BANK MERGERS AND ACQUISITIONS IN UKRAINE: EFFICIENCY EFFECTS AND IMPLICATIONS

by

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Abstract

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In the thesis we try to evaluate the efficiency effects of mergers and acquisitions for Ukrainian banks. We use DEA estimator to estimate efficiency of banks and compare efficiency of banks that took part in the consolidation before and after the merger occurs. We also use the truncated regression with bootstrap to estimate relationship between the efficiency of bank and different factors such as size, risk, specialization, involvement into the merger, ownership. Our findings show that there is a negative dependence between the fact of the merger and efficiency of the bank; we also conclude that merger can indirectly affect bank efficiency through changes in its size, ownership and specialization.

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Chapter 1

INTRODUCTION

During 1991-2003 about 20 bank mergers and acquisitions (M&A) have taken place in Ukraine. Bank merger is an event, when "previously distinct banks are consolidated into one institution" (Piloff and Santomero, 1997), acquisition is a take-over of a smaller bank by a larger one (Sobek, 2000).

In the nearest future we can expect an increase in the number of bank consolidations in Ukraine due to several reasons:

- *Low level of capitalization of Ukrainian banks*. According to the rating "Top 1000 World Banks" in "The Banker" journal there was a considerable increase in size of banks in the world in 2004. One of the main reasons for this is the steady stream of mergers and acquisitions in the world. The journal notes that the size of smallest banks in the Top 1000 has increased dramatically ($172 mln in 2004 comparatively to $153 mln in 2003). Journal also notes the expansion in the capital of banks in the Central and Eastern Europe. In the Poland (the country with which Ukraine has strong economic relationship) 19 largest banks have capital exceeding $9 bln which is more than 4 times larger then the whole Ukrainian banking system capital in 2004 (approximately $3 bln)! With such a low level of capital it will be very difficult for Ukrainian banks not only to get access to foreign financial markets, but even survive in competition in Ukraine in case foreign banks are allowed to come into the Ukrainian financial markets without restrictions (which is expected in the nearest future). Consolidation first of all leads to increase in the

capital of the bank, so Ukrainian banks will tend to merge if they want to be internationally competitive.

- *Large number of small regional banks,* which can be bought by large ones to increase their power in regions.

Yildirim and Philippatos (2002) indicate that due to developing stage of money and capital markets in transition countries, these states have primarily bank-based financial system. Banks play an important role in providing firms with the capital in all countries, but in transition countries this is often the main capital source for businesses. The healthy banking system makes it possible for the Central Bank (National Bank of Ukraine – NBU) to conduct its monetary policy effectively. Thus, the efficiency of banking system in Ukraine has a significant impact on growth and stability of the country's economy. This is why events, such as mergers and acquisitions, which supposed to have direct influence on efficiency of banks, should be of the main concern of the theoretical and empirical studies. At the same time there is no empirical research studying efficiency effects of the bank mergers and acquisitions in transition countries and in Ukraine in particular.

In the thesis we determine how bank M&A influence efficiency of banks. In the literature efficiency is defined in several ways. According to Amel et al (2002) a firm is cost efficient, if it minimizes costs for a given quantity of input, and it is profit efficient, if it maximizes profits for a given combinations of input and output. Taking technology and size as given, estimation focuses on how production factors are combined, by comparing a firm actual costs or profits with the costs or profits of the best practice institution. In the thesis we will use the concept of technical efficiency proposed by Farell (1957). The main attention of this paper is paid on efficiency changes of merged banks relatively to efficiency of other banks. This paper contributes to the field, since as Berger (1999) notes, although there are a lot of papers dedicated to estimation of the impact of merger

on the efficiency of the engaged banks, results are very ambiguous: some show increase in efficiency scores, while other demonstrate evidence of efficiency decline after the merger. Hence, further investigation on this topic is needed.

Moreover, despite the huge number of studies dedicated to estimating banks' efficiency, only few of them analyze the sources of inefficiencies. Here we try to determine what factors affect efficiency scores, thus finding ways for banks to increase their efficiency.

Due to changes in accounting standards only data from 1998 is available. There are quarterly observations for 7 years on 8 mergers. Non-merged banks are also included in the sample to see relative changes in efficiency scores among merged and non-merged institutions.

The rest of the thesis is organized as follows. Chapter 2 reviews literature related to banks' efficiency estimation and bank mergers and acquisitions in different countries. Chapter 3 presents the methodology used to perform the empirical estimation. Chapter 4 presents results of empirical estimation. Chapter 5 concludes and describes directions for further research.

Chapter 2

LITERATURE REVIEW

There exist a large number of papers dedicated to bank mergers or mergers of other financial institutions, as well as banks' efficiency measurements.

Studying the causes of bank M&A, researchers note two main motives: the value-maximizing motive and non-value maximizing motive. The first one refers to increasing market power in setting prices or to increase in efficiency due to the merger (Berger et al., 1999). This research shows that increased market concentration can influence the banks' market power in setting prices. But this argument is valid only for substantial increase in concentration, and thus can be a cause for M&A primarily for large banks. At the same time potential gains in efficiency can be an important reason for M&A. It was shown that large and more efficient banks tend to acquire less efficient banks, which have a potential to increase efficiency (Vander Vennet, 1997; Berger and Humphrey, 1992). Non-maximizing value motives include managerial objectives and the role of government. Berger et al. (1999) refer to empire-building resulting usually in higher managers' compensation as one of managerial goals of M&A. At the same time if managers own a large share of potential target bank, they are more likely to try to prevent the outside acquisition, than if they left after the merger (Hadlock et al, 1999). The role of the government in M&A decision is in its ability to restrict or permit some types of mergers. Thus, international mergers are usually legally limited as well as mergers between banks and other firms (Berger et al., 1999).

Bank of International Settlements (2001) investigates motives for bank consolidation in ten countries. Economies of scale is singled out in this research as the main reason for M&A. External factors also play important role in forcing M&A in different countries. For example, removal of interstate branching permission pushed consolidation in USA (Berger et. al (1999), also obviously that European integration influence consolidation processes in European countries.
There is not much research in the field of bank mergers in Ukraine. Stepanenko (2004) tried to describe main reasons that influence bank's decision about the merger. Two main of them are urging to increase market value of a bank and – not so usual for developed countries - increasing lobby potential of merged banks.

Since this paper concentrates primarily on estimating efficiency effects of M&A, literature on estimating efficiency of banks and other financial institutions should be also reviewed. Berger and Humphrey (1997) make a survey of about 130 studies of efficiency of different financial institutions. There are two approaches of measuring efficiency: parametric and non-parametric. Their main differences are in the assumptions concerning functional form of the frontier, random error, probability distributions for inefficiencies. Nonparametric approaches include Data Envelopment Analysis (DEA) and Free Disposable Hull (FDH). DEA is a linear programming technique, which does not impose restrictions on the functional form of the frontier. Observations with the highest outputs (given inputs level and technology) or lowest inputs (given outputs level and technology) are considered as a frontier observations. The efficiency frontier is formed as a convex combination of these observations. FDH is a special case of DEA, which assumes that points on lines connecting best-practice observations are not counted as a part of the frontier. The main disadvantage of non-parametric approaches is that it assumes no random error. So, such issues as measurement errors, accounting inaccuracies, different shocks, which can make a firm to

deviate from the frontier are not taken into account. Parametric approach (Stochastic Frontier Analysis – SFA, Thick Frontier Approach - TFA) solves this problem by splitting residual into the random and inefficiency component; however it also has a disadvantage of imposing a specific functional form on the frontier.

Berger and Humphrey (1997) state that there are difficulties in choosing particular approach, since real efficiency estimates are not known, so it is not possible to say which approach estimates it better. In their study of the existing literature on financial institutions efficiency estimation, they found that there is approximately equal division between choices of parametric or non-parametric approaches (69 studies use non-parametric approach, 60 – parametric one). Usually researches use DEA or SFA (or both) in their studies. For example, Drake (2001) uses DEA to estimate efficiency in Japanese banking, so does Shepetko (2004) in her study of efficiency of Ukrainian banks. Limam (n.d.) uses SFA to estimate efficiency of Kuwaiti banks. Cummins (n.d.) uses both DEA and SFA to estimate performance of insurance companies. Berger and Mester (1997) not only estimate efficiency of financial institutions using parametric methods, but also look at how the estimates differ across estimation procedures used. They use three economic efficiency concepts estimating cost standard profit and alternative profit efficiencies. Their findings show that efficiency estimates are different among all these concepts, since each off them involves additional information. At the same time average efficiency and individual firm ranking are quite robust to differences in methodology.

