and Economics	-	Netherlands Central Bank (DNB)	2
Journal of Accounting Research	-	Org. for Econ. Co-operation and Dev. (OECD)	-
Journal of Applied Econometrics	1	The Bank of Finland Inst. for E. in Transition (BOFIT)	2
Journal of Banking and Finance	26	The European Money & Finance Forum (SUERF)	1
Journal of Consumer Research	-	The Institute for Advanced Studies (IHS)	-
Journal of Development Studies	-	US Federal Reserve Board (US Fed)	1
Journal of Econometrics	-	Wharton Financial Institutions Center	2
Journal of Economic Perspectives	-	World Bank	1
Journal of Economic Theory	-	<b>Total</b>	<b>29</b>
Journal of Finance	-		
Journal of Financial Economics	-		
Journal of Financial Intermediation	-		
Journal of Financial Research	-		
Journal of Int. Accounting, Auditing & Taxation	1		
Journal of Int. Fin. Markets, Institutions & Money	1		
Journal of International Money and Finance	-		
Journal of Macroeconomics	-		
Journal of Marketing	-		
Journal of Marketing Research	-		
Journal of Marketing Research JMR	-		
Journal of Monetary Economics	-		
Journal of Money, Credit and Banking	2		
Journal of Political Economy	-		
Journal of Productivity Analysis	3		
Journal of Public Economics	-		
Management Science MS	-		
Marketing Science	-		
Operations Research	-		
Psychological Bulletin	-		
Psychometrika	-		
Quarterly Journal of Economics	-		
RAND Journal of Economics	-		
Research in Finance	1		
Research in International Business and Finance	1		
Research in Organizational Behavior	-		
Review of Economic Studies	-		
Review of Financial Economics	2		
Review of Financial Studies	-		
Review of World Economics	-		
The Economic Journal	-		
<b>Total</b>	<b>52</b>		

Studies are considered relevant if they contain results for at least one of the countries surveyed or if they yield significant additions from a methodological point of view. Due to the limited number of recent empirical studies of the region, those using parametric models are also included together with selected single-market studies which cover comparable CEE countries which are not part of the sample used in this study. Studies published in multiple publications are only counted once with their most recent publication date.

### 3.2 Design of Previous Empirical Studies

Of the above publications, 32 are empirical studies. The below graph splits them according to regional coverage and methodology used.

*Table 11 - Empirical Studies Grouped by Country Coverage And Frontier Method Used (in Alphabetical Order)*

	Study	DEA	Malmquist	Parametric
<i>Cross-Country</i>	Altunbas / Gardener / Molyneux / Moore (2001)			X
	Bonin / Hasan / Wachtel (2005)			X
	Bos / Schmiedel (2007)	X		
	Casu / Molyneux (2000)	X		
	De Guevara / Maudos (2002)			X
	Fries / Taci (2005)			X
	Grigorian / Manole (2002)	X		
	Hauner (2004)			X
	Hollo / Nagy (2006)			X
	Maudos / De Guevara (2007)			X
	O'Brien / Wagenvoort (2000)			X
	Rossi / Schwaiger / Winkler (2005)			X
	Schure / Wagenvoort (2000)			X
	Schure / Wagenvoort / O'Brien (2004)			X
	Staikouras / Mamatzakis / Koutsomanoli-Filippaki (2008)			X
	Stavarek (2006)	X		
	Tomova (2005)	X		
	Weill (2003)			X
	Weill (2007)			X
	Yildirim / Philippatos (2007a)			X
<i>Single Market</i>	Ali / Gstach (2000)	X	X	
	El-Gamal / Inanoglu (2005)			X
	Hahn (2004)	X		
	Hahn (2005)	X		
	Hasan / Marton (2003)			X
	Havrylchuk (2006)	X		
	Isik / Hassan (2002)	X		
	Kasman (2002)			X
	Nikiel / Opiela (2002)			X
	Pawlowska (2003)	X	X	
	Pawlowska (2005)	X		
	Podpiera / Podpiera (2005)			X

There are 20 cross-country studies that investigate at least one of those countries also covered by this thesis while the remaining 12 dealt with one country only. All cross-country studies used the for-profit BankScope database as data source. Clearly, in such an outline the relative efficiency scores identified for individual countries heavily depend on which other countries are selected for setting up a common frontier. All of these studies except Weill (2002) have a trend design where the values of the very same variables are obtained for several time periods but for various units. Given the usually high M&A activity in transformation economies, it was to be expected that none of the studies cover a balanced panel of DMUs.

Another 12 empirical studies only cover one single country. Due to lack of data, studies covering CEE markets not sampled in this study were also included in the analysis. While most single-market studies attempt full coverage of the respective banking market, major differences exist with regards to the definition of what a bank is, which shows in different treatment of specialized institutions such as leasing houses or Islamic banks by different authors. Several studies also limit themselves to commercial banks only, thus excluding cooperative or savings banks. Others only take into account banks larger than a certain threshold or exclude outliers.

There is no obvious trend as to which approach is used in single market studies. Parametric methods are more commonly used for cross-country studies. Only Ali / Gstach (2000) and Pawlowska (2003) compute the Malmquist Index in order to compare various periods while all others review the mean efficiency score's change over time.

Table 12 shows a further split of empirical studies according to the underlying assumed production function. Detailed observation does not reveal any obvious trend over time.



*Table 12 - Empirical Studies Grouped by Assumed Production Function (in Chronological Order)*

Study	inter- mediation	service oriented	profita- bility	produc- tion	not stated
Ali / Gstach (2000)		X			
Altunbas / Gardener / Molyneux / Moore (2001)	X				
Bonin / Hasan / Wachtel (2005)					X
Bos / Schmiedel (2007)	X				
Casu / Molyneux (2000)	X				
De Guevara / Maudos (2002)	X				
El-Gamal / Inanoglu (2005)	X				
Fries / Taci (2005)	X				
Grigorian / Manole (2002)		X			
Hahn (2004)	X		X		
Hahn (2005)			X		
Hasan / Marton (2003)					X
Hauner (2004)	X				
Havrylchuk (2006)	X				
Hollo / Nagy (2006)	X				
Isik / Hassan (2002)	X				
Kasman (2002)	X				
Maudos / De Guevara (2007)					X
Nikiel / Opiela (2002)					X
O'Brien / Wagenvoort (2000)		X			
Pawlowska (2003)		X			
Pawlowska (2005)		X			
Podpiera / Podpiera (2005)					X
Rossi / Schwaiger / Winkler (2005)				X	
Schure / Wagenvoort (2000)		X			
Schure / Wagenvoort / O'Brien (2004)		X			
Stavarek (2006)	X				
Tomova (2005)	X		X		
Weill (2003)	X				
Weill (2007)	X				
Yildirim / Philippatos (2007a)		X			
Staikouras / Mamatzakis / Koutsomanoli-Filippaki (2008)	X				

As far as the production functions are concerned, the intermediation approach is by far the most commonly used, followed by the service-oriented approach. This does not mean, however, that the inputs and outputs used in all studies that follow one approach would always be the same. The latter in particular vary from two to as much as six. The most ambiguous outputs seem to be off-balance sheet items as well as securities.

The following two subchapters outline the most important parameters used for each study.

### 3.2.1 Cross-Country Studies

The influence design parameters and model assumptions have on the resulting efficiency scores cannot be overestimated. Unfortunately, it needs to be stated that in some cases very little information about these methodological aspects was published.

It is evident that many facts - if not the whole dataset - would need to be known in order to truly replicate results, which is clearly not feasible for paper publication. Nevertheless, it seems worthwhile to strive for a certain minimum of facts about the design of efficiency analyses to be published. For example, it is rather disappointing that a detailed overview of which studies used variable and which constant returns to scale as well as whether the model was input- or output-oriented in the latter case, was not possible due to a lack of published information. At other times, efficiency scores were not stated in the publication but only shown on a graph. Where this is the case, the score is stated as 'ca.' in the following overview. Nevertheless, the following outline is rather comprehensive and can serve as a profound basis for specifying the model assumptions of this thesis.

The overview is split according to non-parametric and parametric models and covers the following aspects in detail:

- e) The source of data and, related to that, the size of the sample as well as the question of how representative the sampled units are of the total population. This also includes reviewing any checks or modifications the authors may have performed on the data before running the statistical algorithm.
- f) What the authors consider the function of a bank to be and how they therefore model its production function. This includes outlining which inputs and outputs were used. It has to be noted that this is also related to the sample size, as the number of units classified as efficient grows with the number of inputs and outputs used. Using too many on too small a sample will therefore yield higher efficiency scores.
- g) How the units are grouped. Both statistical clustering as well as manual assignment to defined groups are possible. Although neither impact the relative efficiency scores awarded to each unit under a common frontier, this categorization is usually performed based on some assumed element of heterogeneity within the sample. A

different categorization may then lead to a different interpretation, even of the same data.

- h) Last but not least, the relative efficiency scores, if published, are of course of interest.

The following studies used Data Envelopment Analysis:

*Table 13 - Design Parameters of Bos / Schmiedel (2007)*

<b>Bos / Schmiedel (2007)</b>	
aim:	Is there a common cost / profit efficient frontier?
sample:	
source:	Bankscope
sample:	~ 5,000 banks from EU-15 excluding Finland, including Switzerland (1993-2004)
data checks:	none reported; only commercial banks
method:	
approach:	DEA
production function:	intermediation approach
inputs:	price of labor, price of financial capital, price of physical capital, equity ratio
outputs:	loans, investments, off-balance sheet items
DMUs grouped by:	countries
results:	
scores:	0.424 to 0.933 for cost and 0.757 to 0.991 for profit

The study finds evidence for a single European banking market characterized by cost and profit meta-frontiers. However, pooled frontiers tend to underestimate efficiency as compared to meta-frontiers.

*Table 14 - Design Parameters of Casu / Molyneux (2000)*

<b>Casu / Molyneux (2000)</b>	
aim:	to check whether there is convergence towards a common European efficient frontier
sample:	
source:	BankScope
sample:	~ 500 banks from 5 countries (1993-1997)
data checks:	none stated
method:	
approach:	DEA
production function:	intermediation approach
inputs:	total costs (interest, non-interest, personnel), deposits
outputs:	total loans, total earning assets
DMUs grouped by:	none stated
results:	
scores:	input efficiency 0.68 (1997), output efficiency 0.69 (1997)

Interestingly, the gap between efficiency levels increased rather than diminished during the period in question.

*Table 15 - Design Parameters of Grigorian / Manole (2002)*

<b>Grigorian / Manole (2002)</b>	
aim:	to investigate whether DEA can be useful to assess banking markets of transition countries
sample:	
source:	BankScope
sample:	~300 banks from 17 CEE, SEE and CIS countries (1995-1998)
data checks:	coverage ratios range from 2% (Kazakhstan, 1995) to 93% (Estonia, 1998)
method:	
approach:	DEA
production function:	value added approach
inputs:	labor, fixed assets, interest expenditures
outputs:	model 1: revenues, net loans, liquid assets model 2: deposits, net loans and liquid assets
DMUs grouped by:	country, subregion
results:	
scores:	model 1: CIS 0.418, SEE 0.592 and CEE 0.710 (1998) model 2: CIS 0.422, SEE 0.587, CEE 0.688 (1998)

The authors conclude that the results confirm the usefulness of DEA for transition-related applications.

*Table 16 - Design Parameters of Stavarek (2006)*

<b>Stavarek (2006)</b>	
aim:	to analyze bank efficiency in CEE, Portugal and Greece
sample:	
source:	not stated (assumed: BankScope)
sample:	125 banks from 11 countries (2001-2003)
data checks:	asset coverage 90%
method:	
approach:	DEA
production function:	intermediation approach
inputs:	labor, capital, deposits
outputs:	loans, net interest income
DMUs grouped by:	by countries and size of banks
results:	
scores:	average efficiency 0.75 (2002, input-oriented)

The author concludes that significant room for improvement exists in the region as the result implies that the same output could have been produced with 75% costs.

*Table 17 - Design Parameters of Tomova (2005)*

<b>Tomova (2005)</b>	
aim:	to quantify heterogeneity and convergence of bank efficiency
sample:	
source:	BankScope
sample:	~ 1,300 banks in EU-27 and Croatia (1994-2002)
data checks:	excluded banks with missing or negative values, only commercial for old, all types of banks for new members, USD values deflated with CPI
method:	
approach:	DEA
production function:	model 1: intermediation approach model 2: profitability approach
inputs:	physical capital, deposits and other funding, operating costs
outputs:	model 1: loans, investments model 2: gross operating income
DMUs grouped by:	by countries
results:	
scores:	model 1: between ca. 0.18 and 0.32 (2002) model 2: ca. 0.2 (2002)

Very significant levels of heterogeneity and thus relative inefficiency, much below levels from other studies, were calculated.

The following studies used approaches other than Data Envelopment Analysis:

*Table 18 - Design Parameters of Altunbas / Gardener / Molyneux / Moore (2001)*

<b>Altunbas / Gardener / Molyneux / Moore (2001)</b>	
aim:	to model cross-country cost characteristics of banking markets
sample:	
source:	BankScope
sample:	~4,100 banks in EU-15 (1989-1997)
data checks:	none stated
method:	
approach:	SFA
production function:	intermediation approach
inputs:	labour, physical capital, deposits
outputs:	total loans, securities, off-balance sheet items
DMUs grouped by:	type and size of banks
results:	
scores:	cost efficiency from 0.67 to 0.87 (1997)

The results imply that the same level of output could have been achieved with only 67 - 87 % of costs.

*Table 19 - Design Parameters of Bonin / Hasan / Wachtel (2005)***Bonin / Hasan / Wachtel (2005)**

aim:	to investigate the impact of bank privatization in transformation countries	
sample:		
	source:	BankScope
	sample:	67 banks in 6 CEE countries (1994-2002)
	data checks:	asset coverage (75%); added constant amount to avoid zero values
method:		
	approach:	SFA
	production function:	not stated
	inputs:	cost of capital (non-interest expenses / fixed assets), cost of funds (interest expenses / deposits)
	outputs:	total deposits, total loans, total liquid assets, other investments
	DMUs grouped by:	4 types of ownership (foreign greenfield, domestic de novo, state owned, privatized)
results:		
	scores:	cost efficiency 0.786; profit efficiency 0.445 (average over all periods)

State-owned banks are found to be least, foreign greenfield banks most efficient.

*Table 20 - Design Parameters of De Guevara / Maudos (2002)***De Guevara / Maudos (2002)**

aim:	Origins of inequalities of cost and profit efficiency in the banking sector of the European Union	
sample:		
	source:	BankScope
	sample:	~ 2,000 banks in the EU-15 except the Netherlands (1993-1997)
	data checks:	excludes banks smaller than USD 100m and those not available for all years
method:		
	approach:	DFA
	production function:	intermediation approach
	inputs:	labour, loanable funds, physical capital
	outputs:	loans, other earning assets, deposits
	DMUs grouped by:	clustered statistically (traditional intermediary, mortgage, retail, market investment deposit banks)
results:		
	scores:	0.6367 profit and 0.9252 cost efficiency (average over all periods)

Variations which can be explained by clustering are small (for both cost and profit efficiency). Country-specific factors remain the most significant influence, especially for profit efficiency.

*Table 21 - Design Parameters of Fries / Taci (2005)***Fries / Taci (2005)**

aim:	to investigate cost efficiency in transition countries	
sample:	source:	BankScope
	sample:	~ 300 banks in 15 European transition countries (1994-2001)
	data checks:	none stated
method:	approach:	SFA
	production function:	intermediation approach
	inputs:	non-interest expenses
	outputs:	loans to customers (incl. to banks), deposits
	DMUs grouped by:	by countries, 5 types of ownership (newly established foreign ownership, newly established domestic ownership, state-owned, privatized foreign ownership, privatized domestic ownership)
results:	scores:	0.40 - 0.75 (average over all periods without taking country-specific factors into account)

The authors find that while cost efficiency did increase at the beginning of the transformation, this was followed by a decline later on.

*Table 22 - Design Parameters of Hauner (2004)***Hauner (2004)**

aim:	investigate source of efficiency differences among large German and Austrian banks	
sample:	source:	not stated (assumed: BankScope)
	sample:	~100 banks (1995-1999)
	data checks:	selected only non-specialized banks with assets > EUR 5 bn, only the largest of merged entities
method:	approach:	SFA
	production function:	extended intermediation approach
	inputs:	aggregate funds and labor
	outputs:	interbank loans, customer loans, fixed-income securities
	DMUs grouped by:	3 types of size, 4 types of ownership (private, state, cooperative, independent savings banks)
results:	scores:	cost efficiency: overall 0.62 (1999); 0.42 for Austria (average over all periods from 1995 to 1999)

Austrian banks are found to be less cost efficient than their German counterparts. No differences between privately owned and cooperative banks are found. Savings banks are less efficient - perhaps due to their different objectives. State-owned banks are more efficient which may be caused by their access to cheaper refinancing due to state guarantees.

*Table 23 - Design Parameters of Hollo / Nagy (2006)*

<b>Hollo / Nagy (2006)</b>	
aim:	to estimate efficiency differences across EU banking markets
sample:	
source:	BankScope
sample:	~2,500 banks (commercial, savings and cooperative) from EU-25 (1999-2003)
data checks:	coverage of 70-90% by assets for old member states, 40-50% for Sweden and UK
method:	
approach:	SFA
production function:	intermediation approach
inputs:	cost of labour, physical capital, borrowed funds
outputs:	loans, other earning assets, non interest revenues
DMUs grouped by:	countries
results:	
scores:	cost efficiency 0.86; alternative profit efficiency 0.70 (EU-25, 2003, without controlling for external factors)

The study finds the efficiency gap between old and new member states to be narrowing. No significant relationship is found between accounting based efficiency indexes (such as CiR or cost / total assets) and statistical ones.

*Table 24 - Design Parameters of Maudos / De Guevara (2007)*

<b>Maudos / De Guevara (2007)</b>	
aim:	to quantify any welfare losses due to market power
sample:	
source:	BankScope
sample:	~ 3,000 banks in EU-15 (1993-2002)
data checks:	coverage ratio 75%
method:	
approach:	SFA
production function:	not stated
inputs:	price of labor (personnel costs/total assets), price of capital (operating costs except personnel costs/fixed assets)
outputs:	total earning assets (all types of assets that generate interest income), deposits (customer and short term funding)
DMUs grouped by:	by type (commercial, cooperative, savings), country
results:	
scores:	mean cost efficiency 0.848 (2002, for EU-15)

The authors find that "*welfare gains associated with a reduction of market power are greater than the loss of bank cost efficiency, showing the importance of economic policy measures aimed at removing the barriers to outside competition*" and quantify these welfare losses at 0.4% of GDP for EU-15 as of 2002.



Table 25 - Design Parameters of O'Brien / Wagenvoort (2000)

**O'Brien / Wagenvoort (2000)**

aim:	to investigate differences between efficient DMUs (e.g. those on the efficient frontier) and inefficient ones	
sample:		
source:	BankScope	
sample:	~ 2,400 credit institutions in EU-15 excluding Luxembourg (1993-1997)	
data checks:	excludes banks which ceased to exist, units with zero or negative values, some outliers and erroneous data, used real interest rates for costs (subtracted CPI rates from nominal interest rates)	
method:		
approach:	RTFA	
production function:	value added approach	
inputs:	price of loanable funds, price of labour	
outputs:	customer deposits, loans, equity investments, off-balance sheet items, other services	
DMUs grouped by:	country, 6 size groups, 4 types (Commercial, Savings and Cooperative, Mortgage, Long-Term and Non-Bank)	
results:		
scores:	not stated for EU-15; 0.91 for Austria (average relative efficiency score weighted by asset size of each unit excluding outliers, 1997)	

One in five credit institutions is found to be operationally cost efficient with Austria being among the top performers.

Table 26 - Design Parameters of Rossi / Schwaiger / Winkler (2005)

**Rossi / Schwaiger / Winkler (2005)**

aim:	to analyze cost and profit efficiency levels in nine Central and Eastern European countries	
sample:		
source:	BankScope	
sample:	~300 banks in 9 countries (1995-2002)	
data checks:	asset coverage 80%	
method:		
approach:	SFA	
production function:	modified production approach	
inputs:	labor, capital, deposits	
outputs:	loans, deposits, other earning assets	
DMUs grouped by:	by countries	
results:		
scores:	cost efficiency 0.78 (2002); profit efficiency 0.42 (2002)	

The authors follow the argumentation of Berger / DeYoung (1997) who saw four distinct possible reasons for bank inefficiency which they called *bad luck*, *bad management*, *skimping* and *moral hazard*. However, the study does not find evidence for the “bad management” hypothesis which makes the “bad luck” hypothesis more probable.

*Table 27 - Design Parameters of Schure / Wagenvoort (2000)*

<b>Schure / Wagenvoort (2000)</b>	
aim:	to investigate whether banks have managed to reduce costs after implementation of Second Banking Directive of EU
sample:	
source:	BankScope
sample:	~ 2,000 credit institutions in EU-15 (1993-1997)
data checks:	excluded banks which ceased to exist, units with zero or negative values, some outliers and erroneous data
method:	
approach:	RTFA
production function:	value added approach
inputs:	(weighted) price of funds, price of labour
outputs:	customer deposits, loans, equity investments, off-balance sheet items, other services
DMUs grouped by:	by country, 8 size groups, 4 types (Commercial, Savings and Cooperative, Mortgage, Long-Term and Non-Bank)
results:	
scores:	average (relative efficiency score weighted by asset size of each unit, excluding outliers) 0.84 for EU-15 and 0.89 for Austria (1997)

Significant shifts in the cost frontier can only be detected for savings institutions.

*Table 28 - Design Parameters of Schure / Wagenvoort / O'Brien (2004)*

<b>Schure / Wagenvoort / O'Brien (2004)</b>	
aim:	to assess efficiency of the European banking sector following the implementation of the Second Banking Directive of the EU
sample:	
source:	BankScope
sample:	1,347 savings and 873 commercial banks in EU-15 (1993-1997)
data checks:	transformed output variables by adding 1 to ensure non-zero values; excluded banks which ceased to exist, units with zero or negative values, some outliers and erroneous data
method:	
approach:	RTFA
production function:	value added approach
inputs:	(weighted) price of funds, price of labour, price of buildings
outputs:	total deposits, total loans, equity investments, off-balance sheet items, commission revenue, total securities
DMUs grouped by:	by country, type (savings vs. commercial), 6 types of size
results:	
scores:	0.9 for Austrian commercial, 0.94 for Austrian savings banks (both 1997, average X-efficiency weighted by total assets)

The study finds no evidence of convergence, albeit the cost base has been lowered by about 5% annually.

Additionally, clusters of commercial and savings banks are compared against two common frontiers. Efficient savings banks are found to generate 20% more profits and attract more deposits and have higher fee & commission income than their inefficient peers. Efficient commercial banks hold more securities and have higher off-balance-sheet activities but are not more profitable.

*Table 29 - Design Parameters of Staikouras / Mamatzakis / Koutsomanoli-Filippaki (2008)***Staikouras / Mamatzakis / Koutsomanoli-Filippaki (2008)**

aim:	to analyze cost efficiency in six SEE countries	
sample:		
source:	BankScope	
sample:	between 51 and 117 banks from six SEE countries (1998-2003)	
data checks:	none stated	
method:		
approach:	SFA	
production function:	intermediation approach	
inputs:	non-interest expense / assets and interest paid / total funds	
outputs:	loans, other earning assets	
DMUs grouped by:	by country, bank size and ownership (state-owned, domestic private, strategic foreign and other foreign)	
results:		
scores:	average cost inefficiency 0.33 (Bulgaria)-0.47 (Macedonia)	

The study finds a generally low level of cost efficiency (comparable to that detected by other studies) with significant inefficiency differences among countries.

*Table 30 - Design Parameters of Weill (2007)***Weill (2007)**

aim:	to compare performance of banks from Western European and CEE countries to assess any performance group	
sample:		
source:	BankScope	
sample:	800 banks from eleven Western European & 115 banks from six CEE countries (1996-2000)	
data checks:	no checks stated; outliers were excluded	
method:		
approach:	SFA	
production function:	intermediation approach	
inputs:	labour, physical capital, borrowed funds	
outputs:	loans, investment assets	
DMUs grouped by:	by countries and size of banks	
results:		
scores:	efficiency 0.55 (CEE, 2000), 0.69 (Western Europe, 2000)	

Although the average efficiency increased in all countries, the gap to Poland and Slovenia widened during the period in question. The study also checks the correlation of the resulting efficiency scores with seven environmental variables but finds only per capita income to be significant.

