INNOVATIONS AND IMITATIONS AS THE KEY DRIVERS FOR THE RUSSIAN BANKING SECTOR PRODUCTIVITY

by

Viktor Sannikov

A thesis submitted in partial fulfillment of
the requirements for the degree of

Master of Arts in Economics

National University of "Kyiv-Mohyla Academy"
Master's Program in Economics

2008

Approved by _____
Mr. Volodymyr Sidenko (Head of the State Examination Committee)

Program Authorized
to Offer Degree Master's Program in Economics, NaUKMA

Date _____

National University of "Kyiv-Mohyla Academy"

Abstract

INNOVATIONS AND IMITATIONS AS THE KEY DRIVERS FOR THE RUSSIAN BANKING SECTOR PRODUCTIVITY

by Viktor Sannikov

Head of the State Examination Committee: Mr. Volodymyr Sidenko,
Senior Economist
Institute of Economy and Forecasting,
National Academy of Sciences of Ukraine

The thesis aims to investigate productivity issues. It discovers what were the contributions of innovations (How much the production frontier shifted?) and efficiency changes (Does the distance to the production frontier become shorter?) to the Russian banking sector development within the period under study. A dataset on 106 Russian banks (1999-2004) was utilized to decompose productivity onto innovation and imitation components. Additionally, the impact of the post-default deregulations on the productivity growth was analyzed. It was found that incentives to innovate and productivity of private banks decreased in the period of regulations and increased in the period of deregulations. Besides this, the obtained empirical evidences suggest that the deregulations had a significant positive effect on the technical efficiency of the banks headquartered outside Moscow (1.75-1.83%).

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

LIST OF ANNEXES

ACKNOWLEDGMENTS

The author wishes to thank to Professor Valentin Zelenyuk for guidance, helpful comments and computational support. The author is also grateful to Professor Tom Coupé and the experts from the EERC "Call for Proposals – Fall 2007" conference, whose instructions facilitated the data search and whose valuable feedback helped the work sound more convincing.

ABBREVIATIONS

ARCO - the Agency for Restructuring of Credit Organizations

CB - the Central Bank of the Russian Federation

CIS - the Commonwealth of Independent States

CRS - Constant Returns to Scale

DEA - Data Envelopment Analysis

EBRD - the European Bank of Reconstruction and Development

EU - European Union

FDH - Free Disposable Hull

MI - Malmquist index

PPI – Producer Price Index

SFA - Stochastic Frontier Approach

TFA - Thick Frontier Approach

Chapter 1

INTRODUCTION

During the financial crisis of 1998, the Russian government and the Central Bank (CB) imposed strict regulations on the banking sector in order to protect the financial system. When the crisis was overcome numerous deregulations were instituted. In 2002 a wide revision of laws and instructions related to mergers, acquisitions and establishment of banks was adopted.[1] But the main issue was the deregulation of exit. A corporate insolvency legal framework was established by the new bankruptcy law in 1998. But, according to this law, a bank could be liquidated only if it was found bankrupt by Court. In July 2001, the Russian Parliament adopted changes to this law and listed several instances when a bank is to be liquidated simply due to failures in the regulatory standards fulfillment. The article 35 of this law states that any creditor can initiate a bankruptcy procedure after the CB has revoked the bank's license.[2]

And additional insight is gained by considering the regulations which were imposed by the government during the crisis. A bright example of such regulations is the restructuring law which was adopted in July 1999.[3] This law was regulating operations of the Agency for Restructuring of Credit

---

[1] Related information can be found on the site devoted to chronology of Russian Default in 1998 (http://www.internettrading.ru/publish/defolt.html), the Russian Banks Association site archive (http://www.arb.ru/site/action/archive.php) and Wikipedia web sources (http://ru.wikipedia.org/wiki/Дефолт_в_России_1998_года).

[2] Federal Law on Insolvensy (Bancruptcy) of Crediting Organizations. N 40-ФЗ from 25.02.1999 (with changes introduced by laws N 6-ФЗ, N 86-ФЗ).

[3] Federal Law on Restructuring of Credit Organizations. N 144-ФЗ from 08.07.1999.

Organizations (ARCO), which started its affairs in March 1999 and was granted the following authority to intervene the market:

- specific but broad mandates to clean up the banking system;
- access to substantial funding;
- objective to complete its tasks (generally defined as a successful privatization of the restructured banks) in 3-5 years.

Initially the ARCO was provided with RUR 10 billion from the state funds. The ARCO used this money for equity investments, liquidity loans, and purchases of low-quality assets to enhance the balance sheets of the banks which participated in the restructuring program. The ARCO utilized earnings from the privatization and the loan interest payments to undertake further interventions. The majority of the banks from the ARCO's portfolio was sold, merged or liquidated till the end of 2001, which can be also treated as a deregulation of exit within this study. The restructuring law itself was cancelled in 2004. The dynamics of the ARCO's portfolio is presented in the Annex 1.[4]

At the same time, some other bureaucratic procedures were deregulated: "the law on inspections – on August 8, 2001; the law on licensing – on February 11, 2002; the first redaction of the law on registration – on July 1, 2002; the law on certification (i.e., "technical regulation") – on July 1, 2003; and the second redaction of the law on registration – on January 1, 2004" (Yakovlev and Zhuravskaya, 2006).

The volume of the banking sector deregulations for each year can be approximated with the Banking reform & interest rate liberalization index

[4] Fuchs, Michael Joseph et al. (2002), 'Building trust: developing the Russian financial sector.', 1951- II. World Bank.

assessed by the European Bank of Reconstruction and Development (EBRD index). In 1997 this index was equal to 2.33, later it was decreasing and reached the level of 1.67 points between 1999 and 2001. The index recovered to the prior default level (2.33) only in 2005.[5] According to the EBRD ranking, the Russian Federation is now on its way to getting a "substantial progress in establishment of bank solvency and of a framework for prudential supervision and regulation; full interest rate liberalization with little preferential access to cheap refinancing; significant lending to private enterprises and significant presence of private banks"[6] In 1998, though other CIS countries introduced some regulations under threat of a possible default, they did not disturb the basis of the financial market, i.e. they tried to intervene but not to constrain their financial markets. Consequently, the EBRD banking reform indices for other transition economies, except Romania, were stable in 1998.

This research aims to compare the behaviors of private and state banks, assuming that with no deregulations introduced private banks would perform similarly to state banks in every moment of time, as there would be no differences in the government treatment of these types of banks. The deregulations affected private banks because the deregulatory laws and bills constituted changes only in the legal treatment of private banks. A spillover effect on state banks is possible, but it can not be measured within this research framework. The assumption about similar performances before deregulations is required, because even under the regulations behaviors of state and private banks still may differ. For instance, if clients of state banks are completely different from clients of private banks, this difference in the clients' behaviors will at least partially explain the divergence between state and private banks after the deregulations. In order to minimize the influence of the factors which are

[5] http://www.ebrd.com/country/sector/econo/stats/tic.xls

[6] http://www.ebrd.com/country/sector/econo/stats/timeth.htm

not related to the deregulations, the study compares only private and state banks with similar structures of inputs and outputs, i.e. if we have state banks with multiple specializations, we compare them to multi-specialized private banks.

Therefore, it can be estimated by how much these two types of banks converged to the production frontier during the period of the deregulatory reforms in the Russian Federation.