One peculiarity of estimating efficiency of financial institutions was noted by Shepetko (2004). She distinguishes three different approaches of choosing inputs and outputs for the financial industry: production approach, intermediation approach, and value-added approach. The difference among them is in view of

the role of the bank and consequently its inputs and outputs. Table 1 describes all three approaches.

Table 1.

Approaches to definition of banks' outputs and inputs*

	role of the bank	*inputs*	*outputs*
production approach	Production of the services for account holders	Labour, capital	Processed documents, transactions
intermediation approach	Intermediary between savers and investors	Deposits, other funds, labour and physical capital	Loans, other investments
value-added approach	Conventional business entity	Labour, physical capital, purchased funds	Deposits, loans

*Based on Shepetko (2004)

A lot of studies are dedicated to estimation of banks' efficiency in transition countries. Fries and Taci (n.d.) and Yildirim and Philippatos (2002) for example perform a cross-country estimation of efficiency of banks in transition countries. The main attention in such studies is usually paid to connection between ownership (state owned banks, private (domestically owned, foreign-owned) banks) and efficiency, and size and efficiency. Efficiency of banks of one particular post-communist country is also subject to many studies. As some examples studies of banks' efficiency in Croatia (Kraft and Tirtiroglu, 1998) Czech Republic (Matousek and Taci, 2002), and Poland (Nikiel and Opiela, 2002) can be pointed out.

Shepetko (2004) performed a study of Ukrainian banking system with the main attention on efficiency of Ukrainian banks. In her paper she describes the most

important characteristics of banking system in Ukraine, such as: nature of banks' product, growth of the market in recent years, entry barriers, ownership structure, and industry concentration. To estimate efficiency of Ukrainian banks she uses DEA approach. The main findings of this research are:

- there is a tendency of increasing efficiency over time,
- large and medium banks in Ukraine on average perform better than small banks, but there is a convergence in efficiency between these two groups.

Besides a huge number of studies concerning efficiency of banks, there is also a bulk of studies dedicated to estimation of efficiency effects of the merger. Berger et al. (1999) perform an extensive study on the existing literature concerning efficiency consequences of the consolidation of financial institutions and banks in particular. They indicate that early studies of efficiency effects of mergers find that there is no substantial improvement for efficiency after the mergers and some even find negative relations between bank efficiency and mergers. The usual assumption for the early research was translog functional form of the average cost curve (U-shaped). On the other side, more recent research received different results. That is, it indicates that this can be a substantial improvement in banks' efficiency after the merger. Below we describe findings of some interesting studies.

Berger (n.d.) studies consequences of mergers for efficiency. He studies different types of financial integration: integration within a single category of products, integration of financial organizations with different types of products into multi-type institutions, and international integration. He finds that there is a potential to increase efficiency, but not all this potential can be realized. He also finds that it is more likely to have improvements in profit efficiency, while cost efficiency does not change substantially after the merger. These findings are consistent with the results of the following paper.

Akhavein et al. (1997) use the frontier profit function to study the effect of mergers on efficiency. In their paper they use data of megamergers. They found that after the merger banks on average have higher profit efficiency than before the merger. They argue that this improvement arises due to changes in output that takes place after the merger. One of the reasons for the efficiency improvement is also improvement in diversification of the risk, and as a result shifts to more profitable assets. Authors argue that such improvement could be predicted by so called Relative Efficiency Hypothesis, under which acquiring banks usually bring target banks to the same level of efficiency as they have themselves. So, if there where large differences in profit efficiencies among bidders and targets, it is natural to expect substantial gains in efficiency. In turn Low Efficiency Hypothesis predicts improve in efficiency after the merger if both firms before the merger had low efficiency, so "merger event itself have the effect of "waking up" management" to use bank's potential.

Diversification of the risk also can make a contribution to efficiency score of the bank after merger. Thus, Hughes et. al (1999) examine how consolidation can influence such indicators of banks' activity as expected profit, the riskiness of it, profit efficiency, market-value efficiency. Findings of this research show that there are stronger efficiency gains for banks that are engaged in interstate consolidation resulting in diversification of not only usual banks' risks, but also banks' macroeconomic or state-specific risk.

Cuesta and Orea (2002) concentrate not only on estimating efficiency of merged and non-merged banks, but also study whether they have different temporal patterns. They find that there are indeed differences in changes of the efficiency scores in the course of time between these two types of banks. As for changes in

the efficiency scores after the merger, their findings do not support expectations of increase in efficiency due to consolidation.

Although the majority of above described articles find efficiency improvements due to mergers, Amel et. al (2002) find that there are efficiency gains only for small banks, since they have an economies of scale in case of the merger. The evidence for scope and managerial efficiency improvements due to the merger was not found. Therefore, despite the numerous research in this field, it is still some ambiguity in determining whether there can be expected a substantial improvement in efficiency after the merger.

To our best knowledge there are no studies on efficiency changes after the mergers for transition countries and for Ukraine in particular. Stepanenko (2004) proposes a description of the most important bank mergers in Ukraine and reports changes in the capital of merged banks, but it is not clear whether such increase in capital positively affects efficiency of banks.

The DEA approach used for estimation of banks' efficiency in this paper will allow us to compare efficiency score of a bank before and after it took part in a consolidation process and to make conclusion whether the merger affects efficiency of the bank. At the same time other factors influence changes in efficiency and the merger is only one of them. For the purpose of identification of such factors we use the regression analysis, which will show whether the fact of the merger have an important influence comparatively to other factors on the efficiency score of the bank. There is not a lot of research trying to explain sources of banks' inefficiencies. Thus, Hauner (2004) estimates efficiency of German and Austrian banks and then tries to explain sources of differences in efficiency scores for these groups of banks (Austrian banks turned to be less efficient than German). For this purpose he regresses cost-efficiency on several

explanatory variables (such as size of the bank, riskiness of assets, ownership, etc.), which theoretically can influence banks' efficiency. One interesting paper that investigates the sources of inefficiencies of Ukrainian firms is Zelenyuk and Zheka (2004). They use the algorithm of obtaining unbiased estimators of regression coefficients developed in Simar and Wilson (2004). In the algorithm bootstrap methodology is used to find first the bias corrected estimators of the technical efficiency scores, and then to correct regression coefficients for the bias.

Chapter 3

METHODOLOGY AND DATA DESCRIPTION

To estimate efficiency of banks in this research we use the Data Envelopment Analysis, which is widely used in many studies evaluating the efficiency of decision making units (DMU) for different industries. This approach was initially introduced by Farrell (1957) and further developed by Fare et al. (1985). The choice of DEA approach over parametric approach such as Stochastic Frontier analysis is explained by the requirement to specify a particular profit function in case of using SFA with indication of output prices, which is not available. At the same time DEA approach imposes little structure on the best-practice frontier and does not requires the above mentioned information. Simar and Zelenyuk (2003) have shown that DEA efficiency estimators are consistent maximum likelihood estimators of true efficiencies of DMUs with distribution asymptotically equal to true distribution of efficiency scores.

To explain the essence of DEA approach we assume that there are n banks in the industry, and each bank produces M outputs $y^k=(y^k_1,\ldots,y^k_M)$ using N inputs $x^k=(x^k_1,\ldots,x^k_N)$. The technology of the industry can be characterized by the following set:

$T^k=\{(x^k,y^k) : x^k \text{ can produce } y^k\}$,

or alternatively by output set

$$P^k(x^k)=\{y^k: x^k \text{ can produce } y^k\},\ x^k \in R^N_+,$$

and input set

$L^k(y^k)=\{x^k: x^k \text{ can produce } y^k\},\ y^k \in R^M_+$

There are some regularity axioms that the technology set should satisfy to make it possible to construct any efficiency estimator for DMUs:

A1. $y \notin P(0_N), \forall y \geq 0_M$.

This axiom says that is not possible to produce any positive amount of output from zero input.

A2. $0_M \in P(x), \forall x \in R_+^N$.

This means that it is possible to produce nothing from the positive amount of inputs.

A3. P(x) is a bounded set for all $x^k \in R^N{}_+$.

A4. T is a closed set for all $x^k \in R^N{}_+$.

A5. Free disposability of all inputs and outputs: if $(x^0, y^0) \in T$ then $(x\ , y\ ) \in T$ for all x $\geq x^0$, y $\leq y^0$.