*Table 31 - Design Parameters of Weill (2003)*

<b>Weill (2003)</b>	
aim:	to compare the performance of domestic and foreign-owned banks in the Czech Republic and Poland
sample:	
source:	BankScope
sample:	31 Polish and 16 Czech banks (1997)
data checks:	none reported
method:	
approach:	SFA
production function:	intermediation approach
inputs:	labour, physical capital, borrowed funds
outputs:	loans, investment assets
DMUs grouped by:	domestic and foreign-owned
results:	
scores:	efficiency: 0.62 for domestic and 0.70 for foreign-owned banks (1997)

The authors find that the degree of openness of the banking sector to foreign capital has a positive impact on performance.

*Table 32 - Design Parameters of Yildirim / Philippatos (2007)*

<b>Yildirim / Philippatos (2007)</b>	
aim:	to investigate cost and profit efficiency in CEE transformation economies
sample:	
source:	BankScope
sample:	325 banks in twelve countries (1993-2000)
data checks:	excluded banks with missing or negative values as well as outliers
method:	
approach:	SFA, DFA
production function:	modified value-added approach
inputs:	borrowed funds, labor, physical capital
outputs:	loans, investments, deposits
DMUs grouped by:	by countries
results:	
scores:	cost efficiency 0.69 (or 0.795 if outliers excluded at 10% level); profit efficiency 0.56 (or 0.67 if outliers excluded at 10% level)

The results for average cost efficiency are much higher than those for profit efficiency. The relative efficiency scores are found to be significantly correlated with the following factors: size, capitalization, competition, market concentration and foreign ownership.

This study is particularly interesting in that it openly states how the average scores would have differed depending on the cut-off point chosen for the definition and exclusion of outliers.

### 3.2.2 Single-Country Studies

The following studies limit their coverage to one country only. As already stated, due to the different data source and different frontier, the stated scores are not directly comparable with those resulting from cross-country studies.

Due to the limited amount of research published concerning the CEE region, studies covering CEE countries are included even where the covered market is not part of the country sample used by this thesis.

#### Austria

The following two studies about the Austrian banking market are formidable examples of how much results can vary due to even minor differences in parameters. Both Ali / Gstach (2000) and Hahn (2005) perform a DEA on data provided by the Austrian National Bank (OeNB). But the former exclude banks which they consider to be specialized or reporting illogical figures. Although no details are provided, given the sample size of ~ 200 banks, a majority of banks reporting to the OeNB must have been excluded. Hahn (2005) does not report any adjustments to the input data as obtained from the OeNB and the sample size is four times as large. The resulting efficiency scores are thus very different: 0.219 versus 0.937.

Due to the different data source and different frontier, these scores are also not directly comparable with those obtained for Austria by the above-mentioned cross-country studies such as the 0.42 calculated by Hauner (2004) or the score of 0.94 for Austrian savings banks as calculated by Schure / Wagenvoort / O'Brien (2004).

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*Table 33 - Design Parameters of Ali / Gstach (2000)*

<b>Ali / Gstach (2000)</b>	
aim:	to investigate changes in bank efficiency preceeding/following Austria's EU accession
sample:	
source:	Austrian National Bank
sample:	~200 Austrian banks (1990, 1995, 1996 and 1997)
data checks:	excluded specialized banks and banks with illogical reported figures
method:	
approach:	DEA, Malmquist index
production function:	value added approach
inputs:	labor, physical capital, interbank deposits, purchased funds, equity
outputs:	customer deposits, interbank loans, small loans, large loans, securities
DMUs grouped by:	size, type
results:	
scores:	geometric mean from 0.937(1990) - 0.838 (1997)

The observed efficiency losses indicate that the gap in the relative performance grew between 1990 and 1996.

*Table 34 - Design Parameters of Hahn (2004)*

<b>Hahn (2004)</b>	
aim:	to investigate the performance of Austrian banks which have been involved in domestic intra-bank M&A
sample:	
source:	Austrian National Bank
sample:	> 800 banks (1999-2002)
data checks:	none stated, full coverage assumed
method:	
approach:	DEA
production function:	profit approach and intermediation approach
inputs:	profit approach (employee expense, other non-interest expense, RWAs) intermediation approach (total cost, deposits)
outputs:	profit approach (net interest revenue, net commission revenue, other income) intermediation approach (total loans, other earnings)
DMUs grouped by:	involved in M&A operation (yes/no)
results:	
scores:	profit approach: 0.219 (2002, mean total sample, input-oriented slacks based model) intermediation approach: 0.263 (2002, mean total sample, input-oriented SBM)

The results indicate a positive impact of M&A on efficiency albeit from a very low starting point.

Table 35 - Design Parameters of Hahn (2005)

<b>Hahn (2005)</b>	
aim:	to investigate the influence of environmental factors on bank performance in Austria
sample:	
source:	Austrian National Bank
sample:	> 800 banks (1995-2002)
data checks:	all inputs and outputs deflated by GDP
method:	
approach:	DEA
production function:	profit approach
inputs:	employee expenses, other noninterest expenses and risk-weighted assets (Basel I)
outputs:	net interest revenue, net commission revenue and other income
DMUs grouped by:	by bank type (commercial, savings, cooperative, mortgage), by regions
results:	
scores:	efficiency 0.224 (2002, all banks, unadjusted), 0.449 (2002, all banks, adjusted)

The study finds that controlling for external local market conditions increases average scores and reduces the average range of volatility. Moreover, initial and environment-adjusted efficiency estimates are only weakly correlated. *"Decomposition of the initial and environment-adjusted efficiency scores along the lines of the traditional segmentation of the Austrian banking system yields that managerial efficiency of the commercial banks (Aktienbanken) tends to be overrated due to favourable environmental factors and that of cooperative banks (Raiffeisenbanken) to be underrated due to harsher local market conditions. Efficiency levels of savings banks (Sparkassen) and mortgage banks (Hypothekenbanken), however, remain unaffected by changing environmental conditions."* (Hahn, 2005, p. 14).

### Czech Republic

Table 36 - Design Parameters of Podpiera / Podpiera (2005)

<b>Podpiera / Podpiera (2005)</b>	
aim:	to investigate whether cost efficiency can predict the risk of bank failure
sample:	
source:	Czech National Bank (CNB)
sample:	quarterly data on 42 (1994) to 28 (2003) Czech commercial banks
data checks:	nominal data deflated by CPI
method:	
approach:	SFA (also random effects model, fixed effects model)
production function:	not stated
inputs:	price of labor, price of physical capital and the price of borrowed funds
outputs:	demand deposits and total loans net of bad loans
DMUs grouped by:	failed / not failed
results:	
scores:	mean cost efficiency 0.82 (2003)

The authors observe that *"the banks that failed tended to gradually descend down the relative efficiency ranking to the bottom quartiles, and one year prior to failure all failed banks were placed in the least efficient quartile by at least one method"* and further conclude that this would confirm that deteriorating efficiency can serve as a signal for the risk of bank failure. However, no hypotheses tests are provided (Podpiera / Podpiera, 2005, p.21).



Hungary*Table 37 - Design Parameters of Hasan / Marton (2003)***Hasan / Marton (2003)**

aim:	to investigate efficiency of Hungarian banking system
sample:	
source:	Hungarian Financial and Stock Exchange Almanac
sample:	~30 banks (1993-1997)
data checks:	none stated, exclusion of some banks due to lack of consistent data
method:	
approach:	EFA
production function:	not stated
inputs:	price of labor(total non-interest expenditure), price of borrowed funds
outputs:	total loans, total investments, total borrowed funds
DMUs grouped by:	domestic vs foreign (as quartiles of involvement)
results:	
scores:	cost inefficiency: 0.1683 and profit inefficiency 0.2501 (1997)

Cost and profit efficiency increased during the period in question. A higher percentage of foreign involvement would indicate higher efficiency. The authors conclude that foreign banks did not encounter restructuring costs and were thus able to exploit their competitive advantage of advanced technology causing lower cost inefficiency.

Poland*Table 38 - Design Parameters of Havrylchuk (2006)***Havrylchuk (2006)**

aim:	to investigate efficiency of Polish banking system between 1997 and 2001	
sample:	source:	Monitor B
	sample:	~50 banks excluding specialized leasing houses (1997-2001)
	data checks:	95% asset coverage, excluded outliers at 1% level and banks with missing data
method:	approach:	DEA
	production function:	intermediation approach
	inputs:	capital, labor (number of employees), deposits
	outputs:	loans, government bonds, off-balance sheet items
	DMUs grouped by:	foreign greenfield, foreign acquired, domestic
results:	scores:	cost efficiency: foreign-owned 0.4862 and domestic 0.6014 (2001)

Cost efficiency of both foreign and domestic banks decreased during the period. The author infers that this could be due to a need to tap new and riskier market segments as financial intermediation deepened or due to restructuring costs of foreign-acquired banks.

*Table 39 - Design Parameters of Nikiel / Opiela (2002)***Nikiel / Opiela (2002)**

aim:	to investigate relationship between ownership structure, type of customers served and efficiency in Poland	
sample:	source:	National Bank of Poland (NBP)
	sample:	semiannual data of 43 banks (1997-2000)
	data checks:	excluded state-owned banks with an explicit deposit guarantee of the government, resulting in an asset coverage ratio of 40%
method:	approach:	DFA
	production function:	not stated
	inputs:	interest rates on funds, price of labor
	outputs:	household loans, business loans, securities
	DMUs grouped by:	6 types (private Polish, state-owned, foreign, foreign banks with foreign customers, foreign banks with Polish customers, business banks)
results:	scores:	cost efficiency: 0.6081 profit efficiency 0.7830 (assumed to be mean over all periods)

The study finds that foreign banks servicing foreign and business customers are more cost-efficient and less profit-efficient than other banks in Poland. As for scale economies, interestingly, results indicate cost economies but profit diseconomies

*Table 40 - Design Parameters of Pawlowska (2003)*

<b>Pawlowska (2003)</b>	
aim:	impact of M&A on efficiency in the Polish banking sector
sample:	
source:	not stated
sample:	all 71 Polish commercial banks covered by National Bank of Poland's balance sheet statistics (1997-2001)
data checks:	pre-merger banks retained as separate entities; asset coverage 95.5%
method:	
approach:	DEA, Malmquist index
production function:	value added approach
inputs:	labor (number of employees), total fixed assets, non-performing loans
outputs:	net loans, current deposits, time deposits, net fee and commissions
DMUs grouped by:	four groups of size, three types of ownership (majority state-owned, majority Polish, majority foreign-owned)
results:	
scores:	0.81 (2001, variable returns to scale)

A stop in the hitherto increasing productivity level, caused by technical regression, was identified for the year 2000. However, productivity growth resumed in 2001.

*Table 41 - Design Parameters of Pawlowska (2005)*

<b>Pawlowska (2005)</b>	
aim:	to investigate whether the concentration of commercial banks had a negative impact on the competition in the Polish banking sector
sample:	
source:	not stated
sample:	all 62 Polish commercial banks covered by National Bank of Poland's balance sheet statistics (1997-2002)
data checks:	pre-merger banks retained as separate entities; asset coverage 95.0%
method:	
approach:	DEA
production function:	value added approach
inputs:	labor (number of employees), total fixed assets, non-performing loans
outputs:	net loans, current deposits, time deposits, net fee and commissions
DMUs grouped by:	four groups of size, three types of ownership (majority state-owned, majority Polish, majority foreign-owned)
results:	
scores:	0.83 (2002, variable returns to scale)

Although concentration increased, the study does not find any empirical evidence for a decrease in competition.

Turkey*Table 42 - Design Parameters of El-Gamal / Inanoglu (2005)***El-Gamal / Inanoglu (2005)**

aim:	to investigate bank efficiency in Turkey	
sample:		
source:	Banks Association of Turkey and banks themselves	
sample:	49 conventional and 4 "Islamic" banks (1990-2000)	
data checks:	none stated, full coverage assumed; figures in Turkish Lira deflated by CPI	
method:		
approach:	SFA	
production function:	intermediation approach	
inputs:	weighted interest expenses, employee and fixed assets expenses	
outputs:	volume of loans	
DMUs grouped by:	foreign, domestic private, domestic-muslim, domestic state-owned, failed transferred to savings deposit insurance fund (SDIF)	
results:		
scores:	not reported	

The study finds that neither state nor Muslim banks increase overall bank efficiency in terms of deepening financial intermediation.

*Table 43 - Design Parameters of Isik / Hassan (2002)***Isik / Hassan (2002)**

aim:	to investigate cost and profit efficiency in the Turkish banking industry	
sample:		
source:	Istanbul Stock Exchange and Banks Association of Turkey	
sample:	~ 50 commercial banks (1988,1992 and 1996)	
data checks:	excluded development, investment and Islamic banks, outliers and banks with zero values for inputs/outputs	
method:		
approach:	DEA and EFA (Economic Frontier Approach)	
production function:	intermediation approach	
inputs:	labour (number of full-time employees), capital (book value of premises and fixed assets), loanable funds	
outputs:	short-term loans, long-term loans, risk-adjusted off-balance sheet items, other earning assets	
DMUs grouped by:	four types (national state banks, national private banks, foreign banks founded in Turkey, foreign banks having branch offices in Turkey)	
results:		
scores:	cost efficiency 0.685 (1996)	

The results suggest that, on average, cost efficiency decreased significantly during the period in question.

*Table 44 - Design Parameters of Kasman (2002)***Kasman (2002)**

aim:	to investigate efficiency in the Turkish banking sector
sample:	
source:	Banks Association of Turkey
sample:	~ 60 commercial banks (1988-1998)
data checks:	excluded national private and state-owned banks, banks that exist for less than 4 years; added 1,000 USD to output to avoid zero values
method:	
approach:	SFA (Fourier flexible function)
production function:	intermediation approach
inputs:	borrowed funds, labor and capital
outputs:	short-term loans, long-term and specialized loans, securities
DMUs grouped by:	6 size groups
results:	
scores:	0.775 cost efficiency (1998)

The results imply significant cost inefficiencies as the same outputs could have been produced with only 78% of the cost base.

## 4 Implications for This Doctoral Thesis

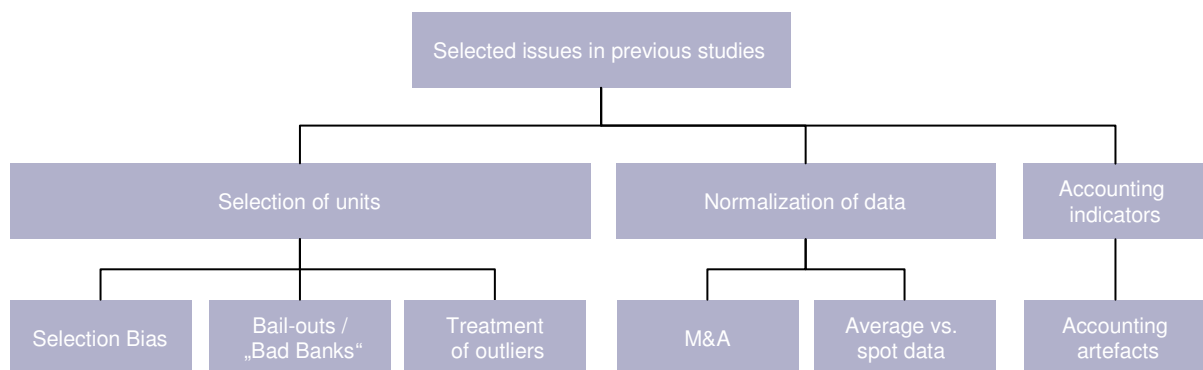
The following subchapter summarizes the implications of the studies presented and their design. It is organized along the following lines: the first part categorizes the issues identified and outlines how they will be addressed. The second part details the setup of the model including the DEA model chosen as well as the production function assumed. Finally, the third and last part describes the way in which results will be grouped and analyzed.

### 4.1 Selected Identified Issues in Previous Studies and How These Will be Addressed

This subchapter outlines selected shortcomings of previous studies, and how they will be avoided. Graph 5 categorizes the various issues into three selected problem areas, which will subsequently be discussed in detail. These are:

- issues regarding the selection of units
- issues regarding the normalization of data and
- issues related to the selection of accounting indicators as inputs and outputs.

*Graph 5 - Selected Issues*



Selection bias can be caused by using databases that do not fully cover the market or omitting units due to an unclear definition of what a bank is (or vice, versa, including units which would not have belonged in the sample).

The creation of "bad banks" is a frequently used approach to restructuring failed banks: parts of the portfolio are spun off into separate entities, usually financed by public funds. In most banking statistics, the costs of restructuring them "fall off the map" and would also not be included in any DEA based on bank-level accounting data.

As for outliers, several studies have resorted to cropping a certain top / bottom percentile off the sample. Clearly, a case by case review of the business model of each unit would have been better.

M&A activity in the sample can be problematic for running a DEA analysis in a number of ways and there is no consensus on how it should best be dealt with. Neither is there a consensus on whether nominal vs. real data should be used.

As demonstrated, the various production approaches favour the use of different inputs and outputs. However, it has also been shown that even where studies used the same approach in theory, they selected different accounting positions for their analyses. Moreover, various specific accounting artefacts which may distort DEA results have not been taken into account so far.

#### **4.1.1 Selection of Units**

##### BankScope data

It is state of the art to base cross-country efficiency research on data contained in BankScope. Only few studies concern themselves with possible selection bias:

Fries / Taci (2005) is among the few studies to specifically draw attention to the possibility of selection bias *"This method of selecting banks from the BankScope database introduces selection bias in the data, as does the selection by BankScope of banks to include in the data set. (These are primarily the larger and financially sounder banks in the region.) The estimation results are, therefore, representative not of the entire population of banks in transition economies, but rather of the relatively successful top tier of banks in the region."*

Cunningham (2001) specifically stress the need for data checks prior to any analysis and notes that cross-checking of sample data needs to be done by institution and not against the overall size of the banking market. That is because, when different accounting standards are used, they usually lead to different balance sheet sizes. And second, checking for balance sheet size alone may leave other important inaccuracies unnoticed: *“The coverage of the database can be assessed by comparing the sum total of the assets of banks covered against estimates of system aggregates from local sources. The exercise is, however, only indicative, as there may be differences in reporting treatment between local sources and the banks’ accounts within the database.”*

Only one study specifically addresses the question of data quality in BankScope: Bhattacharya (2003), who cross-checks the data contained for the Indian banking market with data provided by the Reserve Bank of India. The study finds that BankScope does not contain a fully representative sample of the Indian banking market, although the coverage ratio by total assets is 89%. The author concludes that *“It is, therefore, essential to examine how good and representative these samples are for different countries. Unfortunately, in the absence of a comparable database, such validation exercises are rare and are typically focused on coverage with respect to a size variable ... Comparison of the coverage with respect to total assets is, however, one small aspect of overall data validation.”*

For this reason, this study will use financial data on bank, rather than holding or group level, as provided by the relevant regulators. This ensures high quality of data. For several countries, this is the first time a DEA of the full market is performed. The below graph gives an overview of these alternate publicly available data sources.

*Table 45 - Alternate Data Sources*

Country	Used by Previous Studies	Publicly Available
Austria	Austrian National Bank	Austrian National Bank
Bulgaria	-	National Bank of Bulgaria
Croatia	-	National Bank of Croatia
Serbia	-	National Bank of Serbia
Turkey	Banks Association of Turkey	Banks Association of Turkey



### Conceptual Delineation of Depository Institutions

Several studies based on BankScope definitions of commercial and other banks have encountered problems as to how to define a bank or the banking market and how to delineate it from other financial institutions. For example, Micco / Panizza / Yanez (2007) note “... *we had to carefully edit the data before being able to use them for our statistical analysis, and we believe that this is an important contribution of our paper. As our paper focuses on commercial banks, we start by dropping central banks, investment banks, securities houses, multilateral government banks, non-banking credit institutions, and specialized government financial institutions, which reduces our sample from 143,564 observations to 120,809 observations.*” Bonin / Hasan / Wachtel (2005) state “*As an example of the third problem, two automobile finance companies in Hungary, Opel Bank and Porsche Bank, are included in the data set and designated as commercial banks.*”

In order to avoid such problems, this study uses all depository institutions, that is units licensed to accept retail deposits. This definition is not based on any label in an existing database, but on licensing requirements under the respective legislation which provides higher discriminatory power and transparency. A list of financial institutions allowed to accept retail deposits is publicly available for all countries in question. By cross-checking data with such information, full coverage of all depository institutions can be ensured.

This definition is the broadest of all found in the sampled studies as it includes commercial, savings as well as cooperative banks. However, it excludes specialized banks which are not licensed to accept customer deposits such as leasing houses, asset managers or insurance companies (for the avoidance of doubt: housing savings banks are also excluded).

The drawback of this definition is that it might - incorrectly - attribute any change in financial disintermediation to a change in bank efficiency. In order to assess the likely impact of such inaccuracy, the role of non-depository institutions and their size is briefly outlined and its impact found to be negligible for the time and period in question.

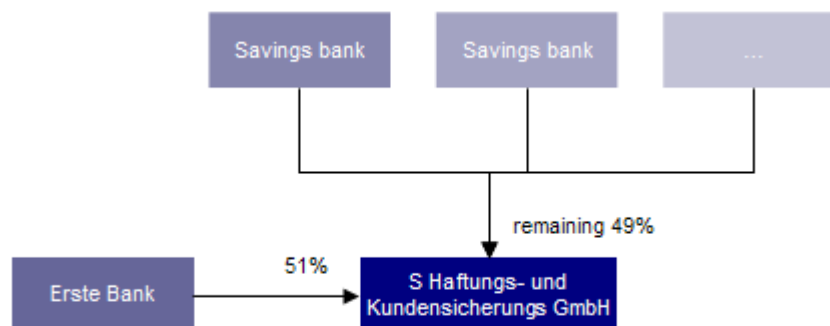
### Outliers

Since DEA computes relative efficiency scores, it is very sensitive to the heterogeneity of units in the sample. The following list outlines examples of specific problematic situations in CEE in more detail, then goes on to summarize how the issue was addressed by previous studies:

- Specialized units can easily become self-identifiers just by being different
- Holdings of internationally active networks: examples in CEE would include Erste Bank Holding, Volksbanken International Holding and Raiffeisen International all of which are Austrian entities used exclusively to bundle international operations. This can be tricky for analyses which use country-specific indicators: particular care needs to be taken to ensure the chosen units are actually comparable and operate in the same country. For example, Arthur D. Little (2007) lists Raiffeisen International (RI) Holding as Austrian bank and compares it with other banks operating in the Republic of Austria. That is correct in terms of ownership, but the RI-Holding is used entirely to bundle the international business of the Raiffeisen cooperative sector and does therefore not operate in the country of Austria. It is therefore disputable in how far a direct comparison can be useful. Due to the requirements of IFRS 8, most holdings do publish a segment report in which at least the P&L is split by countries or regions. However, at least three problems remain. First, an outsider cannot verify which algorithm was used to split income and expenses between segments or the head office and subsidiaries (cmp. Werner / Padberg, 2002, p.29). Second, large loans granted to customers of subsidiaries in CEE may be booked in the head office in order not to strain the capital base of local units. Third, while most countries' tax regimes set out that refinancing costs charged to subsidiaries must be in line with market rates, this does not take into account the effect of implicit or explicit guarantees provided as well as any brand value the subsidiary may benefit from so as to obtain higher amounts of customer deposits at lower rates.
- Holding companies pose a particular problem if they are used to combine fundamentally different types of business, such as asset management, leasing or insurance operations, and where no financial statements for the stand-alone bank can be obtained.

