AN ABSTRACT OF THE DISSERATION OF

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This study has two main objectives. First, we propose an alternative way for treating deposits in modeling a banking firm, which account for both their input and output features. Second, we contribute to modeling failures in the banking sector by distinguishing three groups of factors affecting failures: bank level, industry level and economy-wide level, recognizing the risks associated with these factors. We apply both models to a data set of Russian banks, spanning 1999-2004.

Traditionally researchers assumed that deposits are either an input, used to generate loans (intermediation approach) or an output, a service that a bank provides, utilizing labor and capital (production approach). In Chapter 2 we propose to account for both input and output characteristics of deposits by introducing a substitution effect. In the framework of non-parametric Data Envelopment Analysis we maximize deposits, just like other outputs, while introducing the possibility of substitution between deposits and other borrowed funds, an input. Even though we did not find evidence that the results of our model are significantly different from the other two approaches, it is still preferred, since it provides a more general way of treating deposits: both production and intermediation models can be deduced from it.

Chapter 3 extends existing literature on modeling bank failures. We model failures as a function of different risks that a banking firm faces. We argue that a bank fails if cumulative risks exceed an unobserved critical level and use a binary response model to carry out our empirical estimation for a sample of Russian banks. We add the efficiency metric from Chapter 2 to our data set and use it as a proxy for managerial quality. We also adjust for the fact that bank failures represent rare events as suggested by King and Zeng (2001). We found that higher deposit and liquid assets balances, as well as efficiency (banks-specific variables) were crucial in affecting failures, while macroeconomic and industry-level variables appeared to be not as important.

Measuring Efficiency and Explaining Failures in Banking: Application to the Russian Banking Sector

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Natalia V. Konstandina, Author

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LIST OF ABBREVIATIONS

ARCO	Agency for Reconstruction of Credit Organizations
BIS	Bank of International Settlements
CBR	Central Bank of Russia
DI	Deposit insurance
DIA	Deposit Insurance Agency
EBRD	European Bank for Reconstruction and Development
FIG	Financial Industrial Group
GKO	Russian Government Short-Term T-bills
HHI	Herfindahl-Hirshman Index
IAS	International Accounting Standards
IMF	International Monetary Fund
OFZ	Russian Federal Bonds
RAS	Russian Accounting Standards
TACIS	Technical Assistance to Commonwealth of Independent States
TE	Transition Economies

Measuring Efficiency and Explaining Failures in Banking: Application to the Russian Banking Sector

Introduction

Banking system plays an important role in the functioning of the entire economy, being a vital part of economic infrastructure. It is a support system, channeling savings into loans and promoting economic growth and development. It facilitates transactions and exchange of payments, assisting everyday business functioning. A transition economy needs to restructure its entire banking system. During early restructuring, the demand for banking services is often far greater then the supply. Newly established private enterprises need venture funds to grow into strong and viable entities. Banks and their customers alike are inexperienced in dealing in market-type economy.

In this environment, which was typical for a transition economy in early 1990's, the issues of bank failures and bank efficiency were not investigated. But as transition progressed and problems arose, policy makers, economics commentators, and depositors began paying attention to bank performance. Researchers as well took up these topics.

In this research we start by examining in Chapter 1 the past events that shaped Russian banking industry: the financial crisis of 1998, adoption of laws on bankruptcy of banks, deposit insurance and credit histories. Along with this we evaluated the trends and dynamics of the banking industry structure. In the past 15 years significant progress has been achieved in transforming the Russian banking system from plan to market. Private banks came into being and the scale and scope of bank operations expanded. Deposits are growing, more long-term assets replace short-term ones, and consumer loans are gaining popularity. At the same time banking regulation improved. International Accounting Standards have been

adopted for reporting and acceptance to the deposit insurance system is based on strict norms.

Approaching the first issue – efficiency in the banking sector – we first observed that there are two main ways to model deposits in the banking sector. Deposits have both input and output characteristics, which is reflected in the two methods: the intermediation approach treats deposits as inputs, while the production approach treats them as outputs when computing efficiency of the production units.

In Chapter 2 we offer a new model, based on the directional distance function approach, that reflects the fact that deposits are non-traditional outputs in that they incorporate input characteristics as well. We will look at the possibility of substitution between deposits and other borrowed funds on the input side. The second objective of this study is to illustrate the new substitution model for the banking sector in Russia and to compare the results to the outcomes of the other approaches used to model deposits in the banking sector.

In Chapter 3 we investigate bank failures. The financial crisis of 1998 and turbulence on the market in summer 2004 raise the question of which factors determine bank failures. The changing environment of a transition economy also affects bank vitality. Even though most of the transition economies had to deal with bank failures, not many studies addressed this issue. Here we begin with the classical theory of a banking firm and then turn to specifying failures as a function of risks. This is done to set up a model to estimate the probability of bank failures empirically and to identify key explanatory factors influencing them.

We then reviewed failure definitions and developed our empirical model, building on previous studies and adding several modifications. We included in variable descriptions the features that a transition economy such as Russia exhibits. Among the influential variables that affect failures we used capital adequacy, liquidity, interbank market operations and size. Furthermore, efficiency estimates

produced with the substitution model from Chapter 2 are used as the proxy for managerial quality.

We also added proxies of industry structure to account for its possible effect, which we think should be more pronounced for a transition economy. The influence of macroeconomic environment was also recognized.

Table 1.3. Selected Russian Banking Sector and Macroeconomic Indicators, 1998-2005

	1998	1999	2000	2001	2002	2003	2004	2005
Real GDP growth %	-4.9%	6.4%	10.0%	5.1%	4.7%	7.3%	6.8%	5.2%
GDP per capita, $	1,906	1,346	1,784	2,116	2,385	3,057	4,035	4,668
Inflation (CPI), %	84.5%	36.6%	20.1%	18.8%	15.1%	13.7%	12.7%	11.1%
Banking sector assets*	654,357	1,030,075	1,696,115	2,398,076	3,071,965	3,843,515	5,091207	6,660,909
Banking equity capital*	124,003	102,677	166,259	234,222	352,140	491,277	686,646	898,313
Loans as % of GDP	11.7%	9.8%	11.1%	14.4%	16.2%	19.6%	23.0%	25.8%
Loans to public**	20,078	27,630	44,749	94,653	142,148	299,678	618,862	1,037,609
Loans to firms*	300,248	445,190	763,348	1,191,452	1,612,686	2,299,943	3,189,317	3,948,370
Total public deposits*	201,264	300,449	453,204	690,056	1,046,255	1,517,791	1,977,193	2,496,588
Deposits as % of GDP	7.3%	6.2%	6.2%	7.7%	9.7%	11.4%	11.9%	12.9%

Source: Standard and Poor's (2005) and CBR web site.
** Real values in mln of 1998 roubles.*
*** 'Public' here and everywhere else refers to household's or physical person's loans (or deposits).*

As for the loans structure (Table 1.4), about one third were granted to mining, manufacturing and utilities. Another large share went to trade – about 25% on average. Agriculture received only 4% of the total, which contrasts with the early 1990s. Then many loans were issued to this sector, often due to the government's authoritative suggestion.[9] Moreover, the issues of land ownership are still not clear and this hinders the lending activity in this sector. Loans to the public were on the rise, from 7% of total loans in 2001 to 19% in 2005.

Lending activity varies by the region as well. While the Moscow region dominates on average, the Ural and Siberian regions provide a significant share of financing to mining. Central (excluding Moscow), North West and Volga regions prevail in issuing credit to manufacturing, since these regions host most of the large industrial enterprises. The South, Volga and Central (excluding Moscow) regional banks lead in financing agriculture, since geographical and climate conditions there are particularly suitable for agriculture, in contrast to the Far East and Ural regions, for instance.

Another important dimension to look at is the term structure of banking sector assets and liabilities. According to the Table 1.5, long term loans (over 3 years) constituted only 12% of total loans at the end of 2005, up from 7 % in 1997.

[9] Author's own experience from working at SBS-Agro, a private bank that acquired Agroprombank to strengthen it branch network, offers examples of how government could 'strongly suggest' financing certain projects. In return, some special treatment could be given to this bank. In addition, international organizations and programs (EBRD or TACIS, for instance) granted funds to several banks specifically to be distributed as loans to farmers and small businesses.

Table 1.4. Loans By Region by Sector in 2001, 2003, 2005 (in mln 2001 roubles)

	Region	Mining	Manufacture	Utilities	Agriculture	Construction	Trade	Transport	Other*	Total
End 2005	Central	45,116	269,560	46,392	56,152	133,832	639,159	147,899	749,978	2,088,088
	Moscow	33,865	113,485	32,095	6,067	106,964	530,337	129,393	612,048	1,564,254
	North West	2,430	128,255	22,476	9,536	22,687	94,474	18,777	95,171	593,806
	South	1,070	51,318	8,074	26,882	9,891	83,267	16,590	28,764	225,856
	Volga	15,022	177,856	14,901	32,457	29,786	136,371	26,990	111,281	544,664
	Ural	17,738	86,609	4,341	5,952	16,333	70,288	9,402	58,493	269,156
	Siberia	27,114	87,366	15,725	17,056	14,017	95,342	13,608	45,095	315,323
	Far East	13,898	24,429	11,284	3,718	6,371	33,123	4,954	16,410	114,187
	% of total	3%	20%	8%	4%	6%	28%	6%	27%	100%
End 2003	Central			327,671	21,419	69,638	292,868	76,455	420,701	1,208,752
	Moscow			214,407	1,666	56,642	244,960	65,894	375,121	958,690
	North West			109,232	4,112	8,390	57,161	13,339	39,839	232,073
	South			40,267	11,675	4,190	36,019	12,593	20,339	125,083
	Volga			146,804	13,758	12,266	61,727	13,571	44,286	292,412
	Ural			71,154	3,831	8,569	28,343	4,497	29,625	146,019
	Siberia			109,945	6,768	6,875	44,219	8,675	24,441	200,923
	Far East			58,162	1,088	4,498	12,756	3,356	10,351	90,211
	% of total			33%	2%	5%	24%	6%	30%	100%

Table 1.4. continued

End 2001	Central	185,897	5,233	35,247	142,131	25,911	193,836	588,255
	Moscow	130,011	282	29,551	120,779	20,346	179,311	480,280
	North West	49,530	1,736	3,170	19,921	7,734	20,442	102,533
	South	29,907	4,491	1,989	17,986	7,110	17,505	78,988
	Volga	77,569	6,598	4,394	29,402	5,918	15,946	139,827
	Ural	62,304	1,256	4,065	12,010	3,784	20,652	104,071
	Siberia	75,257	2,337	2,761	24,061	4,058	13,630	122,104
	Far East	30,108	1,240	1,209	4,671	1,934	4,567	43,729
	% of total	39%	1%	5%	22%	5%	28%	100%

Source: CBR web site
**Main contributors to the category "Other" are financial sector and public administration.*

Table 1.5. Term Structure of Real Deposit and Real Loans of Russian Banks in 1997, 2001, 2005 (in mln 1997 roubles)