Giving that technology set satisfies all these axioms we define the output oriented Farrell technical efficiency measure as

TE (x,y) = max $\{\theta : \theta y \in P(x)\}$, $y \in P(x)$

We can define the frontier of the output set as

∂ P(x) = {y: $y \in P(x), \theta y \notin P(x), \forall \theta \in (1, \infty)\}$, $y\ \in R^M{}_+$

If $y^j \in \partial P(x^j)$, the j-th bank is efficient having the efficiency score equal to one, if $y^j \in P(x^j)$, $y^j \notin \partial P(x^j)$, $y^j \neq 0$, the j-th bank is technically inefficient from the output point of view having the efficiency score in the range (1, ∞).

Although in practice we can not observe true technology set, we can construct the one that depicts it using the observed data. Two main assumptions for this are:

- All firms have access to the same technology,
- All observed combinations of inputs and outputs are feasible under T.

We also assume that technology possesses following properties:

- Additivity: if $(x^k, y^k) \in T$ and $(x^j, y^j) \in T$ then $(x^k + x^j, y^k + y^j) \in T$;
- Free disposability of all inputs and outputs: if $(x^0, y^0) \in T$ then $(x\ , y\ ) \in T$ for all $x \geq x^0$, $y \leq y^0$;
- Constant or variable returns to scale: if $(x^k, y^k) \in T$ then $z^k(x^k, y^k) \in T$ for all $z^k \geq 0$ if we assume CRS, and for all $z^k \geq 0$ such that $\sum_{k=1}^{n} z^k = 1$ for VRS.

Here z is a positive scalar, needed to show that if x is in the set then every contraction or expansion of it is also in the set under CRS; under VRS restriction for z ensures that if x and y is in the set, then every linear combination of x and y is also in the set.

Thus, assuming VRS, technology set will be defined as

$$\hat{T} = \{(x,y): y \leq \sum_{k=1}^{n} z^k y^k\ ,\ \sum_{k=1}^{n} z^k x^k \geq x\ ,\ z^k \geq 0,\ \sum_{k=1}^{n} z^k = 1,\ k=1,\ldots,n\}.$$

Corresponding output and input set are:

$$\hat{P}(x) = \{y: y \leq \sum_{k=1}^{n} z^k y^k\ ,\ \sum_{k=1}^{n} z^k x^k \geq x\ ,\ z^k \geq 0,\ \sum_{k=1}^{n} z^k = 1,\ k=1,\ldots,n\} \text{ and}$$

$$\hat{L}(y) = \{x: y \leq \sum_{k=1}^{n} z^k y^k\ ,\ \sum_{k=1}^{n} z^k x^k \geq x\ ,\ z^k \geq 0,\ \sum_{k=1}^{n} z^k = 1,\ k=1,\ldots,n\}$$

These estimators of technology can be used to calculate the DEA-estimator of Farrell output oriented technical efficiency score of bank j, which is equal

$$T\hat{E}(x^j, y^j) = \max_{\theta, z_1, \ldots, z_n} \theta$$

subject to

$$\sum_{k=1}^{n} z^k y_m^k \geq \theta y_m^j, \text{ m=1, …, M}$$

$$\sum_{k=1}^{n} z^k x_i^k \leq x_i^j, \text{ i=1,…, N}$$

$$\theta \geq 0, z^k \geq 0, \sum_{k=1}^{n} z^k = 1, \text{ k=1,…, n.}$$

Efficiency score of one show that the bank is technically efficient or that it is on the best-practice frontier, which we estimate as

$\partial \hat{P}$ (x) = {y: $y \in \hat{P}(x), \theta y \notin \hat{P}(x), \forall \theta \in (1, \infty)$ }, $y \in R^M{}_+$.

To estimate the efficiency scores of the bank, inputs and outputs should be specified. This in turn requires the choice of approach from three indicated in the previous chapter. As it was noted, every approach determines inputs and outputs according to the role of the bank. We prefer the intermediation approach over the production and value-added approaches due to significant role of banks in the economy of Ukraine as a transition country. The efficiency of the bank as an intermediary between savers and investors determines the efficiency of the economy in distributing and using temporarily free capital. Thus, it is more important to determine whether bank efficiently distributes the resources than whether it efficiently produces services for account holders (production approach) or increases its own value (value-added approach). According to the intermediation approach deposits, other funds, labor and physical capital are treated as inputs, while loans and other investments as outputs.

The second choice should be made between the output and the input orientation of the model. According to the first orientation we will estimate whether the bank

produces maximum possible amount of output given inputs and technology, and if we choose input orientation we are to determine whether bank minimizes inputs keeping outputs and technology fixed. Zelenyuk (2004) argues that the choice of orientation should be based on the industry specific facts. Concerning the banking system we consider the output orientation to be more appropriate, since as Shepetko (2004) notes inputs of banks are usually fixed and banks are not able to change them in the short run (for example, the amounts on the deposit accounts are fixed in the contracts and can be changed only in special cases), while the amount of loans and other investments are under banks' control. One more argument for output orientation lies in the importance of banks for the financial sector of Ukraine. Since banks are almost the only source of capital for Ukrainian firms it is highly important for banks to be able to distribute the maximum possible amount of capital in the economy, and by decreasing the amount of inputs banks limit their possibility to lend. That is why the aim of banks should not be to minimize inputs given outputs, but to maximize outputs given inputs. This explains our choice of output orientation of the model.

It should be stressed that in the way described above we can obtain an estimator of true efficiency score; and the latter one is still unknown to us as well as its sampling distribution. At the same time it is possible to recover this distribution from observed data and obtain bias corrected estimates using technique described in Simar and Zelenyk (2003). The main idea here is that we treat the observed sample as a pseudo-population and learn its properties by using sub-sampling technique (we treat the sub-samples randomly chosen from our pseudo-population as pseudo-samples). Kneip, Simar and Wilson (2003) show that bootstrap is consistent for sub-samples smaller than the original sample. Thus, the following is true:

$$T\hat{E}^{*} - T\hat{E} \mid \hat{\wp} \overset{asy}{\sim} T\hat{E} - TE \mid \wp \text{, where}$$

$\hat{TE}^*$ - the estimate of efficiency score obtained using bootstrap technique,

$\hat{TE}$ - the estimate of efficiency score,

TE - the true (unknown) efficiency score,

$\wp, \hat{\wp}$ - data generating processes for distribution of observed sample and randomly chosen sub-samples respectively.

Since this thesis is dedicated to evaluation of the merger effects on the efficiency of banks, we estimate efficiency score for the whole banking industry for different periods, correct them for the bias, and then compare the efficiency scores of banks engaged in the consolidation before and after the merger took place. This enables us to see whether there is any impact of the merger on the efficiency score of the merged banks compared to the whole banking system. In this manner we can evaluate how merger affects efficiency of each bank that took part in the process of consolidation.

We also use the methodology of aggregation of efficiency scores over groups that was developed by Fare and Zelenyuk (2003). They proposed a way of aggregation using the weighted average technique, which uses weights received taking into account the basic economic principle of optimization. Although the method has very intuitive explanation (weights are revenue share of the banks in the sub-group), it has one disadvantage that makes it impossible to use in this research: it needs information on prices. But the solution was proposed by Simar and Zelenyuk (2003) who developed methodology of aggregation using price independent weights. We use this method in the thesis and describe it below.

We can call sub-group of merged banks j with n_j banks included. Let $x^{j,k}=(x_1^k,...,x_N^k)$ be the input vector of the k bank in the sub-group j, and

$y^{j,k} = (y_1^k, ..., y_M^k)$ be its output vector. The aggregate technical efficiency of the subgroup m can then be measured as

$$TE^j = \sum_{k=1}^{n_j} TE^{j,k}(x^{j,k}, y^{j,k}) \cdot S^{j,k},$$

where

$TE^{j,k}$ - the technical efficiency score of the k's bank in the sub-group j;

$S^{j,k}$ – weights calculated as

$$S^k = \frac{1}{M} \sum_{m=1}^{M} w_m^k,$$

where

$w_m^k = \frac{y_m^k}{\bar{Y}_m}$ - the share of firm k in the sub-group j in terms of m^{th} output

$(\bar{Y}_m = \sum_{k=1}^{n} y_m^k)$.

Thus, having estimated the efficiency scores of each bank in the subgroup we can obtain the efficiency score of the whole subgroup by constructing weighted average of the individual scores with weights being the share of the output of the bank in the output of the sub-group. We use this aggregation technique to obtain the aggregate efficiency score of bidder and target before the date of the merger (when the information on both banks is obtainable).