Bank networks which consist of several tiers: examples include savings or cooperative banks, which may have one or more central institutions in which functions such as refinancing the network are processed. In these cases, all the problems mentioned for international holdings above apply and two more problems occur: First, in those countries where a multi-tier structure exists, there is significant heterogeneity between units operating on various tiers. Bos / Kool (2006, p. 1961) use a panel of Dutch cooperative banks and also raise this question. “...whether it is appropriate to view these local Rabo banks as independent banks rather than bank branches, as they all belong to the national Rabo bank network. ... Local Rabo banks with excess funds can deposit these funds at the national centre, while local Rabo banks with a shortage of funds can borrow from the centre. In our analysis, we correct for these financial flows between Rabobank Netherlands and the local banks. Having made these corrections, we believe it is appropriate to treat the 401 local Rabo banks as independent entities ....” Second, network members may grant each other guarantees, free of charge. One of the more complicated such networks exists in Austria where all but two savings banks have formed a cross-guarantee system with their central institution Erste Bank (starting from 2002, as outlined by Table 46). While it is virtually impossible to quantify the benefit each savings bank receives from such an agreement, an effect clearly exists and impacts efficiency, most notably through lowering refinancing costs.

Table 46 - Case: Cross-Guarantee system of Austrian Savings Banks; Source: Erste Bank (2007, p.90)



The following overview shows different possibilities of excluding certain units from the analysis as encountered in literature and their likely effects on measured efficiency levels.

*Table 47 - Treatment of Outliers and Their Likely Effect*

Operation	Likely effect on mean efficiency score
Excluding outliers (both top and bottom x%)	↑
Excluding units with missing data	↑
Limiting analysis to units included in BankScope	↑
Excluding banks that received state guarantee	↓
Excluding specialized banks (self-identifiers)	↓

In this study, non-consolidated data is used for credit institutions rather than any data of holding companies. Guarantees are assumed to be charged at market rates or to be negligible. Where multi-tier institutions exist, institutions of all tiers are included in the analysis, which assumes that all business within the group is conducted “at arm’s length”. Specialized institutions are excluded based on a case by case analysis, not percentiles.

Bail-outs and the creation of bad banks:

The occurrence of bail-outs in a studied sample creates several problems for efficiency research. The first is that bail-outs become necessary due to large losses which occur over a relatively short period but are really due to underlying flaws in a unit’s business model which had been concealed in prior periods. The second is that the measures taken in order to rescue such units in many cases bypass the financial indicators used for efficiency research such as, for example, the bank’s P&L statement. Most notably, state guarantees are sometimes issued or capital is provided free of charge. Another common approach is to separate loss-producing assets into separate entities, often financed by governments.

Berger / Clarke / Cull / Klapper / Udell (2005) point to an interesting artefact in their analysis of the performance of privatized Argentinean banks. “... *privatization appears on the surface to improve bank performance tremendously. Nonperforming loans decline dramatically, and profit efficiency increases substantially as well. However, the main cause for these improvements is almost surely the placing of most of the nonperforming loans into residual entities. The cost performance does not appear to improve significantly, which may be due to*

*the terms of the privatization contracts, which often placed restrictions on firing workers and / or closing branches.”*

One example from the studied sample shall be outlined here (Bawag P.S.K., 2006 and 2007):

- Following large losses and an accounting scandal, a bail-out of Bawag P.S.K. took place in 2006. The package included a federal guarantee as well as support from the Austrian banking and insurance sectors.
- The federal guarantee issued allowed Bawag P.S.K. itself and the Bawag P.S.K. credit institution group as a whole to fulfil the regulatory own fund requirements.
- Additionally, two companies were set up (Aviso Alpha Veranlagung GmbH held by Austrian banks and Aviso Beta Veranlagung GmbH, held by insurers). Although Bawag P.S.K. only held 20 per cent of each company’s shares, it was granted control over them via certain memoranda and the articles of association. This made it possible for both companies to be included in the Anteilsverwaltung Bawag (AVB) credit institution group, Bawag P.S.K.’s parent. Creating these two companies increased the AVB Group’s own funds to above the regulatory minimum.
- After the sale of Bawag P.S.K. was closed in early 2007, the Federal guarantee expired and both Aviso Alpha and Beta were liquidated.

How would this case be reflected in a DEA model? Since there is no publicly available documentation of any charge payable for the federal guarantee, it is assumed that it was provided for free. This means that efficiency scores for the period would be distorted (most prominently through higher profitability as the unit shows lower risk cost - where the guarantee is used as collateral for defaulted loans - and lower funding costs). Although equity is an input in the DEA model, Aviso Alpha and Beta were consolidated into AVB group rather than the institution itself. For this reason, neither would be accounted for in a DEA on single bank level.

This example shows how a major scandal which clearly hit the banking sector as a whole could go unaccounted for in a DEA analysis. But does this mean the tool is flawed? Not if it is used together with knowledge about and a thorough analysis of the sample in question.

Some authors have also referred to another problem: hidden bail-outs. Koetter / Bos / Heid / Kolari / Kool / Porath (2007) use a panel of ~3,000 German banks provided by Deutsche Bundesbank and investigate any possible bias caused by not controlling for hidden bailouts in previous M&A studies. They calculate a CAMEL rating as performance indicator of the respective institution and compare that with any involvement in M&A transactions. The results indicate that *“merger events are more likely to occur among banks that exhibit relatively bad financial profiles ... which may mean that voluntary mergers are motivated to some extent by pre-emptive distress resolution considerations, rather than cherry-picking top performing banks.”* While such costs are indeed hidden, at least in these cases they do remain included in the efficiency analysis.

#### 4.1.2 Normalization of Data

##### Mergers & Acquisitions and Splits

M&A activity has been relatively intense in the CEE region. But mergers and acquisitions raise particular issues for efficiency analyses based on historic timelines. So do privatizations and business splits / divestments.

Problems include the fact that a panel is no longer balanced once M&A activity occurs, the fact that significant changes of the organizational structure and business portfolio often occur simultaneously as well as distortions in accounting figures due to one-time adjustments. Some of the issues found in literature include:

- The costs of carrying out the merger itself. These represent the cost of efficiency improvement and should thus rightfully be included in any efficiency analysis. However, in some cases they are not shown as separate items in the P&L and may be accounted in the balance sheet (cmp. IFRS 3)
- One-off effects from first-time consolidation or divestments (cmp. IFRS 3, IAS 27, IAS 28 and IAS 31)
- Selection effects. There are two main contradictory lines of argument as to which banks are acquired. The first is often referred to as cherry-picking. For example, Lanine / Vander Vennet (2007) study 133 cross-border M&A events between 1995 and 2003 involving 91 CEE target and 59 EU-15 acquiring banks. After obtaining their financial statements from the BankScope database, they run a logit model. Their findings suggest ‘cherry-picking’ of acquiring banks, e.g. acquired institutions are usually already rather large and efficient. On the other hand, Berger / Clarke / Cull / Klapper / Udell (2005) suggest that a significant part of performance improvement upon privatization is caused by side-agreements to the privatization transaction itself such as outsourcing overdue receivables to an external (government) agency (“bad bank”). Since such an agency is not a depository institution, the receivables would thus “disappear” from the analysis. The development of banking markets will be reviewed for such events on a case-by-case basis in order to shed light on any such developments.

Last but not least, it needs to be stated that privatization agencies have the aim to achieve the highest possible sales price for a unit. This may be particularly pronounced where the privatization agency and the supervisory body are close, leading to conflicts of interest. Anecdotal evidence exists of window dressing activities such as bolstering the balance sheet, for example by transferring high-volume business of state-owned or communal electricity or waterworks enterprises to the bank before financial statements are prepared and the bank sold. While such measures would of course not affect efficiency in the banking system overall, it may cause disruptions in the analysis of operating efficiency. Rare incidents of fraudulent behaviour include the court case won by Hypo Alpe Adria bank against Croatia over the sale of Panonska Banka in 1998 (cmp. Dow Jones 2008). Louis (2004) was also able to prove earnings management prior to mergers / sales which, although not fraudulent, may distort efficiency scores during the periods in question.

There is no consensus in the reviewed studies as to how units that engage in M&A should be treated. The most common stances are to either exclude the unit from the analysis in the merger period or to retrospectively add up data for units that merged later on. However, none of them solve all problems as depicted in the below graph:

*Table 48 - Selected Approaches of Addressing Issues Regarding M&A*

	Problem	Unbalanced panel	Selection effects	Earnings management	Merger costs not fully included	Distortion through one-off effects
<i>Possible solution</i>	Exclude unit during merger year (& preceding period)	worsened	-	partly mitigated	worsened	partly mitigated
	Retrospectively add up data	partly mitigated	-	-	-	-

The most commonly used approach is to retrospectively add up data of merged units. Prima facie, this creates a balanced panel. However, the approach also has major drawbacks: The first is that outsiders do not know the amount of interbank business the two banks had between themselves. While such items will add up to zero in terms of total profit when the P&L statements are added up, the resulting balance sheet could potentially be distorted, leading to the incorrect assumption that the merged bank has reduced its business during the first year.



However, anecdotal evidence shows that this effect is usually minor. This can be illustrated based on the example of Bank Austria's acquisition of Creditanstalt. After the merger in 1997, pro-forma financial statements for 1996 were issued (cmp. Bank Austria, 1998). As illustrated by Table 49, if one were to add up the previously issued stand-alone financial statements of both units (cmp. Bank Austria 1997 and Creditanstalt 1997), the resulting differences are minor.

*Table 49 - BA-CA Merger 1998: Quantification of Bias Caused by Retrospectively Adding up DMUs; Source Bank Austria (1996), Creditanstalt (1996), Bank Austria (1997)*

Year	1995	1996	1997
Total banking market in ATSm	5,383,037	5,651,017	6,000,272
Bank Austria group	687,651	758,300	1,568,500
Creditanstalt group	645,000	687,600	n.a.
<b>Pro-forma added up</b>	<b>1,332,651</b>	<b>1,445,900</b>	<b>n.a.</b>
<b>Consolidated figures as reported</b>	<b>n.a.</b>	<b>1,440,951</b>	<b>1,568,500</b>
<i>Market share (pro-forma)</i>	<i>24.8%</i>	<i>25.6%</i>	<i>n.a.</i>
<i>Market share (consolidated)</i>	<i>n.a.</i>	<i>25.5%</i>	<i>26.1%</i>

The second drawback is that such arithmetic exercises are of course not possible to be carried out where units have been split up rather than merged. Such Splits are a rather recent phenomenon in CEE as banks only now start to approach the critical levels where regulators require splits due to competition considerations.

One example of this is the requirement for Unicredit to sell parts of its operations in Croatia and Poland after taking over HVB:

- Unicredit had announced its intention to acquire HVB and indirectly Bank Austria-Creditanstalt as well as its subsidiary Bank BPH. However, in December 2005 the bank announced it had received note from the Polish Ministry of State Treasury which required it to restore compliance with a non-compete undertaking in its privatization agreement concerning Bank Pekao S.A. (Unicredit 2005)
- On 19 April 2006 Unicredit announced an agreement with the Polish state treasury had been reached which stated: *“The agreement is aimed at ensuring that BPH remains an independent bank on the Polish market. Unicredit will divest 200 outlets and banking*

*services associated with them, operating under the BPH brand, for the benefit of an independent third party, by way of an international, competitive and transparent process. The operations not to be divested will be incorporated into Pekao. The completion of the transaction in accordance with the agreement will remove any dispute or controversy between the state treasury and UniCredit or HVB with respect to the privatization agreements related to the Pekao and BPH banks resulting from UniCredit / HVB acquisition of control over BPH.”* (Unicredit 2006a). The agreement also contained various restrictions as to how both Bank BPH and Pekao were to be run. In particular, Unicredit was not to undertake any lay-offs until 31 March 2008 (ibidem).

The anti-trust situation in Croatia was similar. In April 2006, Unicredit announced “*Under Croatian law, merger control requirements make it necessary to sell HVB Splitska banka. The buyer has been selected on the basis of a tender procedure in line with standard international practices”* (Unicredit 2006b).

Coming back to the treatment of outliers, on the positive side, excluding units is somewhat suited to address issues relating to earnings management where profit is lowered in one period to the benefit of the next as it ensures that, over time, such shifts level out. While this is clearly not an ideal solution, it would be unreasonable to expect an external efficiency analysis to be more correct than audited financial statements.

Neither approach can address any selection effects, which need to be investigated on a case by case basis as mentioned before. Where costs of the merger are activated (and no subsequent impairment expense is recognized), they will not be part of the operating expense in the P&L statement and will thus not be taken into consideration for any efficiency analysis based thereon.

As for one-off effects due to M&A activities, these can have a very profound impact on financial results. Table 50 illustrates this based on financial statements of selected Austrian banks for 2006. Clearly such extraordinary one-time effects can disrupt the relative efficiency scores as DEA is very sensitive to outliers. It can be assumed that many units excluded as “outliers” by previous studies actually contained some of these one-offs in their financial

statements. Nevertheless, such costs or income are related to efficiency changes and the author does not believe they should be excluded as a general rule.

*Table 50 - Case: One-Offs of Selected Austrian Banks 2006; Source: Erste Bank (2007), Bank Austria (2007, )*

Name	Profit (in €m)	One- Offs	in %	Description
Bank Austria	3,272	2,075	63%	proceeds of €2,313m and expense of €(248)m due to group restructuring
Raiffeisen Zentralbank	1,882	596	32%	disposal of Raiffeisenbank Ukraine €486m, TuranAlem €110m
Erste Bank	1,522		0%	
ÖVAG	286	25	9%	sale of NOe Hypo €24.6m
BAWAG	19		n.m.	including € 450m primary funds consolidated from Aviso Alpha and Aviso Beta and federal guarantee

No normalizations for M&A activity will be carried out in this study.

#### Spot versus average data

An issue which has not received a lot of attention is the difference between spot values and average values. Banks do not accrue interest on the volumes they have at the end of the accounting period, but rather on the outstanding volumes of each business day. As Colwell / Davis (1992) put it *“Furthermore, production is a “flow” concept expressed as some amount per unit of time, while the amount of assets and deposits are “stock” concepts representing given amounts at a particular point in time.”* The proper basis for interest accruals are thus average volumes.

However, these are not usually available. This problem seems quite relevant for the CEE market: The error will be higher where there is high and heterogeneous growth (i.e. where the growth rates of banks differ heavily). This is the case in the CEE region, which has seen explosive balance sheet growth.

Mester (1997) suggested to use the average from two consequent years (or, to put it differently, from the opening and closing balance of each financial year) in order to somewhat alleviate this problem. The approach has a drawback, however: Where M&A activity occurs, or where units are added to and taken away from the sample, no average can be computed for

the years preceding and following that change - thus further reducing the sample of observations.

Perhaps this might be one reason why none of the sampled 32 studies have picked up Mester's idea. Although it seems sensible in general, it will also not be adopted in this dissertation because the error introduced by reducing the number of observations would be higher than that of taking spot rather than average volumes.

### **4.1.3 Accounting**

Table 52 gives an impression of the most important positions from banks' financial statements which are candidates for constituting inputs and outputs in a DEA analysis. No positions from the cash flow statement are included because most relevant transactions shown in the P&L statement are cash items (see Werner / Padberg, 2002, p.38). Therefore, only values from the balance sheet (including off-balance items) and the P&L statement are considered.

One item that is not contained in either statement but nevertheless should be mentioned are Risk Weighted Assets (RWAs). These are calculated from assets and risk-bearing off-balance sheet items and form (besides haircuts for market and, under Basel 2, operational risk) the basis for establishing statutory capital requirements. Unfortunately, not all countries had ratified either Basel capital accord for the periods studied, so even where data about RWA values was publicly disclosed, no uniform underlying methodology can be assumed. For this reason, RWAs are not used for this analysis.

Out of these possible indicators, six are from the balance sheet, two are off-balance items and seven from the P&L statement. The following paragraphs will briefly outline the merits of each item. In several instances, it will become apparent that there is a similar business logic underlying several items at the same time. The main three of these interconnected topics are the cost of credit risk, the leverage level of the bank and the level of intermediation. For example, for the cost of credit risk direct charges are shown in the P&L, loan loss provisions are shown as credit balances on the asset side and provisions for off-balance items within the balance sheet under other liabilities. Another example would be the leverage level of a bank which is reflected in its capital but also directly influences interest expense and is itself

related to the amount of dividends paid out. For this reason, the merits of each position will first be discussed in detail and then summarized together before the inputs and outputs to be used are defined.

*Table 51 - Potential Positions of Financial Statements*

<b>Balance Sheet Position</b>	<b>Amount (Credit)</b>	<b>Balance Sheet Position</b>	<b>Amount (Debit)</b>
Cash	10.0	Deposits	80.0
(Net) Loans	80.0	Capital & Reserves	10.0
Other Assets	10.0	Other Liabilities	10.0
<b>Total Assets</b>	<b>100.0</b>	<b>Total Liabilities</b>	<b>100.0</b>
<b>Off-Balance Sheet Position</b>			
	<b>Amount</b>		
Risk-bearing	10.0		
Non-Risk Bearing	10.0		
<b>Total</b>	<b>20.0</b>		
<b>Profit &amp; Loss Position</b>			
	<b>Amount (Credit)</b>	<b>Amount (Debit)</b>	
Interest Income	100.0		
Risk Costs		10.0	
Interest Expense		50.0	
(Net) Fee Income	50.0		
FX & Trading Result	10.0		
Operating Expense		50.0	
<b>Profit/Loss before Tax</b>	<b>50.0</b>		
Tax		10.0	
<b>Profit/Loss after Tax</b>	<b>40.0</b>		
Dividends, Ret. Earnings		40.0	

This sub-chapter contains the argumentation for why the chosen inputs / outputs are considered adequate. Before the exact inputs and outputs to be used are defined, the chapter outlines three important aspects of banks' production functions, which permeate several accounting positions, need to be discussed.

While this chapter cannot outline all intricacies or issues facing the accounting of banks, it aims to present the most commonly used groups of indicators with the drawbacks and advantages of each one. For a more detailed introduction to the analysis of banks' financial statements the interested reader is referred to Padberg / Werner (2002). Given the varying

national and supra-national rules for presenting such financial statements, the position names used here are not necessarily those found under any particular accounting regime but rather aim to lay out the business logic behind each position.

Last but not least, it needs to be mentioned that some studies add non-financial data such as the number of employees or the number of automated teller machines to their model. Since this study will only be based on nominal data from financial statements, these are not outlined here.

### **Balance sheet**

#### Cash

This position includes items that can loosely be split into three main categories: a mandatory reserve as determined according to regulatory requirements, a liquidity reserve as deemed necessary by the bank (e.g. for the settlement of domestic or international payment transfers) and “hard” items such as banknotes, coins and precious metals. This position has not been used as an input or output by any bank study.

However, the prescribed level of mandatory reserve requirements has been used as one environmental variable in some regressions of relative efficiency scores. The levels of mandatory reserve requirements in the region vary greatly. One of the highest levels is found in Serbia, with a minimum requirement of 60 percent on deposits received from abroad denominated in foreign currency and no interest paid on such reserves and no grandfathering (cmp. Monetary Policy Council, 2006). As outlined by Table 52, a deposit received from abroad in foreign currency at a cost of 2 percent annually would thus have to be lent on at a rate of 5 percent minimum just for the bank to break even. That is equal to a 250% mark-up without taking into account any risk costs or operating expense incurred. It is surprising to find only little empirical evidence of the impact such drastic environmental factors have on efficiency.

*Table 52 - Example: Impact of a Mandatory Reserve Requirement of 60%*

Balance Sheet Position	Amount (Credit)	Balance Sheet Position	Amount (Debit)
Cash (Mandatory Reserve)	60.0	FC Deposit from abroad	100.0
Loans to customers	40.0		
Other	...	Other	...
<hr/>		<hr/>	
Total Assets	...	Total Liabilities	...

Profit & Loss Position	Amount (Credit)	Amount (Debit)	
Interest Income	2.0		= 40 * 5%
Interest Expense		-2.0	= 100 * -2%
Other	...		
<hr/>		<hr/>	
Profit/Loss before Tax	0.0		

### Loans

This position includes customer loans (both corporate loans, including those granted to government bodies and state-owned enterprises, and retail loans granted to households) as well as loans to other financial institutions (whether banks, insurance companies or any other type). Another common split is to distinguish between regular and overdue (sometimes called ‘bad’ while e.g. the IFRS framework talks of ‘impaired’) loans. Overdue receivables can be further split into those that still accrue interest and those where the bank stopped accruing interest.

Banks must create loan loss provisions (LLPs) for impaired loans and / or receivables. Although these are regulated under International Accounting Standards, various local regulators have set out differing rules. Depending on the regulations in place, the amount of LLPs required can be one of the main differences between IAS and local GAAP-compliant financial statements (cmp. Ernst & Young, 2005, p.25 and RS Official Gazette, 2006).

The term ‘gross loans’ is used to define the sum of loans without deducting LLPs. Sometimes, the same term is also used to describe all client receivables including any unpaid due or overdue interest and fees - although it would then be less ambiguous to refer to them as gross client receivables. ‘Net loans’ or net receivables are the sum of loans with the LLPs already deducted. Either way, it is important to note that the value of LLPs disclosed under this position on the asset side of the balance sheet does not equal the total of credit risk provisions

of a bank, because LLPs for off-balance sheet items are shown on the liability side of the balance sheet.

Of the 31 empirical studies analyzed, 29 mention ‘loans’ or ‘total loans’ as outputs. It is not always clear, however, which of the abovementioned items are or are not considered. Three studies specifically state that net loans were used (Grigorian / Manole, 2002 and Pawlowska, 2003 and 2005). A fourth, Podpiera / Podpiera (2005) uses net loans and excludes bad loans from their sum total. One study takes only a subset of customer loans into account (Nikiel / Opiela, 2002, who use household and business loans separately) while others break them down into several outputs (Hauner, 2004, distinguishes interbank and customer loans; Ali / Gstach, 2000, use interbank loans, small loans and large loans; and both Isik / Hasan, 2002, and Kasman, 2002, use short-term and long-term loans). Maudos / De Guevara, 2007, go further still and only use one output that includes all interest earning assets.

#### Other Assets

Other items shown on the asset side of the balance sheet include securities not disclosed as cash, fixed assets, intangibles, some derivatives and others. The main issues here relate to the question whether any hidden reserves / losses exist in securities or fixed assets. IAS 39 outlines how securities are to be measured and disclosed (cmp. IFRS, 2008, and Ernst & Young, 2006, p.29). Also, sell-and-lease-back arrangements may impact figures. One could argue that this is a potential issue when comparing banks with extensive owned branch networks to those that predominantly lease their office space. However, the decision between owning, refurbishing and renting business space can reasonably be considered under management’s control in the medium term. It would be hard to argue that a manager who makes a purchase decision, without first comparing depreciation and refinancing expense of owned real estate or equipment against the expenses associated with rented one, is acting efficiently.

As already mentioned, intangible assets, including any goodwill from acquisitions, are shown under this position. Some accounting regimes require any positive fair value of derivatives held in the bank book to be disclosed here. Since a detailed review of all accounting issues would



go beyond the scope of this thesis, the interested reader is referred to Werner / Padberg (2002).

### Deposits

Deposits include those received from corporate or private customers as well as interbank deposits. The latter can include refinancing lines from related parties such as central institutions of cooperative bank networks and international holdings or subsidized lines from government or development agencies (such as the European Investment Bank “EIR”, Kreditanstalt für Wiederaufbau “KfW” and others).

The most common descriptions of variables used in previous studies are ‘deposits’ or ‘borrowed funds’. Again, as with loans, it is not always clear what is included in either position. Only one study limits the scope to "demand deposits" (Podpiera / Podpiera, 2005, who define it as output).

### Capital And Other Reserves

This position typically includes the following items:

- Capital
- Capital reserves & retained earnings
- Hybrids, Preferred Stock
- Other Items such as Other Comprehensive Income (“OCI”) booked directly in equity under IFRS (e.g. the result of assets classified as Available-for-Sale together with deferred taxes on this result)

The main distinguishing feature of hybrid and preferred capital is that the cost associated with both is usually disclosed as interest expense. On the contrary, costs of equity are not included in the P&L.

Dividends are a cash outflow and are, depending on the applicable accounting standards, either not shown in the profit and loss statement or only after ‘profit for the year’ as they are not tax-deductible. Only Fries / Taci (2005) include dividends. They do so as part of a bank’s

operating expenses (e.g. an input which should be minimized rather than an output which should be maximised).