The study answers the question whether the data for the Russian banks supports the theory formulated by (Berg, Førsund and Jansen, 1992). They stated that deregulations stimulate banks to converge to the production frontier as well as to innovate, expanding this frontier. In this study, the term "innovations" will be defined according to Peter Drucker, who thought that innovation reflects any "change that creates a new dimension of performance" (Hesselbein, 2002), i.e. innovations are all the new implemented ideas which allow to expand the production possibilities set (Farrell, 1957). And "efficiency" is defined as an output-oriented technical efficiency measure (Farrell, 1957).

Overall, this research is the first, which implements the Malmquist decomposition procedure to a core CIS transition economy data. The research provides useful instruments for a productivity benchmarking and for an analysis of the Russian banking sector deregulatory policies. Hence, the research helps to answer the question about the effectiveness of the policies related to further deregulations of the Russian Federation banking system. The conclusions are based on the observed difference between performance paths (in terms of productivity, technology and technical efficiency changes) of state and private-owned banks. The Malmquist decomposition allows detecting the source of a productivity change – whether it happened due to a pure efficiency change or due to a technology change. So the research creates a new knowledge about the changes in the Russian banking sector productivity, technology and technical efficiency in

the period between 1999 and 2004. It discovers the differences in behavior of the Russian banks relatively to their regulatory environments in the innovation-imitation perspective.

Chapter 2

LITERATURE REVIEW

Possible directions for the effects of the deregulatory policy, the literature related to the choice of the research methodology and the previous studies comparable to ours are discussed in this section.

Within the Malmquist decomposition framework, any deregulations influence productivity either via a technical efficiency improvement or via an enhancement in the incentives to innovate. Pursuing this logic, a theory was formulated in order to describe the impact of the deregulations on the incentives to imitate. It states that after any deregulations the competitiveness in the deregulated industry increases and all the firms start to converge to the production frontier in order to survive in the new environment. Berg, Førsund and Jansen, (1992) indicate that researchers have tested the hypothesis about the influence of the competitiveness on the efficiency convergence, utilizing the Data Envelopment Analysis (DEA) and the Malmquist decomposition. They concluded that the deregulatory policies can attract foreign investments into the industry, which increases the competitiveness there. For instance, the deregulation hypothesis was proved by Kumbhakar et al. (2001) for the Spanish banking sector in 1986-1995. Though a more recent study by Demirguc-Kunt et al. (2003) provides evidences that an increase in the competitiveness does not necessary mean an efficiency improvement.

Some examples of innovations in the banking sector can be considered to investigate the incentives to innovate under deregulations. Those examples – internet banking, electronic payments technologies, information exchanges, and

invention of new methods of microeconomic research – are listed and described by Berger (2003). When sources for the efficiency improvement are almost exhausted, only a new adopted technology can guarantee further development (Yildirim and Philippatos, 2001).

In order to measure the impact of deregulations, first, the DEA estimation of the production frontier and the Malmquist decomposition are performed. Initially, the frontier methods were formulated in the Farrell's (1957) paper, while the Malmquist index (MI) was proposed by Malmquist (1953) and the DEA was introduced by Charnes et al. (1978).

Berger and Humphrey (1997) surveyed 130 recent studies of the financial institutions' efficiency and came up with two major parametric approaches for the frontier efficiency estimation, which are the stochastic frontier approach (SFA) and the thick frontier approach (TFA). Besides those, two non-parametric techniques were mentioned – the DEA and the Free Disposable Hull (FDH).

Fries and Taci (2004) and Huang and Kao (2006) also studied deregulations within the SFA framework. The former authors collected data on 289 banks in 15 post-communist countries and found out that the early stages of a banking sector reforms were associated with cost reductions, while during the more advanced stages costs were to rise. Also the former pair of authors investigated that the private banks were more cost efficient than the state banks. The latter pair of authors studied the Taiwanese banks and came to the conclusion that the more risk averse banks became more technically efficient after the deregulations.

There are researches on deregulations within the TFA framework as well. Humphrey (1993) used the panel data set of the largest U.S. banks (683) over 1977-1988 and assessed the cost frontier under the TFA. He concluded that the deregulations of early 1980s had a negative impact on the US banks' cost

efficiency, while Vivas (1997) found that the profit frontier mostly remained unchanged and the profit inefficiency significantly decreased at the period of the deregulations (1986-1991) for the Spanish savings banks.

There already exists a SFA study by Styrin (2003) dedicated to the Russian banks. Styrin (2003) investigated that the banks operating with foreign funds and the state-owned banks were less cost efficient, while the banks having risky loan portfolio or located in Moscow were more cost efficient. Thus, Styrin (2003) researched the issues within the SFA framework, which is also useful for the production frontier estimation, but he made an assumption about the functional form of the model, while the DEA methodology allows us to relax this assumption. Furthermore, Styrin (2003) assessed the cost function and the X-inefficiency, i.e. the inefficiency due to poor management, while in a study of deregulations it is more applicable to estimate the technology set and measure the productivity changes. Styrin (2003) provided reasoning for his choice of the SFA. He thought that the SFA's vulnerability to an incorrect specification is lower than the DEA's sensitivity to errors in the raw data. However, the latter problem can be resolved, as long as confidence intervals are constructed and a z-test is performed relying on the bootstrap technique within the DEA framework.

In the sample under consideration, the risk of choosing an incorrect specification is high, as the reliance on the functional form assumption leads to the misspecification problem, which can significantly bias the results. Moreover, the existing literature does not propose any test to check whether the model is correctly specified under the SFA. The impact of errors in the raw data can be minimized through the check for outliers as well as through the implementation of the bootstrap z-test. At the same time, there is no possibility to minimize the risk of the functional form misspecification. Indeed, Styrin (2003) used the translog specification only due to a theoretic assumption about the

Cobb-Douglas form of the production function. Furthermore, the translog function is a second-order approximation for the Cobb-Douglas. Another advantage of the DEA procedure is "that, unlike econometric approaches, it does not smooth effects; flexibility inherent in this nonparametric methodology allows for substantial annual variations to be detected if they exist in the data." (Alam, 2001).

Thus, the non-parametric technique, particularly the DEA, is used within the entire study. The hypothesis about constant returns to scale (CRS) was not rejected by Styrin (2003) for the Interfax.100 quarterly data set between 1999 and 2002. Hence, CRS are assumed to set properly the DEA problem for our research.

Initially, the statistical bootstrap theory was proposed by Efron (1979). A detailed description of the bootstrap methodology for the thesis issues is done by Simar and Zelenyuk (2007) and Simar and Wilson (2000). Additionally, a group-wise heterogeneous sub-sampling bootstrap of aggregates of the DEA efficiency scores algorithm was constructed by Färe and Zelenyuk (2003). This algorithm allows operations with small samples, bias correction and determination of the corresponding confidence intervals.

There are some analogous researches, which study the same problem and apply the MI for other economies. Primarily, Berg, Førsund and Jansen (1992) investigated a productivity regress before the deregulations and a significant progress after (Norway, 1980-1989). Wheelock and Wilson (1999) discovered a tendency to a productivity decrease due to an efficiency decline and technological disinnovations (USA, 1984-1993). Alam (2001) concluded that the productivity changed mainly due to the production frontier shifts, but it changed little due to the convergence to the frontier (the US banks with more than 500 million in assets, 1980-1989). Alam (2001) assumed CRS in his study,

because McAllister and McManus (1993) proved earlier that CRS hold for the large (with more than 500 million in assets) US banks, and that IRS hold for the rest of the US banks. Rezitis (2006) came to conclusion that the productivity growth was higher after the deregulations (Greece, compared 1982-1992 vs. 1993-1997). Moreover, before the deregulations the major source of the productivity growth was the efficiency improvement, while after – the productivity grew mainly due to the technological progress. Percin and Ayan (2006) found out a negligible efficiency increase in the period of deregulations (2003-2004), while the main driving factor of the growth at that time was the technological progress (Turkey, after crisis of 2001). Additionally, the latter pair of the authors concluded that the state owned banks appeared to be more efficient than the private owned ones. This happened because Turkish state banks were much stronger than their private counterparts.