The next step of research is to determine what bank specific variables affect efficiency score of the bank in order to see whether the merger effect is significant for efficiency score (in case we are able to make a conclusion that merger does affect efficiency from the calculations described above). Following Zelenyuk and Zheka (2004) we adopt the following specification of the model:

$TE_j = Z_j\beta + \varepsilon_j$, j=1,…,n, where

Z_j is the row vector of bank-specific variables for j's bank;

β - vector of parameters to be estimated;

ε_j – statistical noise.

Hauner (2004) investigates the dependence of efficiency scores of banks on the following factors (some of them usually change after a merger, so their impact to some extend can also be considered as the impact of the merger):

- *Ownership of the bank*: We suppose that state-owned banks are to be less efficient then private banks, since there are less incentives for them to use inputs in the most efficient way; at the same time it is expected that foreign owned banks are more efficient than domestically owned ones due to better access to markets with cheaper resources;
- *Size of the bank*: Shepetko (2004) showed that on average large banks perform better than small ones. Thus, if we see that the merger affects the efficiency score of the bank, this change can also be explained by increase of the size of the bank;
- *Specialization of the bank*: After the merger the activities of the bank can become more diversified, which can influence its efficiency scores;
- *Riskiness of bank's assets:* The riskier are assets the more reserves should be formed by the bank to protect clients and itself from failure. Since reserves are formed from the amount of attracted deposits (inputs) and provide no interest, we expect the negative dependence between the riskiness of assets and banks efficiency;
- *Structure of funding:* Some characteristics of attracted funds (for example, term to maturity) can affects bank's ability to allocate these funds in a most efficient way;
- *Involvement in the merger:* We expect the dummy for merger to have significant coefficient (but the sign is ambiguous, and we are going to determine it in the research).

As shown in Simar and Wilson (2004) the most appropriate approach in estimating such type of model is a truncated regression with bootstrap. In this paper we replace the unobserved technical efficiency score by the bias-corrected estimate TE_j^{bc}, which we obtain trough the bootstrap procedure. Also since TE cannot exceed one, ε_j should satisfy the condition $\varepsilon_j \geq 1 - Z_j\beta$. Simar and Wilson (2004) assume that the distribution of ε_j is truncated zero-mean normal with unknown variance, and we will use this assumption in the estimation. As in Zelenyuk and Zheka (2004) we estimate the following model using the maximum likelihood method:

$TE_j^{bc} \approx Z_j\beta + \varepsilon_j$, j= 1,…,n,

where

$\varepsilon_j \sim N(0, \sigma_\varepsilon^2)$, such that $\varepsilon_j \geq 1 - Z_j\beta$, j= 1,…,n.

After this estimation we can obtain the bootstrap confidence intervals for estimates of parameters $(\beta, \sigma_\varepsilon^2)$ using parametric bootstrap. The algorithm for such estimation and inference is completely described in Simar and Wilson (2004). [1]

DATA DESCRIPTION

The data is obtained from the official issues of National Bank of Ukraine "Visnyk NBU" and covers period from 1998 to 2004. The data set includes quarterly information on the most important indicators of banks' activity (loans, reserves, deposits, capital) taken from balance sheets of banks. There are about 150 observations in each quarter and information on 8 mergers is available.

[1] Authors propose two algorithms in their paper; here we use Algorithm 2

As we discuss above, for the estimation of efficiency scores of Ukrainian banks we follow the intermediation approach. Outputs and inputs used for DEA estimation are described in the table below:

Table 2.

Model specification for efficiency estimation

Outputs		***Inputs***	
Variable	**Description**	**Variable**	**Description**
Earning assets	Securities and other earning assets	Purchased funds	NBU funds, budget funds, interbank credits
Loans	Loan portfolio	Deposits	Households and firms deposits
		Physical capital	Physical capital

Here we use result by Shepetko (2004) who has shown that labor and physical capital are highly correlated, which can be explained by the necessity to increase physical capital when the number of employees and consequently labor expenses increase. Thus, the physical capital can be used as a proxy of labor. But we also can use physical capital as an input by itself and note that information about labor input is incorporated into the model due to its high correlation with physical capital.

We also should note here that due to data limitations in our estimation we do not account for loans that were not repaid to the bank. The information about loan loss reserves (which we can use as a proxy for "bad loans") is available only for 5 quarters. But in the regression analysis we take riskiness of assets into consideration by using data only for these quarters modes estimation.

Since we assume different technology frontiers for each quarter there is no sense to present descriptive statistics for inputs and outputs pooled for all quarters. We present quarterly descriptive statistics in the appendix (Appendix 2).

To evaluate the merger effects we run truncated regression with the efficiency score as the dependent variable. We described the factors that supposedly affect the efficiency of the bank above. In the following table we present the descriptive statistics for all the variables used in the estimation.

Table 3.

Description of variables in regression analysis

Factor	Variable	Description	Descriptive statistics	
			Mean	Standard deviation
Size of the bank	Size	Total assets (UAH thousands)	364265.1	858830.9
Ownership of the bank	State	Dummy: 1 for state owned banks (100% of state ownership), 0 otherwise	0.014	0.116
	Foreign	Dummy: 1 for foreign-owned banks (more than 50% of foreign ownership), 0 otherwise	0.110	0.313
Riskiness	Risk	"Loan loss" reserves per unit of total assets	0.057	0.051
Specialization of the bank	Spec	Herfindahl index of loans and securities in bank's portfolio	0.467	0.169
Structure of funding	STL	Short-term liabilities (UAH thousands)	98594.5	325298.3
	LTL	Long-term liabilities (UAH thousands)	96935.1	237841.9
Involvement in the merger	Merger[2]	Dummy: 1 for banks that merged with another, 0 otherwise	0.061	0.240

[2] Merger dummy constructed as 1 in the quarter of merger and afterwards, 0 before

Chapter 4

EMPIRICAL RESULTS

In this chapter we present the main results of estimation. Here we follow the order outlined in the previous chapter.

First, the estimation of technical efficiency scores for all banks in all quarters during 1998-2004 (except Q4 of 1998 and Q4 of 2004 data on which is not available) was done. Since DEA estimator used to get the efficiency scores is biased we used the bootstrap technique to correct obtained scores for the bias.

After that we selected the efficiency scores for banks that were merged during the observed period and constructed graphs depicting the change in the efficiency score for the bidder bank. We present graphs for each merger in the appendix (Appendix 1). For each merger there are two graphs. One depicts efficiency score changes only for the bidder bank with the indication of the merger date. The second one was constructed by the following logic: after the merger we have only one bank, and only its efficiency score can be estimated, while, before the merger we have two different banks with different efficiency scores. Thus, to take into account efficiency score of the target bank (which is not observed after the merger, but exists before it) we can construct an aggregated efficiency score for the bidder and the target and compare this score with the one after the merger. To aggregate the scores we use price independent weights described in the previous chapter.

As can be seen from the graphs, for the majority of banks there is not much difference between the pattern of efficiency scores of the bidder bank alone and the aggregated efficiency score of bidder and target before the merger. This can be explained by the significant difference in the size of bidder and target in the proposed examples. Since weights are constructed with respect of the share of each bank in each output, small targets do not contribute much in the aggregated efficiency scores. At the same time when sizes of the bidder and the target are close to each other we can note that the pattern of efficiency score of the bidder alone can be different from the aggregated efficiency score (this is the case of Ukrgazbank-Ukrnavtogazbank and "International Commercial Bank"-"Tavriya"). This leads us to expect that if the target is small relative to the bidder the influence of the merger on the bidder efficiency will not be significant (we can treat the bidder bank after the merger as a "composite" bank, which efficiency score is the aggregate efficiency of bidder and target constructed with the relevant weights described above).

At the same time looking at the efficiency scores of the bidder we can not make any conclusion about merger efficiency effects, since in some cases we can observe increase in efficiency after the merger, while in other efficiency decreases. In table 4 we compare average (unweighted) efficiency scores for buyers and targets produced by averaging scores for each bank over the periods before the merger. From the data presented in Table 4 we can not make any conclusion about relationship between the efficiency of the target and its attractiveness for the buyer. We can see that in a half of cases target on average was more efficient then the bidder, and in the half of cases vice versa.

Table 4.