Some local regulations, such as Austrian GAAP, allow for the creation of a specific position called ‘Fund for general banking risks’. This reserve is created out of the bank’s operating income and thus very similar to retained earnings. However, allocations to it are tax-deductible so that they are excluded from net income and capital (and shown under liabilities).

Since the question of how leverage levels are taken into account is closely related to the interest expense shown in the P&L statement, more on that topic will be said in the summary part of this sub-chapter.

#### Other Liabilities

This position includes any provisions created under IAS 19 ‘Employee Benefits’ and IAS 37 ‘Provisions, contingent liabilities and contingent assets’. As mentioned under ‘Loans’, loan loss provisions for off-balance items are also disclosed here. By contrast, any negative fair value of bank book derivatives would be disclosed under this position.

#### **Off-balance Sheet Items**

As demonstrated, this is one of the most ambiguous indicators and previous studies vary greatly in its treatment. In general, the following three kinds of items may be reported here:

- Risk-bearing items include commitments such as undrawn revocable or irrevocable credit lines, including account overdraft facilities of private households as well as issued guarantees and letters of credit. All of these are also part of the calculation of risk-weighted assets.
- Non-risk bearing assets on which the bank receives fee income. These can include custody volumes (also called ‘Assets under Management’) or commission business carried out on behalf of a third party (such as some subsidized loans dispersed on behalf of third parties such as state agencies or international development banks (cmp. National Bank of Serbia, 2004 and 2005)).

- Purely informational items such as collaterals received

The position does not, of course, contain any business a bank may conduct via non-consolidated special purpose vehicles or conduits - although these are sometimes referred to as ‘off-balance activities’ in the media.

While the first type of items can be considered similar to loans granted, the second group generates fee and commission income without putting the bank at risk. The third may but is not usually disclosed and will not be discussed further.

Evidence is mixed as to whether these items should be taken into account when conducting a DEA. Clark / Siems (2002) investigate the impact the inclusion of off-balance sheet items has on efficiency measures and conclude that they should be included. Casu / Girardone (2005) examine whether not including off-balance sheet items as an output can significantly impact efficiency scores. Based on data of ~2,000 large European banks taken from BankScope for the period 1994 to 2000, they find that “*omitting off-balance sheet items in the definition of bank output understates productivity levels and may lead to biased results.*” Bikker / Bos (2005) look into the same question and find that “*Including off-balance sheet items in the intermediation approach therefore is a first step towards a more balanced view of bank production*”. Pasiouras (2007) study a sample of Greek banks and state that “*Inclusion of off-balance sheet items as output does not significantly impact results, but adding loan loss provisions as input does increase efficiency scores.*” However, this could be due to the relatively small and geographically concentrated panel used.

## **Profit and Loss Statement**

### Interest income

This position, sometimes referred to as ‘gross interest income’, represents the interest income on the bank’s interest earning assets. However, this figure does not take into account differing levels of credit or currency risk as well as refinancing expenses and therefore cannot reasonably be compared across units. It was also not used as output in any study except those using the profit approach (Hahn, 2004 and 2005).

### Allocation to loan loss provisions

This position contains the net balance from allocations to and releases of loan loss provisions, both for on- as well as for off-balance sheet exposure. Given the correlation of risk and return in fixed income business, one would expect higher risk costs for banks with a risky loan portfolio. The sum of gross interest income and risk charges would then be a better indicator for overall loan margins than interest income alone.

In a sense, this position may also serve as an indicator for whether the quality of a bank’s loan portfolio improved or worsened during a given period. However, it can by no means be sufficient by itself to reliably judge whether a bank handles its business risk efficiently.

### Interest expense

The expense shown in this position is often included in efficiency analyses as the cost of funding the bank’s business. But as interest income before, it also does not take into account any currency or term mismatches.

### Bank and Foreign Currency Services fees

This position includes the sum of all fee income and fee expense related to the provision of services to bank customers. Shifts in the exact attribution of items between this position and operating expenses may occur across accounting regimes and institutions. For example, settlement fees charged by some card operators or maintenance costs of ATMs could be

netted here or, potentially, be shown as operating expenses. This, however, does not seem like a significant issue.

### Trading income

For banks with substantial trading books, this position shows how successful they are in their proprietary trading. However, values reported here relate to interest expense in at least two significant ways.

First, under IFRS the expense for refinancing the trading book is shown here (see Werner / Padberg, 2002) Second, it includes any revaluation of the open foreign currency position the bank holds due to its strategic Asset Liability Management. It is important to understand how this position is related to the net interest income of the bank.

Table 53 shows the very simplified financial statements of a bank at the beginning and the end of the reporting period. We assume that there is only one foreign currency available which has a much lower interest rate than the domestic currency. The foreign currency further appreciates against the domestic currency over the course of the period. This is in line with purchasing power parity: since presumably domestic inflation is higher than that in the foreign country, the domestic currency is expected to depreciate.

As we can see, the bank is refinancing itself predominantly in foreign currency (this would be in line with it being a greenfield subsidiary of an international holding). Such a move reduces the interest expense due. However, as the foreign currency appreciates, these liabilities increase in volume - only that the resulting revaluation loss is shown under trading and not as part of the interest result.

Essentially, a shift between these two positions occurs. This means that only both positions together could show the true picture of whether the bank managed to profitably convert its deposits into loans.

*Table 53 - Example: FX Open Position, Interest Rate Differential and Revaluation Result*

<b>Date</b>		<b>01/01/2007</b>			
FX rate local / foreign currency		1.2			
Interest rate local currency p.a.		9.5%			
Interest rate foreign currency p.a.		3.0%			
<b>Balance Sheet Position</b>	<b>Amount</b>	<b>Amount in LCY</b>	<b>Balance Sheet Position</b>	<b>Amount</b>	<b>Amount in LCY</b>
Assets (local currency)	150	150	Liabilities (local currency)	30	30
Assets (foreign currency)	50	60	Liabilities (foreign currency)	133	160
...			...		
			Capital	20	20
<b>Total Assets</b>		<b>210</b>	<b>Total Liabilities</b>		<b>210</b>
<b>Date</b>		<b>31/12/2007</b>			
FX rate local / foreign currency		1.3			
Interest rate local currency p.a.		9.5%			
Interest rate foreign currency p.a.		3.0%			
<b>Balance Sheet Position</b>	<b>Amount</b>	<b>Amount in LCY</b>	<b>Balance Sheet Position</b>	<b>Amount</b>	<b>Amount in LCY</b>
Assets (local currency)	150	150	Liabilities (local currency)	30	30
Assets (foreign currency)	50	65	Liabilities (foreign currency)	133	173
Accrued interest	16	16	Accrued interest	8	8
...			...		
			Capital	20	20
<b>Total Assets</b>		<b>231</b>	<b>Total Liabilities</b>		<b>231</b>
<b>Profit &amp; Loss Position</b>	<b>Amount in LCY</b>				
Interest income (local currency assets)	14		=150 * 9.5%		
Interest income (for. currency assets)	2		=60 * 3.0%		
Interest expense (local currency liabilities)	(3)		=30 * -9.5%		
Interest expense (for. currency liabilities)	(5)		=160 * -3.0%		
Revaluation Result	(8)		=65-60-173+160		
<b>Profit/Loss</b>	<b>0</b>				

### Operating expenses

Although this is likely one of the least ambiguous positions, some ambiguities remain, the main being cost accruals. The biggest question mark here is compliance with IAS 19 'Employee Benefits' and IAS 37 'Provisions, contingent liabilities and contingent assets' which regulate the creation of provisions for employee benefits and obligations.

One interesting previous study includes Beccalli (2007) who investigates the effect of IT investments on bank performance (cost and profit efficiency) as well as traditional accounting measures (RoE, RoA). Their sample consists of ~700 commercial banks operating in France, Germany, Italy, Spain and the UK between 1995-2000. Financial data were obtained from BankScope and the Financial Analysis Made Easy (FAME) database while information on bank-specific IT spending was obtained from International Data Corporation (IDC). The study uses SFA and, interestingly, finds no evidence for improved performance or efficiency due to overall IT spending. There is, however a positive influence on accounting profits and profit efficiency from investment in external IT services such as consulting services, implementation services, training and education or support services while the acquisition of hardware and software seems to reduce banks' performance.

Kauko (2007) investigate the impact personal characteristics of managers have on the cost efficiency of banks. To this end the study performs an SFA based on a balanced sample of ~300 Finnish savings and cooperative banks for the years 1999 to 2004. The results suggest that university graduates have a comparative advantage in minimizing costs at large banks while managers with vocational level qualification perform better in very small banks. The correlation with age shows an inverted u-shape as the performance of young managers improves as they gain experience, then decreases again. "If an old manager retires, a significant cost efficiency improvement typically follows". In other cases of management change, there is no regularity in the direction of the subsequent efficiency change.

### Profit

This position is the sum of all P&L items, including any allocations to the fund for general banking risks as well as interest paid on hybrid capital and preference shares, but excluding dividends.

Not surprisingly all three studies (Hahn 2004, 2005 and Tomova 2005) that use the profitability approach define profit as an output.

## 4.2 Inputs and Outputs Used

This subchapter outlines the inputs and outputs used and the reasons why these were selected as the most suitable approach to modelling the bank production function for the given sample.

Under the **intermediation approach**, inputs include

- client deposits,
- capital and reserves and
- total operating expense.

Outputs include

- net loans (with loan loss provision from the asset side of the balance sheet excluded) and
- profit before tax.

Under the **service-oriented approach**, inputs include

- capital and reserves and
- total operating expense.

Outputs include

- client deposits,
- net loans (with loan loss provision from the asset side of the balance sheet excluded) and
- profit before tax.

The profitability approach is not applied because it does not seem reasonable to assume that banks saw profit-maximization as their main focus during the sample period. Profitability is incorporated as an objective in both models via the inclusion of profit before tax. This indicator also abstracts from distortions due to extraordinary P&L items and one-time tax effects (for example due to tax credits granted in order to attract foreign direct investment).

The five indicators imply a minimum sample size of 15 which is feasible.



The use of two models based on the intermediation and service-oriented approach follows the suggestions of Berger / Humphrey (1997) who stated that *“Neither of these two [production or intermediation] approaches is perfect because neither fully captures the dual roles of financial institutions as (i) providing transactions/document processing services and (ii) being financial intermediaries that transfer funds from savers to investors. While it would probably be best to employ both approaches to determine whether the results were qualitatively affected by the choice of output metric, sufficient data to implement such a research design are not usually available.”*

Even though this suggestion was published in 1997, only two of the 32 sampled studies covering the CEE region have used more than one approach and compares the results (Hahn, 2004, and Tomova, 2005). For this reason, two additional studies not related to the CEE region shall be briefly outlined here:

Das / Ghosh (2006) perform a DEA on the same data but under three different approaches: the intermediation, value-added and operating approach. The study uses a broad sample of banks operating in India between 1992 and 2002 and finds that these produced divergent sets of efficiency estimates. In particular, efficiency scores under the value-added approach were higher than those under the intermediation approach.

Pasiouras (2007) uses a dataset of between 12 and 18 Greek commercial banks taken from BankScope to test the impact of different production functions as well as the inclusion of certain inputs and outputs. No significant differences in efficiency scores are observed between the profit oriented and the intermediation approach. Inclusion of off-balance sheet items as output does not significantly impact results, but adding loan loss provisions as input does increase efficiency scores. A tobit regression of environmental factors finds that higher market power and a higher number of branches have a positive and significant impact on efficiency scores. The authors interpret this as a possible confirmation for the strategy of Greek banks to increase the number of their branches further. The study also splits the banks into those that operate abroad and those which don't and finds confirmation for higher efficiency of internationally active banks under the intermediation approach.

The accounting figures selected as inputs and outputs are the same for both approaches so that any difference in resulting scores is due to the role of customer deposits. In selecting these indicators, the following key aspects were considered:

- Reasonable number of inputs / outputs
- Intermediation volumes
- Leverage levels
- Risk Costs

### **Reasonable number of inputs / outputs**

As outlined in chapter 3.2 ‘Design of Previous Empirical Studies’, even where there is consensus as to the function of a bank and its main aim, inputs and outputs used can nevertheless vary greatly between studies. This because, firstly, using more variables for inputs and outputs always increases the number of technically efficient DMUs thereby yielding higher average efficiency scores. Therefore, it is necessary to limit the analysis to a small number of meaningful indicators.

Just how many inputs and outputs can reasonably be used? This depends on the sample size. Studies of different markets can have more or less room to manoeuvre. Various rules of thumb have been put forward, but most researchers seem to agree that the number of DMUs should be at least three times the sum of inputs and outputs added together. “... *the sample size also exceeds the rule of thumb given by Soteriou and Zenios (1998) and Dyson et al. (1998) who state that it should be larger than the product of the number of inputs and outputs. Nunamaker (1985) holds the view that the sample size should be at least three times larger than the sum of the number of inputs and outputs.*”(Sathye, 2001).

The second reason is that it is disputed how certain factors should be accounted for. The most notable are credit risk, off-balance items and the growing income from the provision of services. It also needs to be mentioned that, since assets must equal liabilities for any company, indicators used under the intermediation approach must not be close to the balance sheet total. Otherwise they would always be equal and render the analysis meaningless.

The third reason is simply the lack of details available. This is especially relevant for single-market studies that rely on data obtained from national sources and are often based on local GAAP. For example, Bikker / Bos (2005) openly state “*Our choice of variables in all models described here is mostly determined by banks’ balance sheets*”.

### **Intermediation volumes**

Since the intermediation approach derives its very name from its focus on financial intermediation, it seems worthwhile to place specific attention on the various indicators commonly used to proxy for it. One commonly used indicator is the ratio of bank assets to GDP. However, total assets cannot form a reasonable indicator for use in DEA analyses. Since assets and liabilities have to match for any bank, the scores derived would be meaningless.

Another commonly used indicator is total earning assets. But it can hardly be beneficial to the real economy per se if banks aim to expand their earning assets as much as possible. There is no reason why an economy should benefit in any significant way from increasing interbank business. Equities and fixed income products are offered to a wide range of retail and institutional customers - both domestic and abroad - with the aim of raising funds from other sources than bank loans.

For this reason, rather than earning assets in total, only customer loans are included as output.

On the liabilities side, the same arguments regarding interbank business apply. However, the situation regarding issued bonds is not that clear-cut. Various countries have regulations in place where retail customers can place their savings in products which are legally structured as securities such as bills or bonds rather than savings accounts. One such example in Austria are Pfandbrief securities. In Austria, physical persons can also open an account with the federal debt office directly and place their funds in treasury bills this way.

Would it then not make sense to include securities issued as input? Not necessarily. The most important argument against it is the lack of data available. In most cases, it is not visible which part of funding instruments issued was purchased by retail or institutional investors. Since the markets for these products tend to be international, it can also not be reliably judged whether the funding provided through these sources was generated within the local economy. Therefore, only customer deposits will be used as input. This is also consistent with the use of customer loans as outputs.

As for off-balance sheet assets, evidence of their relevance is mixed. Since the larger part of contingent claims will never be drawn, the larger part of income generated will usually be shown as fee rather than interest income. Undrawn guarantees and the like therefore often constitute a risk management rather than a funding tool. For these reasons, off-balance items are excluded from the analysis.

### **Leverage levels**

Where both deposits and capital are included as inputs without any cost associated with them, the DEA algorithm will weigh them without any prioritization. Although shareholder value theory defines capital as the most expensive source of funds (Damodaran, 2001), no associated cost is shown in the P&L.

Since DEA compares units to each other, the effect of ignoring cost of capital would be negligible where capitalization levels are stable and similar (i.e. data for all units would be distorted in a similar fashion). This was not always the case in Central and Eastern Europe.

In this study, accounting data will not be normalized to take into account differing leverage levels. The following paragraphs outline why not.

Table 54 illustrates just how different capitalization levels can be based on data for Bulgarian banks as of 1999. In terms of meeting statutory capitalization requirements, these are based on risk weighted assets. Thus, in certain cases, banks with a low level of capital shown below must not necessarily be in breach of these regulations (although no plausible reason why

negative values should be acceptable comes to mind). However, refinancing expense occurs for the balance sheet total, not risk weighted assets. The differences impact a unit's refinancing expense.

*Table 54 - Levels of Equity of Bulgarian Banks, 1999; Source: National Bank of Bulgaria (2009)*

<b>Name</b>	<b>Liabilities</b>	<b>Capital and Reserves</b>	<b>Balance Sheet Volume</b>	<b>Equity / Bal. Sheet</b>
Piraeus Bank S.A.-Sofia Branch	68,090	1,028	69,118	1%
ING Bank-Sofia Branch	243,267	4,242	247,509	2%
Alpha Bank S.A.-Sofia Branch	26,282	1,638	27,920	6%
BNP Paribas	289,219	20,839	310,058	7%
Bank Biochim	398,052	34,236	432,288	8%
DSK Bank	950,762	114,214	1,064,976	11%
Raiffeisenbank (Bulgaria)	166,491	21,398	187,889	11%
First Investment Bank	176,180	27,651	203,831	14%
Allianz Bulgaria	72,411	11,860	84,271	14%
Municipal Bank	119,739	20,301	140,040	14%
Economic And Investment Bank	104,179	17,743	121,922	15%
Central Cooperative Bank	161,516	28,744	190,260	15%
Bulgarian Post Bank	371,339	67,299	438,638	15%
Bulbank	1,826,301	339,095	2,165,396	16%
Hebros Commercial Bank	263,261	53,790	317,051	17%
S.G. Expressbank	292,617	61,555	354,172	17%
DZI Bank	86,011	18,863	104,874	18%
Eurobank	49,508	11,785	61,293	19%
Demir Bank	49,152	14,732	63,884	23%
First East International Bank	51,665	15,730	67,395	23%
Union Bank	53,239	17,029	70,268	24%
United Bulgarian Bank	767,641	250,886	1,018,527	25%
Bulgarian American Credit Bank	43,799	15,462	59,261	26%
International Bank For Trade & Devel.	34,729	13,142	47,871	27%
Invest Bank	61,960	31,170	93,130	33%
T. C. Ziraat Bankasi-Sofia Branch	13,472	9,355	22,827	41%
Emporiki Bank-Bulgaria	15,172	15,304	30,476	50%
Tokuda Bank	6,866	10,898	17,764	61%
Texim Private Entrepreneurial Bank	4,295	12,239	16,534	74%
Promotional Bank	2,307	11,703	14,010	84%
Corporate Commercial Bank	1,221	14,969	16,190	92%
HVB Bank	69,740	(874)	68,866	n.a.
National Bank Of Greece-Sofia Branch	47,259	(2,576)	44,683	n.a.
Societe Generale, Sofia Branch	56,971	(6,735)	50,236	n.a.
<b>Total</b>	<b>6,944,713</b>	<b>1,278,715</b>	<b>8,223,428</b>	<b>16%</b>

While such dispersion can be expected to occur more frequently in transformation markets, there are also incidents reported from EU-15 countries. For example, as of 31 December 2006, GE Money Bank Austria disclosed total assets of € 1,178m and shareholders' equity of € 911m (cmp. GE Money Bank Austria, 2006).

How was this addressed by other studies? None of the 31 studies sampled have reported using any particular weighting for capital as input. There were no systematic corrections or normalizations carried out for over- or undercapitalized banks either (except where banks were classified as outliers and excluded as such). None of the sampled studies took into account any cost of equity according to shareholder value theory. However, four studies tried to take the effect of different capitalization levels into account.

Schure / Wagenvoort (2000 and 2004) compute the price of funds by adding to the interest expense shown in P&L statements *“The price of funds is obtained by taking a weighted average of the average 3-month interbank rate and the deposit rate. This data is obtained from Datastream International and IFS, respectively. The weights are determined by the amount of deposit funding as part of total funding (total assets) of each bank. ... The prices we use are fundamentally different from most other bank efficiency studies. Normally the price of funds is defined as the ratio of the interest expenses to the total amount of funds.”* (cmp. Schure / Wagenvoort, 2000, p.21).

O’Brien / Wagenvoort (2000) also used the weighted average of the interbank rate and deposit rate but computed real interest rates for costs (subtracted CPI rates from nominal interest rates).

Valverde / Humphrey / del Paso (2007a) split up cost efficiency into interest cost efficiency and operating cost efficiency. They use semi-annual data of 46 savings and 31 commercial banks operating in Spain between 1992 and 2001. After backward aggregating all data to account for M&A activity, they construct two frontiers for the two types of banks. In order to account for environmental factors and bank specifics, they include 34 parameters in their DEA model, which shall not be mentioned in detail here, and obtain inefficiency values of only one to five percent.

Table 55 gives an overview of possibilities of addressing differing leverage levels in a sample.

*Table 55 - Possible Ways of Dealing With Differing Leverage Levels*

Approach	Influences P&L? (position)	Basis for adjustment	Interest rate used
No normalization	-	-	-
Approach 2: Schure / Wagenvoort (2000, 2004)	-	all capital	3m Euribor 3m Euribor
Approach 3: O'Brien / Wagenvoort (2000)	-	all capital	and CPI
Approach 4: Valverde / Humphrey / del Paso (2007a)	-	-	-

- The first would be not to normalize data.
- The second possibility is to follow Schure / Wagenvoort (2000) and assume financing costs weighted by the equity ratio. Although a first step, this is not ideal for the following reasons:
  - o It is not in line with shareholder value theory as to how the cost of equity should be calculated (as a 3 month interest rate hardly reflects the cost of capital).
  - o It also does not take into account the additional mandatory reserve or lower tax burden that taking on additional refinancing would trigger.
  - o It does not take into account that a lower equity ratio would change the bank's financial standing which could increase refinancing costs on existing liabilities.
- A third alternative is to extend the second option by using real rather than nominal interest rates as suggested by O'Brien / Wagenvoort (2000). However, this approach does not solve the problems with the previous approach. The authors themselves state *"During our sample period 1993-1997 many EU countries prepared themselves for the introduction of the Euro on the 1st of January 1999. Therefore, inflation rates were substantially reduced in countries such as Italy, Greece and Portugal. Would this suggest that taking nominal interest rates would be more adequate than taking real interest rates for our sample period? Unfortunately, we do not have a straightforward and decisive answer to this question."* (cmp. O'Brien / Wagenvoort, 2000).
- A fourth alternative is to calculate separate efficiency scores for funding efficiency and operational efficiency like in Valverde / Humphrey / del Paso (2007a). This, however, is contradictory to the basic premise of the intermediation approach. Unlike in the real economy, funding the balance sheet is very much part of the operating performance of banks, so the two are inseparably linked.

Given the limitations of each approach and the limited data available, this thesis follows the first approach and does not normalize accounting data.

#### Risk costs

No universal solution to incorporating risk costs in DEA exists. The quality of banks' receivables and the amount of risk costs (loan loss provisioning expense) are major influences on all aspects of bank performance such as profitability, solvency and efficiency. Without considering the context, the interpretation of provisioning expense as a sign of efficiency is hardly possible. One reason for this is that regulatory requirements vary greatly both between countries as well as over time (cmp. Ernst & Young, 2006, and Basel Committee on Banking Supervision, 2005).

Another reason is the complex interaction between loan volumes, profitability and provisioning levels. Low provisioning expense may mean the bank is too conservative and not gathering all the lending business it potentially could acquire. In this case, low loan loss provision (LLP) charges would be seen as a measure of inefficiency (the lower the expense, the less efficiently the bank is pursuing its intermediation target). But it is also possible to argue to the contrary: that low provisioning levels are a sign of superior risk management and therefore a sign of efficiency. Table 56 shows this as a cross-tab.



*Table 56 - Implications of Assumptions Regarding LLPs*

	<b>Implication for unit with low LLPs</b>	<b>Implication for unit with high LLPs</b>
LLPs as output (the higher the better)	A	B
LLPs as input (the lower the better)	C	D

- A... analysis attests low quantity of output (loan portfolio)
- B... unit is found to be aggressively targeting its intermediation target
- C... analysis attests superior risk management capabilities
- D... analysis attests low quality of output (loan portfolio)

The question of how to take this problem into account when defining inputs for DEAs has been the subject of the following previous studies:

Mester (1997, p. 231) state that *“Unless such differences are controlled for, some banks might be mislabelled as inefficient because they are operating in a more risk-averse manner than others, while others might be mislabelled as efficient because they are producing lower quality output than others.”* and go on to include two factors in their analysis: *“output quality,  $q_i$ , and the level of financial capital,  $k_i$ , are included in the cost model, since both can affect measures of X-inefficiency. ... The level of financial capital, rather than its price, is included because banks may not be using the cost-minimizing level of financial capital. ... Loan output quality,  $q$ , was proxied by the average volume of nonperforming loans in 1992. Nonperforming loans are loans that are 30 or more days past due but still accruing interest plus loans that are not accruing interest.”*

Berger / DeYoung (1997, p. 849) arrive at the conclusion that *“our results are ambiguous concerning whether or not researchers should control for problem loans in efficiency estimation”*.