		Term	End 1997				End 2001				End 2005			
			Roubles	FC*	Total	%**Total**°	Roubles	FC	Total	% **Total**	Roubles	FC	Total	% **Total**
Deposits	**Private**	Demand	68,224	12,539	80,763	47%	123,101	57,422	180,523	27%	287,083	85,779	372,862	15%
		< 30 days	564	970	1,534	1%	623	916	1,539	0.2%	1,191	515	1,706	0.1%
		31-90 days	19,587	2,875	22,462	13%	22,714	8,971	31,685	5%	27,457	9,546	37,003	1%
		91-180 days	35,098	3,355	38,453	23%	135,623	83,190	218,813	33%	135,567	40,949	176,516	7%
		181day-1 year	9,991	5,435	15,426	9%	38,562	58,246	96,808	14%	275,868	129,038	404,906	16%
		1-3 years	6,176	2,587	8,763	5%	102,929	33,586	136,515	20%	1,013,723	323,348	1,337,071	54%
		> 3 years	2,194	768	2,962	2%	2,588	1,317	3,905	1%	138,462	28,063	166,525	7%
		Total	141,834	28,529	170,363	100%	426,140	243,648	669,788	100%	1,879,351	617,238	2,496,589	100%
	Corporate	Demand	339	1,733	2,072	4%	2,370	784	3,154	1%	23,034	463	23,497	3%
		< 30 days	647	4,035	4,682	9%	16,438	58,313	74,751	27%	39,878	61,839	101,717	11%
		31-90 days	2,400	2,409	4,809	9%	13,431	21,773	35,204	13%	80,531	32,479	113,010	12%
		91-180 days	4,003	3,713	7,716	15%	10,777	11,943	22,720	8%	115,619	50,338	165,957	18%
		181day-1 year	1,341	4,723	6,064	12%	10,454	51,247	61,701	22%	103,308	93,980	197,288	21%
		1-3 years	780	1,433	2,213	4%	7,941	23,543	31,484	11%	60,509	101,920	162,429	18%
		> 3 years	349	2,131	2,480	5%	6,710	16,679	23,389	8%	40,469	32,350	72,819	8%
		Banks	1,705	18,889	20,594	41%	1,807	27,303	29,110	10%	8,801	77,799	86,600	9%
		Total	11,564	39,066	50,630	100%	69,928	211,585	281,513	100%	472,149	451,168	923,317	100%
	Grand Total		153,398	67,595	220,993		496,068	455,233	951,301		2,351,500	1,068,406	3,419,906	

Table 1.5. continued

		Term	End 1997				End 2001				End 2005			
			Roubles	FC	Total	% **Total**	Roubles	FC	Total	%**Total**	Roubles	FC	Total	%**Total**
Loans	**Corporate**	< 30 days	5,117	3,287	8,404	4%	161,556	13,878	175,434	14%	245,262	12,233	257,495	6%
		31-90 days	13,149	5,038	18,187	8%	92,298	26,102	118,400	9%	237,022	48,783	285,805	7%
		91-180 days	26,457	14,024	40,481	17%	134,754	41,416	176,170	14%	383,219	97,139	480,358	11%
		181day-1 year	52,094	19,592	71,686	30%	266,637	108,882	375,519	29%	959,137	229,516	1,188,653	27%
		1-3 years	22,761	18,543	41,304	17%	117,871	113,117	230,988	18%	730,784	400,758	1,131,542	26%
		> 3 years	7,318	9,204	16,522	7%	36,188	51,176	87,364	7%	267,598	275,988	543,586	12%
		Banks	14,094	25,448	39,542	17%	68,156	61,773	129,929	10%	200,511	274,072	474,583	11%
		Total	140,990	95,136	236,126	100%	877,460	416,344	1,293,804	100%	3,023,533	1,338,489	4,362,022	100%
	Private Loans		11,895	5,421	17,316		78,446	16,207	94,653		880,712	156,897	1,037,609	
	Grand Total		152,885	100,557	253,442		955,906	432,551	1,388,457		3,904,245	1,495,386	5,399,631	

,

Source: CBR web site.

[*] *FC – foreign currency denominated.*

[°] *Refers to the 'Total' computed in the rows.*

Most loans are still issued for six months to three years. When banks lend short term, it is hard for businesses to undertake long projects with outside financing unless roll-over is automatic. This is one of the areas where Russian financial development remains immature.

A similar trend in the term structure of deposits is observed. Few deposits are long-term (greater than three years): 7% of private deposits and 8% of corporate deposits. Private medium-term (1-3 years) deposit growth, however, has been impressive, showing more than a ten-fold increase over 1997-2005. This boom is associated with greater trust in the banking system, higher interest rates on medium-term relative to short-term rates, a stronger rouble (2/3 of the medium-term deposits are now denominated in roubles) and robust economic growth.

Even though long-term financing is not fully developed, it appears that Russian banks maintain a relatively good balance between assets and liabilities. The low level of intermediation might reflect inefficiencies in management. Since this presents an important characteristic of banking industry development, we devote our Chapter 2 to investigation of (in)efficiency.

The Law on Credit Histories (06/01/2005), which set standards for collection and dissemination of deposit information on private borrowers, will further help banks manage the risks of issuing loans to public. The Information Agency Interfax in collaboration with the US credit bureau Experian established an independent credit bureau shortly thereafter. The state-controlled Sberbank also announced its intent to develop its own credit bureau, which will probably become a major player in the field (Rubchenko, 2005).

After the crisis of 1998, the banking system in Russia as well as the entire economy rebounded. Of course, the crisis had a major detrimental effect, but it drove home important lessons and prompted fundamental changes in banking regulation: in particular, deposit insurance and the credit law just mentioned above. Deposit insurance is of major important for the Russian banking system and we turn to its detailed discussion in the next section.

1.2.3. Deposit Insurance in Russia

After extensive discussion dating back to 1999, the law approving deposit insurance (DI was finally passed on December 23, 2003. As of the beginning of 2005, private deposits in Russia were insured up to 100,000 roubles (about $3700 at the current exchange rate). Member banks pay no more than 0.15% of the average value of deposits in the previous quarter to the DI fund. If the Deposit Insurance Agency (DIA), an independent body partially funded by assets, inherited from ARCO, needs more funds, it can directly apply for budgetary support.

By September 2005, 75% of all applicants were admitted to deposit insurance subject to special prudential requirements. Banks failing qualification have the right to appeal, but if unsuccessful, they will not be able to accept deposits in the future.

There are several compelling reasons for establishing DI. Protecting small unsophisticated depositors and reducing the chances of bank runs would help strengthen trust in the banking system. As we have mentioned, the question of trust is central to well-functioning of Russian banking system, since many events effectively undermined it during early transition. The stability of the Russian banking system will be strengthened as well due to DI. In addition, DI would help mobilize savings (Tompson, 2004a) and help accumulate much-needed funds for investments. Another benefit of DI is leveling the playing field for private smaller banks, which do not enjoy government support, as opposed to large state-owned banks like Sberbank in Russia.[10] This would enhance competition in the Russian banking sector and improve efficiency.

A single strong argument against DI can outweigh all the good things that it is designed to promote. Banks can take on excessive risks encouraged by the bail-out possibilities available to depositors. Creditors, on the other hand, are less

[10] Sberbank will remain outside of the DI system through 2007, but its deposits will be under state guarantee.

encouraged to monitor banks closely, counting on the same DI funds to be available to compensate them should the bank experience problems.

Consequently establishment of DI could have two competing effects: it may decrease failures due to fewer bank runs or bring about more failures due to excessive risk-taking. This trade-off has been the subject of much research. In general, the evidence that deposit insurance promotes banking sector stability is mixed. Summing up several studies, Demirgüç-Kunt and Kane (2001) conclude that the institutional environment and DI design greatly affect the probability of future banking crises in countries with DI in place. Weak institutional environment, characterized by low level of contract enforcement will be likely to cause greater moral hazard due to DI.

Since transition economies have a less stable and predictable environment than developed countries, it is necessary that the DI scheme is adjusted for that. Fantini (2003) believes that the high deposit premiums and capital adequacy requirements of Russian DI (compared to the US for instance) would be sufficient to cover additional risks to Russia's transition economy setting.

The recent mini-crisis shows that even though the banking system was apparently stable in 2004, had not the government and the CBR intervened, the "mini" part would not have applied. The crisis of 1998 was triggered by government debt default and deteriorating macro conditions. But in 2004 the government was fiscally sound and the macroeconomic situation was favorable. Even though illegal operations triggered the disturbance in 2004, the probability of bank failure due to economic reasons remains significant. This vulnerability and possibility of distress motivated us to study further bank failures. In Chapter 3 we develop a failure model that incorporates industry structure, local market conditions and macroeconomic influence, together with bank-specific factors, including efficiency scores as a proxy for managerial quality. We explore the structure and dynamics of the Russian banking sector in the next section to be able to account for these features in our modeling exercise.

1.3. Market Structure of the Russian Banking Industry

1.3.1. Ownership Structure

During the early 1990's, several specialized banks (Agroprombank, Zhilsotsbank and Promstroibank) became private property, while others – Sberbank and Vneshtorgbank – continue to have the state as primary stakeholder. The CBR estimates only the total number of banks with state participation exceeding 50% (CBR, 2005a), which was 21 at the end of 2004. Berglof et al. (2003) estimated that in 2002 the government owned shares in 424 and blocking stakes (over 25%) in 62 banks. *The Economist* (May 20, 2006) claims that 2/5 of total assets are controlled either directly by government or by government-affiliated entities. Even though the number of banks with state involvement is not large, they control a large proportion of banking service markets, especially deposits. This is mostly due to Sberbank's leading positions, inherited from the Soviet past, and increasing efforts of Vneshtorgbank, the second largest entity, to capture a large share of the deposits market. The third largest bank, Gazprombank, is also government controlled.

Foreign capital participation and foreign entry historically are not significant: the strong traditions of protectionism in the Russian banking industry trace back to the nineteenth century. The share of foreign capital was limited to 12% of total banking capital in Russia until 2001 when this restriction was abandoned. But this limitation was never binding – in fact foreign participation never reached that level and as of 2006 was about 10%. Also, according to the decree "On conditions for opening banks with foreign ownership in Russia" (04.03.1993) the number of branches and offices was restricted to one. The increase in the number of 100% foreign-owned banks is insignificant: four new banks in 2002, five in 2003, and one in both 2004 and 2005. Besides, in 2002 and 2003 the

number of banks with over 50% foreign ownership was slightly decreased, possibly due to moving to the 100% foreign-owned category (Table 1.6).[11]

Table 1.6. Banking Industry Structure, 1996-2005

End of year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Licensed to conduct banking operations	2029	1697	1476	1349	1311	1319	1329	1329	1299	1296
- banks	2007	1675	1447	1315	1274	1276	1282	1277	1249	1246
- with 100% foreign capital	13	16	18	20	22	23	27	32	33	34
- with 50-100% foreign capital	10	10	12	12	11	12	10	9	9	9
- attract household deposits	1914	1589	1372	1264	1239	1223	1202	1190	1165	1162
Total # of branches	39549	6353	4453	3923	3793	3433	3326	3219	3238	3287
- Sberbank*	34426	1928	1852	1689	1529	1233	1162	1045	1011	1009
- 100% foreign owned	0	3	4	4	7	9	12	15	16	28

Source: CBR web site.
**Until 1998 this number included total number of Sberbank's subsidiaries, including small rural service stations.*

In addition, several foreign banks (Goldman Sachs, for instance) closed operations in Russia after the crisis of 1998. As of 2006, the total number of banks with foreign capital stake of more than 50% was only 43. Nevertheless, banks with 100% foreign capital participating in the Russian market are among the 200 largest banks, with Raiffeisen International Bank (Austria), Citibank, ING Eurasia being in the top 30. Raiffeisen recently acquired Russian Impex bank in what has been described as "the first significant acquisition by a foreign player in the banking

[11] Foreign banks are not allowed to open their subsidiaries in Russia. They need to register a new credit institution in Russia as a legal entity that is governed entirely by Russian law. Most foreign banks keep the same name for their "Russian daughters".

sector" (*The Economist*, May 20, 2006). Investment banks also consider Russia as an attractive opportunity.