Comparison of efficiency of buyers and targets

Buyer		Target	
Name	**Average efficiency score**	**Name**	**Average efficiency score**
Avtokrazbank	2.181	Ukruniversalbank	1.408
Ukrgazbank	2.225	Ukrnaftogazbank	1.210
Bank "Aval"	1.269	Bank "Etalon"	1.602
"International Commercial Bank"	1.647	Bank "Tavriya"	2.056
Investbank	1.329	Bank "Arkadiya"	1.285
Bank "Nadra"	1.302	Bank "Slobozhanshyna"	2.056
Bank "Eurocenter"	1.385	Bank "Viktoriya"	1.252
Bank "Ukrkoopspilka"	1.256	Bank "Podillya"	1.301

At the same time the efficiency of the target before consolidation can influence the resulting efficiency of the bidder, but as we note above only in those cases, when the target is relatively large comparatived to the bidder. That is, in cases when efficiency of the target is higher than efficiency of the bidder, we can expect an increase in efficiency of the buyer after the consolidation took place. Similarly, the efficiency of the buyer is expected to decrease, if it buys a less efficient bank. In our case there are only two mergers where targets and bidders were of approximately the same size: Ukrgazbank - Ukrnaftogazbank and "International Commercial Bank" – Bank "Tavriya". We can see from the Table 4 that in the first case target was more efficient than the bidder, while in the latter one target had higher efficiency score. From the Appendix 1 it is also evident that efficiency of Ukrgazbank increased after the consolidation in comparison to itself and to itself and Uknaftogazbank aggregated efficiency before the merger (it has slightly decreased right after the merger date, but then there is a tendency of efficiency to

rise), but it is no clear evidence of efficiency change of "International Commercial Bank" following the purchase. Unfortunately, it is hard to make any conclusion on the basis of two examples to confirm or reject our hypothesis.

Of course, not only the fact of the merger influences efficiency of the bank, other factors affect it as well. As we stated in the previous chapter to investigate this issue we run the truncated regression to discover factors that lead to changes in the efficiency score of the bank. We specify the model in the following way:

$TE^{bc} = C + \beta_1 LOG\ (SIZE) + \beta_2 RISK + \beta_3 SPEC + \beta_4 MERGER + \beta_5 STATE + \beta_6 FOREIGN + \beta_7 LOG\ (STL) + \beta_8 LOG\ (LTL) + \varepsilon.$

But we can expect the explanatory variables to be correlated with each other, so we check for multicollinearity in the model. We obtain the following matrix of covariances:

Table 5.

Variance – covariance matrix for independent variables

	Risk	**Log (size)**	**Foreign**	**Spec**	**Merger**	**State**	**Log (ltl)**	**Log (stl)**
Risk	1.00							
Log (size)	-0.11	1.00						
Foreign	-0.23	0.12	1.00					
Spec	-0.06	-0.04	0.07	1.00				
Merger	-0.05	0.07	-0.07	0.01	1.00			
State	0.06	0.31	-0.04	-0.12	-0.03	1.00		
Log (ltl)	-0.15	**0.81**	0.02	0.08	0.06	0.21	1.00	
Log (stl)	-0.21	**0.90**	0.08	-0.04	0.10	0.28	**0.80**	1.00

There is evidence of high correlation between variables describing the bank's structure of funding and a size variable. This is quite natural, since the amount of liabilities usually determines the amount of assets. Taking this into account we

drop variables LOG (LTL) and LOG (STL) to avoid multicollinearity in the model. The final model specification is:

$TE^{bc} = C + \beta_1 LOG(SIZE) + \beta_2 RISK + \beta_3 SPEC + \beta_4 MERGER + \beta_5 STATE + \beta_6 FOREIGN + \varepsilon.$

Data on loan loss reserves is available for 5 quarters (in one quarter there is no division on short-term and long-term liabilities, but since we drop these variables, we do not need this information). Thus, the number of observations is 724 (161 banks in five periods).

Before estimating the proposed model we estimate the density of true efficiency scores. This is needed to analyze the distribution of the dependent variable, since if there are a lot of outliers in the sample the MLE estimator will be difficult to obtain because such outliers can prevent (and they do in our case) the convergence of the maximum likelihood function. For this purpose, following Zelenyuk and Zheka (2004), we use kernel density estimator (using Gaussian kernel and Sheather and Jones (1991) bandwidth). Since technical efficiency scores are bounded by one from the left we use Silverman reflection method described in Silverman (1986). The following picture present estimated density for technical efficiency scores for initial sample of banks (solid line). It is easy to note that there are some outliers with technical efficiency less then 30%. We cut the 10% right tail of the distribution, thus, reducing the sample to 653 observations. The estimated density for distribution of efficiency scores for all banks after removing outliers is also presented in the Figure 1 (solid line).

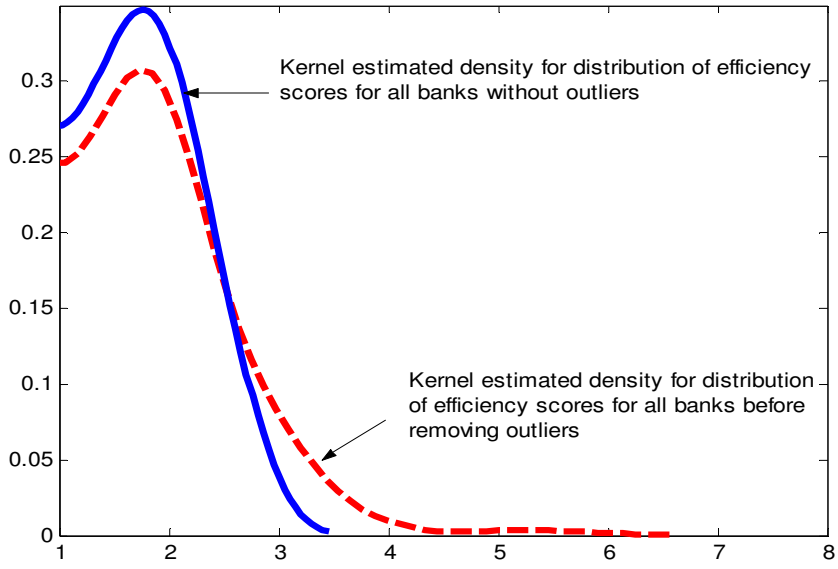

Figure 1. Kernel estimated density for all banks before and after removing outliers (724 and 653 observations respectively).

The estimation results are summarized in the following Table 6 (Specification 1). In the regression all coefficients are significant at 5% level. All coefficients except one for the merger dummy have the negative sign, which means positive influence on the bank's efficiency.

The fact that the efficiency of the bank is positively related to its size indicates the economy of scale effect in the banking industry of Ukraine. We should note that the positive dependence between size of the bank and its efficiency is in accordance with Shepetko (2004) conclusions about higher efficiency of large and medium banks in comparison with small banks.

Positive dependence between the level of bank's specialization and its efficiency has a very intuitive explanation. As bank become more specialized in one or

several types of services, it starts to find better ways of providing these services to consumers, the transaction costs may decrease, thus enabling the bank to increase the amount of output per unit of input and improve its efficiency.

Table 6.

Results of regression analysis (653 observations) [3]

Dependent variable: Technical efficiency score		
Variable	***Coefficients***	
	Specification 1	***Specification 2***
CONST	4.9303*	4.7692*
LOG (SIZE)	-0.1998*	-0.19215*
RISK	-1.6718*	-
SPEC	-0.79584*	-0.84718*
STATE	-1.1072*	-1.1918*
FOREIGN	-0.41162*	-0.38015*
MERGER	0.19452*	0.20957*
σ_ε^2	0.26731*	0.27319*

Note: *- significant at 5% level (we present estimated confidence intervals in Appendix 4)

It is also possible to explain in the context of this research the positive correlation between the level of risk and efficiency of the bank. The point here is that in the estimation of technical efficiency we do not correct the amount of loans which are used as one of the bank's output by the amount of loans that were not repaid to the bank (as noted above, the information on loan loss reserves which can be used as a proxy for "bad loans" is available only for 5 quarters). The banks that try to decrease risk usually provide lower amount of loans in general refusing to a

[3] The estimation with 100 replications for bias correction of technical efficiency score and 2000 replications for confidence intervals for the estimated coefficients

greater number of potential borrowers than do less risk-averse banks. As a result banks that agree to take more risk have more output and thus are more efficient. For the sake of completeness for five quarters, in which proxy for risk is available, we estimate efficiency correcting loans for the possible amount of loans which might be not repaid to the bank (deducting the amount of reserves from the amount of loans). The estimation results are presented in Appendix 5. We can note that coefficient for the risk variable became insignificant at 10% level, which shows that risk does not affect efficiency of the bank. Coefficient signs for other variables remain without changes.