Weill (2007) investigated the question of whether banks in CEE are different (overly aggressive or prudent) in their risk taking than Western European banks, but found no evidence to back up either claim.

So, neither study has used the P&L position (that is, credit risk costs) to proxy output quality. Instead, they have opted for non-performing loans. This may be due to the third problem with this indicator: that it may fluctuate greatly between periods. In fact, there is evidence that this position may be used as a buffer to smooth income streams through business cycles. Anandarajan / Hasan / Lozano-Vivas (2005) run an SFA on a panel of Spanish depository institutions obtained from the Spanish Confederation of Savings Banks (CECA) and the Banco de España for the years 1986, 1991 and 1995. They check for inefficiency in creating loan loss provisions (which would indicate that banks are using these reserves for other ends such as smoothing income streams rather than to cover expected losses from lending activities) and find that commercial banks and, in particular, stock institutions are less efficient. This is consistent with the assumption that such institutions face higher pressure to reduce earnings volatility as compared to savings or mutual banks. An older study of German cooperative banks also managed to prove that this position is used as a buffer (cmp. Werner / Padberg, 1999).

Putting the problem of earnings management aside, it could be argued that the interest income after risk is equal to what income remains from a bank's loan portfolio after credit risk is accounted for and should thus be comparable across institutions. However, foreign currency and liquidity risk remain unaccounted for.

### **4.3 Grouping**

Since many foreign banks entered the market during the late 1990s, much of the previous research focuses on questions regarding the interrelation of bank ownership and efficiency. As financial markets in the region mature, new types of ownership such as stock market listings have emerged.

A broader look at the range of recent empirical studies and their findings reveals that what many studies refer to as ‘type of ownership’ can entail such different things as nationality of the majority owner, mode of entry of that partner, recent change of ownership through privatization or M&A transaction, legal form, types of business focus and mix, organisational structures and distribution network.

In this study, units will be grouped into the following categories:

- Cooperative
- Savings
- Universal
- And Other (including direct banks, wealth managers and specialized institutions)

The following subchapter outlines why these categories were chosen.

#### **Type of Ownership**

Of the sampled cross-country studies, Fries / Taci (2005) use the most, namely five, groups. They also use this category to distinguish between banks that have recently been privatized from those that have not and find differences in efficiency that justify such a split. Various international studies confirm this, such as:

Boubakri / Cosset / Fischer / Guedhami (2005) study the post privatization performance of 81 banks from 22 developing countries and find that although privatized banks on average were characterized by lower economic efficiency and solvency, over time their economic efficiency as well as credit risk exposure improved.

Another popular split is to distinguish banks with a majority foreign owner from domestic ones, whether privatized or not. De Haas / Van Lelyveld (2006) use a panel of ~250 banks taken from BankScope which covers ten CEE countries over the period from 1993 to 2000 in order to examine whether foreign and domestic banks in the region react differently to business cycles and banking crises. They group the data according to bank ownership and mode of entry and find that during crisis periods domestic banks contracted their credit base, whereas greenfield foreign banks did not. However, they also found that the amount of credit such greenfield banks granted abroad (e.g. in CEE) was related to the economic situation within the home country of the respective bank.

However, the samples used by these studies differed significantly from the one used here in that they either considered a very short timeframe or a period of relatively low M&A activity (where banks entered the markets either by founding Greenfield operations or acquiring privatized banks) but without the occurrence of mergers or spin-offs. In the meantime and during the period from 2003 to 2006, the picture changes in most of these countries: banks which had initially entered CEE as Greenfield operations merged with newly privatized units, the newly formed companies merged with each other or operations were spun off. It would therefore be nearly impossible to assign any meaningful codes for the whole period of 2003-2006. For this reason, no such split will be introduced here.

### **Legal Form and Business Mix**

As far as the legal form in which banks are organized is concerned, it has been repeatedly stated that banks' objectives may actually differ in line with the organizational form chosen. For example, many savings banks were founded as not-for-profit organizations and are sometimes credited with extending access to bank services in rural areas.

Based on that argument, Iannotta / Nocera / Sironi (2007) set out to investigate any interrelation between legal form and business mix. They use a BankScope sample of 181 large banks from 15 European countries over the period from 1999 to 2004 to perform a regression of environmental and bank specific factors. Their findings regarding different ownership types are quite interesting "*our findings indicate that public sector banks are on*

*average less profitable and riskier than other banks. Moreover, their banking activity seems to be very peculiar, with a larger share of their funding coming from the wholesale interbank and capital markets, a higher liquidity and lower investments in loans. This different kind of financial intermediation model appears consistent with the existence of conjectural or explicit government guarantees, which in turn allow these banks to avoid the indirect costs - in terms of capital markets effects - of their poorer asset quality and less profitable intermediation activity.”* The study also finds that mutual banks enjoy higher loan quality, perhaps through more favourable customer relationships, but warns that demutualisation may be necessary for banks that aim at growth beyond their local community.

Micco / Panizza / Yanez (2007) delve even deeper into the business mix of state-owned banks. They use a BankScope database ranging from ~5,500 (in 1995) to 6,700 (in 2002) banks to investigate any differences in performance. The results of their regression analysis show that *“state-owned banks located in developing countries are less profitable than their private counterparts and that the difference between the performance of public and private banks increases during election years.”*

Moreover, savings banks and cooperative banks are often characterized by a two- or even three-tier structure. These pose a specific challenge for computing relative efficiency scores due to the heterogeneity of units located in different tiers. Bos / Kool (2006) have encountered this issue when examining Dutch cooperative banks and opted to treat each one as its own, independent entity.

As discussed above, these categories are also used by this study.

Another aspect that has recently raised attention is the emergence of direct banks - that is, banks that rely solely or predominantly on the internet as their distribution channel. Delgado / Hernando / Nieto (2004) perform a regression of accounting based performance indicators to investigate whether banks that use the internet as their primary distribution channel perform better than traditional ones. Based on financial statements of ~400 banks (thereof 13 internet banks) taken from BankScope for the years 1994-2001, they find that although overall profitability of this particular kind of banks is lower than those of newly chartered traditional

ones, an increase of 50% in asset size results in an RoA increase of 1.85%. Apart from these scale effects, however, they do not find evidence for any experience effects once internet banks are established.

Finally, it shall not go unmentioned that several studies group banks according to their orientation on specialized (e.g. investment) or universal banking. This, however, is largely motivated by the specific regulatory situation in the United States of America and is not a prime concern in the European Union. Vander Venet (2002) examines a sample of ~2,400 banks from EU-15 spanning from 1995 - 1996 split into three groups: financial conglomerates, universal banks and specialized institutions. The results show that universal banks dominate competitors in terms of profit efficiency while conglomerates are more cost-efficient in non-traditional activities. The study finds neither disadvantages nor advantages in cost efficiency of specialized banks when dealing with traditional intermediation activities. The author notes that bank sizes for which economies of scale are found have increased since the 1980s.

### **Statistical Clustering**

Rather than setting up a priori grouping categories and assigning units to them, there is the possibility to gather data and then have statistical software perform a clustering algorithm. Maudos / Pastor / Perez (2002) applied a clustering algorithm on a panel of Spanish banks with observations ranging from 1985-1996. The study finds that creating four clusters (universal, small, regional & savings and foreign) improves overall levels of measured cost efficiency while a further improvement over time remains evident.

Such an approach has two drawbacks, however: First, the clustering algorithm is based on assumptions regarding criteria, which are inputs and outputs. So, if the clustering is dependent on which inputs and outputs are defined as important and the inputs and outputs are defined based on what captures bank functions and types, one can easily end up with ever more complex cross-dependencies that are ever harder to justify objectively.

Second, the categories created will always depend on the sample chosen so that it is doubtful whether any conclusion derived may be generalized to a different period or sample.

For these reasons, no statistical clustering will be used in this study.

### **Bank Size**

Various studies have split units by size. There is also interesting international research regarding the impact of bank size. Most notably, Fung (2006) investigates whether less productive banks are catching up with the more productive ones. Based on a panel of US banks from 1996-2003, he finds that although smaller banks tend to grow quicker, the resulting scale economies are not enough to cause overall convergence. Rather, it seems that each unit “*possesses its own steady-state productivity to which it is converging*”.

Barros / Ferreira / Williams (2007) investigate which factors explain the probability of a bank being the best or worst performer. They utilise a mixed logit model based on ~ 1,400 commercial banks operating in the EU-15 between 1993 and 2001. The results suggest that performance can be explained by location, legal tradition, bank ownership, balance sheet structure and size. In particular, the probability of worst performance is explained by location.

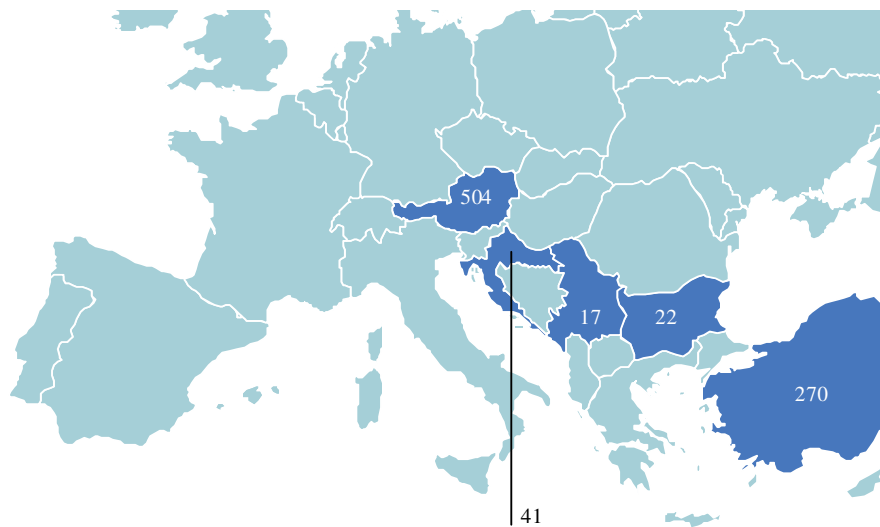
A drawback of this approach is that bank size, as expressed by balance sheet volume, can be expected to correlate with the size of the banking market. This would mix up effects of a DMU operating in a large market and the bank being large itself.

More importantly, where a VRS model is applied, it compares only DMUs of similar size to each other rendering any additional grouping of results according to size redundant. For this reason, no split by size is used in this study.

## 5 Country-level Analyses

This study covers a sample of five countries (Austria, Bulgaria, Croatia, Serbia and Turkey) as outlined by Graph 6.

*Graph 6 – Total Bank Assets by Country (as of 2006 in €bn); Source: Austrian National Bank (2007), National Bank of Bulgaria (2007), Croatian National Bank (2007), National Bank of Serbia (2007), Central Bank of the Republic of Turkey (2007)*



In order to appreciate the full extent of the transformation process in these countries, the initial situation under the Communist regime must be outlined. In his book, Barisitz (2008) identifies two main waves of banking reform. The first is characterized by what he terms soft budget constraints and many times results in another banking crisis, followed by a second wave during which hard budget constraints are introduced. Table 57 below illustrates this. Where the temporal sequence of events was exceedingly short, some characteristics of both waves may have existed in parallel.



Table 57 - Stages of Bank Sector Transformation in Selected Countries

	Bulgaria	Croatia	Serbia & Montenegro
<b>Point of departure:</b> state-owned banking system, soft budget constraints, regime change, external shocks, weak rule of law	90	90 - 91	90 - 92
Transition recession and banking crises	90 - 93	90 - 93	90 - 93
<b>"First wave" of banking reform</b>			
Liberalization of licensing policies, establishment of generous/lenient regulatory and supervisory systems	90 - 94	90 - 92	90 - 94
Up-front rehabilitation measures (e.g. swap of inherited and new non-performing loans for government securities)	91 - 94	91 - 92	-
Surface privatization of banks (e.g. mass privatization, MEBOs)	-	-	-
Initial tightening of banking regulation and supervision	-	93 - 94	96 - 97
Temporary stabilization of macroeconomic and banking situation	94 - 95	94 - 97	95 - 97
Renewed accumulation of bad loans and structural problems, sometimes complemented by new external shocks	92 - 96	93 - 97	- 00
Establishment of deposit insurance fund	95	94	
New transition banking crises and (or) recession	96 - 97	98 - 99	99 - 00
<b>"Second wave" of banking reform</b>			
Important restructuring, resolution and recapitalization measures: in most cases at least one large bank goes under	96 - 97	98 - 00	01 - 02
Establishment of hard budget constraints for banks	96 - 97	99	02
Banks become much more cautious in lending	97 - 98	98 - 99	02 - 03
Substantial tightening of banking regulation and supervision, upgrading of bookkeeping standards	96 - 97	98 - 99	01 - 02
Strengthening of property and creditor rights, hard budget constraints spread to real	98 - 99	00	03
In-depth privatization (e.g. takeover by strategic investor), FDI boom in banking	97 - 03	99 - 02	03 -
Introduction of credit registers/bureaux	00		
Bank lending gathers momentum or turns into credit boom	02	04	01
Authorities' reaction and credit containment policies (e.g. prudential tightening, administrative restrictions)	03 -	05 -	

## Notes

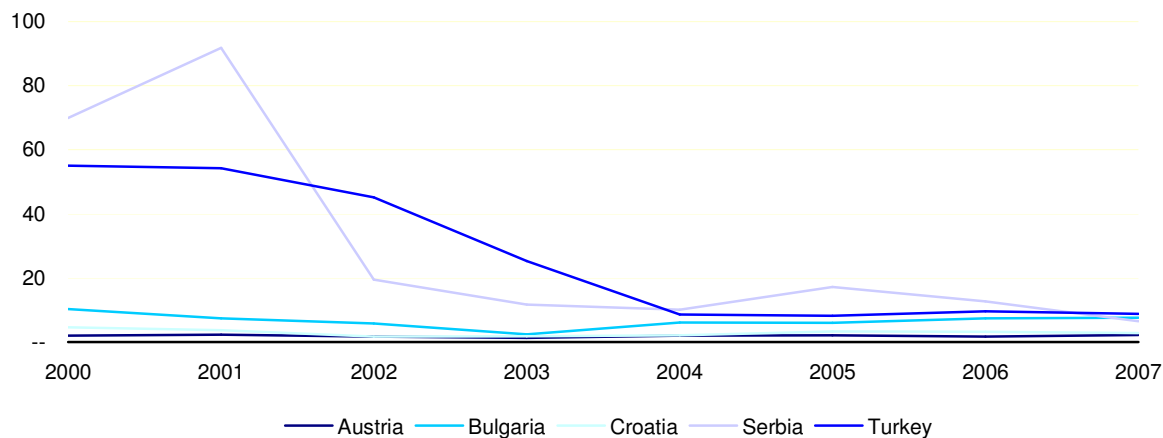
For example: 91 stands for 1991, 03 stands for 2003, - 98 stands for a policy measure / event going on until 1998, but with no clear starting point, 02 - stands for a policy measure / event starting in 2002 and not yet over

Source: *cmp. Barisitz (2008)*

As can be seen, all countries with the exception of Serbia and Montenegro entered the second phase of banking reform in the late nineties. This was followed by increased FDI and - later - a lending boom with very high growth (in relative terms) of loans outstanding. Turkey, not shown in the table, was also a planned economy until 1980 and saw a banking crisis unfold as early as in the year 2000. Austria's economy did not need to go through such major transitions and has thus been more stable than the rest of the sample (also not shown).

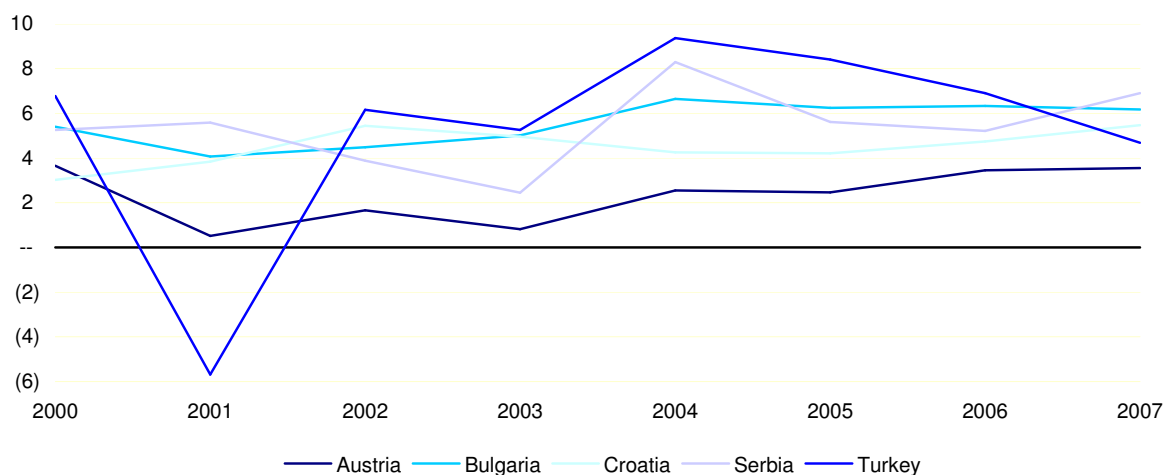
The following graphs depict the development of inflation and GDP growth which are closely related to financial stability and financial crises in the region.

*Graph 7 – Inflation (average consumer prices); Source: IMF (2009)*



As can be seen, Turkey and Serbia showed the highest levels of inflation during the period in question, even though by the beginning of 2003 they were already much lower than during the preceding years.

*Graph 8 – Annual Change of GDP (at constant prices); Source: IMF(2009)*



The region experienced significant GDP growth overall. Initially, Turkey was an exception as it was hit by an economic crisis in 2001. However, it was soon able to recover. Austria clearly lags behind the dynamic growth of CEE countries.

Table 58 outlines the availability of data for each country. Detailed coverage ratios by assets and number of units can be found in the appendix.

*Table 58 - Data Availability by Country*

	2003	2004	2005	2006
Austria	X	X	X	X
Bulgaria	X	X	X	X
Croatia	X	X	X	X
Serbia <sup>a</sup>	X	X	X	X
Turkey	X	X	X	X

<sup>a</sup> Historic data only available for units which still exist as of October 2008

Full samples are available for all countries with the exception of Serbia where no historic data was available for units which ceased to exist before October 2008.

For Austria and Turkey, the sum of data on single unit level cannot be reconciled with the size of the total banking market. In Austria, this is caused by the usage of non-consolidated data. The same presumably applies to the data for Turkey. Since all financials are obtained from the local regulators, they are nevertheless reliable.

The following subchapters discuss each country in detail:

## 5.1 Austria

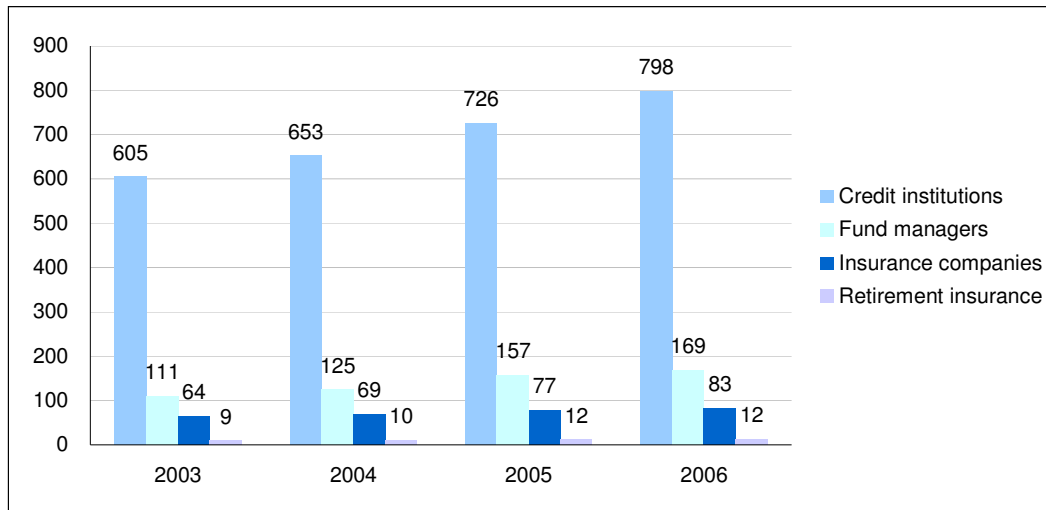
The Austrian banking market has seen constant growth over the sampled period. Much of that growth stems from expansion abroad, particularly into the CEE region. The market is dominated by five bank networks and Unicredit Bank Austria. These large networks are the 3 Tier Raiffeisen cooperatives, the 2 Tier “*Volksbanken*” cooperatives, the savings banks, the 3 Bank Group and Bawag P.S.K. which uses many post offices to offer banking services.

Additionally, several specialized institutions operate in the country:

- Direct banks do not operate branches, but offer their services via the internet
- The private banking market is relatively small compared to neighbouring Switzerland, but nevertheless a range of institutions is active in this niche either as part of the larger banking networks, or under the ownership of individuals (often families)
- Hypo banks used to be owned or guaranteed by regional governments and are major issuers of securities. State support was, however, largely withdrawn after EU accession
- Some highly specialized institutions focus on public finance, commercial real estate financing, factoring and other services
- House Savings Banks will only accept purpose-bound deposits from a specific group of customers and grant loans for specific causes (i.e. buying real estate and some others)
- Banks from other EU countries may operate branches in Austria without establishing a local subsidiary

As illustrated by Graph 9, the financial market is dominated by credit institutions.

Graph 9 - Importance of Non-Depository Financial Institutions (Source: Austrian National Bank, 2009, in €bn)



Although a substantial share of credit institutions' assets is held outside of Austria, these institutions dominate the domestic market as well. Private pension funds are a relatively new phenomenon and remain comparably small.

### Types of institutions

#### Raiffeisen

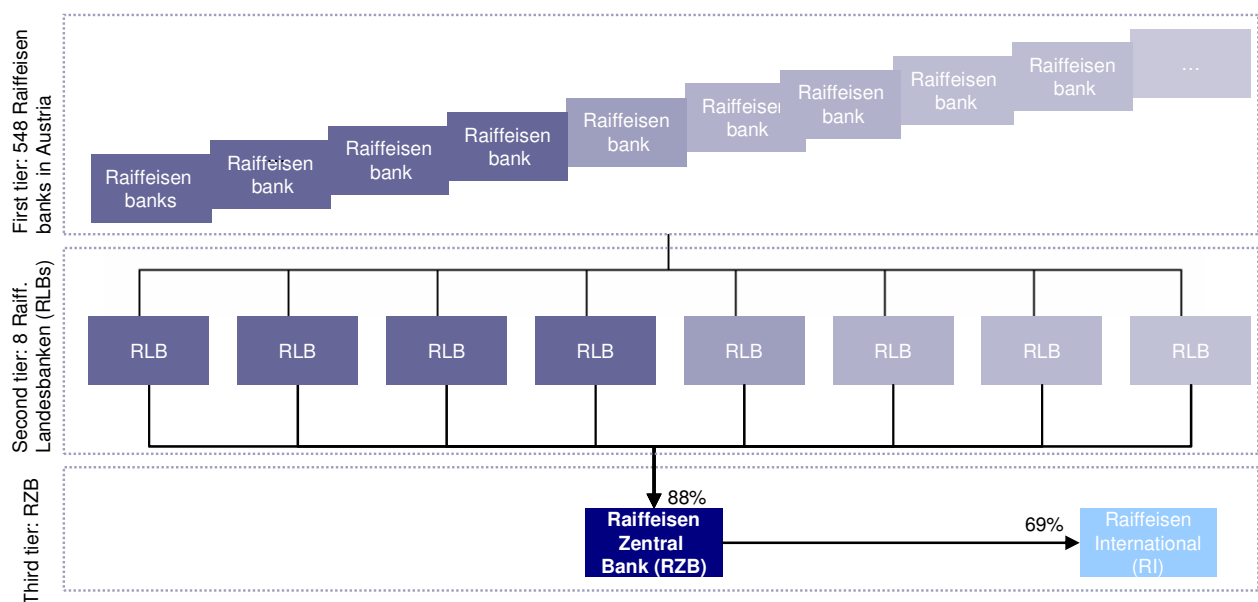
The Raiffeisen cooperative network is the most complex among Austria's bank networks in that it is organized in a 3 Tier structure and bundles its operations in Eastern Europe within a separate holding company, Raiffeisen International. The individual banks are connected via a reciprocal guarantee scheme and common liquidity management and use centralized services within the network.