According to Heather Timmons (*The Wall Street Journal*, February 3, 2006), booming oil and natural gas prices prompt many Russian companies to engage in acquisitions. In turn, underwriting becomes a highly demanded service and Russian companies turn to foreign banks who have the most credible expertise in this niche. To get established in the market, Deutsche bank, acquired 40% of Moscow investment bank UFG in 2003 and the remaining 60% in 2006. Citibank, Deutsche Bank and Dresdner Kleinwort Wasserstein are the three top advisers on mergers and acquisition, each totaling over $20 billion in deals (based on 2005 data of Thomson Financial). Increased foreign involvement in the Russian banking sector is a good thing, as the experience of other transition economies (Hungary for example) suggests.

Most of the banks that appeared in early 1990's were private banks. Some of them came into being as financial arms of industrial corporations and together formed financial industrial groups (FIGs). Such a structure was encouraged by a favorable tax regime and the so-called "loans-for-shares" plan.[12] Another mechanism for forming a FIG involves either buying or establishing a bank with a more powerful industrial enterprise at the core. These banks became known as "pocket banks" later. Most of Russia's large private banks are FIG members and now are becoming increasingly active outside of their own FIG. These banks control about 30% of banking assets.[13]

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[12] Under the latter arrangement, banks would issue loans to firms and later, during privatization, receive shares in lieu of pay back. Most of bank-centered FIGs came into being this way. Alfa-group with Alfa bank at the core may serve as an example. The group controls major stakes at aluminum processing and aircraft engine plants together with food processing companies and investment companies.

[13] Standard and Poor's (2005).

Even though the main players in the banking industry are well known, ownership structure is not transparent. Ownership information, as a rule, is not publicly available and even the CBR is not fully aware of ownership structure of most banks. This constrains our analysis as well. It would have been instrumental to evaluate efficiencies and failure probability of banks with different owners. A few large state banks, smaller private banks and foreign banks define the landscape of the Russian banking sector, and the next section takes a closer look at this.

1.3.2. Concentration and Sberbank's Dominance

Due to the domineering role of Sberbank and the existence of several other big banks, the Russian banking sector is heavily concentrated. The share of the five largest banks on the loans markets is close to 50%. They also lead in the deposits market and in the government securities trade. (See Table 1.7.) Sberbank accounts for 29% of assets of the entire banking sector, holds 60% of total public deposits and about 71% of all government securities. Likewise, Sberbank has issued 33% of all loans to the non-financial sector and owns about one third of the total number of bank branches in the country (1,009, see Table 1.6.), while the total number of Sberbank operating offices is close to 20,000.

The influence of another state bank – Vneshtorgbank – continues to grow. After acquiring Guta-bank for a ridiculously low price (about the cost of two ATMs),[14] it also acquired a major stake of St. Petersburg's Promstroibank, a credit institution whose volume of deposits is about 1/3 of Vneshtorgbank and which was ranked number nine according to asset size before the merger.

[14] Rubchenko (2006).

Table 1.7. Share of Five Largest Banks in the Main Banking System Indicators, Selected Years, 1997-2005

	1997	1999	2001	2003	2005
Total assets	41%	41%	43%	43%	44%
Total loans	32%	43%	47%	44%	47%
- loans to enterprises	32%	42%	48%	45%	47%
- loans to public	41%	27%	48%	50%	50%
- loans to banks	27%	36%	28%	20%	34%
Government securities	67%	79%	76%	79%	67%
Budget accounts	26%	23%	16%	21%	47%
Public deposits	80%	78%	71%	68%	64%

Source: CBR web site.

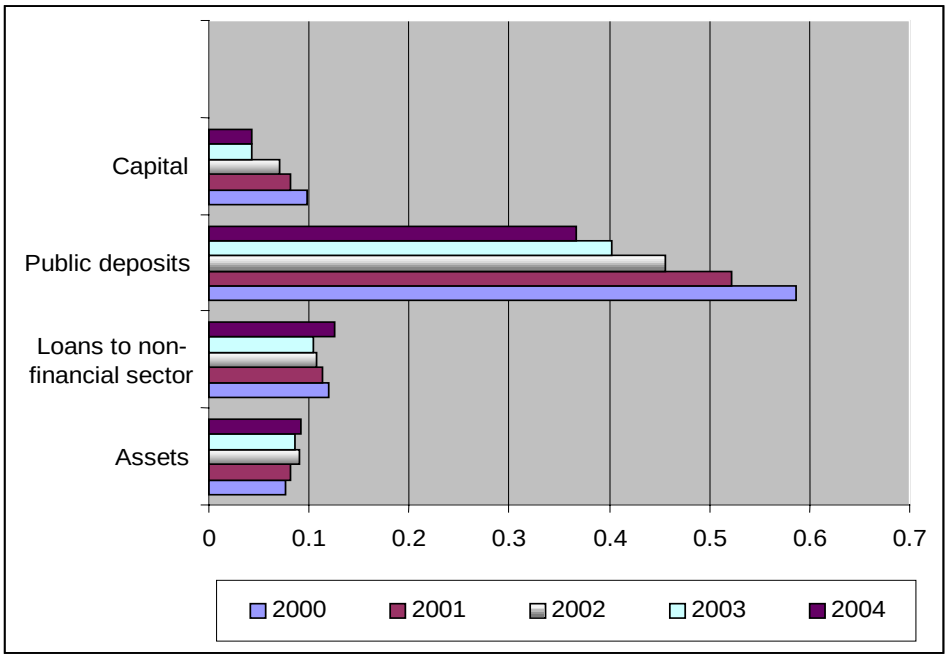
This provides additional evidence of the increasing government presence in the banking sector that we noted earlier. Blount (2004) concurs that such power moves have provoked fear that private banking in Russia is threatened. If continued, this trend would certainly hurt banking and the overall business environment. However, recent high pressure government takeovers in energy sector show both that the government is capable of carrying off such quasi-expropriations and prepared to accept some growth deterioration in growth incentives in return.

To describe concentration quantitatively, the Herindahl-Hirshman Index (HHI) is often used.[15] The CBR reports the numbers for national markets, and the dynamics are presented on Figures 1.2 and 1.3. Values below 0.18, according to IMF guidelines, characterize a medium level of concentration. Using this as a yardstick, only the deposits market exhibits high concentration, even though it has declined from almost 0.6 to 0.37 over 2000-2004 (Figure 1.2).

On the regional markets the highest but still moderate (below 0.14) asset concentration indicators are in the Central region, where Moscow is located, and the North-Western region, where St. Petersburg is located (Figure 1.3).

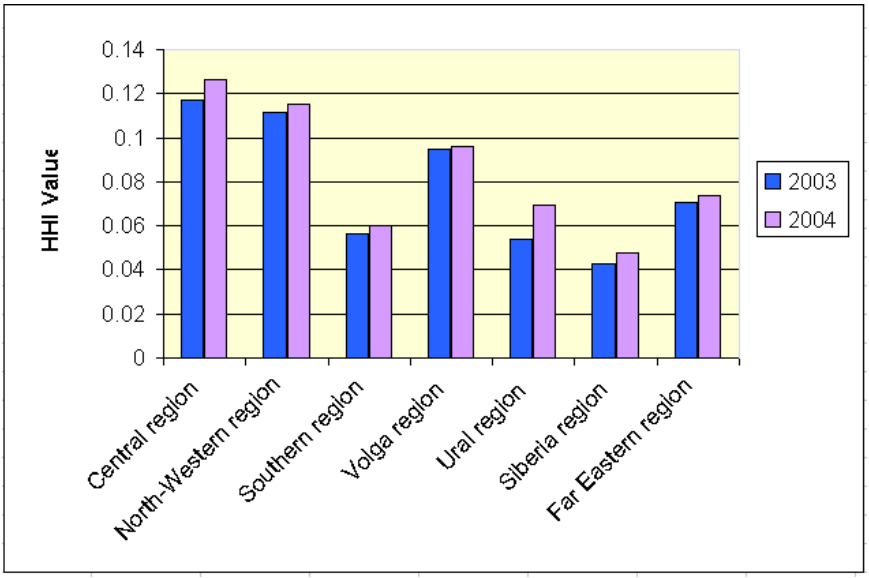
[15] HHI is calculated as a sum of squares of market shares of all firms in the industry.

Figure 1.2. Concentration (HHI) on Certain Banking Markets, 2000-2004



Source: CBR web site.

Figure 1.3. Assets Concentration (HHI) by Region, 2003-2004



Source: CBR web site.

But the information these numbers convey is problematical. The CBR does not explicitly define banking markets. An understanding of the boundaries of the market would be instrumental in the analysis. Adams (2006) provides stylized rules, based on extensive literature, for assessing whether markets for banking services are local or national. An important difficulty is that banks usually offer clusters of products and services, which are hard to separate and therefore assign to specific markets.

One of the aspects to look at when defining a geographic boundary of the market is to look at branching activity. Since local activities imply local presence, extensive branch network would suggest that markets are local. Customer location is another characteristic: if customers purchase locally, markets are local as well. For the US, retail banking is a local industry. One exception is the mortgage market, but even there the origination of the contracts continue to be influenced by local conditions.

In the Russian case, we consider banking markets to be predominantly local. Customer base is local. Extending branch network is the strategic goal for larger banks, indicating that they realize that markets are not national and even regional. Indeed, often issuing a loan to an enterprise implies that the bank has a 'local' relationship with it.