According to the results presented Table 6, state or foreign ownership positively affects technical efficiency of the bank. We can suppose that foreign banks are more efficient due to availability of cheaper resources in the foreign capital markets, and due to better organization of the management and larger experience of banking in the market economy. The sign of the coefficient for state ownership dummy is somewhat unexpected, since state owned firms are usually considered to be less efficient than private ones. The reason for such expectation is assumed lack of motivation for state-owned firms to proceed in the most efficient way. Thus, the same result was expected for banks. But there is one fact that has to be taken into account: in Ukraine there are only two state owned banks. One of them (Oschadbank) possesses the high share of the market in the household savings (this bank is the only Ukrainian bank where individual deposits and their issue on the first request are guaranteed by the state by law) and the most dispersed branch network among all Ukrainian banks. The second state owned bank (Eximbank) services a major part of export-import operations of Ukrainian firms due to its correspondent relationships with banks in almost all countries of the world. These competitive advantages of two state-owned banks cause their higher efficiency in comparison with other banks and explain positive dependence between state-ownership and technical efficiency of the bank. One

more possible explanation for this is concentrated ownership (the state owns 100% of shares in these banks), which is considered to be good for efficiency.

The regression results show that efficiency of the bank depends on its involvement into a merger. This result is somewhat unexpected, since in the case study we can not see the clear evidence of the efficiency change after the merger.

As noted above, data on only four quarters were used in the estimation analysis due to availability of the risk variable. Although this variable appears to be highly significant, table 5 shows no high correlation between this variable and other variables in the regression. So we try to remove it to increase the number of observations in the regression and, as a result, higher precision of estimation. Results for this specification of the model are shown in Table 6 (Specification 2). We note that there is no change either in signs or in significance of coefficients; σ_ε^2 (the standard error of regression) also remains almost the same. This allows us to add observations for additional four quarters, thus obtaining the sample of 1317 observations. We do not add all the quarters, since in the algorithm for estimation of truncated regression with bootstrap we assume the same technological frontier for all observations. And if assumption about no change in technology for two years is not very strong, it is not very reasonable to assume the same technology for all 7 years in our data set. Similarly to the previous sample we estimate the density of efficiency scores for all banks and because it is also an evidence of outliers in the sample, remove 5% right tail of the distribution (in the previous case we remove 10%, since removal of 5% of outliers still does not allow us to obtain MLE estimatior). We present the visual representation of estimated densities in the appendix (Appendix 3). The estimation of the model with 1257 observations (95% of 1317) produced results reported in the Table 7.

Estimation with the larger number of observation shows the same signs for the coefficients (except for the state dummy, which turned to be insignificant); standard error of regression decreased, which is an evidence of the increased "goodness of fit" of the model. The fact that the state-dummy coefficient is insignificant even at 10 % level can be explained by the small number of state-owned banks in the sample (only two among 161 banks in each quarter).

Table 7.

Results of regression analysis (1257 observations)

Dependent variable: Technical efficiency score					
Variable	***Coefficient***	***Lower bound (5%)***	***Upper bound (5%)***	***Lower bound (10%)***	***Upper bound (10%)***
CONST	4.7390*	4.4329	5.0216	4.4797	4.9717
LOG (SIZE)	-0.5742*	-0.6280	-0.5141	-0.6207	-0.5250
SPEC	-0.2387*	-0.3777	-0.1002	-0.3522	-0.1214
STATE	0.0807	-0.1964	0.4666	-0.1551	0.3909
FOREIGN	-0.1026*	-0.1884	-0.0196	-0.1759	-0.0345
MERGER	0.1544*	0.0615	0.2524	0.0748	0.2381
σ_ε^2	0.1456*	0.1303	0.1603	0.1334	0.1583

Note: *, **- significant at 5%and 10% level

When the number of observations increases we also can note the increase in the absolute value of the size-variable coefficient and decrease in the absolute value for coefficients for other variables. Since with the larger number of observations we obtain more precise estimators of coefficients, we conclude that the size of the bank has the largest impact of on its efficiency comparatively to other parameters.

The variable of largest interest for us in the regression is the dummy for merger. We note that the coefficient is significant at 5% level and have a positive sign, which is robust to different specifications and different number of observations. The possible explanation for this negative relation between the fact of the merger and efficiency of the bank is that right after the merger bank uses its funds for financing reorganization activities and not for investment in earning assets. The inputs (recourses) of banks increase after the consolidation, output increase as well, but we can expect that it takes certain time to allocate these outputs in the most efficient way.

As supposed above, the fact that we observe a significant relationship between merger and efficiency can be explained by indirect influence of the merger on the efficiency through change in the size, specialization and ownership. But since in the case of merger size of the bank increases and this should positively affect efficiency of the bank, the negative relation between merger and size can not be explained by its influence on the size. Rather due to very small size of targets in our sample comparatively to the bidders' size, we conclude that the change in the size is not large enough to overweight negative influence of the merger itself. Amel et al. (2002) conducting a survey of the merger effects also underline this feature of mergers: "organizational diseconomies of scale could offset and gains in scale efficiencies arising from technologies".

Amel et al. (2002) also note that it is difficult to see any gains from merger, if the post-merger period under investigation is short. Cuesta and Orea (2001) investigating the differences in temporal patterns of efficiency scores for merged and non-merged banks find that right after the merger efficiency of merged banks decrease substantially in comparison to non-merged banks. Efficiency starts to recover in their case in four years after the merger, but still is less then efficiency of non-merged banks even in eight years after the consolidation. We have

information for only a short period after the merger. This can explain the fact that negative influence of the merger on efficiency in our case is observed

Thus, our conclusion obtained from the case study analysis about independence between efficiency score and the merger fact in case of small size of the target comparatively to the bidder is not confirmed by the results of regression analysis. In the sample the majority of targets is small, so we expected to see no dependence between the merger and the efficiency. This means that not only the size of the target matters in determining the efficiency of the bidder after the merger, but other factors that are subject to changes in the process of the merger.

Chapter 5

CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH

In the thesis we try to find whether bank mergers and acquisitions in Ukraine affect efficiency of banks, which were engaged into consolidation. We use DEA technique to estimate the efficiency of Ukrainian banks and truncated regression analysis to evaluate dependence between technical efficiency scores of the bank and different factors such as size, specialization, ownership of the bank, riskiness of its assets and involvement into the merger.

From the analysis of time pattern of efficiency scores of banks that took part in the consolidation we conclude that if the target is small, the efficiency of the bidder will not be affected after the merger. This conclusion is not confirmed by results of the estimation of truncated regression model. We find that the fact that the bank took part in the consolidation negatively affect efficiency of the bank. The main reason for this is distortions that are brought to the bank's functioning by the fact of the merger.

We also conclude that increase in the size of the bank positively affects its efficiency, thus, merger indirectly can affect efficiency through increase in the size. In our case due to small size of majority of targets this effect can be overweighted by the "distortion effect".

Specialization of the bank positively affects its efficiency. So if, as a result of the merger, bank becomes more specialized in one or some particular types of activity; this also will positively affect its efficiency and if bank operations become

more diversified its efficiency may decrease. This can also be treated as an indirect effect of the merger.

Foreign ownership positively affects efficiency of the banks. If as a result of the merger domestic bank becomes a foreign owned it supposed to become more efficient in the future. Since there is a tendency for Ukrainian banks to be consolidated with foreign ones, we can expect increase in the efficiency of banks, which will be engaged in this process, and of banking system as a whole.

Since we find negative efficiency effect from the merger, we conclude that immediate change in efficiency is not the main aim of the mergers in Ukraine, while a probable aim can be an increase in geographical dispersion and influence in the regions by large banks (which can result in the increasing efficiency in the future).

As we note in the thesis there is a problem of a small sample of merged banks. From our discussion about the dependence of the size of the target and the impact of the merger on the efficiency level, we can conclude that if the target's size is comparable to the size of the buyer, efficiency of the buyer will increase after the merger in case when prior efficiency of the target was higher than efficiency of the bidder and vice versa. Unfortunately, this expectation can not be checked empirically with the available data. Taking this into account we would consider research based on the larger data sample as a possible expansion of the present research. It would be interesting to test empirically the hypothesis proposed in this paper about dependence of technical efficiency of the bank after the merger and the size of its merger partners.