Graph 10 outlines selected aspects of the network's structure. *"The Raiffeisen Landesbanks manage liquidity and render other centralised services for the Raiffeisen Banks in their respective regions. Through a reciprocal Guarantee Scheme, members of the Raiffeisen Banking Group back up default risks and money claims in the event of a bankruptcy etc. on a reciprocal basis."* (cmp. Raiffeisen Zentralbank, 2008, p.1).

It is not clear whether the services, liquidity or guarantees provided are charged at market rates. In particular, there is no publicly available evidence that a risk-adjusted guarantee fee is charged for the granted guarantees (or that any fee would be charged at all). Ignoring such costs would overstate efficiency and have the highest impact of efficiency scores of units with weak financial standing.

The centralized liquidity management function makes comparisons with other banks, which are not part of any network, difficult. It does not simplify matters that the reciprocal Guarantee Scheme does not cover all Raiffeisen banks. According to Zentrale Raiffeisenwerbung (2006), “Approximately 80% of all the Austrian Raiffeisen Banks currently belong to a customer guarantee association. Raiffeisen Zentralbank Österreich AG (RZB), the Raiffeisen Banking Group’s top institution rated A1 by Moody’s, is also a member of Raiffeisen-Kundengarantiegemeinschaft Österreich.”

Graph 10 - Raiffeisen Cooperative Sector in Austria; Source: Raiffeisen Zentralbank (2008)



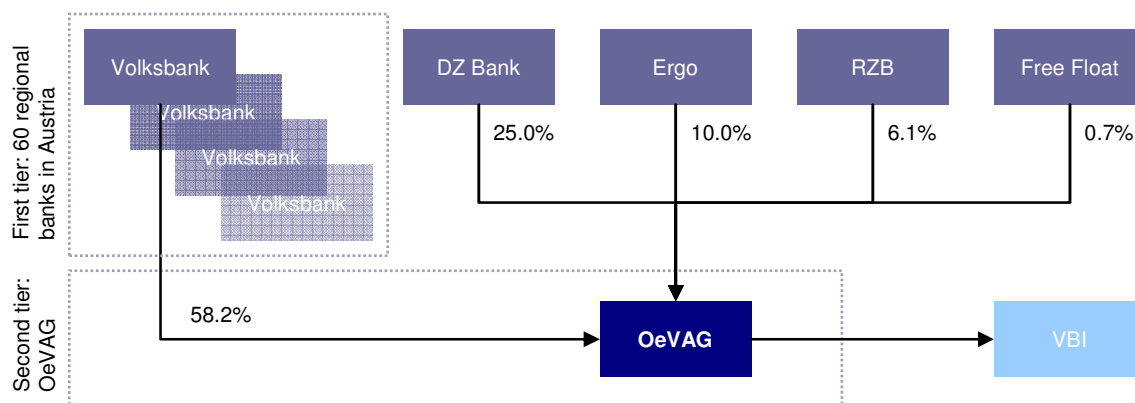
Raiffeisen International (RI) is a holding company which bundles all stakes held in CEE subsidiaries. Its majority is held by RZB with a minority stake listed on the Vienna Stock exchange. RI does not engage in business with Austrian customers and does not hold an Austrian banking license. It is not included in the sample used here which also ensures that no double counts across the region exist. Nevertheless, the financial statements of RZB do contain income received as dividends from all its subsidiaries, including those in CEE.

### Volksbanken

The *Volksbanken* sector, organized as a 2 Tier structure, is Austria's second largest cooperative network (cmp. Graph 11). Similarly to the Raiffeisen network, the stakes held in CEE subsidiaries are bundled in a separate unit called Volksbank International (VBI) and majority-owned by OeVAG, the network's central institution.

Limited cross-shareholdings between the cooperative networks exist, such as a 6.1% stake in OeVAG held by RZB.

*Graph 11 - Volksbanken Cooperative Sector; Source: OeVAG (2008)*



As at the end of 2006, OeVAG also owned stakes in banks specialized in Public Finance (Kommunalkredit) and Commercial Real Estate (Investkredit, Europolis).

### Other

Apart from the two cooperative networks described above, there are three more bank groups active in Austria.

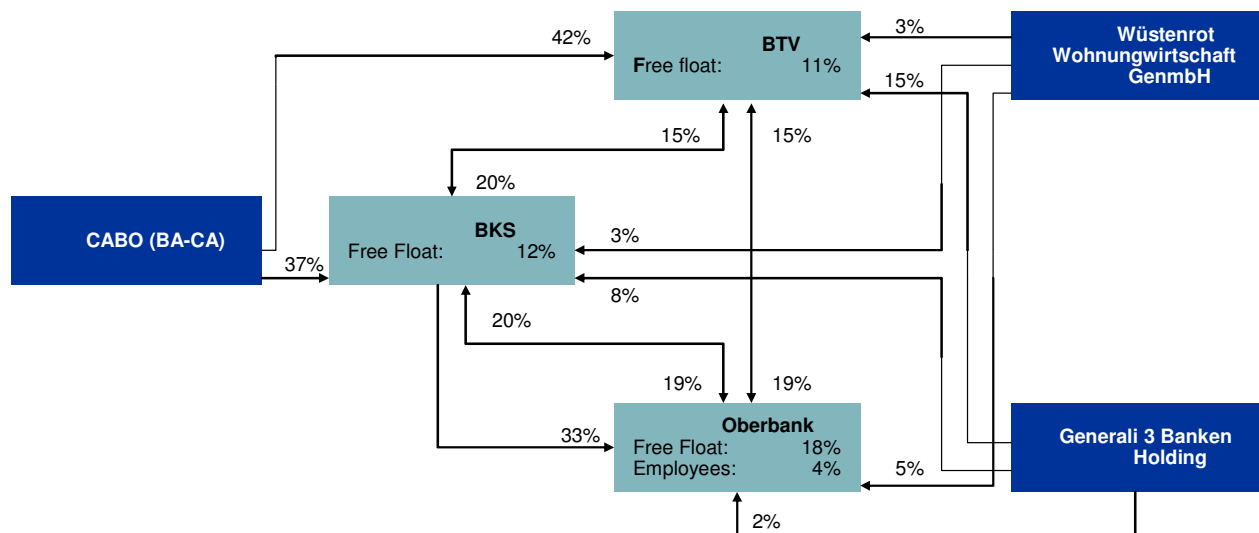
The savings banks sector is also organized in two tiers with Erste Bank as its central institution. The bank runs various subsidiaries throughout the region.

Bawag P.S.K. underwent various changes during the period in question, all of which have a high impact on its financials and efficiency. In 2005, Österreichische Postsparkasse AG and Bank für Arbeit und Wirtschaft AG merged to become BAWAG P.S.K. Bank für Arbeit und

Wirtschaft und Österreichische Postsparkasse AG. Bawag P.S.K. was later involved in an accounting scandal and subsequent bail-out (cmp. subchapter 4.1.1.).

The 3 Bank Group is an alliance, confirmed by cross-shareholdings, between Oberbank, Bank für Tirol und Vorarlberg and Bank für Kärnten und Steiermark. Although shares in the individual banks are listed, the free float is very low as outlined by Graph 12.

Graph 12 - Cross-shareholdings of 3 Bank Group (Source: Oberbank 2007, Bank für Tirol und Vorarlberg 2007, BKS Bank 2007)



### Data source

The data set used was provided by the National Bank of Austria and is available for public download (Austrian National Bank, 2009). It contains non-consolidated data of all credit institutions operating in Austria. The comparably high level of development and differentiation of the Austrian banking market as compared to the other sampled countries merits a detailed analysis of the included units.

For a start, not all credit institutions are allowed to accept customer deposits. This excludes the so-called *Sonderbanken* from the sample. Since not all EU banks allowed to run representative offices in Austria report figures to the Austrian supervisory authorities, these were excluded as well. Further, Housing Savings Banks were excluded from the sample. For the avoidance of doubt, holding units used to bundle stakes held in subsidiaries abroad (such



as Raiffeisen International) do not hold an Austrian banking license and are therefore not part of the sample. The outlined steps reduce the sample size by roughly 100.

Table 59 shows descriptive data for the remaining units.

*Table 59 - Selected Indicators (sample of Austrian depository institutions)*

Year		Uni- versal	Savings	Volks- banken	Raiff- eisen	Direct banks	Wealth Mgmt	Hypos	Special	Total
<b>2003</b>	<i># of DMUs</i>	15	61	60	587	4	23	7	15	772
	Capital	8,707	4,920	1,479	6,389	19	547	1,066	861	23,988
	Operating exp.	3,025	1,688	558	2,079	41	268	326	116	8,100
	Deposits	82,956	40,588	13,675	58,131	405	5,799	8,900	1,219	211,673
	Loans	107,634	50,346	15,820	60,033	72	4,312	22,963	4,156	265,336
	Profit before tax	596	372	162	722	(14)	115	120	82	2,155
<b>2004</b>	<i># of DMUs</i>	15	58	60	575	4	23	7	13	755
	Capital	8,905	5,132	1,548	7,685	24	575	1,167	1,189	26,223
	Operating exp.	2,923	1,730	582	2,142	42	283	327	128	8,159
	Deposits	85,524	41,703	14,603	60,431	570	6,437	9,596	1,534	220,399
	Loans	109,167	53,123	17,300	63,505	107	3,973	24,748	8,577	280,499
	Profit before tax	704	515	165	1,304	(11)	121	146	403	3,347
<b>2005</b>	<i># of DMUs</i>	13	56	60	570	4	22	7	13	745
	Capital	8,695	5,631	1,865	9,123	16	594	1,257	1,341	28,522
	Operating exp.	2,964	1,709	582	2,227	51	322	349	153	8,357
	Deposits	85,355	43,545	15,768	66,387	790	7,167	10,442	1,870	231,324
	Loans	113,410	56,806	18,805	72,369	336	3,957	26,254	10,876	302,813
	Profit before tax	863	794	192	1,202	(7)	216	149	157	3,566
<b>2006</b>	<i># of DMUs</i>	13	53	59	561	4	24	7	14	735
	Capital	9,145	9,149	2,088	9,899	35	690	1,405	1,824	34,234
	Operating exp.	3,216	1,787	594	2,330	66	387	363	210	8,952
	Deposits	83,267	49,490	16,608	74,564	1,099	10,554	11,715	3,108	250,405
	Loans	117,487	59,649	17,271	79,689	488	4,515	27,378	17,198	323,673
	Profit before tax	3,390	815	313	991	1	275	136	191	6,112

Data is grouped into categories in the following way: cooperative and savings banks of all tiers are categorized based on the network they belong to. Members of the 3 Bank Group are classified as universal banks. So are Hypo Alpe Adria Bank, Bawag P.S.K. and Bank Austria Unicredit.

The remaining categories contain units with a highly focused business model. Direct banks base their business on a cost structure that is significantly different from that of brick-and-mortar businesses. Private wealth managers derive a high part of their income from fees and are usually very selective in their lending. Hypo banks gather a large part of their funding by issuing securities rather than from customer deposits. So do banks specialized in public

finance and commercial real estate as well as those active in other highly specialized business lines.

For a detailed list of which units were assigned to each category please see Appendix 9.1.

### DEA results

A DEA based on the full sample assigns above-average and, in some cases remarkably high, scores to most specialized units. Average scores are shown in Table 60 below. These differences reaffirm that the conducted review of business models identified units that really do operate based on a specialized model. The assigned DEA scores confirm that the mix of inputs and outputs used by these earmarked units differs significantly from that of other DMUs.

*Table 60 - Efficiency Scores Obtained From Full Sample (Intermediation Approach)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average Score</b>	<b>Average Rank</b>
Universal	69.8%	67.8%	68.6%	69.2%	68.9%	<b>3</b>
Savings	52.6%	54.0%	54.0%	54.0%	53.6%	<b>6</b>
Volksbanken	51.0%	51.1%	51.4%	51.3%	51.2%	<b>7</b>
Raiffeisen	50.0%	51.7%	49.2%	49.2%	50.0%	<b>8</b>
Direct banks	49.8%	53.0%	55.0%	62.2%	55.0%	<b>5</b>
Wealth Mgmt	56.4%	54.3%	60.6%	60.1%	57.8%	<b>4</b>
Special	75.6%	79.3%	80.9%	82.2%	79.4%	<b>2</b>
Hypos	92.2%	92.8%	92.9%	90.5%	92.1%	<b>1</b>
<b>Average</b>	<b>51.8%</b>	<b>53.1%</b>	<b>51.4%</b>	<b>51.5%</b>	<b>51.9%</b>	

Leaving DMUs with a highly specialized business model in the sample creates two problems: first, they are likely to become self-identifiers (which means they will be assigned unrealistically high scores simply because they cannot be compared against any peers) and second they are not reasonable references for evaluating other units' efficiency (as this would artificially drag the average efficiency score down).

In order to make results more meaningful, the sample is therefore reduced once more by another 63 DMUs by excluding Direct Banks, Wealth Managers, Specialized Banks and Hypos.

Table 61 shows DEA scores based on an analysis of the reduced sample. The top quartile is highlighted green and the bottom quartile highlighted red.

*Table 61 - Efficiency Scores Derived From Reduced Sample (Intermediation Approach)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average</b>	<b>Rank</b>
Raiffeisen	67.6%	68.2%	65.7%	65.4%	66.7%	<b>2</b>
Savings	64.4%	65.4%	65.8%	65.7%	65.3%	<b>3</b>
Universal	76.1%	76.0%	76.0%	78.8%	76.7%	<b>1</b>
Volksbanken	64.1%	64.1%	64.8%	64.9%	64.5%	<b>4</b>
<b>Average</b>	<b>67.2%</b>	<b>67.8%</b>	<b>65.8%</b>	<b>65.6%</b>	<b>66.6%</b>	

While overall scores still indicate significant inefficiencies, they improved across all categories. Interestingly, the rank of units did not change except for Raiffeisen, which improved its rank. This result is indicative: A universal bank is bound to score lower when compared against a direct bank than against brick-and-mortar peers. However, the ranking of universal banks between themselves should be correct even if they are all compared against an unrealistically high target.

In light of these results, it is reasonable to use the reduced sample for all further analyses.

Under the Service-oriented Approach, deposits are treated as outputs which should be maximized rather than inputs which should be minimized. As Table 62 indicates, modelling the data this way produces much higher scores across all categories.

*Table 62 - Efficiency Scores Derived From Reduced Sample (Service-oriented Approach, top quartile highlighted green and bottom quartile red)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average</b>	<b>Rank</b>
Raiffeisen	80.9%	81.0%	79.5%	79.3%	80.2%	<b>2</b>
Savings	78.8%	79.3%	79.6%	79.7%	79.3%	<b>3</b>
Universal	88.1%	87.0%	87.9%	87.4%	87.6%	<b>1</b>
Volksbanken	78.3%	78.6%	79.2%	79.9%	79.0%	<b>4</b>
<b>Average</b>	<b>80.7%</b>	<b>80.8%</b>	<b>79.6%</b>	<b>79.5%</b>	<b>80.2%</b>	

Interestingly, the rank of bank groups does not change compared to the intermediation approach: universal banks score highest for all periods, while the cooperative sector (Raiffeisen and *Volksbanken*) shows the lowest efficiency under both approaches.

The fact that scores obtained under the Service-oriented Approach are higher is in line with the assumption that Austrian banks see deposits as products they offer to their customers and which they do not attempt to minimize - otherwise they would be consistently failing in that aim.

### **Interpretation**

Although significant inefficiencies exist within the Austrian banking market, average efficiency scores calculated for the period from 2005 to 2006 are much higher than those reported by Hahn 2004 and 2005 (for 1995-2002) and closer to those identified by Ali / Gstach (2000) based on data from the 1990s. This could be due to the fact that Hahn's sample covered many more units while Ali / Gstach used a limited sample which excluded specialized units.

Among the four bank categories, the Raiffeisen group shows the highest inefficiency both under the intermediation as well as the Service-oriented Approach. This result is particularly striking given that Raiffeisen runs the country's largest network. One possible interpretation is that the cooperative network does not focus solely on the goal of minimizing costs but tries to provide bank services even in remote places where other profit-maximising organizations would not choose to be present. Although this could also be argued for the *Volksbanken*, the savings banks and Bawag P.S.K (at least as far as the presence of post offices is concerned), the pressure on Raiffeisen as the market leader might be greater. In spite of ongoing urbanisation, the rural population might exert pressure on the group not to close outlets even if the number of inhabitants in the area is declining.

Another possible interpretation is that the high inefficiencies may be due to Raiffeisen's decentralized organization and 3 Tier structure which may keep it from streamlining business processes and cause additional overhead. Also, it could be argued that the market does not believe the complex system of cross-guarantees can measure up to the safety a fully consolidated nation-wide universal bank can provide. This would reduce profitability by increasing funding costs.

The *Volksbanken* group is ranked second but last under the intermediation and slightly higher by the service-oriented approach. Everything that has been said about Raiffeisen applies here as well, only that the *Volksbanken* network is smaller. Perhaps this puts it under less pressure to keep unprofitable outlets in highly remote areas open. The fact that it is organized in only two tiers might also have a positive influence on costs.

The savings bank sector does not profit disproportionately from applying the service-oriented approach. This is surprising given that the savings banks, as their very name suggests, are traditionally perceived to put significant emphasis on liability-side products. Nevertheless scores under both approaches improved over time, demonstrating increasing willingness to consolidate operations and improve efficiency across the group.

Universal banks clearly show the highest efficiency compared to their peers. Within this group, Bank Austria Unicredit, Bawag P.S.K. and Hypo Alpe Adria serve as benchmarks in several periods.

In light of the bail-out of Bawag P.S.K. in 2006, this result is startling as it demonstrates what has been said about the need to carefully review whether accounting data used as input for a DEA is meaningful. In this case, the financials reported before the accounting scandal came to light were indeed ‘too good to be true’. The costs of the subsequent bail-out were carried by the government and other Austrian banks which allowed Bawag P.S.K. to not only obtain testified financials for 2006, but to report figures which continued to position it remarkably well against its peers (some of which had stemmed the bail-out of their competitor!).

Overall, four important conclusions can be drawn:

- Austrian banks do not show a tendency to minimize customer deposits, which suggests they see them as a product offered to their clients which contributes to their profitability and efficiency, as suggested by the service-oriented approach
- There is significant room for efficiency improvement among Austria’s cooperative bank networks

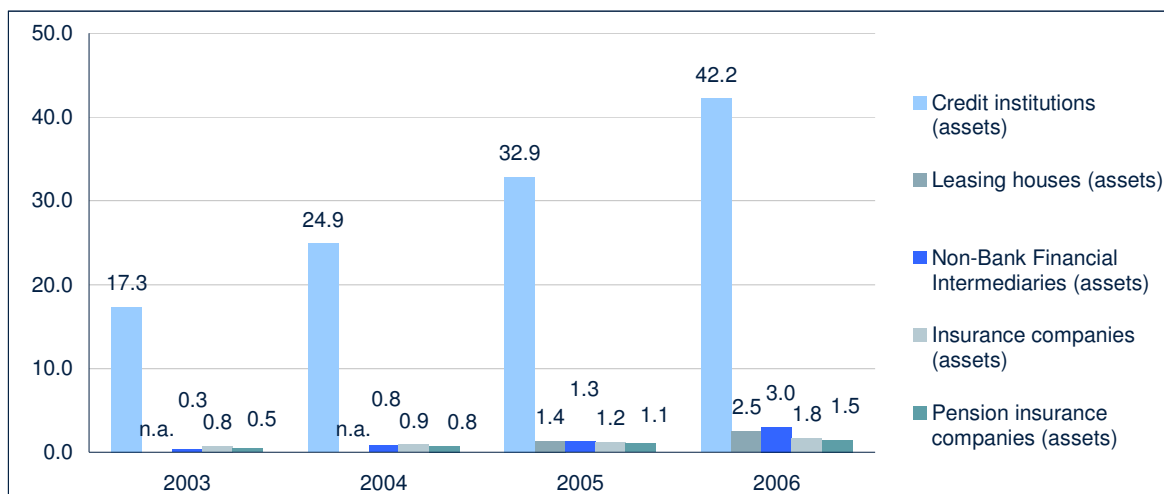
- Those institutions which actively invested in consolidating their operations, such as Bank Austria Unicredit, were left with either strong, efficient operations by 2006 or had at least managed to improve, such as the savings banks
- DEA may produce misleading results in specific cases, such as not adequately reflecting bail-outs as demonstrated for Bawag P.S.K. It is therefore important that researchers check for the presence of such events in their sample

## 5.2 Bulgaria

Bulgaria experienced a major financial crisis in 1996 (see Balyozov, 1999). Following this crisis, intermediation levels remained rather stable for a prolonged period. Only in 2003 did the asset / GDP indicator (a common proxy for a country's overall intermediation level) rise by 15 percent (from only 5.1 percent in the year before).

Worried about this acceleration in growth in one year, the regulatory authorities responded by increasing minimum reserve requirements during 2004 and in April 2005 resorted to specifying limitations to banks' annual loan growth. The resulting slow-down in loan growth went hand in hand with the emergence of non-depository financial institutions such as leasing houses (cmp. Barisitz, 2008). Table 63 outlines the increasing role of other financial intermediaries in the recent past. Although growth is observed, the limitation of this analysis to only depository institutions can be upheld.

*Table 63 - Importance of Non-Depository Financial Institutions in Bulgaria; Source: National Bank of Bulgaria (2008, in BGN bn)*



### Data source

The dataset provided by the National Bank of Bulgaria is publicly available for download (National Bank of Bulgaria, 2009). It contains the balance sheet and P&L statements of all

commercial banks in Bulgaria from 2003 to 2006 (4 periods). Descriptive statistics of the sample as well as inputs and outputs used can be found in the appendix.

Following the previously established logic, a total of four units are classified as cooperative banks. Of these, three are subsidiaries of internationally active cooperative banks (DZI Bank which was owned by the German cooperative sector during most of the period before being acquired by EFG Eurobank towards the end of 2006, Raiffeisenbank (Bulgaria) which belongs to the Austrian Raiffeisen group, and Emporiki Bank - Bulgaria which is owned by Credit Agricole) while one is a Bulgarian cooperative (Central Cooperative Bank AD).

Two units are classified as savings banks, although the case for neither is clear-cut:

- DSK Bank was traditionally the countries' savings bank before being acquired by OTP in 2003. Since OTP has also traditionally been a savings bank before it was privatized, DSK (and all other members of OTP group) are classified as savings banks
- MKB Unionbank is majority-owned by Bayerische Landesbank since late 2006. It is thus indirectly held by the state of Bavaria and German savings banks

## Results

DEA analyses are run for both the intermediation and the service-oriented approach. The results are shown in Table 64 and Table 65 below.

*Table 64 - Scores Based on Intermediation Approach (top quartile highlighted green and bottom quartile red)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average</b>	<b>Rank</b>
Cooperative	64.8%	65.1%	63.8%	66.0%	64.9%	<b>3</b>
Savings	61.3%	71.2%	79.0%	77.0%	72.1%	<b>1</b>
Universal	69.6%	71.0%	71.2%	70.4%	70.6%	<b>2</b>
<b>Average</b>	<b>68.6%</b>	<b>70.3%</b>	<b>70.8%</b>	<b>70.3%</b>	<b>70.0%</b>	

Savings banks show the highest efficiency scores during three out of four periods and exclusively belong to the top quartile of observations. This is a marked improvement after starting out in the bottom quartile in 2003.