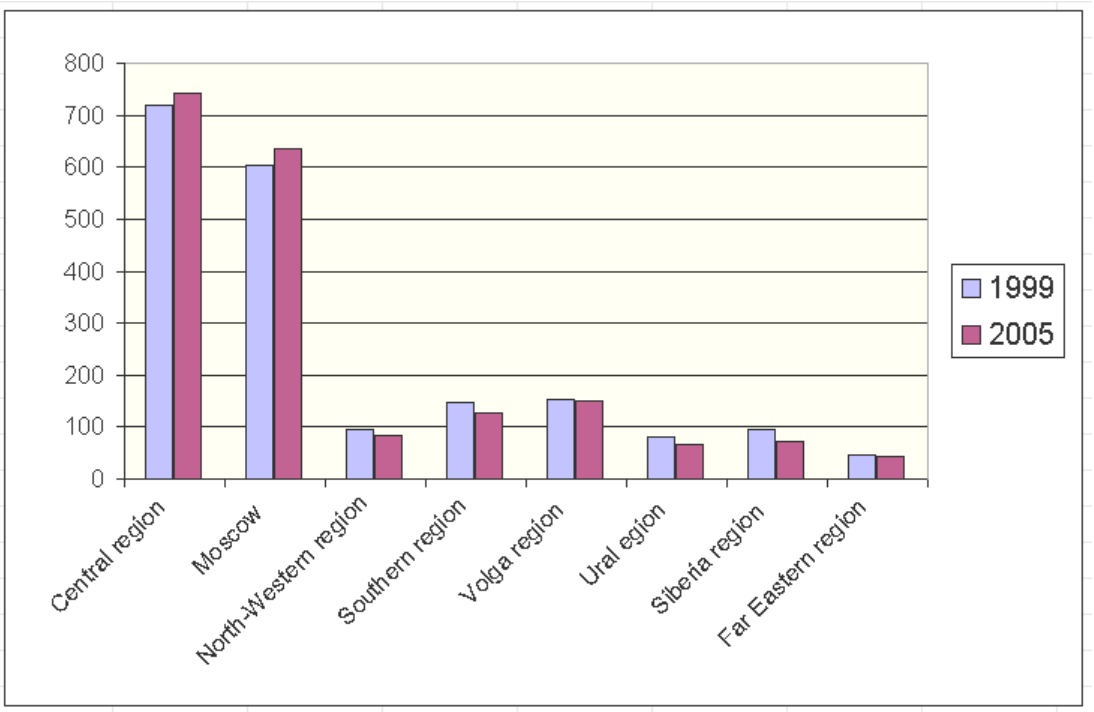
For these reasons the information revealed by HHI dynamics might be dubious, since CBR provides numbers on the regional or national level but not local level. In addition, the methodology of calculating HHI is not transparent. The main concern here is whether the regional branches of big banks (mostly Sberbank) are included in calculating the HHI values for a given region. It is very likely that Sberbank only enters the computation of HHI for the Central region with consolidated numbers, where its headquarters in Moscow are. And consequently the effect of its regional branches on the concentration in other regions is disregarded. Because of that the conclusion based on the numbers from CBR

should be taken with a grain of salt: concentration is likely to be lower than the numbers suggest.

1.3.3. Geographical Distribution

The location of banks across Russian regions is uneven. About one half (!) of all banks are located in Moscow (Figure 1.4). The capital's dominance is even greater in terms of asset concentration – steady over the years with 85% of all banking assets there.

Figure 1.4. Number of Russian Banks by Region, 1999 and 2005



Source: CBR web site.

Most Moscow banks are large and far more developed than their regional counterparts. Of the 50 largest banks in Russia, only nine are located outside of Moscow (five of them are in St. Petersburg, another four in other bigger cities).

This seems reasonable though: being a financial center, Moscow attracts the most capital and top professionals in the industry. In addition, most of the big borrowers, such as manufacturing, mining or trading companies, have an office in Moscow and will often seek to initiate a loan from there.

It is hard for regional banks to compete with Moscow banks. Not only are Moscow banks larger, they are more advanced in terms of types of investments they can make, technology they use and expertise they have developed. But as banks from the capital try to establish themselves on the local markets, they bring in their superior technology as well, similar to the effect of foreign banks' presence. This will eventually help development of the entire Russian banking sector.

1.3.4. Size Distribution and the Number of Banks

This is another defining feature of Russian banking industry. As we observe, the number of small banks declined by two-thirds in the seven years separating 1998 and 2005, while the number of big banks grew more than eight-fold (Table 1.8 and Figure 1.5).[16] This was due to the CBR's efforts to encourage consolidation. Another source of growth is internal – banks detected opportunities for profits and targeted resources in this direction. Expansion into the consumer loans and aggressive strategies to attract depositors serve as examples.

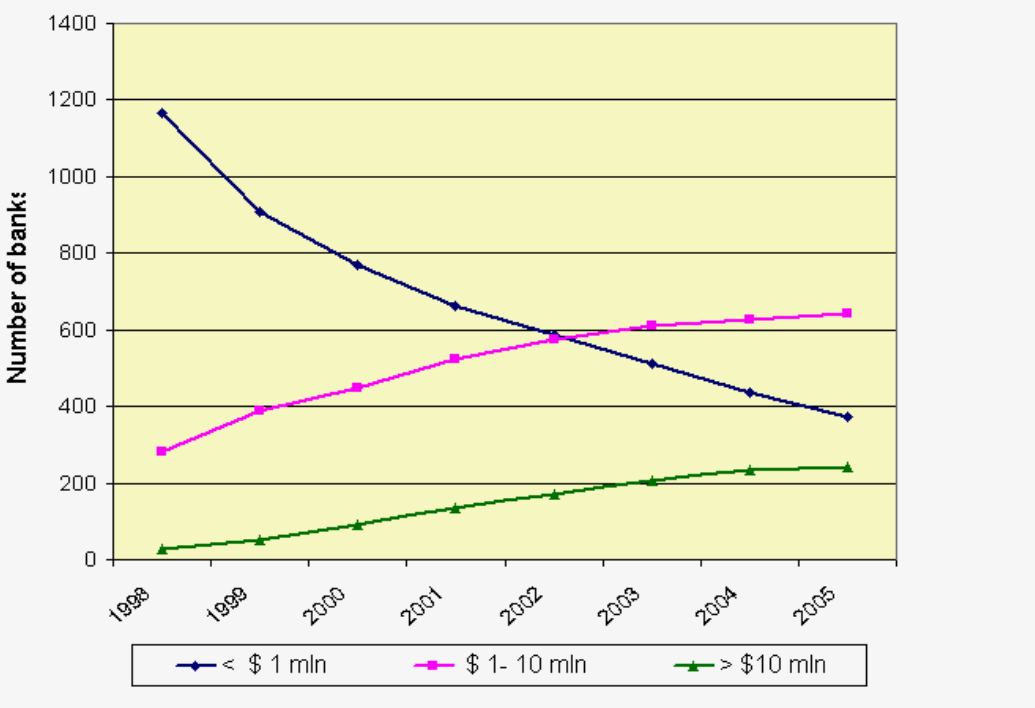
[16] Russian 'big' banks are not really big. They are big relative to Russian peers.

Table 1.8. Russian Banks by Assets Size, 1998-2005.

Group	Assets size*	1998	1999	2000	2001	2002	2003	2004	2005
Small	< 3 mln	352	230	174	128	102	86	73	56
	3-10 mln	464	365	282	218	192	157	133	108
	10-30 mln	349	313	313	317	291	267	232	208
	< $ 1 mln	**1165**	**908**	**769**	**663**	**585**	**510**	**438**	**372**
Medium	30-60 mln	189	253	254	255	253	240	225	212
	60-150 mln	72	93	127	171	198	205	211	226
	150-300 mln	21	43	68	97	123	166	191	205
	$1- $10 mln	**282**	**389**	**449**	**523**	**574**	**611**	**627**	**643**
Big	> 300 mln	29	52	93	133	170	208	234	243
	> $10 mln	**29**	**52**	**93**	**133**	**170**	**208**	**234**	**243**
Total number		1476	1349	1311	1319	1329	1329	1299	1258

Source: Authors' calculations based on the data from CBR web site.
**Real values, in mln of roubles; bold – $ US equivalent size.*

Figure 1.5. Bank Size, 1998-2005



Source: same as Table 1.8.

Many experts, see for instance, Berglof et al. (2003), agree that the Russian banking system is fragmented. A large number of small banks – about 1,000, control no more than 10% of total assets. These so-called "dwarf" banks have limited ability to compete with large players. Chowdhury (2003) pointed out that "greater trust in the system would be promoted by consolidation, i.e., fewer banks that have greater viability that are run more prudently" (page 99). Also, there are concerns that supervision and monitoring is more difficult when there are too many banks.

The debates concerning which policy CBR should adopt towards small banks continue. The policy of increasing equity capital requirements will likely make these banks takeover targets for larger banks intent on penetrating regional markets.

When a large number of banks exists in the economy, it is often considered 'overbanked', meaning, according to different authors, too many banks created without adequate capital, regulations and consideration of market conditions.[17]

Pyle (2002) argues that Russia is "overbanked" yet "credit-starved". Suboptimal lending can be explained by the fact that a crowded banking sector can actually diminish the scale of commercial lending. This happens due to information diffusion. If in place of one larger bank there exist several small ones, which do not share information on the quality of borrowers, banks tend to lend less. Poor information sharing allows borrowers to default with impunity. This is intrinsic to the transition environment with poor protection of lender's rights, absence of credit history agencies, and underdeveloped expertise.

Hainz (2004) argues that the equilibrium number of banks for a transition economy is greater than for a developed economy. She uses Salop's two-stage circular city model from game theory to show that transition countries are actually 'underbanked' (have too few banks). From her perspective, each individual bank

[17] Bank creation and destruction are considered in detail in the next subsection.

provides a suboptimal level of lending, so total loans will increase if more banks enter the industry. Furthermore, when new banks enter the market during transition, they do not have a history of attachment to inefficient clients from pre-transition period. If new banking firms assist newly established enterprises in obtaining funds, it promotes intermediation and helps facilitate growth (Gorton and Winton, 1998). But whether credit growth shall be achieved by increasing the scale of lending of the existing banks or encouraging new entry remains a policy issue.

The large number of banks per se should not be regarded as a problem,[18] especially accounting for Russia's vast territory, as some argue (see for example Chowdhury (2003) and World Bank (2002)). But this issue has long been on the agenda of discussions with World Bank and other multilateral organizations. The main concern was that many small banks did not really provide much benefit to the economy and had murky origins and activities. Eventually Russian authorities agreed to this view. Equity capital requirements were raised, prudential regulations were tightened, and measures to fight money laundering and other illegal activities were taken.[19]

We next turn to describing Russian banking industry dynamics in terms of banking firms' turnover and its relationship with other defining events in the banking sector. This should be helpful in understanding the progress and changing environment of a transition country that is slowly but surely moving toward a market economy.

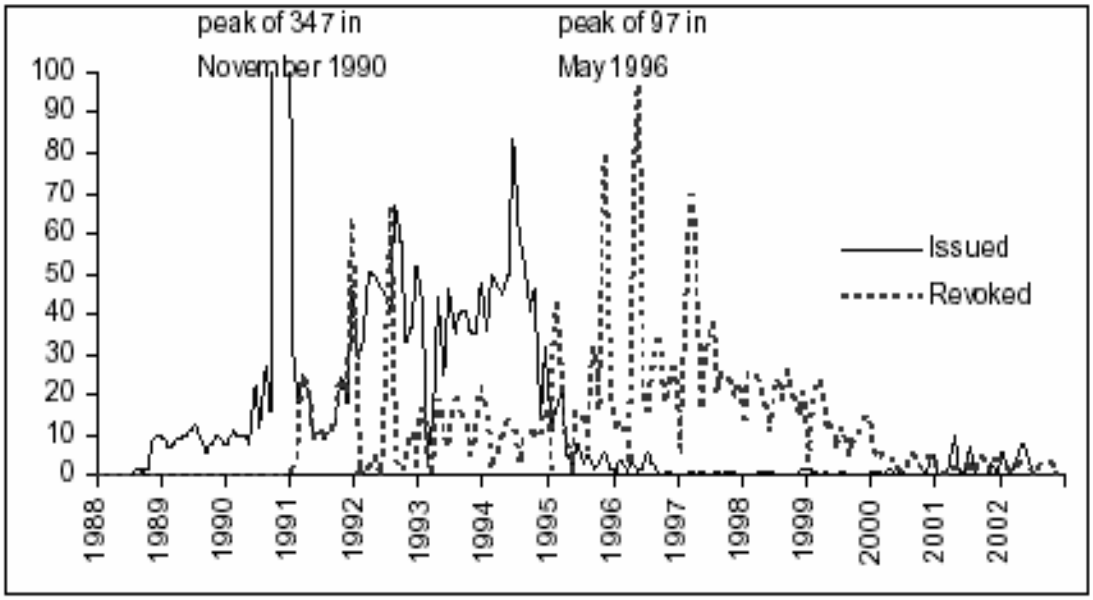
[18] The US, for example, had about 8000 banks in 2004, not including other financial institutions, such as savings and loans and credit unions.