Consequently, no studies implementing the Malmquist decomposition to a CIS country exist. And our research is the first to utilize this methodology for a data on the Russian banking sector (1999-2004) and to investigate separately shifts of the production frontier and movements of the banks to the production frontier. Besides this, the DEA and the further Malmquist decomposition procedure is the most relevant methodology developed to achieve the entire research goals.

Chapter 3

DATA DESCRIPTION

The necessary data consists of two parts:

1. The yearly data on all the Russian banks for 1999 and 2000 years was acquired from the Interfax-Russia agency. The questionnaire can be found in the corresponding website.[7]

2. The yearly data (2001-2004) on all the Russian banks was collected from the website of the Mobilé agency.[8]

The variables for both agencies are compactly described in the Annex 2. X's are the inputs and Y's are the outputs. All the indicators are denominated in thousands of rubles and corrected for inflation, using 1999 as the base year and the annual average PPI from the EBRD transition report[9]. A yearly sample for 1999-2004 is constructed from both agencies' datasets. Therefore, all the variables are denoted with labels from both questionnaires (see Annex 2).

The variables are selected from the balance sheets of the banks. Analogous variables can be found in the studies of Alam (2001), Wheelock and Wilson (1999), Kumbhakar (2001) and Rezitis(2006).

---

[7] The corresponding questionnaire can be checked in the Appendix 1. In the last "Interfax-100. Russian Banks" survey 1300 banks were included, but permanently only about 700 of them were surveyed regularly. This is essential, as a panel sample should be constructed for this research purposes.

[8] http://mobile.ru/banking/CD_DEMO/BankCD.htm

[9] http://www.ebrd.com/country/sector/econo/stats/index.htm

The initial data sample contains over 1200 observations for each year. The number of observations varies across years. From the initial sample, we gathered information on those banks which satisfy the following conditions:

- the bank existed during the period under study;
- observations for the bank had no missing values;
- the banks had a positive equity.

Consequently, a yearly balanced panel of 622 observations p.a. was obtained. The blanks at the data or negative equities[10] have occurred due to on-going bankruptcy procedures or when the banks did not report part of the required information.

Majority of the banks which had negative equities for a couple of periods soon exited the market. But SBS-Agro, for instance, maintained a negative equity for several years till its liquidation in 2004. It means that SBS-Agro faced restrictions to exit the market, i.e. this bank was regulated and bailed out.

Styrin (2003) suggested that the state banks were universal banks by their nature, meaning that they offered a full range of banking services to their customers. Since the state banks have majority of the inputs and the outputs, we can compare them only to the private banks, which also have a full range of banking services. Therefore, 5 pure state and 101 comparable to them private banks were selected from the constructed earlier balanced panel.

Hence, the table 1 reveals summary statistics on the variables from the resulting yearly sample.

[10] Equity is defined as Assets less Debt.

Table 1. Descriptive statistics of the variables.

	Variables	Obs.	Mean	St. Dev.	Min.	Max.
y1	Gvt securities	636	1911655.3	13154595.0	0.4	148883436.0
y2	Non-gvt securities	636	2138184.3	9228506.9	0.9	121121696.0
y3	Total securities	636	4049839.7	19180540.0	64.6	270005132.0
y4	Loans to economy	636	6107391.8	30270469.9	0.0	482467728.8
y5	Loans to other banks	636	912938.3	2761837.6	19.1	29061711.0
y6	Total loans	636	7020330.1	31430583.5	5219.1	491574055.2
x1	Equity capital	636	1636910.8	5870837.6	9518.4	68797926.3
x2	Loans from other banks	636	8624320.4	83403718.9	0.0	1281225074.3
x3	Securities issued	636	720160.7	2233578.8	0.0	25766552.0
x4	Purchased funds	636	9344481.1	83488268.7	0.0	1283164863.7
x5	Individuals deposits	636	3310554.2	28562270.5	0.0	384071222.2
x6	Entities deposits	636	2052115.6	6593134.1	0.0	81539605.7
x7	Total deposits	636	5362669.7	32238711.0	0.0	413953729.1
x8	Loanable funds	636	14707150.9	89896796.8	1058.6	1283849358.3
	Regional	636	0.23	0.42	0	1
	Year	636	2001.50	1.71	1999	2004

We can infer relying on this table that none of the banks under study had zero equity in 1999-2004. The variable "Equity" is defined at the data as the difference between assets and debt. The high standard deviations may be caused by increases in the size of indicators from period to period and high volatility across the data. However, none of the issues is treated as a problem within the DEA framework. Total number of observation is 636 (106 banks operating for 6 years). There are 5 purely state banks and 101 private banks (i.e. stock companies which contained private capital) among 106 banks under study. 77% of the banks are headquartered in Moscow.

Styrin (2003) supposes that the banks headquartered in Moscow are different from the banks headquartered in other regions, because the regional markets tend to be more concentrated than the Moscow market. Therefore, the managers of the banks headquartered in the regions may enjoy "quiet life", i.e.

slack their work. Finally, we define as small Moscow banks 62 Moscow banks which lied below RUR 8 bln. in their outputs in 2000. We highlighted the small Moscow banks as a separate group, because only small banks are comparable in size to the non-Moscow banks.

Chapter 4

METHODOLOGY

The issues concerning the model construction and the estimation process are discussed in this section.

The research utilizes the Farrell technical efficiency measure. It is assumed that the technology satisfies all the regulatory axioms of production theory. The technical efficiency measure is considered to be an output orientated. The reasons for the output orientation are following. During the period under study the Russian economy experienced positive shocks to the terms of trade as the oil prices went up. Therefore, the banks did not suffer from lack of the inputs at the period between 1999 and 2004, e.g. the inflow of the deposits from the economy was significant even in cases of low interest rates.[11] Additionally, Alam (2001) argues that "banks not allocating their resources efficiently would perish unless they could become more like their efficient competitors by producing more output with existing inputs". Based on rather similar assumptions, other relevant studies have chosen the output orientation of the technical efficiency measure (Wheelock and Wilson (1999), Kumbhakar (2001), Rezitis(2006)).

By contrast, Berg et al. (1992) and Percin and Ayan (2006) have chosen the input orientation because they studied the "asset side" deregulations of Norwegian and Turkish banks correspondingly, i.e. they studied the adoption of the EU standards for their financial sectors. But in other countries and, particularly, in

[11] A site devoted to chronology of Russian Default in 1998 (http://www.internettrading.ru/publish/defolt.html).

the Russian Federation, deregulations were concentrated at the realm of loan interest rates ceilings, bailing out policies and restrictions on exit.

"An output-efficient firm is one which can not increase its output unless it also increases one or more of its inputs, such firm has an efficiency score of 1" (Alam, 2001). In general, output-oriented technical efficiency scores belong to the interval $[1, \infty)$.

The hypothesis about CRS is not rejected by Styrin (2003) for the Russian banking sector. Thus, the MI formula under CRS is the following:

$$MI = E_{t+1} * A_{t+1}$$

Values of the MI below one implies a productivity decline, and above one – a productivity growth. In the formula above, E_{t+1} means the technical efficiency change and A_{t+1} stays for the change in the technology.

If we assume for simplicity the one-input-one-output case and CRS, peculiarities of the production frontier growth can be demonstrated with the following graph (Alam, 2001).