The performance of universal banks is much steadier while cooperative banks exhibit significant inefficiencies and no clear trend of improvement between periods.

*Table 65 - Scores Based on Service-oriented Approach (top quartile highlighted green and bottom quartile red)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average</b>	<b>Rank</b>
Cooperative	76.6%	82.0%	83.8%	85.3%	81.9%	<b>2</b>
Savings	79.0%	82.4%	88.7%	89.3%	84.8%	<b>1</b>
Universal	79.0%	80.8%	81.7%	85.2%	81.6%	<b>3</b>
<b>Average</b>	<b>78.8%</b>	<b>81.0%</b>	<b>82.3%</b>	<b>85.5%</b>	<b>81.8%</b>	

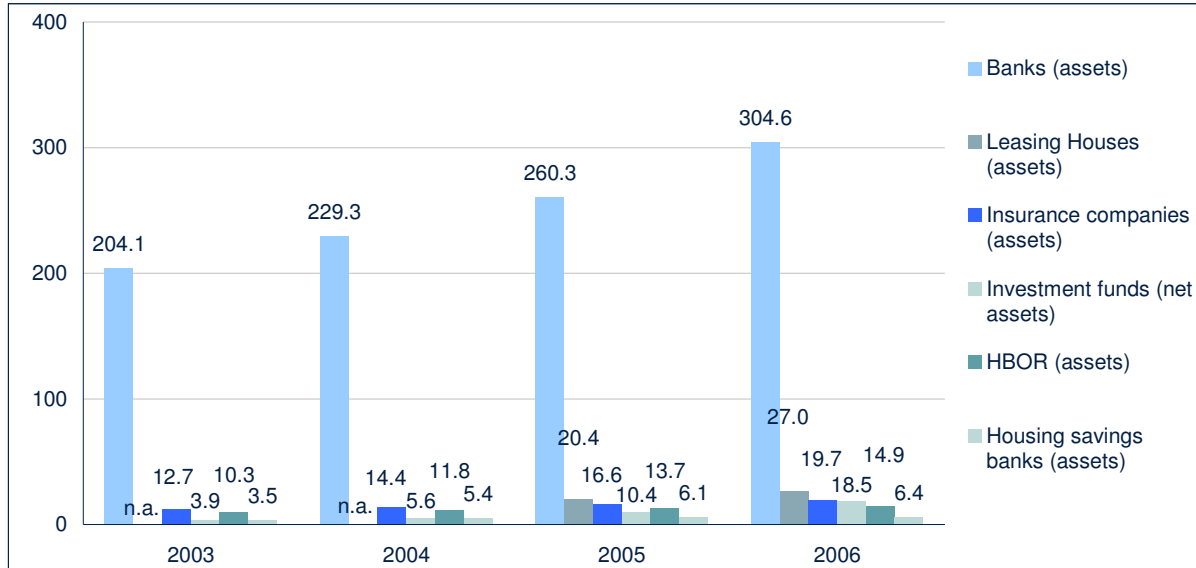
As in Austria before, average scores under the service-oriented approach are consistently higher than those under the intermediation approach. Interestingly, the service-oriented approach shows a marked improvement over time where all three categories of banks start off in the bottom quartile consistently improve each year.

Savings banks continue to lead the ranking and display high levels of efficiency during later periods. Cooperative banks benefit most when deposits are viewed as output. With consistent improvement between periods, they even manage to enter the top quartile in 2006. Universal banks benefit least from applying the service-oriented approach and are ranked lowest, albeit with higher scores.

### 5.3 Croatia

Following the political turmoil after the collapse of Yugoslavia, balance sheets of Croatian banks showed considerable growth for several years. In 2003, the first year of the sample period, the Croatian National Bank introduced a range of consecutive measures aimed at curbing lending growth. *"In January 2003, the monetary authorities adopted a Decision on the Compulsory Purchase of HNB Bills, under which banks whose credit growth exceeded an annual rate of 16 percent were required to subscribe to low yield-HNB bills in an amount equal to 200 percent of the exceeded growth."* (Barisitz, 2008, p.118) As Table 66 shows, alternative financiers such as leasing houses saw dynamic growth during that time. However, their volumes remain insignificant compared to the dominant banks. As in all other countries, they are not included in the sample.

*Table 66 - Importance of Non-Depository Financial Institutions in Croatia; Source: Croatian National Bank (2009, in HRK bn)*



During the period in question, the Croatian banking market was also characterized by a high share of loans either denominated in or directly linked to foreign currency. The local authorities tried to curb currency risks in the banking system through the use of different mandatory reserve rates for different currency deposits. *"The measure was repealed in 2004 and replaced by tighter prudential requirements and more market-based instruments, including adjustments to minimum foreign currency reserves for new bank borrowing from*

abroad, which were subsequently further tightened. But these steps could not prevent lending from re-accelerating in 2005.” (Barisitz, 2008, p. 116)

Three internationally active cooperative banks have established a presence in Croatia. These are Banco Popolare, Raiffeisenbank and Volksbank. Banca Sonic was not included in this category as it had only been acquired by Banco Popolare di Verona e Novara in 2007. As far as savings banks are concerned, the sample contains four such institutions: Erste & Steiermärkische Bank, Hypo Alpe-Adria-Bank, OTP Banka Hrvatska and Slavonska Bank.

Additional descriptive statistics regarding the sample of Croatia can be found in the appendix.

*Table 67 - Scores Based on Intermediation Approach (top quartile highlighted green and bottom quartile red)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average Score</b>	<b>Average Rank</b>
Cooperative	97.5%	100.0%	95.2%	91.4%	95.5%	1
Savings	93.7%	88.6%	86.5%	92.1%	90.1%	2
Universal	86.7%	86.1%	86.5%	86.6%	86.5%	3
<b>Average</b>	<b>87.7%</b>	<b>87.1%</b>	<b>87.0%</b>	<b>87.7%</b>	<b>87.4%</b>	

Results based on the intermediation approach show a levelling out between categories of banks in 2006. While cooperative banks were by far the most efficient at the beginning of the sampled period, their scores then started to decrease until they were overtaken by savings banks. Universal banks remained stable during the entire period. Although their scores are consistently the lowest, the average levels of efficiency detected are quite high.

*Table 68 - Scores Based on Service-oriented Approach (top quartile highlighted green and bottom quartile red)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average Score</b>	<b>Average Rank</b>
Cooperative	87.7%	91.9%	87.0%	81.9%	86.6%	2
Savings	92.8%	90.2%	87.2%	94.0%	91.0%	1
Universal	85.1%	83.7%	84.4%	85.4%	84.6%	3
<b>Average</b>	<b>85.8%</b>	<b>84.7%</b>	<b>84.9%</b>	<b>86.2%</b>	<b>85.4%</b>	

Running the same analysis based on the service-oriented approach yields lower scores than those identified with the intermediation approach. This is different from the results for Austria and Bulgaria before. Additionally, the difference between scores identified by the two approaches is much smaller than previously.

Interestingly, the performance of savings banks is judged much more favourably when deposits are viewed as product - they become most efficient category of bank. The cooperative banks' efficiency scores deteriorate by 10 percentage points between 2004 and 2006 and this category is even placed in the bottom quartile during the last period. Universal banks ranks lowest and are part of the bottom quartile in two periods irrespectively of the approach applied.

These results imply that Croatian banks either did not attempt to, or did not succeed to, maximize their deposit base and opted to obtain a larger part of their funding from other sources instead.

This is in line with what has been said about the market. The Croatian population placed little trust in banks after their negative experience during the war. This presumably increased prices as customers required a higher premium for taking the perceived risk of placing their savings with a potentially unsafe institution. Given the high cost of obtaining customer deposits, it would therefore be more attractive for banks to obtain wholesale funding either domestically or from abroad.

In order to reduce the dependence of the local banking system on wholesale funding from abroad, the Croatian National Bank saw it necessary to introduce forceful measures aimed at motivating banks to push for local deposits. For example, mandatory reserve requirements for funding obtained from abroad were higher than that levied on local deposits. This highlights how strong a measure the regulator thought necessary to offer to banks in order to make the acceptance of deposits attractive.

It would be interesting to repeat this analysis for later periods to gauge whether banks' attitudes to deposits changed once trust in the banking system returned.

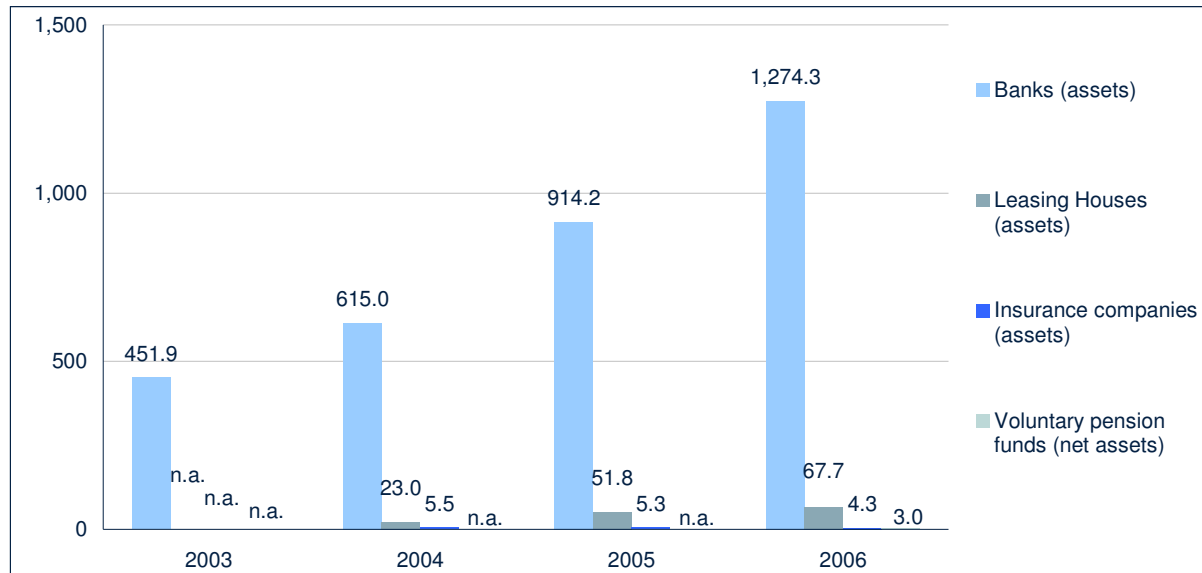
## 5.4 Serbia

The Serbian banking sector underwent major restructuring during 2002 with significant write-offs and the liquidation of several large banks. “Frozen savings” posed a particular issue. *“Frozen liabilities referred to citizens’ foreign currency accounts that had been transferred to the NBJ and then in fact confiscated and spent by the authorities, and to forex loans received from commercial or official creditors abroad for on lending to domestic enterprises that then defaulted. Frozen assets referred to banks’ corresponding claims on the NBJ for transferred forex accounts and on domestic delinquent firms for onlent forex credits. New banks (mostly private) did not have this problem, but they were initially very small. With regard to citizens’ frozen accounts, the Serbian authorities in the summer of 2002 launched the issue of €4.2bn of state bonds in exchange for such deposits”* (Barisitz 2008, p.120).

Initially, several international banks were allowed to enter the market via greenfield investments. Later entries were realized through acquisitions. Overall restructuring measures are estimated to amount to roughly 1 percent of GDP (Barisitz 2008, p.121). However, they did not show much effect initially. Only in 2002 did lending growth start to increase. Similar to Croatia, a large part of the Serbian loan books is either denominated in or linked to the Euro.

During the period in question, new types of financial institutions such as leasing houses and voluntary pension funds were established, but their size and influence remained limited. As for all other sampled countries, the analysis is therefore limited to banks and excludes other financial intermediaries.

*Table 69 - Growth of Non-Depository Financial Institutions in Serbia; Source: Serbian National Bank (2009)*



Although Montenegro was part of the union of Serbia and Montenegro during the period 2002-2006, banks needed a separate license in order to operate there. For this reason the sample does not include Montenegrin banks. The analysis does, however include the Kosovo, where some banks were also operating as separate entities (i.e. Raiffeisenbank and Raiffeisen Bank Kosovo).

In the sample, there are four cooperative banks (the aforementioned two units of Raiffeisen, Meridian Bank as part of Credit Agricole Group and Volksbank).

The sample contains nine savings banks, of which two are local (Nacionalna Stedionica and Postanske Stedionice), three are part of international savings bank networks (Erste Bank, Eurobank EFG Stedionica and Hypo Alpe-Adria-Bank) and an additional four are labelled as such due to being acquired by OTP (Niska Banka, Zepter Banka and Kulska Banka). Findomestic Bank was not assigned to the savings banks category because it was acquired by Cassa di Risparmio di Firenze together with BNP Paribas in 2005.

*Table 70 - Scores Based on Intermediation Approach (top quartile highlighted green and bottom quartile red)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average Score</b>	<b>Average Rank</b>
Cooperative	90.8%	96.5%	93.9%	83.5%	91.2%	<b>1</b>
Savings	84.1%	83.1%	79.7%	75.1%	80.5%	<b>3</b>
Universal	85.7%	84.0%	79.6%	77.4%	81.7%	<b>2</b>
<b>Average</b>	<b>85.9%</b>	<b>85.1%</b>	<b>81.0%</b>	<b>77.7%</b>	<b>82.4%</b>	

Although results based on the intermediation approach start off on a comparably high efficiency level, scores decrease steadily throughout the sample period. Overall, the banking market in Serbia seems to be heading in the wrong direction with bank efficiency decreasing across all categories of banks.

Cooperative banks continue to lead the ranking, but have been losing ground since 2004 with a decrease of 7 percentage points. This decrease is still modest compared to minus 9% for savings and 8% for universal banks.

*Table 71 - Scores Based on Service-oriented Approach (top quartile highlighted green and bottom quartile red)*

<b>Category</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average Score</b>	<b>Average Rank</b>
Cooperative	96.4%	97.0%	95.8%	86.0%	93.8%	<b>1</b>
Savings	86.1%	82.1%	83.9%	79.2%	82.8%	<b>3</b>
Universal	88.8%	87.3%	84.6%	84.6%	86.3%	<b>2</b>
<b>Average</b>	<b>89.1%</b>	<b>87.4%</b>	<b>85.6%</b>	<b>83.9%</b>	<b>86.5%</b>	

Application of the service-oriented approach confirms the trends described above, but the performance of savings banks is now by far the worst while universal banks benefit most from viewing deposits as output.

These results are interesting in light of the high growth of bank assets during the sample period (cmp. Table 69). It seems banks were so strongly focused on expanding their business and platforms that they did not manage to keep up the initially high levels of efficiency.

In light of these results, further in-depth research of the Serbian banking market could prove highly interesting. The following questions could merit a case-by-case analysis: given the uneven distribution of greenfield operations between categories of banks, could the disappointing scores of savings banks be influenced by the difficulties with frozen deposits and non-performing loans? Are the effects of government interventions such as frozen savings bonds or government-driven cleaning up of balance sheets before privatizations, if any, adequately reflected in banks' accounting data? Did any extraordinary effects such as a change in the regulatory framework occur in 2006 which could have negatively impacted banks performance?



## 5.5 Turkey

The Turkish economy was a planned economy until 1980. *“The economic stabilization and structural adjustment program announced in 1980, largely known as the 24<sup>th</sup> Decisions, adopted policies giving the priority to economic growth based on export promotion and to structural reforms including deregulation and liberalization of financial markets.”* (Özutku, 2003, p.2). A major overhaul of the banking law took place in 1999 which appointed the Banking Regulation and Supervision agency (BRSA) as an independent authority to regulate and supervise the banking sector in Turkey (ibidem, p.4).

Following a bank crisis, a total of 26 banks had to be restructured of which 22 were taken over by the Savings and Deposit Insurance Fund (SDIF) and four were taken out of the banking system without SDIF intervention during the period between 2000 and 2006. *“Merger method was used for 13 of 22 banks taken over by the SDIF, while sales method were used for 5 banks and liquidation method was used for 3 banks and 1 bank was structured as a transition bank to execute asset management function.”* (BRSA 2007, pp.35f). The overall cost of restructuring the banking sector amounted to 34% of GDP (ibidem, p.42). Following the initiation of the banking reforms, several international banks entered the Turkish market by acquiring Turkish entities.

The dataset used is available for public download from the webpage of the Banks Association of Turkey (Banks Association of Turkey, 2009). Following the methodology adopted for the Austrian market, two foreign banks with a very specialized business model were excluded from the sample (Calyon Yatırım Bankası Türk and Merrill Lynch Yatırım Bank). The sample also excludes representative offices and Participation banks.

Participation banks in Turkey operate a very specific different business model. Firstly, they abstain from issuing or investing in any interest-bearing instruments and their only source of funding, except for capital, consists of specially structured deposits. Also, they do not invest in any government bonds or similar securities.

Second, their aim is often to foster the growth of specific businesses. *“Interest-free special finance corporations served in two ways in the process of capital accumulation. First, they attracted the savings of religious persons who did not use traditional banks, hence bringing new funds to the system. Secondly, they provided funds to the religious business circles not using banks for capital loans, hence contributing to their development.”* (Demir / Acar / Toprak, 2004, p.170). Further, they are not run with the aim of maximising profits. *“Another frequently used way of demonstrating legitimacy is to set up a non-profit charity organization, a foundation or an association, and declare that economic activities are a means to support these organizations. By this way they become a respected member of the society who works for the common good, while incidentally earning money. This need for legitimacy is probably more crucial for the religious–conservative bourgeoisie.”* (ibidem, p.173).

It is reasonable to exclude these four companies (Al Baraka Türk Katılım Bankası, Asya Katılım Bankası, Kuveyt Türk Katılım Bankası and Türkiye Finans Katılım Bankası) from the sample.

Table 72 - Growth of Non-Depository Financial Institutions in Turkey (in TRYbn); Source: BRSA (2007)

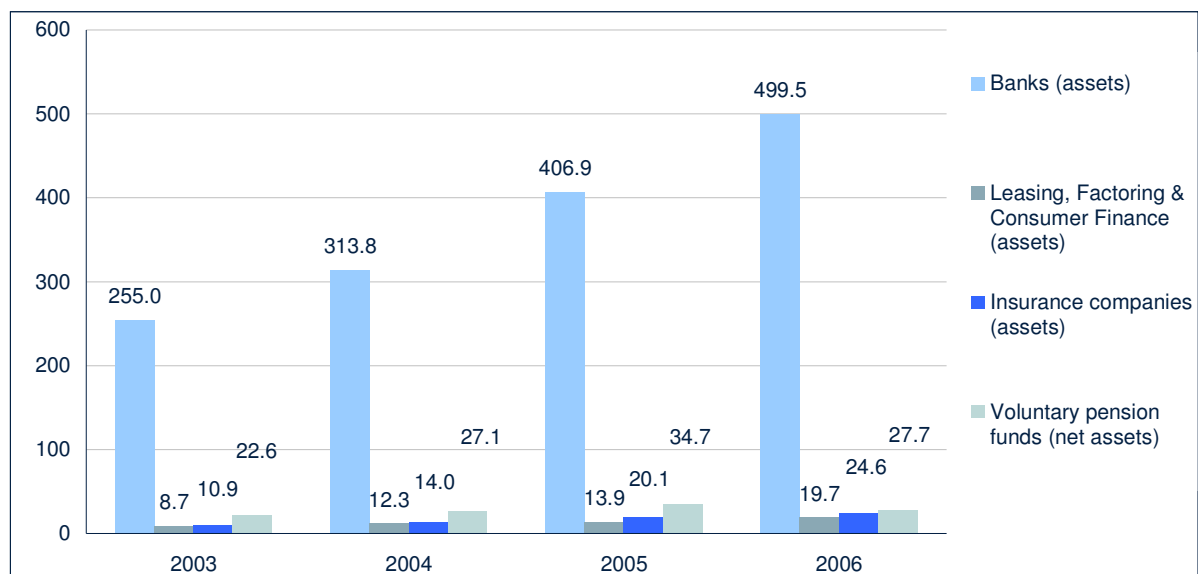


Table 73 outlines scores obtained under both the intermediation and service-oriented approach with the top quartile highlighted green and the bottom quartile red.

*Table 73 - Scores (top quartile highlighted green and bottom quartile red)*

<b>Approach</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average</b>
Intermediation	69.9%	71.7%	74.0%	82.5%	74.5%
Service-oriented	82.8%	82.0%	84.5%	88.3%	84.4%

Results are broadly in line with those for the previously outlined countries. A clear improvement in average efficiency is shown under both approaches. Scores under the service-oriented approach tend to be significantly higher than under the intermediation approach.

The identified efficiency levels based on the intermediation approach start off on a similar level as reported by Isik / Hassan (2002) and Kasman (2002) and strongly improve in 2006. This would merit further research covering a longer period in order to investigate whether 2006 was a particularly positive outlier.

## 6 Results Against a Common Frontier

Although the detailed analyses on country level outlined in the previous chapter have addressed many important aspects of the markets' development, they have a fundamental flaw: the country-level efficiency frontiers are not comparable.

In order to be able to compare units from different countries with one another, a separate analysis against a common frontier must be performed. As outlined, this implies that banks from different countries operate with the same technology. In order to be consistent and not distort results through self-identifiers, specialized institutions excluded from the samples for Austria and Turkey are also excluded here.

Due to technical limitations, it was not possible to include the whole sample, so that the common frontier only spans the period from 2004 to 2006.

### 6.1 DEA

*Table 74 - Scores Based on Intermediation Approach (top quartile highlighted green and bottom quartile red)*

<b>Country</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average</b>
Austria	69.7%	66.5%	66.0%	67.4%
Bulgaria	61.1%	59.8%	57.3%	59.5%
Croatia	67.4%	67.3%	73.4%	69.2%
Serbia	54.5%	53.4%	54.1%	54.0%
Turkey	63.9%	64.4%	67.5%	65.3%
<b>Average</b>	<b>68.5%</b>	<b>65.6%</b>	<b>65.6%</b>	<b>66.6%</b>

The analysis of the pooled sample confirms the results on country level: average efficiency scores improved in Croatia and Turkey but declined in Austria, Bulgaria and Serbia. These three countries also rank last in 2006. Average scores as measured against a common frontier are generally lower than those measured against single country frontiers.

Although there is no clear trend over time as to which country shows highest efficiency, it is obvious that Serbia consistently ranks lowest.

*Table 75 - Scores Based on Service-oriented Approach (top quartile highlighted green and bottom quartile red)*

<b>Country</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Average</b>
Austria	82.3%	79.6%	79.4%	80.4%
Bulgaria	72.5%	71.2%	71.9%	71.9%
Croatia	76.9%	77.2%	79.6%	77.9%
Serbia	67.1%	67.5%	68.5%	67.7%
Turkey	72.6%	74.7%	75.9%	74.4%
<b>Average</b>	<b>80.7%</b>	<b>78.5%</b>	<b>78.5%</b>	<b>79.2%</b>

Table 75 shows results under the service-oriented approach. Interestingly, overall scores under this approach are higher even Croatia where this was not the case based on a country-specific efficiency frontier.

The development of scores over time is consistent with country-level analyses in Austria, Croatia and Turkey while the data for Bulgaria and Serbia are reversed. While scores for Bulgarian banks showed improved against a country-level frontier showed improvement, they decreased against a common frontier. The situation for Serbian entities is the opposite: while efficiency scores against a single-country frontier decreased, they improve against a common frontier.

This does not change the fact that observations from Serbia rank last in every single period. Austria emerges as clear leader with an average efficiency score of 80.4% over all periods, although its advantage seems to level-off over time.

How do the different bank categories fit into the picture? Table 76 outlines scores split by bank categories.

*Table 76 - Scores by Category (2004-2006, Intermediation Approach, top quartile highlighted green and bottom quartile red)*

<b>Country</b>	<b>Cooperative</b>	<b>Savings</b>	<b>Universal</b>	<b>Average</b>
Austria	67.4%	65.7%	76.0%	67.4%
Bulgaria	56.0%	58.1%	60.1%	59.5%
Croatia	71.9%	77.4%	68.0%	69.2%
Serbia	57.2%	53.5%	53.7%	54.0%
Turkey			65.3%	65.3%
<b>Average</b>	<b>67.3%</b>	<b>65.2%</b>	<b>63.9%</b>	<b>66.6%</b>

Overall, cooperative banks rank highest throughout the region, followed by savings banks and universal banks. Country-specific factors seem to heavily impact the performance of local units, as all categories of Croatian and Serbian banks rank highest, respectively lowest.