[19] This is described in detail in Section 1.4.

1.3.5. Comparative Dynamics of Bank Entry and Exit

In this section we address the question of entry and exit of the banking firms in Russia. Figure 1.6, borrowed from Claeys et al. (2005)[20] exhibits bank creation and destruction in Russia.

Figure 1.6. Entry and Exit in the Russian Banking Sector, 1988-2002



Source: Claeys et al. (2005).

The beginning of the transition period in the early 1990's is characterized by the fast and largely uncontrolled growth in the number of banks: starting with only a few in 1989, by the beginning of 1995 there were 2,517 banks. The massive entry in the first half of the 1990's was followed by a period of many exits after the interbank market crisis in August 1995, when the CBR tightened monetary policy

[20] Claeys et al. (2005) based this diagram on CBR data.

and regulation. In 1996 higher capital requirements (2 million ECU[21] for newly established banks) and a higher capital adequacy ratio of 5% (2% previously) were established. A peak of 97 license revocations was reached in May of 1996.

Similar patterns were observed in other banking industries. Pangestu and Habir (2002) describe very similar dynamics in Indonesia: high growth in the number of banks at the end of 1980's – beginning of 1990's and massive exit in late 1990's, tied with financial crisis in this country.

These cases exhibit a strong resemblance to the events of the 1920's in the US. In the US "free banking period" was characterized by significant growth in the number of banks over a relatively short period of time: the number of banks grew from about 5,000 at the end of 19th century to 30,000 in the 1920's. All three countries experienced a severe shake out, which was inevitable given the fast development.[22]

Rapid increase in the number of firms in the industry followed by an equally fast decline is a pattern observed in a number of other industries, including automobiles, tires, televisions, penicillin (Klepper, 2002). These findings are in line with an earlier result due to Agarwal and Gort (1996), who showed that both entry and exit rates depend systematically on the stage of development of a market and summarized examples from 25 industries. The number of firms tends to grow quickly in newly established markets, and then drops just as fast. This is what happened in Russia.

In the Russian case several factors explain this phenomenon. First of all, the regulations on establishment of new banks were very liberal and the capital requirement small (Dmitriev et al., 1998), so it was easy to penetrate the market. In

[21] Until the Euro became the official European Union currency, ECU – European currency unit, calculated as weighted average of rates of EU members' currencies, was widely used for devising rules.

[22] Flood and Kwan (1998) confirm that the high rates of bank failure observed in the 1920s are part of a boom-and-bust phenomenon: high statewide failure rates were preceded by large growth rates in the number of banks.

addition, the early transition environment with vaguely defined property rights, partial liberalization of interest rates and laws full of loopholes made it possible to engage in money laundering and financing doubtful activities and schemes, which were profitable. It is worth noting that the massive entry in banking industry occurred during dire economic times. But even hyperinflation,[23] stagnating GDP, lack of rule of law and general instability pertinent to a transition economy did not deter entry. Many banks were created with little prospects of long-term viability: not adequately capitalized, unfavorably located, and poorly managed. These factors are still influential in determining survival of banking firms in Russia.

1.4. Russian Banking in the Transition Context

Even though it is now commonly acknowledged that development of a sound banking system is crucial for the success of transition economies, different countries choose specific strategies to this end and have different achievements.

The EBRD devised a system of scoring to measure the progress and reflect

> "reform and development of the banking sector … as well as creation of securities market and non-bank financial institutions. It also shows the extent to which banking and financial regulations have been raised to the international standards, whether they have been enforced effectively and if procedures exist for resolving the failure of financial institutions." (EBRD, 2003)

These scores range from 1 to 4+, one being the lowest. According to this system, Russia scored poorly on banking sector reform (see Table 1.9). Its rating was below average for transition economies in 1995-1997 and dropped significantly (from 2.3 to 1.7) as an aftermath of the financial crisis of 1998: many prominent banks became insolvent, and their reputations were 'beyond repair' (EBRD, 1999).

[23] During that period inflation "worked in the banks' favor – their assets re-priced faster than their liabilities and inflation reduced the real value of non-performing loans."(The Economist Intelligence Unit, 2004, page 47.)

Table 1.9. EBRD's Index of Banking Sector Reforms by Year for Transition Economies, 1995-2005

Country	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Armenia	2.0	2.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.7	2.7
Azerbaijan	2.0	2.0	2.0	2.0	2.0	2.0	2.3	2.3	2.3	2.3	2.3	2.3
Belarus	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.7	1.7	1.7	1.7	1.7
Georgia	2.0	2.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.7	2.7	2.7
Kazakhstan	2.0	2.0	2.3	2.3	2.3	2.3	2.7	2.7	3.0	3.0	3.0	3.0
Kyrgyz Rep	2.0	2.0	2.7	2.7	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Moldova	2.0	2.0	2	2.3	2.3	2.3	2.3	2.3	2.3	2.7	2.7	2.7
Russia	**2.0**	**2.0**	**2.3**	**2.0**	**1.7**	**1.7**	**1.7**	**2.0**	**2.0**	**2.0**	**2.3**	**2.7**
Tajikistan	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.7	1.7	2.0	2.0	2.3
Turkmenistan	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ukraine	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.3	2.3	2.3	2.7	3.0
Uzbekistan	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
CIS average	1.8	1.7	1.9	1.9	1.8	1.8	1.9	2.1	2.1	2.2	2.3	2.3
Albania	2.0	2.0	2.0	2.0	2.0	2.3	2.3	2.3	2.3	2.7	2.7	2.7
Bosnia and Herz.	1.0	1.0	1.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Bulgaria	2.0	2.0	2.7	2.7	2.7	3.0	3.0	3.3	3.3	3.7	3.7	3.7
Croatia	2.7	2.7	2.7	2.7	3	3.3	3.3	3.7	3.7	4.0	4.0	4.0
Czech Rep	3.0	3.0	3.0	3.0	3.3	3.3	3.7	3.7	3.7	3.7	4.0	4.0
Estonia	3.0	3.0	3.3	3.3	3.7	3.7	3.7	3.7	3.7	4.0	4.0	4.0
FYR Macedonia	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Hungary	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Latvia	3.0	3.0	3.0	2.7	3.0	3.0	3.3	3.7	3.7	3.7	3.7	3.7
Luthuania	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.3	3.7	3.7
Poland	3.0	3.0	3.0	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.7	3.7
Romania	3.0	3.0	2.7	2.3	2.7	2.7	2.7	2.7	2.7	3.0	3.0	3.0
Serbia and Mont.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.3	2.3	2.3	2.7	2.7
Slovak Rep	2.7	2.7	2.7	2.7	2.7	3.0	3.3	3.3	3.3	3.7	3.7	3.7
Slovenia	3.0	3.0	3.0	3.0	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Non-CIS Average	2.5	2.5	2.7	2.7	2.8	2.9	3.0	3.2	3.2	3.3	3.4	3.4
Average	2.2	2.2	2.3	2.4	2.4	2.4	2.5	2.7	2.7	2.8	2.9	2.9

Classification system for transition indicators:	
1	Little progress beyond establishment of two-tier system
2	Significant liberalization of interest rates and credit allocation; limited use of directed credit or interest rate liberalization ceilings.
3	Substantial progress in establishment of bank solvency and of a framework for prudential regulation and supervision; full interest rate liberalization with little preferential access to cheap refinancing; significant lending to private enterprises and significant presence of private banks.
4	Significant movement of banking laws and regulations towards BIS standards; well-functioning banking competition and effective prudential supervision; significant term lending to private enterprises; substantial financial deepening.
4+	Standards and performance norms of advances industrial economies: full convergence of banking laws and regulations with BIS standards; provision of full set of competitive banking services.

Source: EBRD (2003), EBRD (2006).

And the situation did not get better for a long time: it took seven years to get to the pre-crisis score of 2.3.[24]

In 2000, even though the liquidity improved, banks were still weak and not lending enough, while state banks strengthened their dominant role. In 2001 a program of banking sector development was devised. The transformation of pocket banks into independent financial organizations and development of regional banks became priority goals (EBRD, 2002). These goals gained even more significance recently and were also accompanied by the efforts to increase ownership transparency and fight money laundering.[25]

In the recent past the situation has changed for the better. Russia's scores attained the average for CIS economies in 2005 (2.3) and exceeded it in 2006. In

[24] Latvia and Romania were the other two countries that observed the decline in their rating in 1998, but they were able to rebound right away.

[25] As this manuscript was prepared, one of the key banking sector reformers, deputy head of CBR Andrey Kozlov was killed in what is considered arranged murder. Commentators largely agree that this was a consequence of his trying to clean up Russian banking sector and closing banks with dubious activities and money laundering history. (See New York Times, September 15, 2006, A3).

fact, over the same period of time Russia has been reported to have an improved investment climate due to the stable political situation, rational macroeconomic policy and significant liquidity reserves (EBRD, 2005).[26] The increase in the banking sector's rating in 2005 was due to the growth in intermediation, establishment of more stringent capital adequacy requirement and obligatory use of International Accounting Standards (IAS) for reporting. Year 2006 was marked by yet further expansion in loan provision, especially in consumer financing, growth in the share of foreign assets in the banking sector as well as an increase in pubic trust in the financial system. These factors allowed Russia to get a score of 2.7 in 2006.

But relative to the entire set of transition economies the performance of the banking sector is not favorable: only in 1997 and 2005 did Russia just reach the average for all transition economies (score of 2.3), while the average for non-CIS countries has never been achieved. The top performers – Hungary, Croatia and Estonia – already had the high score of 4 by 2004. The differential success in financial sector transformation in transition economies seems fundamentally determined by patterns of bank privatization and foreign presence in the industry (Hawkins and Mihaljek, 2001).

In general, the banking sectors in most of the European transition economies are much more open to foreign participation, which evidently together with significant capital inflow brings modern technologies and much needed expertise, as well as competitive pressure on local banks (Anderson and Kegels, 1998). As of 2000, foreign banks in Czech Republic, Hungary and Poland controlled 66, 62 and 70 percent of total banking assets, respectively. This indeed helped to build independent strong banks (Bonin and Wachtel, 2003).[27] As long as

[26] At the same time, many commentators agree that the state becomes increasingly involved in the private sector, undermining competition and suppressing mass media.

[27] In Hungary, for example, the idea was to sell banks to strategic partners, usually well-established foreign banks and to clean up the banks' balance sheets before privatization. The foreign banks opened many subsidiaries and took up equity shareholdings as strategic investors.

Russia maintains a robust state sector in banking, it will not achieve the degree of sector reform found in the Baltics or Central Europe. Staying out of WTO will have a similar non-conformist effect.

In Russia bank privatization was not complete: the state still controls Sberbank, Vneshtorgbank and Gazprombank (the three largest banks in terms of assets), Vnesheconombank, and has stakes in many other smaller institutions.