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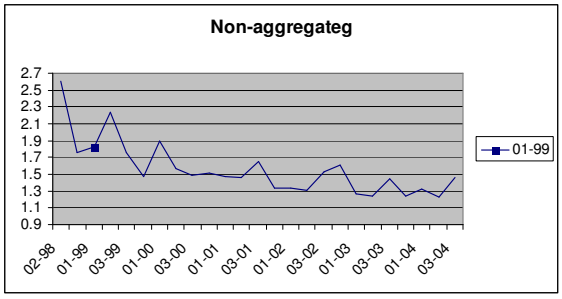
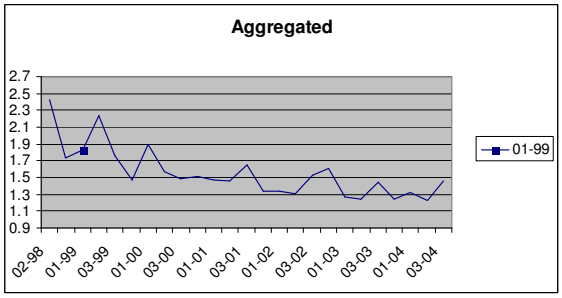
APPENDICES

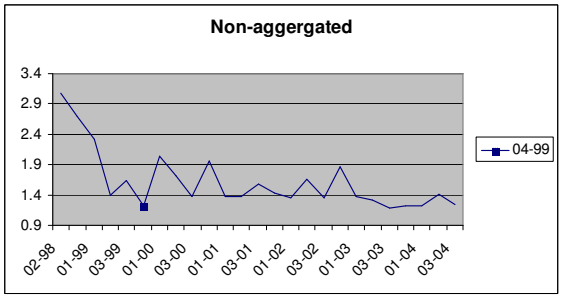
<u>Appendix 1.</u> Efficiency scores trends for merged banks (date of the merger is marked on graphs).

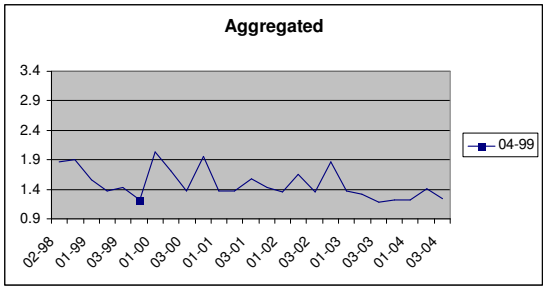
1). <u>Bidder</u>: Avtocrazbank <u>Target</u>: Ukruniversalbank



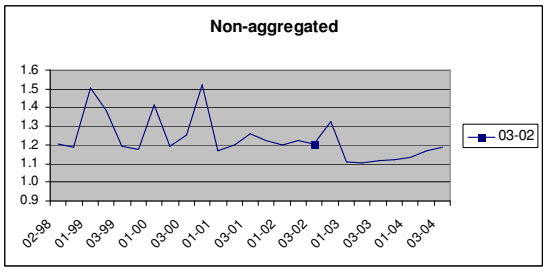


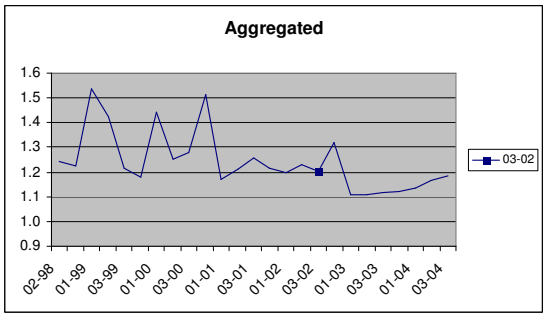
2). <u>Bidder</u>: Ukrgazbank <u>Target</u>: Ukrnaftogazbank



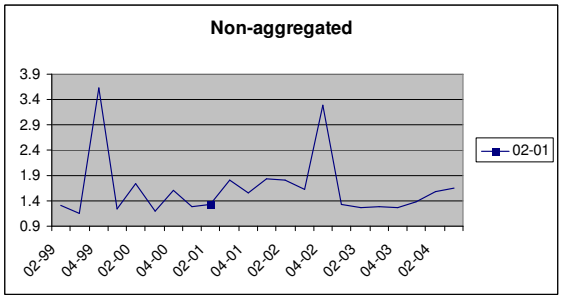


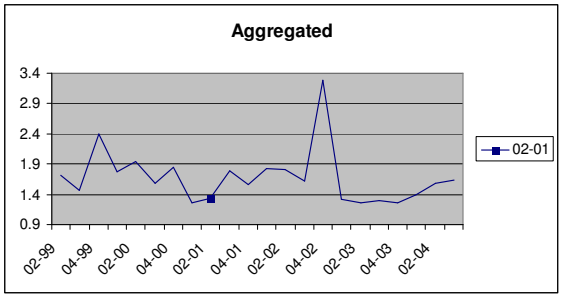
3). Bidder: Bank "Aval" Target: Bank "Etalon"



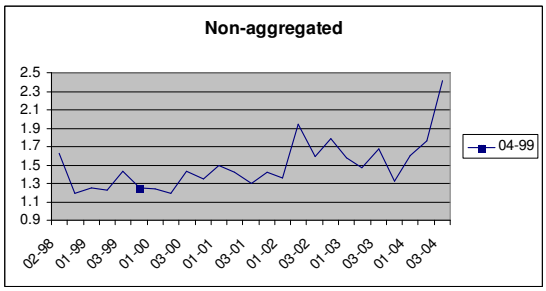


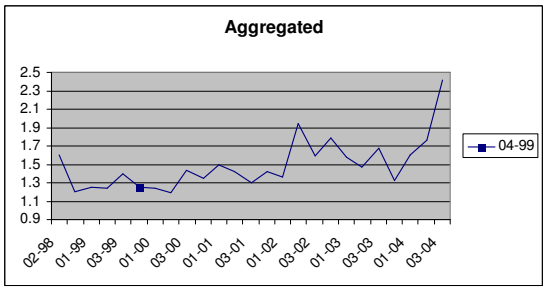
4). Bidder: "International Commercial Bank" Target: Bank "Tavriya"



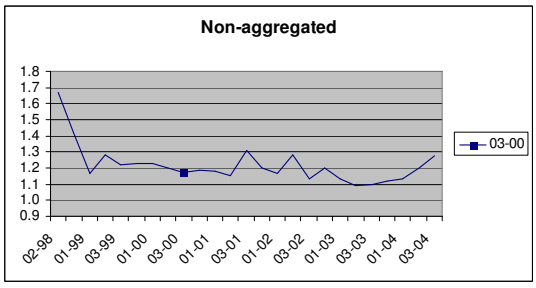


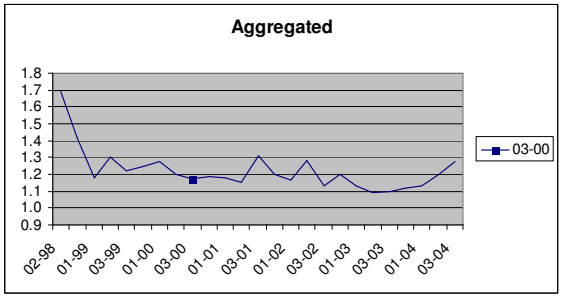
5). Bidder: Investbank Target: Bank "Arkadiya"



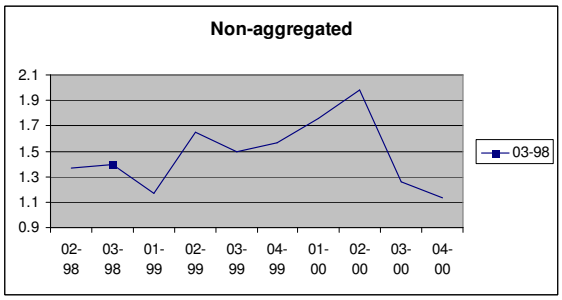


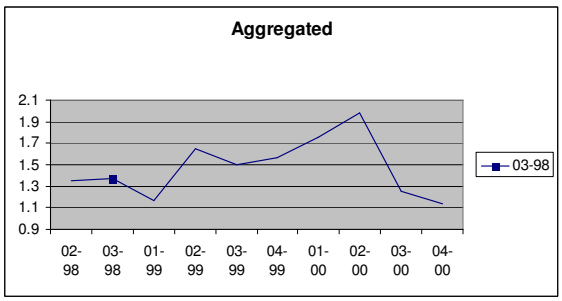
6). Bidder: Bank "Nadra" Target: Bank "Slobozhanshyna"