Figure 1. Expansion of technology set under CRS: single-output-single-input case.

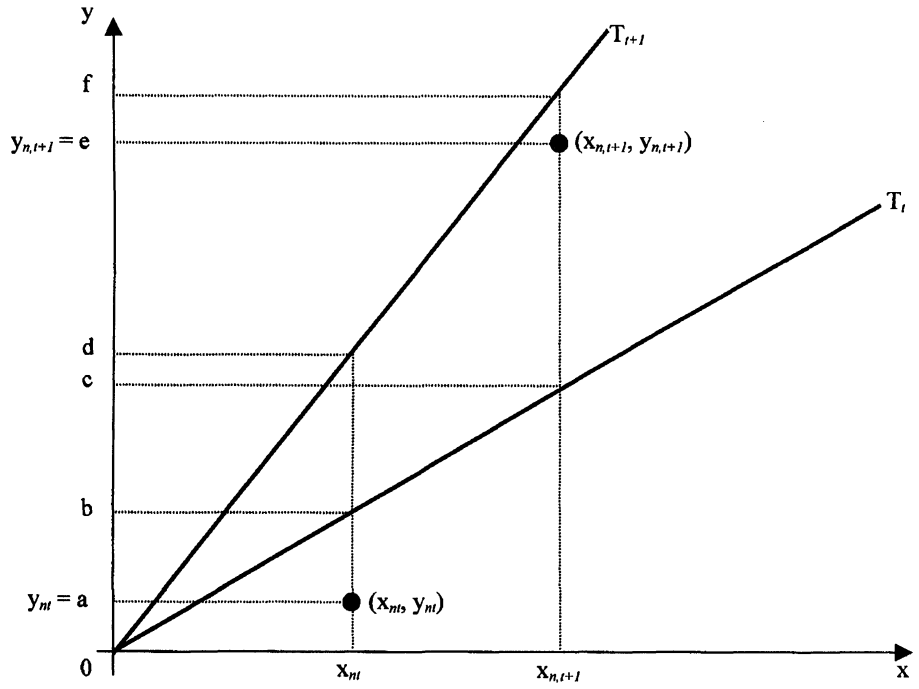


FIG.1. Single-Input, Single-Output Production Technology Illustrating Determination of Efficiency Scores and Malmquist Index of Total Factor Productivity under Constant Returns to Scale

T_t and T_{t+1} represent the technology set boundaries in the corresponding periods. The technology improvement is illustrated by the graph, which implies an expansion of the production possibilities set. Also the graph reveals how the bank n moves from the position in the time t to the position in the time t+1. Here $x_{n,t}$ and $x_{n,t+1}$ indicates the input, and $y_{n,t}$ and $y_{n,t+1}$ indicates the output in different periods. So the efficiency score for the bank n in the period t is equal to the ratio 0a/0b and in the period t+1 – to 0e/0f. Hence, the MI is the following:

$$MI = \frac{(0e/0f)}{(0a/0b)}\left\{\frac{(0e/0c)}{(0e/0f)}\frac{(0a/0b)}{(0a/0d)}\right\}^{1/2} = \left(\frac{0e}{0f}\right)\left(\frac{0b}{0a}\right) * \left\{\left(\frac{0f}{0c}\right)\left(\frac{0d}{0b}\right)\right\}^{1/2} = E_{t+1} * A_{t+1}$$

A general formula for the MI can be found in Coelli et al. (1997).

$$MI = \frac{d_o^{t+1}(y_{t+1}, x_{t+1})}{d_o^t(y_t, x_t)} * \left[\frac{d_o^t(y_{t+1}, x_{t+1})}{d_o^{t+1}(y_{t+1}, x_{t+1})} * \frac{d_o^t(y_t, x_t)}{d_o^{t+1}(y_t, x_t)} \right]^{1/2} = E_{t+1} * A_{t+1}$$

$d^r_o(y_s, x_s)$ denotes technical efficiency measure for a bank with inputs y and outputs x in the period s under technology r, which is the level of the technological development in some period (r = t, t+1). If $E_{t+1}>1$, the bank converges to the production frontier and its efficiency increases. If $A_{t+1}>1$, a technology progress occurs and the production frontier also shifts. If one of the multipliers is less than one, the opposite relationships are observed. For the MI itself a value below one implies a productivity decline, and above one – a productivity growth. Thus, the main issue of the research is computation of the MI and its components.

Besides CRS, some conventional (Rezitis (2006), Percin and Ayan (2006), Alam (2001), Bhattacharyya et al. (1997) etc.) assumptions about banking industries should be enumerated. Those are the strong disposability and convexity of inputs as well as outputs (Simar and Wilson, 2000) and the bank's pursuit of the maximization of "their service provision given the resources at their disposal" (Bhattacharyya et al., 1997). The latter assumption implies the choice of the output orientated distance function for the DEA estimation.

According to the theory discussed above, the following econometric procedures are performed. "The Malmquist [index] is calculated within the framework of Data Envelopment Analysis (DEA), which is a linear programming methodology that constructs a non-parametric, piecewise-linear, "best-practice" frontier from observable input and output data" (Alam, 2001). Hence, technical efficiency indicators are estimated for each bank under the DEA methodology using four model specifications. The number of inputs and outputs is decreasing

from the first to the forth model. As it was proved by previous researches, DEA average efficiency may rise even just due to an increase in number of variables, since "each firm has a greater opportunity to be efficient in some dimension of production" (Alam, 2001). The reason for estimation of all those four specifications is to see by how much the technical efficiencies of each group of the banks diminish only due to decreases in the number of the inputs and the outputs. The four models are roughly proposed in the following table.

Table 2. Models for MI estimation.

Model #	Outputs		Inputs	
1]	y1	Government securities	x1	Equity capital
	y2	Non-government securities	x2	Loans from other banks
	y4	Loans to economy	x3	Bank's securities in circulation
	y5	Loans to other banks	x5	Private individuals deposits
			x6	Juridical entities deposits
2]	y3	Total securities	x1	Equity capital
	y6	Total loans	x2	Bank's securities in circulation
			x3	Private individuals deposits
			x5	Private individuals deposits
			x6	Juridical entities deposits
3]	y3	Total securities	x1	Equity capital
	y6	Total loans	x4	Purchased funds
			x7	Deposits
4]	y3	Total securities	x1	Equity capital
	y6	Total loans	x8	Total loanable funds

These four models are estimated within the DEA and the Malmquist decomposition framework, using a group of modules in Matlab created by Léopold Simar and Valentin Zelenyuk.

"Data Envelopment Analysis (DEA) involves the use of linear programming methods to construct a non-parametric piece-wise surface (or frontier) over the data. Efficiency measures are then calculated relative to this surface."

(Coelli et al., 1997) The Malmquist decomposition is performed according to the Coelli et al. (1997) algorithm discussed further.