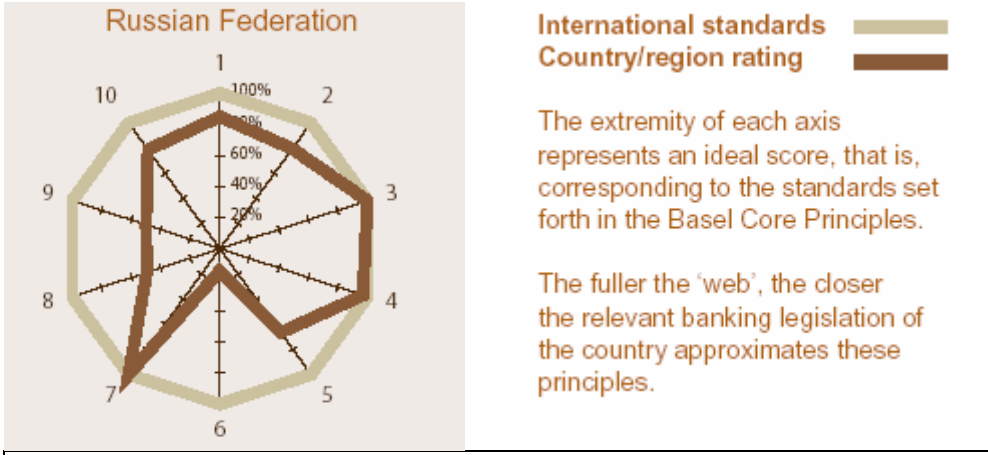
Foreign banks are still not major players, even though there is no formal restriction to the entry of foreign banks. Russian authorities have always been reluctant to open up to foreigners, especially when it comes to such lucrative activities as banking (Jensen, Rutherford and Tarr (2004)). The Russian banking elite fear (Mekhriakov (2003) can serve as an example) that opening up the banking industry may hurt domestic banks more than it benefits customers. Domestic bankers are afraid that foreign banks, having better technology and access to funds, will attract the best customers by offering them better deals. The arguments that we also often hear are that most public deposits will be channeled abroad and eventually foreigners will control not only interest rates, but dominate the market – something that a Russian banker can never accept.

A detailed evaluation of banking legal reform, which overlaps with some of the more aggregated reform embodied in the EBRD's Indices from Table 1.9, assesses the compliance of transition economies with The Core Principles for Effective Banking Supervision, established in 1997 by the Basle Committee on Banking Supervision (Cigna, 2005). Ten different areas were scored. The closer the score to 100% the better. Selected results of this evaluation are depicted in Figure 1.7.

Russia scored high on definitions of banking institutions, licensing requirements and prudential regulations, while three categories received scores lower than CIS averages. Transfers of ownership and major acquisitions (axis 6) do not require prior supervisory approval, which can cause excessive risk exposure and obstruct effective supervision. In general, risk management is of unsatisfactory

quality (axis 8 and 9): credit risk is not monitored adequately and other risks (market risk, interest rate risk, liquidity risk) are either not identified or measured appropriately due to the absence of "suitable banking procedures". On the whole, Russia was barely able to get to the medium compliance level, even though significant amendments to existing laws and several new laws were adopted recently.

Figure 1.7. Quality of the Banking Legislation in Russia According to EBRD Evaluation



Axis 1: Competence of the banking supervisory authority
Axis 2: Discharge of the banking supervisory authority's powers
Axis 3: Definitions of banks and banking activities
Axis 4: Licensing authority and requirements
Axis 5:Supervision of operations by domestic banks overseas and foreign banks locally
Axis 6: Transfer of ownership
Axis 7: Prudential regulations
Axis 8: Extension of credits and investment activities
Axis 9: Risk management
Axis 10: Governance and auditing

Source: Cigna, J. P. (2005).

While Russia's progress in reforming the financial sector has been mediocre, it has performed much better in terms of overall financial development.

It has recovered from crisis quite successfully and now compared to several other transition countries looks quite encouraging (Table 1.10).

Since the crisis, the level of non-performing loans fell to 10% from 30% and is lower than in Serbia and the Slovak Republic. Stock market capitalization increased nearly four times and now is the highest among transition economies. The level of loans to the private sector relative to GDP is still low (22% of GDP) by international standards, and is below the average for the countries in Table 1.10.

Table 1.10. Comparative Indicators for Selected Transition Economies

	Non-perform. loans/Total loans		Loans to private sector/GDP		Stock mkt capitaliza-tion/GDP		GDP Growth, %		GDP per capita, $		External debt/GDP	
	1998	**2004**	**1998**	**2004**	**1998**	**2004**	**1998**	**2004**	**1998**	**2004**	**1998**	**2004**
Russia	30.9	10.0	13.2	22.0	16.9	54.0	-5.3	6.9	1,802	2,987	70.4	40.0
Bulgaria	11.8	4.4	12.2	25.8	7.4	8.0	4.0	5.0	1,548	2,531	80.6	60.0
Croatia	12.6	9.4	26.6	50.0	14.5	19.2	2.5	3.7	4,805	6,518	44.8	81.8
Czech Rep	22.7	5.0	44	17.9	18.4	17.9	-1.0	4.0	5,906	8,708	40.0	33.4
Hungary	7.9	3.8	24.2	42.3	29.9	18.7	4.9	4.0	4,641	8,282	58.0	62.0
Poland	11.8	25.1	17.5	17.8	13.0	17.3	4.8	3.8	4,096	5,402	37.3	50.2
Serbia	13.1	23.8	11.2	N/a	N/a	N/a	1.9	5.0	1,475	2,492	67.3	68.9
Slovak Rep	44.3	9.1	42.1	25.0	4.5	7.6	4.2	4.8	4,112	6,045	53.7	56.3

Source: EBRD (2004).

The progress that has been achieved together with lessons from the experience of other transition economies and the commitment of the CBR to the pursuit of reforms indicate that Russia has a good chance to develop an efficient and stable banking system.

1.5. Concluding Remarks

This chapter examined the history, structure and dynamics of Russian banking industry in the recent 15 years. We started by describing the transition period and its defining features. Rapid growth in the number of banks marked the

early 1990's, the so-called 'free banking' period, with lax regulation and macroeconomic instability. Many fundamental weaknesses first came into sight at that time - low level of intermediation, lack of long-term lending, dominance of the state-owned banks, and high protectionism. The financial crisis of 1998 dramatically revealed these drawbacks.

But after the crisis the Russian banking sector rebounded together with the entire economy. High GDP growth, stabilized inflation, high revenues from oil exports contributed to the positive developments in the banking sector. In the recent years growth of lending was significant, banks and the public slowly began to move towards medium-term contracts (deposits and loans) from predominantly short-term ones.

Many significant bills were signed into law as well. The law on bankruptcy of credit organizations, deposit insurance law, law on credit histories, to mention the most important ones, clarified and defined the institutional environment that banks operate in.

Structure of the Russian banking industry is complex. On the one hand, there exist large banks that accumulate most of the assets. The largest – state-owned Sberbank – holds the majority of public savings. Most of the big banks are located in Moscow. On the other hand, a large number of medium-sized and small banks is unevenly scattered around the country. They can hardly compete with Moscow banks. Not only are they unable to provide the whole spectrum of banking services, they also lack the expertise and infrastructure necessary to foster development. Presence of foreign banks historically has not been significant. Even though they recently expanded their operations, they remain a minority. Acquiring local banks seems to be a good strategy for them to get better established on the Russian market.

Compared to other transition economies, Russian banks performed reasonably well, given that conditions external to the sector were probably the most

turbulent. The quality of assets improved, the loan market deepened and intermediation expanded.

With that in mind, we move on to study efficiency and failures in the Russian banking sector. Chapter 2 offers a new perspective on modeling deposits in banking which accommodates both their input and output characteristics. In Chapter 3 we develop and apply a framework for failure analysis. In both chapters we apply our models to a sample of Russian banks.

Chapter 2. Accounting for The Input and Output Characteristics of Deposits in the Banking Sector: An Application to Russia [28]

2.1. Introduction

This chapter treats the subject of modeling nontraditional outputs when measuring the efficiency of production units in a non-parametric framework. More specifically, we consider deposits in the banking sector that have both input and output characteristics.

On the one hand, deposits can be seen as outputs since banks seek to maximize deposits due to strategic reasons.[29] Attracting deposits also absorbs real resources, as in the production of other outputs. On the other hand, deposits have input features. Together with other sources of funds (equity, discount window lending, interbank market), deposits can be used as an input to produce loans and other investments – traditional banking outputs. In addition, this implies that deposits can be substituted for these other sources of financing. Such input and output characteristics of deposits together with a substitutability effect pose a problem when modeling the technology set of a banking firm: the researcher has to decide whether to treat them as inputs or as outputs.

In the literature the problem of modeling deposits as inputs or outputs in the banking industry has been reflected in a continuing debate between two schools of thought. Followers of the intermediation approach (Sealey and Lindley, (1977))

[28] This chapter is based on a manuscript "Modeling Deposits in the Banking Sector Using Directional Distance Function Approach" written in close collaboration with Elena V. Pachkova (Department of Mathematical Sciences, University of Copenhagen) and submitted to the Journal of Productivity Analysis.

[29] Deposit holders are potential borrowers and buyers of other products. They also pay non-interest fees and make payments through banks. Often they become loyal to the bank and rely on the same institution for all their financial matters. Moreover, depositors spread the word about their experience with a particular bank and can facilitate the growth of the clientele base. Jane Kim of Wall Street Journal (August 29, 2006) reports that banks around the world compete for new depositors precisely for the same reasons: "despite the higher payouts [banks] expect to end up with more profitable customer relationships. They say consumers are likely to do more business with a bank where they have their primary transaction account."

view the banks as intermediaries, which channel funds from depositors to borrowers and therefore place deposits on the input side. The production approach (see Baltensperger (1980)) emphasizes that certain bank services are attached to deposit accounts, such as check clearing, safekeeping and payment services, and thus view them as outputs.

In empirical work researchers usually pick one of these two approaches, depending on which one fits the research question better.[30] As a way to reconcile the debate, the user cost approach was developed for the banking industry. It was first described by Donovan (1978) and Barnett (1980) and then modified for application to banks as a user cost of monetary goods version by Hancock (1985, 1991). A product's user cost served as a criterion to classify inputs and outputs: if the net economic cost of providing the attached financial services is positive (negative), then the product is viewed as an input (output). These costs and prices for monetary goods are derived from an intertemporal model of financial production. The main idea here is not to prescribe a priori characteristics to deposits but rather to let the data reveal them. However, this approach does not model the substitutability effect between the deposits and other inputs. Moreover, it is a data-driven mechanism that does not necessarily provide grounds for reliable conclusions.

Substitutability in the non-parametric Data Envelopment Analysis approach has been investigated by Dervaux et al. (2006). The main interest of their study is to model the substitutability among outputs[31] of nursing homes in France, where patients with different severity of impairment constitute different output types. In

[30] Berger and Humphrey (1997) provide a comprehensive review of the earlier studies of banking sectors focused on efficiency estimation, while Konstandina (2000) provides a review of input-output combinations employed for estimation of various models in banking. More recent studies mostly rely on the prior research in the choice of input-output formulation (see Devaney and Weber (2002), McKillop et al.(2002), Kasman (2003)) with an exception of Dongili and Zago (2005) and Kang and Weber (2006), who suggest a new formulation, treating overdue loans as a ‘bad output’.