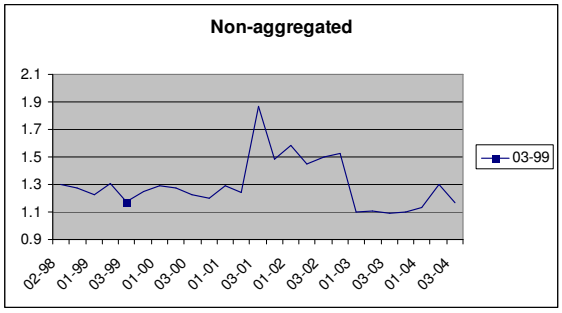


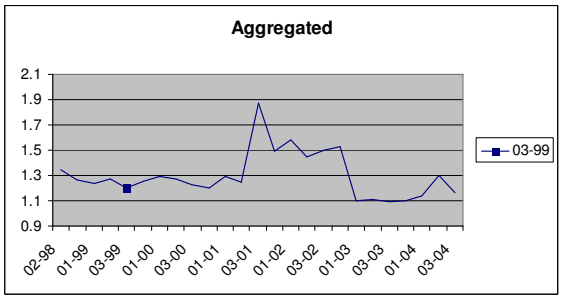
7). Bidder: Bank ”Eurocenter” Target: Bank “Viktoriya”





8). Bidder: Bank "Ukoopspilka" Target: Bank "Podillya"



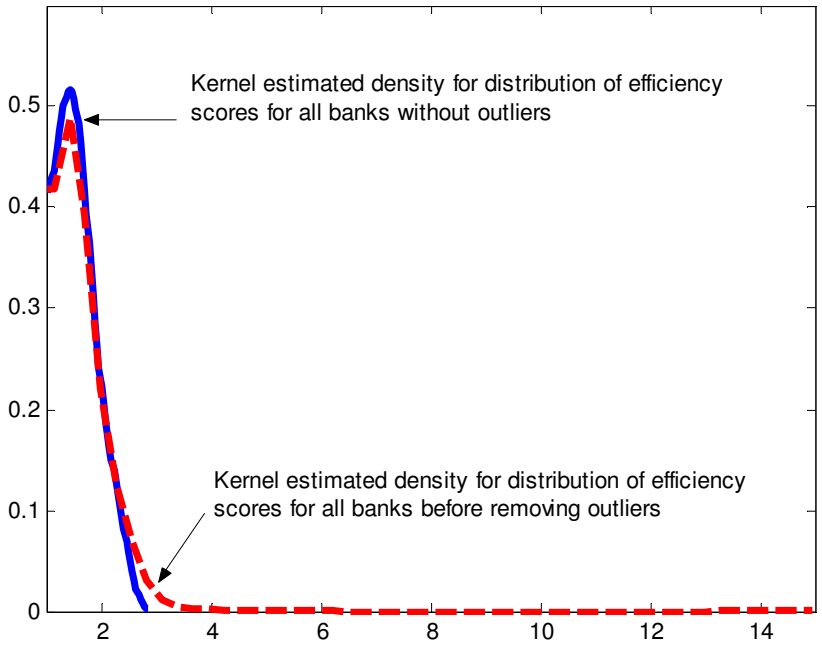


Appendix 2. Descriptive statistics for inputs and outputs in the DEA model (UAH thousands)

Quarter	Outputs				Inputs					
	Loans		Earning assets		Physical capital		Deposits		Purchased funds	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Q2 1998	51752	174815	13708	38105	11133	52915	39102	138887	21931	72715
Q3 1998	51847	165501	28531	67991	12166	51617	48857	155829	25495	83725
Q1 1999	58959	179268	32383	75718	12912	53152	54757	172821	32575	101499
Q2 1999	55906	171661	21383	57965	13523	53965	63841	200973	29371	92170
Q3 1999	63350	188232	23274	61996	14024	54708	67633	207790	36828	114325
Q4 1999	66717	183084	23313	52716	15565	56938	76632	218027	33332	99477
Q1 2000	80044	218577	33272	88786	16426	58197	89273	243523	42838	127496
Q2 2000	89398	222030	35774	89624	17404	59196	101704	275328	43600	124326
Q3 2000	99883	239365	37131	84750	18554	61005	109789	289598	48786	128425
Q4 2000	115061	267870	34931	82219	20290	63722	124794	334177	52842	130836
Q1 2001	168095	382712	15117	49993	20490	63832	129333	344177	54587	139908
Q2 2001	185886	421263	15572	46550	21560	64872	144591	385441	55600	133235
Q3 2001	196040	439432	21766	100031	19744	56071	150466	407970	59188	156097
Q4 2001	209623	461582	28881	147172	23676	65518	170818	477029	57111	138514
Q1 2002	222567	505094	19664	97328	24873	67763	179595	505291	62440	161219
Q2 2002	242706	559280	19171	71221	27265	74414	194746	535121	63503	158546
Q3 2002	272507	644779	29237	122985	28907	78213	233418	664828	67912	170530
Q4 2002	297679	708539	28038	125444	31378	81737	247104	685437	79670	164766
Q1 2003	267615	668704	90050	200612	31752	81423	317159	888149	52570	97720
Q2 2003	311565	772683	106260	228750	34060	84267	356065	986628	72452	136820
Q3 2003	359702	735884	113513	208080	35672	83714	409056	928320	83233	148820
Q4 2003	398108	978371	128206	267222	40726	102227	431747	1137364	105331	237781
Q1 2004	426259	1047514	132288	291805	43242	111904	475162	1256435	102650	234749
Q2 2004	508175	1267349	174270	602553	47060	115659	534976	1489175	112032	248299
Q3 2004	540315	1344005	176726	400968	53046	126408	597575	1695527	118041	255599

Appendix 3

Kernel estimated density for all banks before and after removing outliers (1317 and 1257 observation respectively).



Appendix 4

Table A 4.1

Regression results for specification with inclusion of RISK variable (653 observations)

Dependent variable: Technical efficiency score			
Variable	***Coefficient***	***Lower bound (5%)***	***Upper bound (5%)***
CONST	4.9303	4.4294	5.4302
LOG (SIZE)	-0.1998	-0.2403	-0.1603
RISK	-1.6718	-2.6406	-0.7084
SPEC	-0.7958	-1.0737	-0.5064
STATE	-1.1072	-1.7339	-0.1290
FOREIGN	-0.4116	-0.5693	-0.2433
MERGER	0.1945	0.0140	0.3737
σ_ε^2	0.2673	0.2306	0.3036

Table A 4.2

Regression results for specification without variable (653 observations)

Dependent variable: Technical efficiency score			
Variable	***Coefficient***	***Lower bound (5%)***	***Upper bound (5%)***
CONST	4.7692	4.2608	5.2536
LOG (SIZE)	-0.1921	-0.2318	-0.1506
SPEC	-0.8471	-1.1120	-0.5721
STATE	-1.1918	-1.8037	-0.0652
FOREIGN	-0.3801	-0.5335	-0.2098
MERGER	0.2095	0.0402	0.3914
σ_ε^2	0.2731	0.2355	0.3098

Appendix 5

Table A 5.1

Regression results for specification with inclusion of RISK variable (653 observations)

*Dependent variable: Technical efficiency score **			
Variable	***Coefficient***	***Lower bound (5%)***	***Upper bound (5%)***
CONST	4.9621	4.3592	5.5544
LOG (SIZE)	-0.2045	-0.2515	-0.1551
RISK	0.2067	-0.8742	1.3192
SPEC	-0.7507	-1.0625	-0.4302
STATE	-1.1156	-1.7871	-0.0456
FOREIGN	-0.4423	-0.6203	-0.2546
MERGER	0.1981	0.0059	0.3998
σ_ε^2	0.3397	0.2952	0.3880

Table A 5.2

Regression results for specification without variable (653 observations)

*Dependent variable: Technical efficiency score **			
Variable	***Coefficient***	***Lower bound (5%)***	***Upper bound (5%)***
CONST	4.9816	4.3751	5.5458
LOG (SIZE)	-0.2054	-0.2524	-0.1571
SPEC	-0.7452	-1.0493	-0.4236
STATE	-1.1081	-1.778	-0.0404
FOREIGN	-0.4466	-0.6220	-0.2604
MERGER	0.1958	0.0046	0.3976
σ_ε^2	0.3400	0.2942	0.3878

Note: * - technical efficiency score is estimated taking "bad loans" into account