There are some data on k inputs and m outputs for i-th bank i=1, 2…n. x_i is the vector of the inputs for the i-th bank, and y_i is the vector of the outputs for the i-th bank. X is the kxn input matrix, and Y is the mxn output matrix for all the banks. Since Styrin (2003) rejected hypothesis that well capitalized (i.e. large) banks are more efficient, than poorly capitalized (i.e. small) banks, for a quarterly sample of all the Russian banks in the period from 1999 till 2002, we implemented the CRS specification of the models. For this purpose, the ratio of all the i-th bank's outputs over all its inputs is obtained: $u^T y_i / v^T x_i$, where u is an mx1 vector of the output weights and v is a kx1 vector of the input weights. These weights are the solution of the initial linear optimization problem. Imposing an additional constraint $\mu^T y_i = 1$, which helps to receive unique (not multiple) solution, the initial (1) and the dual (2) linear programming problems are formulated. Then, the dual problem is solved, where θ stays for a scalar and λ is an nx1 vector of constants.

$$\min_{\mu,\vartheta}(\vartheta^T x_i)$$

$$s.t.\begin{cases} \mu^T y_i = 1 \\ \mu^T y_j - \vartheta^T x_j \le 0 \\ \mu, \vartheta \ge 0 \\ i = \overline{1,k} \\ j = \overline{1,n} \end{cases} \qquad (1)$$

$$\max_{\theta,\lambda} \theta$$

$$s.t.\begin{cases} -\theta y_i + Y\lambda \ge 0 \\ x_i - X\lambda \ge 0 \\ \lambda \ge 0 \\ i = \overline{1,n} \end{cases} \qquad (2)$$

Resulting θ^*_i will be the efficiency score for each bank (i=1, 2,… n).

Using θ^*_i , we receive the efficiency levels (for each bank and for each year), which may highly depend on the number of observations and the number of

variables. Then, the change in θ^*_i is decomposed with the MI onto the pure technical efficiency change and the technology change.

The MI and its components are used for assessment of the effect of the deregulations. The impact of the deregulations is estimated as the difference between the private banks' aggregated scores and the corresponding state banks' aggregated scores.

The further discussed bootstrap procedure is based on the assumptions[12] from Kneip et al. (1998) transformed by Simar and Zelenyuk (2007) for the output-oriented Farrell technical efficiency measure. The group-wise heterogeneous subsampling bootstrap of aggregates of the Malmquist decomposition scores was performed according to the corresponding algorithm developed by Simar and Zelenyuk (2007) and using a group of modules in Matlab created by Léopold Simar and Valentin Zelenyuk. Then, we used the bootstrap results to perform a z-test for the statistical difference of the MI and its components from unity and another z-test for the statistical difference of the deregulations' effects from zero.

[12] Assumptions about independence and randomness of variables, convex technology set, existence of p.d.f., existence of conditional p.d.f., continuity of conditional p.d.f., differentiability of the technical efficiency measure both in the inputs and the outputs.

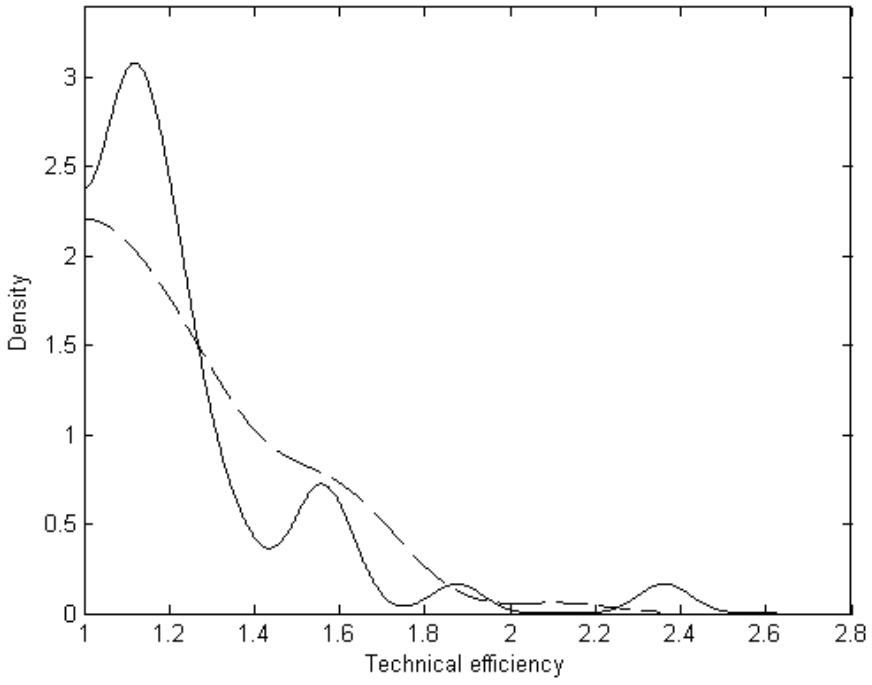
Chapter 5

RESULTS

In this section the results of the work are presented and interpreted.

Figure 2 displays kernel densities for two output-oriented DEA technical efficiency measures, one of them estimated in 2000 (solid line) and the other in 2004 (dashed line).

Figure 2. Kernel densities for the technical efficiency measures in 2000 and 2004.



When the technical efficiency measure is equal to one, the corresponding bank is defined as technically efficient. If the technical efficiency measure exceeds one, the underlying bank is regarded as technically inefficient. The kernel density is estimated only for technically inefficient banks. Following Simar and Zelenyuk (2007), all the banks which had unity as their technical efficiency score were disregarded. Thus, the picture reveals that the density had four picks in 2000, but it became more monotonously distributed after the deregulations in 2004. This happened because after the deregulations some smaller banks exited the technically inefficient group but several larger banks entered this group (see Annex 3).

Thereafter, the four models, specified in the table 2, were estimated. Formula for weighted average developed by Simar and Zelenyuk (2007) was used to generalize the results for different types of banks. The estimation results are listed in the Annex 4. Values greater than one are associated with a progress, values less than one mean a deterioration, and values not different from one confirm no change in the relative performance. Predominantly, we can observe the discussed earlier feature of the DEA-based estimates to grow slightly with increase in the number of variables.

The cumulative growth of the MI by regulatory environment for the model 1 is plotted in the Annex 5. Thus, the cumulative Malmquist indices for all the banks have their minima in 2000/2001. However, the state banks grew too slow after the deregulations and did not manage to return on their initial productivity growth path in 2004. The cumulative Malmquist index for the private banks exceeds the corresponding indicator for the state banks in the period under study. Moreover, the graph implies that the private banks' productivity growth recovered to its initial level after 2002.

Then, we followed the group-wise heterogeneous sub-sampling bootstrap of aggregates of the DEA efficiency scores algorithm developed by Simar and Zelenyuk (2007). Here, we used the model 1 variables and performed resampling of 80% of the observations from each group per year. Consequently, we ended up with bootstrap confidence intervals and tested the hypothesis about the statistical difference of our estimates from unity. The alternative hypothesis stated that no changes in productivity, technical efficiency or technology occurred. Therefore, in the Annexes 6 and 7 we can notice several estimates which statistically differ from unity, i.e. for which the main hypothesis (Ho: $\theta=1$) is rejected with a certain level of significance.

Based on the z-test results, we can conclude that there was some growth in technical efficiency of the state banks between years 2000 and 2001 as well as 2001 and 2002. However, the hypothesis about constant technical efficiency for the private banks can not be rejected for this sample.

Technology and productivity for all the banks were decreasing during the regulations (2000-2001) but these estimates started to grow after the deregulations (2002-2003). The results for all banks thoroughly support Alam's (2001) conclusions about the large US banks. The private banks demonstrated stable technical efficiency as well as mostly stable technology and productivity. The latter pair of indicators significantly increased between 2002 and 2003.

Comparing the state banks to the banks headquartered in Moscow (Moscow banks), we received quite similar results. Productivity and technology growths of the Moscow banks after the deregulations became even more pronounce.

Comparing the state banks to the banks headquartered in other regions (non-Moscow banks), we again received analogous to the first case results. The non-Moscow banks reached a significant increase in productivity and technology after the deregulations. Furthermore, the non-Moscow banks revealed a significant decline in technical efficiency in 1999/2000 and a significant technical efficiency increase in 2000/2001.