[31] An equivalent approach can be used to model substitutability of inputs.

this text we model substitutability between inputs and outputs in the framework of directional distance functions, which are generalized benefit functions introduced by Luenberger (1992). This model can be used to construct technology sets for industries that include inputs and outputs that are substitutable, as e.g. the banking sector. The second goal of this study is to illustrate the new substitution model for the banking sector in Russia and to compare the results to the outcomes of the other approaches used to model deposits in the banking sector. Furthermore, efficiency estimates produced with this substitution model are used in the failure model in the Chapter 3. Efficiency in that estimation serves as a proxy for managerial quality.

Apart from modeling deposits in the banking sector, the approach can be used to model other inputs and outputs that are substitutable. One example of possible fields of application is estimating efficiency in university hospitals. Here, the medical students are outputs, but they can also be used to substitute for doctors, and therefore also serve as inputs. Another example is universities, where graduate students both can be viewed as outputs, but also are used as labor (or input) reducing the workload of the professors.

This chapter unfolds as follows. In section 2.2 we present the theoretical framework and develop a new substitution model. In section 2.3 we apply this new model to the Russian banking sector and contrast the results with the outcomes of intermediation and production approaches. Finally, section 2.4 concludes.

2.2. Theoretical Underpinnings of the New Substitution Approach

2.2.1. Constructing Technology

In this text we distinguish 4 distinct cases of substitutability:

	Perfect	Imperfect
Symmetric	1-to-1 substitution between inputs or between outputs	Weighted substitution between Inputs or between outputs
Asymmetric	1-to-1 substitution between inputs and outputs	Weighted substitution between inputs and outputs

We define *symmetric substitution* to be the interchangeability among either only inputs or only outputs. *Asymmetric substitution* notion is related to the exchange between *inputs* and *outputs*. We call one-to-one substitution *perfect*, and *imperfect* otherwise. In this paper we will focus on developing a non-parametric model for the asymmetric case, i.e. where some inputs can be substituted by some outputs (and possibly vice versa). Inputs and outputs that can be substituted will be called substitutable inputs and substitutable outputs respectively.

Conventional economic theory implies some level of substitution among inputs. Standard parametric specifications of a cost function, for example, would include elasticity of substitution parameters that reflect a possibility of using more of one input to compensate for the lack of the other. In the non-parametric literature substitution has not been explored to this extent. In the study of Derveaux et al. (2006) the idea of *symmetric* substitution is developed. As we mentioned, for nursing homes that they studied, severity of residents' impairment is used to classify them into several output types. Then they allow for *imperfect* substitution: more severely impaired patients can be 'traded' for less impaired at a ratio different from 1:1. To the best of our knowledge, for the banking industry the idea of substitutability has not been applied so far and in our study we attempt to develop a model and apply it to the Russian banking industry.

Let's first consider the case where there is only one substitutable input $b \in \Re_+$ and one substitutable output $d \in \Re_+$.[32] For simplicity let the substitutability be *perfect*. Moreover, denote the ordinary outputs by $y \in \Re_+^M$ and ordinary inputs by $x \in \Re_+^N$. The technology is then:

$T = \{(x, b, d, y)$: (x, b) can produce $(d, y)\}$.

The asymmetric substitutability between the input *b* and the output *d* is modeled in the following way:

[32] For a banking firm, think of *b* being 'other borrowed funds' and *d* – 'deposits'. We explain it further in section 2.3, when we set up the empirical model.

$$\text{if } (x,b,d,y) \in T \text{ and } \beta \geq 0, \text{ then } (x,b+\beta,d-\beta,y) \in T,$$

$$\text{and there exists } (x,b,d,y) \in T \text{ such that } (x,b-\beta,d+\beta,y) \notin T$$

In words this means that to produce some given *y* using some given *x* a reduction in the substitutable output *d* (e.g. deposits) is only possible with an equivalent increase in the substitutable input *b* (e.g. other borrowed funds).[33] At the same time, *d* represents an output. And an increase in *d* is only possible if more, not less of the inputs is used, so $(x,b-\beta,d+\beta,y)$ is not feasible. Technology with the asymmetric substitutability between the input *b* and the output *d* is illustrated in Figure 2.1.

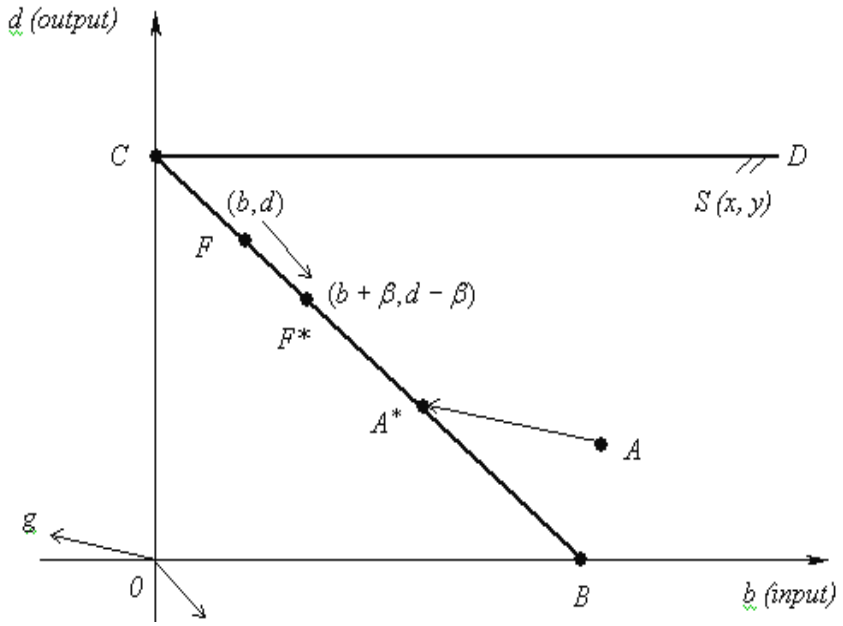
It shows the combination of feasible substitutable input *b* and substitutable output *d* (other borrowed funds and deposits) for some given level (*x,y*) of ordinary inputs and outputs. Line *BC* represents one-to-one (or perfect, according to our convention) substitution between holding deposits and other borrowed funds and has a 45 degree angle.[34] Any combination along this line is feasible. The area of the triangle *OBC* represents infeasible points. *CD* bounds the level of deposits possible to attract given technological constraints. Thus, for some given (*x, y*), the area outlined by *BCD* and denoted by *S (x, y)* represents the technology.[35]

[33] Other borrowed funds may include interbank market borrowings, discount window lending, etc. – cheaper and in general easier to dispose of funds compared to deposits.

[34] Imperfect substitution will be pictured as a line with a slope, different from 45 degree.

[35] Other elements of Figure 2.1 will be explained in the Section 2.2.2.

Figure 2.1. Technology for Substitutable Inputs and Outputs



For some point F (b, d) and some positive β, $F^{*}(b+\beta, d-\beta)$ is feasible. On the other hand, consider the point C. For any β, such that $\beta > 0$, $(b-\beta, d+\beta) \notin S(x,y)$. At point C total funds (deposits plus other borrowed funds) are OC. Thus, with maximum deposits a bank does not need other borrowed funds. In other cases, where the needed funds for the given (x,y) are higher than the maximum possible level of deposits, we move along CD to the right, so that at maximum deposits (at C) the level of other borrowed funds is higher than 0.

Suppose now that we are given K observations from the technology, e.g. K operating production units. Each observation is then denoted by (x_k, b_k, d_k, y_k), $k = 1, \ldots, K$. In the following we impose these assumptions:

$$\sum_{k=1}^{K} x_{kn} > 0,\ n = 1,\ldots,N;$$

$$\sum_{n=1}^{Q} x_{kn} > 0,\ k = 1,\ldots,K;$$

$$\sum_{k=1}^{K} y_{km} > 0,\ m = 1,\ldots,M;$$

$$\sum_{m=1}^{M} y_{km} > 0,\ k = 1,\ldots,K;$$

$$\sum_{k=1}^{K} b_k > 0; \quad \sum_{k=1}^{K} d_k > 0.$$

The first two assumptions make sure that each input is used by at least one production units, as well as that each production unit uses at least one of the inputs. The other assumptions model the same idea for outputs, the substitutable input and the substitutable output.

Using the activity analysis approach (DEA approach) following Färe and Grosskopf (1996) and adding the substitution conditions, we can construct the following technology:

$$\begin{aligned} T = \{&(x,b,d,y): \\ &\sum_{k=1}^{K} \lambda_k y_{km} \geq y_m,\ m = 1,\ldots,M \\ &\sum_{k=1}^{K} \lambda_k x_{kn} \leq x_n,\ n = 1,\ldots,N \\ &\sum_{k=1}^{K} \lambda_k d_k \geq d \\ &\sum_{k=1}^{K} \lambda_k (d_k + b_k) \leq b + d \\ &\lambda_k \geq 0,\ k = 1,\ldots,K\}, \end{aligned} \tag{2.1}$$

where λ_ks denote the intensity levels at which each of k activities (banking firms) are conducted.[36]

According to Proposition 1 below, the technology T satisfies the necessary conditions of being non-empty, closed and convex (see Färe and Primont (1995)).

[36] Having imposed a 'mix' constraint on (d + b), an additional 'input' constraint on b is redundant. Free disposability of b follows from the fourth constraint, since for some $(x,b,d,y) \in T$, $(x,b+\beta,d,y) \in T$ for all $\beta \geq 0$.

This ensures that a solution exists when we optimize over T to compute efficiency of some point in T.

Proposition 1. *The technology T given by* (2.1) *is*

i) non-empty

ii) closed

iii) convex.

Proof: See Appendix A.

Additionally, the technology T given by (2.1) satisfies the free disposability assumption of outputs y, inputs x and substitutable input b, which can be seen from the inequalities in the corresponding constraints in (2.1).[37]

The substitutable output d is not freely disposable along CB. Modeling d as an output (third constraint) ensures that d cannot be increased without a change in other variables. At the same time, the fourth (substitutability) constraint ensures that d cannot be decreased freely without also adjusting b.

Moreover, T satisfies the asymmetric substitutability between b and d. To see this, consider $\beta \geq 0$ and suppose that (x, b, d, y) is feasible (point F on Figure 2.1). Then, inserting $(x, b+\beta, d-\beta, y)$ does not violate any constraints, and $(x, b+\beta, d-\beta, y)$ is therefore feasible (point F^* on Figure 2.1). At the same time, let (x, b, d, y) be on the efficient boundary of T, such that the constraint $\sum_{k=1}^{K} \lambda_k d_k \geq d$ is binding (point C on Figure 2.1). Then $(x, b+\beta, d-\beta, y)$, $\beta \geq 0$ is feasible, but $(x, b-\beta, d+\beta, y)$ is not, showing the asymmetric nature of the substitution.

[37] Strong or free disposability of inputs (including b) implies that if $x \in T$ and $x \geq x^*$, then $x^* \in T$. Strong or free disposability of outputs implies that if $y \in T$ and $y^* \leq y$, then $y^* \in T$.