*Table 77 - Scores by Category (2004-2006, Service-oriented Approach, top quartile highlighted green and bottom quartile red)*

<b>Country</b>	<b>Cooperative</b>	<b>Savings</b>	<b>Universal</b>	<b>Average</b>
Austria	80.3%	79.8%	88.0%	80.4%
Bulgaria	71.0%	73.1%	71.9%	71.9%
Croatia	81.0%	86.6%	76.5%	77.9%
Serbia	71.6%	67.1%	67.3%	67.7%
Turkey			74.4%	74.4%
<b>Average</b>	<b>80.2%</b>	<b>79.0%</b>	<b>74.5%</b>	<b>79.2%</b>

The ranking of bank categories does not change once the service-oriented approach is applied, even though overall scores increase.

While universal banks dominate efficiency rankings in Austria under both approaches, they do not fare particularly well in CEE and even rank last in Croatia. In spite of their highest overall average score, cooperative banks rank low in terms of efficiency in Austria, but seem to run their operations in Croatia comparably efficiently.

One possible explanation is that universal banks with their stringent organization put more resources into rolling out the same standards to all operational units – even if they are in fact too sophisticated for less developed markets. Savings and cooperative networks, on the other

hand, are more competent at working in a decentralized way and may feel content with a lower degree of integration. This could allow them to adapt better to local circumstances.

Another explanation might be that cooperative banks and savings banks expanded eastwards earlier and more forcefully precisely because they suffered more from the saturation and inefficiency of the Austrian banking market.

## 6.2 Malmquist Index

Table 78 shows the results of a Malmquist Index analysis based on pooled data. Two methodological aspects need to be pointed out: since the Malmquist Index requires a balanced panel, only units which existed in both periods were included in the calculation. In order to be consistent and not distort results through self-identifiers, specialized institutions previously excluded from the samples for Austria and Turkey are also excluded here.

Table 78 - Malmquist Index

Country		Intermediation			Service-oriented		
		2004/03	2005/04	2006/05	2004/03	2005/04	2006/05
Austria	Catch-up	1.06	0.97	0.96	1.03	0.96	0.94
	Frontier-shift	0.99	1.10	1.01	0.99	1.04	1.02
	Malmquist Index	1.04	1.04	0.97	1.03	1.00	0.96
Bulgaria	Catch-up	1.02	0.99	0.97	1.01	1.00	0.93
	Frontier-shift	1.01	1.01	1.01	1.00	1.02	1.00
	Malmquist Index	1.01	1.00	0.97	1.01	1.01	0.93
Croatia	Catch-up	1.03	1.01	0.99	1.02	1.02	0.91
	Frontier-shift	1.01	1.00	0.98	1.00	1.00	1.01
	Malmquist Index	1.04	1.01	0.95	1.02	1.02	0.91
Serbia	Catch-up	1.01	0.99	0.98	1.03	1.03	0.95
	Frontier-shift	1.02	1.19	1.00	0.98	1.00	0.98
	Malmquist Index	1.02	1.16	0.95	1.02	1.02	0.93
Turkey	Catch-up	1.05	1.04	1.08	0.99	1.06	0.85
	Frontier-shift	1.00	1.04	1.00	1.02	0.99	1.08
	Malmquist Index	1.03	0.93	0.98	1.00	1.01	0.86
<b>Catch-up</b>		<b>1.05</b>	<b>0.98</b>	<b>0.97</b>	<b>1.03</b>	<b>0.97</b>	<b>0.93</b>
<b>Frontier-shift</b>		<b>0.99</b>	<b>1.09</b>	<b>1.01</b>	<b>0.99</b>	<b>1.03</b>	<b>1.02</b>
<b>Malmquist Index</b>		<b>1.04</b>	<b>1.03</b>	<b>0.97</b>	<b>1.02</b>	<b>1.00</b>	<b>0.95</b>

Overall results for the whole sample show that the frontier-shift effect was close to one with only few exceptions, which will be discussed later. Innovation and technological change therefore played a minor role during the period in question. Technological change in the sample was lowest in the years of 2003 and 2004 and increased slightly since.

In light of overall dynamic growth this could be interpreted to mean that banks focused on gaining scale rather than investing further in ever new technology. Another way of looking at this result is that perhaps foreign banks which entered the market did not attempt to



implement the newest available technology throughout the region but were content to establish one common basic platform.

On country-level, there are three exceptions. Data for Serbia shows a strong frontier-shift effect 2005/04 according to the intermediation approach but this is not mirrored under the service-oriented approach. In Turkey 2006/05 the opposite is the case: data shows improvement under the service-oriented approach but when the intermediation approach is applied. Neither is therefore conclusive. Only data for Austria shows a strongly positive frontier-shift effect under both approaches in 2005/04.

The highest technological improvement therefore did not take place in CEE but in Austria. This could mean that management saw the Austrian market as saturated and stable and thus turned their attention to reducing costs and increasing efficiency in a bid to improve overall performance in the absence of further growth expectations.

## 7 Conclusions

This thesis investigates the efficiency of depository institutions in Austria, Bulgaria, Croatia, Serbia and Turkey. Four of these countries switched from a planned to a market economy in the early 1980ies. They are contrasted with Austria based on a sample which covers the period from 2003 to 2006.

DEA and the Malmquist Index are used as tools for measuring efficiency and its change over time. Chapter 3 discusses other ways of measuring efficiency such as single factor productivity measures and parametric models before establishing DEA as the method of choice. The chapter goes on to outline the most important extensions of the initial DEA model published in Charnes / Cooper / Rhodes (1978) and lays the ground for selecting a slacks-based input-oriented variable returns to scale model as most appropriate for the given panel. Chapter 4 establishes criteria for classifying and analyzing existing efficiency research and continues with a tour d’horizon of research into banks’ efficiency in the CEE region.

DEA research needs to combine expertise from various disciplines in order to be accurate and meaningful. The review of the state of the field identifies a need to put more emphasis on interpreting banks’ accounting data and the challenge of obtaining a representative sample. While previous studies have often lavished attention on the programming and mathematical aspects of DEA, these equally important aspects have sometimes been neglected.

Chapter 5 therefore focuses on problematic aspects of both areas and how these will be addressed. Among the most important issues covered are: the impact the emergence of funds-transfer-pricing has on modelling the production function, the treatment of outliers, the need to deflate data, the presence of cross-guarantees and cross-shareholdings within a sample and the presence of M&A and bank bail-outs in the sample. The chapter then outlines the inputs and outputs used as well as categories according to which results are later analyzed.

In Chapter 6, data for each country is analyzed and interpreted within a national context. Following best practice (Berger / Humphrey, 1997) and in order to demonstrate how the

model selection process can have a major impact on the obtained results, two DEA analyses based on both the intermediation and service-oriented approach are applied on data obtained from regulatory authorities for each country.

The results show that efficiency scores based on the service-oriented approach are significantly higher in all but one country (Croatia). This implies that banks see deposits as products they offer to their customers and which they do not attempt to minimize - otherwise they would be consistently failing at that aim. The service-oriented approach therefore seems better aligned with banks' actual business models.

In Austria, significant inefficiencies exist within the cooperative sector. These can be interpreted in different ways: on the one hand, it could be argued that high operational inefficiencies are caused by Raiffeisen group's 3 Tier structure. Since Raiffeisen also runs the country's most extensive branch network, the result would imply significant cost saving potential which could then be passed on to consumers, i.e. via lower prices. But one could also argue to the contrary: the cooperative bank sector, and the Raiffeisen group in particular, may be providing bank services even in remote places where other profit-maximising organizations would not choose to be present. In that case, realizing cost savings would not benefit consumers. Further research would thus be necessary before any clear-cut recommendations can be given.

Surprisingly, the Austrian savings bank which traditionally put significant emphasis on liability-side products do not profit disproportionately from applying the service-oriented approach. Although universal banks show the highest efficiency compared to their peers, this category also contains Bawag P.S.K. which was bailed-out in 2006. This result demonstrates the need to carefully review whether accounting data used as input for a DEA is meaningful in addition to focusing on the econometric aspects of DEA.

In Bulgaria, savings banks continue to lead the ranking and display high levels of efficiency during later periods. But it is the cooperative banks that benefit most when deposits are viewed as output.

Croatia is the only country where banks' scores are lower under the service-oriented than under the intermediation approach. This means that Croatian banks either did not attempt to, or did not succeed in maximizing their deposit base. In light of the historic context this might be due to a lack of trust in the stability of the banking system and a need for offering high prices on customer deposits. Given the high cost of obtaining customer deposits, it would therefore be more attractive for banks to obtain wholesale funding either domestically or from abroad.

These findings could serve as starting point for further research into supply and demand in the Croatian market for bank deposits.

In Serbia, high growth of bank assets during the sample period went hand in hand with decreasing efficiency scores. Banks were either focused on expanding their platforms up to a point where they did not manage to keep up the initially high levels of efficiency anymore or exogenous effects must have taken place towards the end of the sample period which negatively impacted banks performance. Further in-depth research of the Serbian banking market could prove highly interesting - also in light of the effect specific local artefacts such as the ongoing redemption of frozen savings bonds may have had on the efficiency of banks.

Results for Turkey start off on a similar level as reported by Isik / Hassan (2002) and Kasman (2002) and strongly improve in 2006. The market seems to have rebounded well from the last banking crisis.

In Chapter 7, all units are evaluated against one common frontier for the period 2004 to 2006. No overall efficiency improvement can be identified and average scores are generally lower than those measured against single country frontiers. Cooperative banks rank highest throughout the region, followed by savings banks and universal banks. When grouped by countries, the analysis of the pooled sample confirms the results on country level under the intermediation approach. Country-specific factors seem to heavily impact the performance of local units, as all categories of Croatian and Serbian banks rank highest, respectively lowest.

As expected, the service-oriented approach produces higher overall scores. This is in line with previous research (cmp. Das / Ghosh, 2006, who also found that efficiency scores under the value-added approach were higher than those under the intermediation approach). Surprisingly, this is even the case for Croatia where scores under the intermediation approach were higher when measured against a country-specific efficiency frontier.

An interesting pattern emerges when DMUs are grouped by category (savings, cooperative and universal banks) and country. It can then be seen that the first two show comparably low efficiency in Austria but comparably high scores in Serbia and Croatia. For universal banks, this pattern is reversed. This might indicate that universal banks overinvested in these markets in a quest for offering too many products at too many outlets or that foreign-owned banks implemented solutions and infrastructure that turned out to be too sophisticated for these less developed markets while savings and cooperative networks felt more at ease working in a decentralized way and were content with a lower degree of integration.

Results of a Malmquist Index analysis are inconclusive for the region as a whole, although technological improvement can be shown for Austria between 2004 and 2005.

Given the high hopes many have placed in the expansion of Western banks in CEE markets it is disappointing not to see any clear efficiency gains across the region. However, the results also point to the existence of national factors which seem to allow banks to operate more efficiently in some countries but not in others.

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## 9 Appendix

### 9.1 Austria

Table 79 - Descriptive Statistics of Austrian Sample (2006, in €m)

OeNB Sector	Category	Loans	Deposits	Capital	Op. expense	Profit
<i>Aktienbanken</i>	Universal	112,581	81,358	8,987	3,145	3,379
	Wealth Management	3,735	9,484	623	375	302
	Volksbanken	326	259	14	8	1
	Direct banks	488	1,099	35	66	1
	Special	1,908	133	324	71	80
<i>Sparkassen</i>	Savings	59,649	49,490	9,155	1,787	815
	Special	-	0	6	0	(0)
<i>Volksbanken</i>	Volksbanken	16,967	16,392	2,077	586	313
	Special	9,204	1,782	745	81	72
<i>Raiffeisen</i>	Wealth Management	784	1,064	76	41	13
	Raiffeisen	79,925	74,564	10,497	2,362	1,023
	Special	0	6	0	1	(1)
<i>Landeshypothekenbanken</i>	Universal	4,905	1,909	158	72	11
	Hypos	27,378	11,715	1,405	363	136
	Special	6,875	1,149	763	86	51
<i>Bausparkassen</i>	excluded	12,740	16,466	414	344	53
<i>Sonderbanken</i>	excluded	17,546	2,553	1,677	1,003	445
<i>§9 - Institute laut BWG</i>	excluded	118	33	4	48	4
<b>Total</b>		<b>355,128</b>	<b>269,457</b>	<b>36,959</b>	<b>10,439</b>	<b>6,700</b>

## Appendix

Table 80 - Austrian Banks Excluded From Refined Sample<sup>1</sup>

Category	OeNB Sector	Name
Direct banks	Aktienbanken	direktanlage.at AG easybank AG ecetra Central European e-Finance AG Generali Bank AG
	Raiffeisen	bankdirekt.at AG
Wealth Management	Aktienbanken	Allianz Investmentbank AG Alpenbank AG Banco do Brasil AG Bank Gutmann AG Bank Sal. Oppenheim jr. & Cie. (Österreich) AG Bank Vontobel Österreich AG Bank Winter & Co. AG Bankhaus Carl Spängler & Co. AG Bankhaus Krentschker & Co. AG Bankhaus Schelhammer & Schattera AG BANKPRIVAT AG Brüll Kallmus Bank AG CAPITAL BANK - GRAWE GRUPPE AG Commerzbank (Schweiz) AG Private Banking CONSTANTIA PRIVATBANK AG European American Investment Bank AG Kathrein & Co. Privatgeschäftsbank AG Kommunalkredit Depotbank AG LGT Bank (Österreich) AG MEINL BANK AG PRIVATINVEST BANK AG Schoellerbank AG UniCredit CAIB AG Valartis Bank (Austria) AG Wiener Privatbank SE Spar - Finanz - Investitions- und Vermittlungs-AG
	Landeshypothekenbanken	HYPO Investmentbank AG
	Raiffeisen	Bankhaus Jungholz International Private Banking AG PRIVAT BANK AG der Raiffeisenlandesbank Oberösterreich Raiffeisen Vermögensverwaltungsbank AG Raiffeisenbank Reutte reg.Gen.m.b.H.
Hypos	Landeshypothekenbanken	HYPO TIROL BANK AG HYPO-BANK BURGENLAND AG Landes-Hypothekenbank Steiermark AG Niederösterreichische Landesbank-Hypothekenbank AG Oberösterreichische Landesbank AG Pfandbriefstelle der österreichischen Landes-Hypothekenbanken SALZBURGER LANDES-HYPOTHEKENBANK AG Vorarlberger Landes- und Hypothekenbank AG
	Aktienbanken	Adria Bank AG AMERICAN EXPRESS BANK LTD. Coface Austria Bank AG Dexia Kommunalkredit Bank AG FactorBank AG Intermarket Bank AG VTB Bank (Austria) AG Western Union International Bank GmbH Die Burgenländische Anlage & Kredit Bank AG Service Bank GmbH Golden Star Bank - Aktiengesellschaft in Abwicklung Fiat Auto Kreditbank GmbH
Special	Landeshypothekenbanken	HYPO ALPE-ADRIA-BANK INTERNATIONAL AG
	Raiffeisen	Privatlade der Marktgemeinde Falkenstein
	Sparkassen	Die Zweite Wiener Vereins-Sparcasse
	Volksbanken	Europolis AG IMMO-BANK AG Investkredit Bank AG Investkredit Investmentbank AG Spar- und Vorschuß-Verein der Beamtenschaft der Oesterreichischen Nationalbank reg.Gen.m.b.H. Spar- und Vorschußverein Graphik" reg.Gen.m.b.H." VB Factoring Bank AG Spar- und Vorschussverein der Mitarbeiter der Niederösterreichischen Landesbank-Hypothekenbank AG

<sup>1</sup> Housing Saving Banks, Representative Offices (acc. to BWG) and *Sonderbanken* were excluded entirely

## 9.2 Bulgaria

Table 81 - Data Used; Source: National Bank of Bulgaria (2008)

Bulgaria (in BGN bn)	2003	2004	2005	2006
total assets banking system	17.3	24.9	32.9	42.2
total assets leasing houses	n.a.	n.a.	1.4	2.5
total assets of non-banking investment intermediaries	0.3	0.8	1.3	3.0
total assets insurance companies	0.8	0.9	1.2	1.8
total assets pension insurance companies	0.5	0.8	1.1	1.5
# of units start of year	n.a.	35	35	34
events	a	b	c	2 mergers, 1 name change <sup>d</sup>
# of units end of year	35	35	34	32
units in sample	35	35	34	32
assets of sample (in BGN bn)	17.32	24.92	32.85	42.19
coverage in terms of units	100%	100%	100%	100%
coverage in terms of assets	100%	100%	100%	100%
input 1: client deposits	12.1	16.7	20.4	27.6
input 2: capital and reserves	2.3	2.7	3.4	4.4
input 3: total operating expense	0.7	0.9	1.1	1.3
customer loans	n.a.	n.a.	n.a.	n.a.
loan loss provisions	n.a.	n.a.	n.a.	n.a.
output 1: net loans	9.0	13.3	17.7	22.1
output 2: profit before tax	0.4	0.5	0.7	0.9
profit after tax	0.4	0.4	0.6	0.8
imputed cost of equity	(0.2)	(0.3)	(0.3)	(0.4)
output 2: profit after cost of equity	0.2	0.2	0.3	0.4
Ø average risk-free rate	9.7%	9.7%	9.7%	9.7%
FX rate end of period (BGN /€)	0.51	0.51	0.51	0.51

a 8 January 2003 the Sofia City Court entered the change in the name of DSK Bank reflecting its legal status

b 2004, permitting RoseximbankAD to change its name in the license to DZI Bank AD February 2004, permitting Commercial Bank of Greece Bulgaria to change its name in the license to Emporiki Bank Bulgaria

c During the first quarter of 2005 the name of UNIBANK was changed to International Asset Bank and the name of Demirbank was changed to D Commerce Bank.

d Piraeus Bank, sofia, and Piraeus euroBank merged National Bank of Greece C.A., merged with WestEast Bank to NLB WestEast Bank, Unionbank changed ist name to MKB UnionBank

### 9.3 Croatia

Table 82 - Data Used; Source: Croatian National Bank (2008)

Croatia (in HRK bn)	2003	2004	2005	2006
Banks	204.1	229.3	260.3	304.6
Leasing Houses	n.a.	n.a.	20.4	27.0
Insurance Companies	12.7	14.4	16.6	19.7
Net assets investment funds (open-end and closed)	3.9	5.6	10.4	18.5
HBOR	10.3	11.8	13.7	14.9
Housing savings banks	3.5	5.4	6.1	6.4
# of units start of year	50	41	37	34
events	9 mergers <sup>a</sup>	3 mergers, 1 liquidation, 3 name changes <sup>b</sup>	2 mergers, 1 liquidation, 1 name change <sup>c</sup>	1 merger <sup>d</sup>
# of units end of year	41	37	34	33
units in sample	41	37	34	33
assets of sample (in HRK bn)	204.1	229.3	260.3	304.6
coverage in terms of units	100%	100%	100%	100%
coverage in terms of assets	100%	100%	100%	100%
input 1: client deposits	143.7	151.7	171.7	202.3
input 2: capital and reserves	15.8	24.6	23.5	31.0
input 3: total operating expense	4.8	4.9	5.4	5.4
customer loans	n.a.	n.a.	n.a.	n.a.
loan loss provisions	n.a.	n.a.	n.a.	n.a.
output 1: net loans	167.4	183.9	208.6	243.6
output 2: profit	3.1	3.7	4.0	4.2
FX rate end of period (HRK / €)	0.14	0.14	0.14	0.14

a Erste & Steiermärkische Bank merged with Riječka banka on 1 August 2003.  
 HVB Bank Croatia merged with Splitska banka on 1 July 2003.  
 Riadria banka merged with Privredna banka Zagreb on 1 January 2004.  
 Zagorska banka merged with Samoborska banka on 17 December 2003.  
 Cassa di Risparmio di Trieste merged with Zagrebačka banka on 30 May 2003.  
 Splitsko-dalmatinska banka changed its name into Banka Splitsko-dalmatinska on 3 March 2004.

b Dubrovačka banka merged with Nova banka on 1 October 2004.  
 Riadria banka merged with Privredna banka Zagreb on 1 January 2004.  
 Varaždinska banka merged with Zagrebačka banka on 1 July 2004.  
 Primus banka was liquidated  
 Splitsko-dalmatinska banka changed its name into Banka Splitsko-Dalmatinska on 3 March 2004.  
 Splitska banka changed its name into HVB Splitska banka on 21 April 2004.  
 Brodsko-posavska banka changed its name into Vaba banka on 27 December 2004.

c Privredna banka - Laguna banka merged with Privredna banka Zagreb on 1 January 2005  
 Zagrebačka banka merged with Dresdner bank Croatia on 1 July 2005  
 Krizevačka banka was liquidated

Nova banka changed its name into OTP banka Hrvatska on 1 September 2005

d Podravska banka merged with Požeška banka on 1 July 2006.

## 9.4 Serbia

Table 83 - Data Used; Source: Serbian National Bank (2008)

Serbia (in RSD bn)	2003	2004	2005	2006
Banking system	451.9	615.0	914.2	1,274.3
Leasing houses	n.a.	23.0	51.8	67.7
Insurance companies	n.a.	5.5	5.3	4.3
Net assets of voluntary pension funds	n.a.	n.a.	n.a.	3.0
# of units start of year	n.a.	n.a.	42	40
events				3 mergers <sup>a</sup>
# of units end of year	n.a.	42	40	37
units in sample	33.0	33.0	33.0	33.0
assets of sample (in RSD bn)	319.9	450.9	709.6	1,110.7
coverage in terms of units	n.a.	n.a.	n.a.	89%
coverage in terms of assets	71%	73%	78%	87%
input 1: client deposits	200.6	312.2	534.0	772.3
input 2: capital and reserves	70.9	85.2	114.0	206.2
input 3: total operating expense	22.5	45.0	41.4	49.6
customer loans	217.3	328.6	491.1	585.3
loan loss provisions	(51.3)	(71.0)	(96.4)	(66.9)
output 1: net loans	167.6	257.6	394.7	518.9
output 2: profit	(0.9)	(3.8)	7.8	15.1
FX rate end of period (RSD / €)	0.01	0.01	0.01	0.01

a Nacionalna stedionica – banka a.d. merged with EFG Eurobank a.d. Beograd and its name was changed to Eurobank EFG stedionica a.d. Beograd

Niska banka a.d. Nis in Q1 2006, in Q4 OTP Bank RT from Hungary acquired another two domestic private banks – Kulska banka a.d. and Zepter banka Beograd

In Q4 2006, privatization of Vojvodjanska banka was completed by the sale of this bank to National Bank of Greece a.d. Beograd. As three state banks were privatized in 2006

## 9.5 Turkey

Table 84 - Data Used; Source: Banks Association of Turkey (2008)

Turkey (in TRY bn)	2003	2004	2005	2006
total assets banking system	255.00	313.80	406.90	499.50
total investment funds / brokers	22.60	27.10	34.70	27.70
total assets insurance companies	10.90	14.00	20.10	24.60
total assets leasing, factoring & consumer finance companies	8.70	12.30	13.90	19.70
# of units start of year	59	55	53	51
# of units end of year	55	53	51	50
units in sample	45	45	45	45
assets of sample	240.2	295.7	382.1	484.8
coverage in terms of units	82%	85%	88%	90%
coverage in terms of assets	94%	94%	94%	97%
input 1: client deposits (€bn)	84.3	142.4	181.9	222.6
input 2: capital and reserves (€bn)	22.1	33.7	38.0	41.2
input 3: total operating expense (€bn)	6.1	8.0	10.6	10.4
customer loans (€bn)	46.9	78.3	113.5	160.4
loan loss provisions (€bn)	(3.3)	(4.0)	(4.8)	(5.3)
output 1: net loans (€bn)	43.6	74.3	108.7	155.1
output 2: profit (€bn)	4.3	6.6	6.5	10.0
FX rate end of period (TRY / €)	0.57	0.55	0.63	0.54