To measure the impact of the deregulations, we, first, considered the aggregated Malmquist indices and their components separately for state and private banks between a year of the regulations and a year of the deregulations (case A: 2000/2003 and case B: 2000/2004). Hence, the corresponding estimates were used to assess the differences between behaviors of private and state banks in cases A and B to check for discrepancies between earlier and later periods of the deregulations. In the same way, we obtained results for Moscow, small Moscow and non-Moscow banks.

The main hypothesis (Ho: $\theta=0$) for the difference measures was tested within bootstrap z-test technique. Thus, there was detected a statistically significant improvement in technical efficiency of the non-Moscow banks. Neither technology, nor productivity of the non-Moscow banks were affected by the deregulations (see Table 3).

Table 3. Estimates of deregulations impact and bootstrap z-test results for non-Moscow and small Moscow banks using the first model specification.

DIFFERENCES: NON-MOSCOW and SMALL MOSCOW

	Technical Efficiency Change	Technology Change	Productivity Change
Years	Non-Moscow-State	Non-Moscow-State	Non-Moscow-State
00/03	0.0183***	0.2382	0.2474
00/04	0.0175**	0.1092	0.1235
	Technical Efficiency Change	Technology Change	Productivity Change
Years	Small Mosc.-State	Small Mosc.-State	Small Mosc.-State
00/03	-0.1219	0.0899	0.0051
00/04	0.0419	0.0230	0.0358

* - significantly different from 1 at α=10%
** - significantly different from 1 at α=5%
*** - significantly different from 1 at α=1%

There is no statistically significant evidence which could confirm an existence of some impact of the deregulations onto private, Moscow or small Moscow banks. The analogous results for private and Moscow banks are compactly described in the Annex 8.

CONCLUSIONS

The research studies impact of the Russian banking sector deregulations on productivity dynamics as well as on innovating and imitating incentives of the private banks between 1999 and 2004.

After the deregulations of exit in 2001, the imbalances were disappearing and we got a smoother distribution for the technically inefficient banks. Also the deregulations had a significant positive effect on technical efficiency of the non-Moscow banks. The deregulations caused an increase in technical efficiency of the non-Moscow banks by 1.75-1.83%. In other words, the deregulations contributed positively to incentives of the non-Moscow banks to copy behavior of their peers. Probably, the managers of the non-Moscow banks started to work harder under the threat of possible bankruptcy. Thus, technical efficiency growth of non-Moscow banks significantly exceeded technical efficiency growth of state banks after the deregulations. However, there was no plain effect of the deregulations on incentives to innovate or productivity of non-Moscow banks.

Moreover, we failed to reject the hypotheses that there was a difference in innovative or imitative incentives of state banks, on the one hand, and private, Moscow and small Moscow banks, on the other hand.

Additionally, there are significant empirical evidences supporting the fact that all types of the banks, which are considered in the study, disinnovated between 2000 and 2001 and innovated between 2002 and 2003. Consequently, there was

a significant productivity regress in the times of regulations followed by a productivity progress in the times of deregulations for the whole banking sector.

Besides this, state banks also had a statistically significant increase in technical efficiency (i.e. in incentives to imitate) during the period of regulations, while non-Moscow banks were loosing technical efficiency between 1999 and 2000 and gaining it back between 2000 and 2001.

Thus, there was a positive shock to innovative incentives after the deregulations which caused enhancement in productivity of the whole banking sector. A question for a further study arises: whether this shock reflects a spillover effect from the deregulations onto the entire banking industry.

There is still much room left for deregulations in the Russian banking sector. We found a significant positive effect of the previous deregulatory policies on the banks headquartered outside Moscow and no effect on other private banks. Hence, the Russian banking sector can benefit from further deregulations. The Russian government and the legislative authorities should implement banking deregulation programs aimed to affect not only the group of non-Moscow banks but also all other private banks. Besides this, the government should incorporate into the future deregulatory policies stimuli for development of innovative incentives.

Although profit misreporting is a wide spread phenomenon in Russia, the entire research topic can be further developed with a study focused on the impact of deregulations onto revenue and profit efficiencies of the Russian banking sector.

BIBLIOGRAPHY

Alam, Ila M.S. (2001), '*A Nonparametric Approach for Assessing Productivity Dynamics of Large U.S. Banks*', Journal of Money, Credit and Banking, vol. 33, No. 1, p. 121-139.

Berg, Sigbjam A., Finn R. Farsund, and Eilev S. Jansen (1992), '*Malmquist Indices of Productivity Growth during the Deregulation of Norwegian Banking, 1980-89*', Scandinavian Journal of Economics, vol. 94, p. 211-228.

Berger, Allen N. (2003), '*The economic effects of technological progress: Evidence from the banking Industry*', Journal of Money, Credit, and Banking; 35, 2; ABI/INFORM Global p. 141.

Berger, Allen N. and David B. Humphrey (1997), '*Efficiency of Financial Institutions: International Survey and Directions for Further Research*', European Journal of Operational Research.

Bhattacharyya, Arunava et al. (1997), '*The Impact of Liberalization on the Productive Efficiency of Indian Commercial Banks*', European Journal of Operational Research vol. 98, p. 332-345.

Charnes, A., W.W. Cooper, and E. Rhodes (1978), '*Measuring the Efficiency of Decision Making Units*', European Journal of Operational Research, vol. 2, p. 429-444.

Coelli, Tom, D.S.P. Rao, and George E. Battese (1997), '*An Introduction to the Efficiency and Productivity Analysis*', London, 275 p.

Demirguc-Kunt, Asli, Luc Leaven and Ross Levine (2003), '*Regulations, Market Structure, Institutions and the Cost of Financial Intermediation*', NBER working paper 9890.

Efron, B. (1979), '*Bootstrap Methods: Another Look at the Jackknife*', Annals of Statistics, vol. 7, 1-26.

Färe, R. and V. Zelenyuk (2003), '*On Aggregate Farrell Efficiencies*', European Journal of Operational Research vol. 146, p. 615-620.

Farrell, M.J. (1957), '*Measurement of Productive Efficiency*', Journal of Royal Statistical Society, Series A (General), vol. 120, issue 3.

Federal law on Insolvensy (Bancruptcy) of Crediting Organizations. N 40-ФЗ from 25.02.1999 (with changes introduced by laws N 6-ФЗ, N 86-ФЗ).

Federal Law on Restructuring of Credit Organizations. N 144-ФЗ from 08.07.1999.

Fries, Steven and Anita Taci (2004), '*Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries*', EBRD working paper 86.

Fuchs, Michael Joseph et al. (2002), '*Building trust: developing the Russian financial sector*', 1951- II. World Bank.

Hesselbein, Frances (2002), '*Hesselbein on Leadership*', 1st edition, Jossey-Bass, San Francisco, 188 p.

Huang, Tai-Hsin and Tong-Liang Kao (2006), '*Joint estimation of technical efficiency and production risk for multi-output banks under a panel data cost frontier model*', Springer Science + Business Media.

Humphrey, D. B. (1993), '*Cost and Technical Change: Effects from Bank Deregulation*', Journal of Productivity Analysis, vol. 4, 9-34.

Kneip, A., B. Park, and L. Simar (1998), '*A Note on the Convergence of Nonparametric DEA Estimators for Production Efficiency Scores*', Econometric Theory, vol. 14, p. 783-793.

Kumbhakar, Subal C. (2001), '*The Effects of Deregulation on the Performance of Financial Institutions: The Case of Spanish Savings Banks*', Journal of Money, Credit and Banking, vol. 33, No. 1, p. 101-120.

Malmquist, Sten (1953), '*Index Numbers and Indifference Surfaces*', Trabajos de Estadística, vol. 4, p. 209-242, Madrid, Instituto de Investigaciones Estadísticas del Concejos.

McAllister, Patrick H. and Douglas McManus (1993), '*Resolving the Scale Efficiency Puzzle in Banking*', Journal of Banking and Finance, vol. 17, p. 389-405.

Percin, Selcuk and Tuba Yakici Ayan (2006), '*Measuring Efficiency of Commercial Banks in Developing Country: The Case of Turkey*', Investment Management and Financial Innovations, vol. 3, Issue 2.

Rezitis, Anthony N. (2006), '*Productivity Growth in The Greek Banking Industry: A Non-parametric Approach*', Journal of Applied Economics, vol. IX, No. 1, p. 119-138.

Simar, Léopold and Paul W. Wilson (2000), '*A General Methodology for Bootstrapping in Non-Parametric Frontier Models*', Journal of Applied Econometrics, vol. 27, No. 6, p. 779-802.

Simar, Léopold and Valentin Zelenyuk (2007), '*Statistical Inference for Aggregates of Farrell-Type Efficiencies*', Journal of Applied Econometrics, vol. 22, JAE991.

Styrin, K. (2003), '*What Explains Differences in Efficiency across Russian Bank?*' Interim Report, CEFIR.

Vivas, Ana Lozano (1997), '*Profit Efficiency for Spanish savings Banks*', European Jornal of Operational Research, vol. 98, p. 381-394.

Wheelock, David C. and Paul W. Wilson (1999), '*Technical Progress, Inefficiency, and Productivity Change in U.S. Banking, 1984-1993*', Journal of Money, Credit, and Banking; vol. 31, p. 212-234.

Yakovlev, Yevgeny and Yekaterina Zhuravskaya (2006), '*Deregulation*', EBRD.

Yildirim, H.S. and G.S. Philippatos (2001), '*Efficiency of Banks: Recent Evidence from the Transitional Economies of Europe*', Working paper, University of Tennessee.

http://analytics.interfax.ru/spicok.htm

http://www.arb.ru/site/action/archive.php

http://www.ebrd.com/country/sector/econo/stats/sei.xls

http://www.ebrd.com/country/sector/econo/stats/tic.xls

http://www.ebrd.com/country/sector/econo/stats/timeth.htm

http://www.internettrading.ru/publish/defolt.html

http://ru.wikipedia.org/wiki/Дефолт_в_России_1998_года

ANNEXES

Annex 1. Banks in ARCO's portfolio as of December 31, 2000.

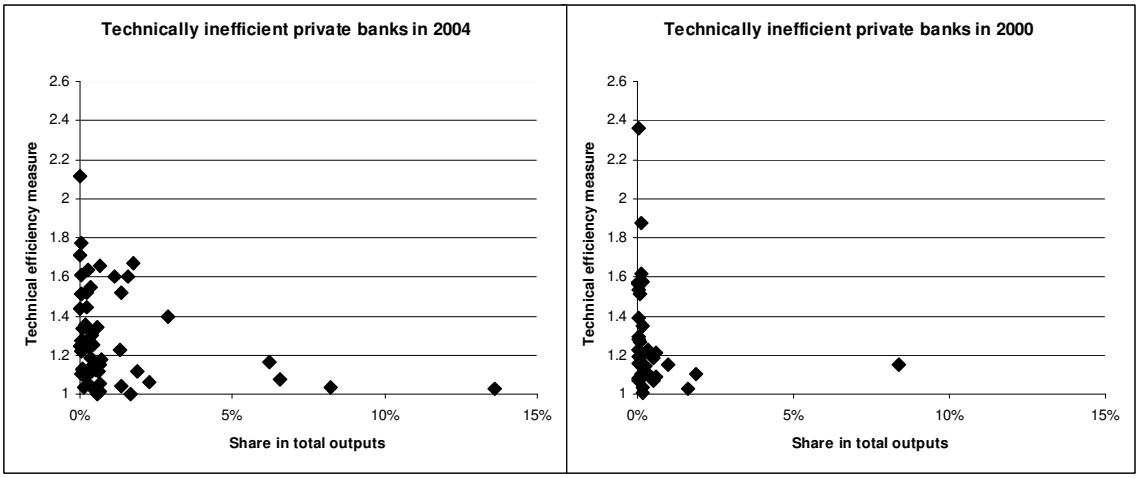
Bank Name	*Region*	*ARCO Ownership*	*Comments*
AvtoVAZbank	Samara	88.1%	Sold 2001
Investbank	Kaliningrad	85.15%	Sold 2001
Rossiyskiy Kredit	Moscow	25% + 1 (+ 50% in trust)	
Kuzbassugolbank	Kemerovo	90.9%	Sold 2001
Kemerovo	*Kemerovo*	—	*Merged 2001*
Kuzbassocbank	Kemerovo	—	
Kuzbassprombank	Kemerovo	99%	In liquidation
Eurasia	Izhevsk	50% + 1	
RNKB	Moscow	46.09%	Sold 2001
Vyatka	Kirov	73.63%	
Peter the First	Voronezh	96.6%	Sold 2001
Bank Voronezh	*Voronezh*	*99%*	*Merged 2001*
ChelyabComZemBank	Chelyabinsk	74.62%	Sold 2001
Dalrybbank	Vladivostok	99%	
SBS-AGRO	Moscow	99.9%	
Amurpromstroybank	Blagoveshensk	99%	Tendering
Bashprombank	Ufa	97%	
Alfa–Bank	Moscow	25% + 1 in trust	
Vozrozhdenie	Moscow	—	

— None.
Source: ARCO.

Annex 2. Sources of data.

		Place in Questionnaire	
Var	Definition	Interfax-Russia	Mobile
y1	ruble amount of government securities	3.a	ГДО
y2	ruble amount of non-government securities	4.e+9.c+7.b(3)	НЦБ+ВЕП
y3	ruble amount of total securities (y1+y2+y4)	3.a+4.e+9.c+7.b(3)	ГДО+НЦБ+ВЕП
y4	ruble amount of loans to economy	5.d+e	КЭ
y5	ruble amount of loans to other banks	8.a	МБК
y6	ruble amount of total loans (y5+y6)	5.d+5.e+8.a	КЭ+МБК
x1	ruble amount of bank equity capital	1.c	СК
x2	ruble amount of loans from other banks	12.a*12.e	КДБ
x3	ruble amount of securities issued by the banks in circulation	14.a	ВБЦБ
x4	ruble amount of purchased funds(x2+x3)	12.a*12.e+14.a	КДБ+ВБЦБ
x5	ruble amount of private individuals deposits	2.a	ВДФЛ
x6	ruble amount of juridical entities deposits	11.a*11.d-2.a	ВДЮЛ
x7	ruble amount of deposits (x5+x6)	11.a*11.d	ВДФЛ+ВДЮЛ
x8	ruble amount of total loanable funds (x4+x7)	12.a+14.a +11.a*11.d	КДБ+ВБЦБ+ВДФЛ+ВДЮЛ

Annex 3. Technically inefficient banks plotted by size for 2004 and 2000.



Annex 4. MI estimation results using four specifications.

Technical Efficiency Change

	State Banks				Private Banks				All Banks			
Model	1	2	3	4	1	2	3	4	1	2	3	4
99/00	1.000	1.000	1.019	0.957	0.980	0.967	0.964	0.954	0.991	0.985	0.993	0.956
00/01	1.039	1.113	0.956	1.254	1.146	1.188	1.292	1.339	1.095	1.147	1.108	1.292
01/02	1.082	1.006	1.130	1.025	1.009	1.029	1.045	1.000	1.044	1.016	1.093	1.014
02/03	1.004	1.000	0.885	0.783	0.997	0.956	0.899	0.901	1.000	0.981	0.891	0.835
03/04	0.983	0.970	0.970	0.930	0.885	0.990	0.986	1.027	0.969	0.978	0.976	0.969

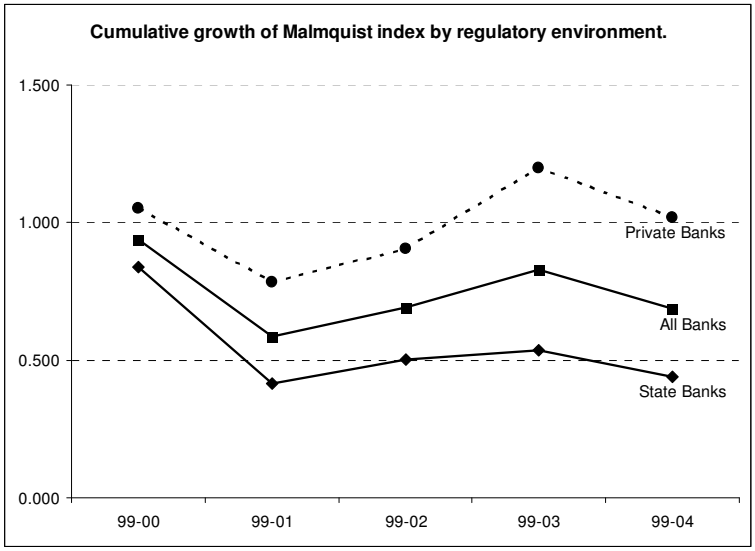
Technology Change

	State Banks				Private Banks				All Banks			
Model	1	2	3	4	1	2	3	4	1	2	3	4
99/00	0.839	0.943	1.056	1.134	1.070	1.063	1.068	1.095	0.946	0.999	1.061	1.116
00/01	0.480	0.486	0.783	1.058	0.669	0.579	0.708	0.778	0.579	0.528	0.749	0.932
01/02	1.137	1.143	1.043	0.905	1.147	1.073	1.041	1.043	1.142	1.113	1.042	0.964
02/03	1.067	1.119	1.271	1.236	1.332	1.180	1.161	1.155	1.202	1.146	1.222	1.200
03/04	0.841	0.799	0.759	0.852	0.961	1.025	0.955	0.920	0.858	0.891	0.838	0.879

Productivity Change

	State Banks				Private Banks				All Banks			
Model	1	2	3	4	1	2	3	4	1	2	3	4
99/00	0.839	0.943	1.076	1.054	1.050	1.031	1.035	1.048	0.937	0.984	1.057	1.051
00/01	0.494	0.524	0.659	1.085	0.747	0.669	0.832	0.932	0.625	0.589	0.737	1.016
01/02	1.210	1.149	1.181	0.922	1.152	1.100	1.067	1.026	1.180	1.128	1.132	0.967
02/03	1.072	1.119	1.122	0.966	1.328	1.129	1.042	1.041	1.203	1.123	1.087	1.000
03/04	0.821	0.769	0.727	0.786	0.851	1.011	0.935	0.941	0.825	0.867	0.811	0.849

Annex 5. Cumulative growth of MI by regulatory environment.



Annex 6. MI estimates and bootstrap z-test results for the first model specification: state banks vs. private banks.

PRIVATE-STATE

Technical Efficiency Change			
Years	State Banks	Private Banks	All Banks
99-00	1.0000	0.9798	0.9906
00-01	1.0386***	1.1463	1.0946
01-02	1.0818***	1.0092	1.0437
02-03	1.0043	0.9966	1.0003
03-04	0.9826	0.8852	0.9688
Technology Change			
Years	State Banks	Private Banks	All Banks
99-00	0.8389	1.0696	0.9463
00-01	0.4804	0.6691	0.5785*
01-02	1.1370	1.1470	1.1423
02-03	1.0667*	1.3318**	1.2023***
03-04	0.8405	0.9614	0.8576
Productivity Change			
Years	State Banks	Private Banks	All Banks
99-00	0.8389	1.0499	0.9372
00-01	0.4935	0.7465	0.6250*
01-02	1.2103	1.1521	1.1798
02-03	1.0717*	1.3275**	1.2026***
03-04	0.8206	0.8508	0.8249

* - significantly different from 1 at α=10%

** - significantly different from 1 at α=5%

*** - significantly different from 1 at α=1%

Annex 7. MI estimates and bootstrap z-test results for the first model specification: Moscow based and non-Moscow based headquarters vs. state banks.

MOSCOW-STATE				NON-MOSCOW-STATE			
Technical Efficiency Change				Technical Efficiency Change			
Years	State Banks	Mosc. Banks	All Banks	Years	State Banks	non-Mosc. Banks	All Banks
99-00	1.0000	0.9917	0.9963	99-00	1.0000	0.9680***	0.9977***
00-01	1.0388***	1.1542	1.0965	00-01	1.0000	1.0022**	1.0002**
01-02	1.0829**	0.9911	1.0365	01-02	1.0615***	1.0159	1.0554
02-03	1.0044*	1.0104	1.0074	02-03	0.9523***	0.9987	0.9582
03-04	0.9574**	0.9663	0.9613	03-04	1.0000	1.0064	1.0006
Technology Change				Technology Change			
Years	State Banks	Mosc. Banks	All Banks	Years	State Banks	non-Mosc. Banks	All Banks
99-00	0.8339	1.0200	0.9173	99-00	0.8455	1.3095	0.8790
00-01	0.5007	0.6584	0.5796**	00-01	0.5791	0.7037	0.5929*
01-02	1.1322	1.2048	1.1689	01-02	1.0332	1.0087	1.0299
02-03	1.1441	1.4463**	1.2925***	02-03	1.3668*	1.3930**	1.3701**
03-04	0.7722	1.1154	0.9227	03-04	1.0855	0.8251	1.0628
Productivity Change				Productivity Change			
Years	State Banks	Mosc. Banks	All Banks	Years	State Banks	non-Mosc. Banks	All Banks
99-00	0.8339	1.0121	0.9138	99-00	0.8455	1.2850	0.8773
00-01	0.5133	0.7391	0.6263**	00-01	0.5791	0.7041	0.5930*
01-02	1.2063	1.1883	1.1972	01-02	1.0795	1.0299	1.0729
02-03	1.1492*	1.4615*	1.3025***	02-03	1.2911*	1.3847**	1.3030**
03-04	0.7290	1.0803	0.8831	03-04	1.0855	0.8324	1.0634

* - significantly different from 1 at α=10%

** - significantly different from 1 at α=5%

*** - significantly different from 1 at α=1%

Annex 8. Estimates of deregulations impact and bootstrap z-test results for Moscow and private banks using the first model specification.

DIFFERENCES: MOSCOW and PRIVATE

	Technical Efficiency Change	Technology Change	Productivity Change
Years	Private-State	Private-State	Private-State
00/03	-0.0091	0.4705	0.5117
00/04	-0.0031	0.3645	0.3576
	Technical Efficiency Change	Technology Change	Productivity Change
Years	Moscow-State	Moscow-State	Moscow-State
00/03	-0.0097	0.5161	0.5547
00/04	-0.0191	0.3774	0.3613

* - significantly different from 1 at α=10%

** - significantly different from 1 at α=5%

*** - significantly different from 1 at α=1%