2.2.2. Measuring Efficiency

To measure efficiency of some observation (x_0, b_0, d_0, y_0) we will use the directional distance function approach. A directional distance function is defined as $\vec{D}_T(x,b,d,y;g) = \sup\{\beta : (x,b,d,y) + \beta g \in T\}$. It measures the technical efficiency of the considered production unit (x_0, b_0, d_0, y_0) when the efficiency is increased in the desired direction *g*.

Here, *g* is the vector of directions in which the optimization is performed. In our case, $g = (-g_x, -g_b, g_d, g_y)$, i.e. the ordinary inputs *x* as well as the substitutable input *b* are decreased while the substitutable output *d* and the ordinary output *y* are increased. Consider Figure 2.1 again. The technology is denoted by *S (x, y)*, and we are interested in evaluating the observation *A* in the direction of vector *g*. Thus, we would like to increase our substitutable output and decrease the use of the substitutable input. The directional vector *g* projects the observation *A* to the point A^* on the frontier.

To compute the directional technology distance function for our observation (x_0, b_0, d_0, y_0), the following linear programming problem is solved:[38]

$$
\begin{aligned}
&\vec{D}_T(x_0, b_0, d_0, y_0; g) = \max \beta \\
&\textstyle\sum_{k=1}^{K} \lambda_k y_{km} \geq y_{0m} + \beta g_y, \; m = 1, \ldots, M \\
&\textstyle\sum_{k=1}^{K} \lambda_k x_{kn} \leq x_{0n} - \beta g_x, \; n = 1, \ldots, N \\
&\textstyle\sum_{k=1}^{K} \lambda_k x_{ke} \leq x_{0e} - \beta g_e \\
&\textstyle\sum_{k=1}^{K} \lambda_k d_k \geq d_0 + \beta g_d \\
&\textstyle\sum_{k=1}^{K} \lambda_k (d_k + b_k) \leq b_0 - \beta g_b + d_0 + \beta g_d \\
&\lambda_k \geq 0, \; \textstyle\sum_{k=1}^{K} \lambda_k \leq 1, \; k = 1, \ldots, K.
\end{aligned}
\qquad (2.2)
$$

[38] We single out here the constraint on one of the inputs – equity – from the rest, since we will treat its direction g_e differently from other components of g_x.

We call the model in (2.2) the *substitution model* as compared to the aforementioned intermediation model and production model. These two mainstream models are defined as follows:

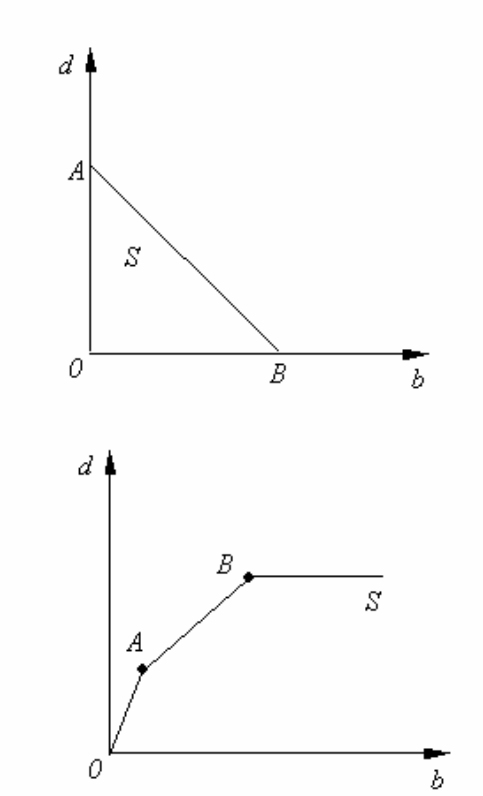
Intermediation Model	Production Model
Other borrowed funds *(b)* and deposits *(d)* are modeled as inputs.	Other borrowed funds *(b)* are modeled as inputs and deposits *(d)* are modeled as outputs.
$\vec{D}_T(x_0, b_0, d_0, y_0; g) = \max \beta$ $\sum_{k=1}^{K} \lambda_k y_{km} \geq y_{0m} + \beta g_y,\ m = 1, \ldots, M$ $\sum_{k=1}^{K} \lambda_k x_{kn} \leq x_{0n} - \beta g_x,\ n = 1, \ldots, N$ $\sum_{k=1}^{K} \lambda_k x_{ke} \leq x_{0e} - \beta g_e$ $\sum_{k=1}^{K} \lambda_k d_k \leq d_0 - \beta g_d$ $\sum_{k=1}^{K} \lambda_k b_k \leq b_0 - \beta g_b$ $\lambda_k \geq 0, \sum_{k=1}^{K} \lambda_k \leq 1, k = 1, \ldots, K$	$\vec{D}_T(x_0, b_0, d_0, y_0; g) = \max \beta$ $\sum_{k=1}^{K} \lambda_k y_{km} \geq y_{0m} + \beta g_y,\ m = 1, \ldots, M$ $\sum_{k=1}^{K} \lambda_k x_{kn} \leq x_{0n} - \beta g_x,\ n = 1, \ldots, N$ $\sum_{k=1}^{K} \lambda_k x_{ke} \leq x_{0e} - \beta g_e$ $\sum_{k=1}^{K} \lambda_k d_k \geq d_0 + \beta g_d$ $\sum_{k=1}^{K} \lambda_k b_k \leq b_0 - \beta g_b$ $\lambda_k \geq 0, \sum_{k=1}^{K} \lambda_k \leq 1, k = 1, \ldots, K$

It is easy to see that the substitution model is more general and both intermediation and production models can be nested within it. If we drop the fourth constraint (on *d*), omit *b* in the fifth constraint and add back the otherwise redundant constraint on *b* in (2.2), we will get intermediation model. Obtaining the production model is even simpler: just omit *d* in the fifth constraint of (2.2).

Technology sets for these two formulations, analogous to set *S* that we described for our substitution model, can be readily visualized as well. The relationship between *b* and *d* given the level of traditional inputs and outputs in the case of the production approach can be represented by the usual graph of the traditional input-output relationship (bottom panel of Figure 2.2). In the case of the intermediation approach, both *b* and *d* are inputs and related to each other like

ordinary inputs. Figure 2.2 depicts this on the top panel, assuming one-to-one (perfect) substitution.

Figure 2.2 Technology Sets for Intermediation and Production Approaches



In the next section we will illustrate this model for a panel of Russian banks, and compare the results of the three models described above.

2.3. Efficiency in the Banking Sector

2.3.1. Empirical Model for the Russian Banking Sector

This section provides an illustration of the substitution model for data from the banking sector in Russia. The results of this new model are compared to the results of the intermediation and the production models. Several studies have compared the intermediation and the production models on the same data sets, coming to different conclusions. Some, like Berger et al. (1997), Hunter and Timme (1995), Wutz (2000) find significant difference in results depending on whether intermediation or the production models are used. Others, Berger et al. (1987), Favero and Papi (1995) do not find such differences, and thus conclude that both models can be equivalently used for the given data set. While the new substitution model might not shed any new light on the latter cases, it could be of interest in cases where a significant difference exists, since it provides a more general way of modeling the deposits. Together with the new substitutability component, we build our input-output mix on several previous studies.

The ordinary outputs produced are chosen to be total loan balances (y_1) and non-interest income (y_2), following Rogers and Sinkey (1999).[39] Treatment of bad loans has also been of interest in the recent literature. Dongili and Zago (2005) provide a review of various ways of dealing with this issue. They model non-performing loans as a "bad" output in the sense of Chung, Färe and Grosskopf (1997). Kang and Weber (2006) follow the same route. Even though this idea is very appealing, many banks in our data set have zero balances of overdue loans.[40] That is why we adopt the approach of Berg et al. (1992) and correct the balances of total loans for this component.

---

[39] Those are not the only outputs that Russian banks produce. They are also engaging in securities trading, in particular investing in government bonds (OFZ and GKO). These investments are hard to identify precisely, because often such operations involve derivatives and are reflected on off-balance sheet accounts. Therefore we do not consider them crucial for the analysis.

[40] According to Yuriy Sakharov (2006), an analyst from business journal *Expert*, many banks often prolong loans to avoid showing any delinquent loans on their books.

The usual inputs are labor (x_1) and physical capital (x_2). Equity (x_e) is not treated as other ordinary inputs, but rather considered a fixed input as in Färe, Grosskopf and Weber (2004). It is quasi-fixed and is not scaled upon in the optimization formulation, since equity often cannot be altered in the short run. Specifically, it is almost never reduced for considerations of optimization and very often is at the minimum level, regulated by the Central Bank of Russia. Finally, as we mentioned earlier, attracted deposits *d* represent the substitutable output, while other borrowed funds *b* play the role of substitutable inputs.

We use the output-oriented approach, where outputs are maximized given the level of input. There are several reasons for this choice. After a period of weakened public's confidence in banking institutions in Russia, the markets for private deposits and loans are experiencing a boom.[41] Banks seek to maximize their shares on these markets, expressing willingness to incur costs to achieve this goal. In addition, cost minimization, which is closely related to input minimization and alternative input-oriented approach, has never been a strong point of Russian companies, partly due to the legacy of soft budget constraints.

Another supporting argument comes from the fact that many banks recognize the opportunities of cross-selling other products and try to attract depositors, even though it is not cost effective. A very popular way to obtain new customers is to bundle the services for corporate clients with so-called "salary projects".[42] These schemes imply that wages and salaries are transferred directly to the employees accounts that are conveniently opened at the same bank. Workers receive debit cards and the usual for Russia salary cash payments are bypassed. Having already established the a relationship with banks, these individuals are more likely to return to the banks for other services – car loans, consumer goods loans, mortgage.

[41] See Sections 1.2.2 and 1.2.3 for a review of deposits and their structure.

[42] This is known from the author's own experience from working at a bank in Russia in late 1990's and communicating with former colleagues later.

In addition, banks have better chances of securing loan payments, if the salary is disbursed to the same account. This implies that banks do not necessarily minimize their costs, but they are very likely to maximize outputs.

The inclusion of the fixed input, equity, represented by x_e is modeled according to Färe et al. (1992). Finally, since the substitutable output, the attracted deposits, and the substitutable input, other borrowed funds, are measured in mln roubles, we use the perfect[43] asymmetric substitutability approach. Thus, the non-parametric substitution model to compute efficiency of a banking unit using the directional distance function is:

$$
\begin{aligned}
&\vec{D}(x_0, b_0, d_0, y_0; g) = \max \beta \\
&\textstyle\sum_{k=1}^{K} \lambda_k y_{km} \geq y_{0m} + \beta \bar{y},\ m = 1, \ldots, M \\
&\textstyle\sum_{k=1}^{K} \lambda_k x_{kn} \leq x_{0n} - \beta * 0,\ n = 1, \ldots, N \\
&\textstyle\sum_{k=1}^{K} \lambda_k x_{ke} \leq x_{0e} \\
&\textstyle\sum_{k=1}^{K} \lambda_k d_k \geq d_0 + \beta \bar{d} \\
&\textstyle\sum_{k=1}^{K} \lambda_k (d_k + b_k) \leq b_0 - \beta * 0 + d_0 + \beta \bar{d} \\
&\lambda_k \geq 0, \textstyle\sum_{k=1}^{K} \lambda_k \leq 1,\ k = 1, \ldots, K
\end{aligned}
\qquad (2.3)
$$

As for the directional vector *g*, its elements representing the input side are zeros. We use the mean of the variables as the directional distance vectors for the outputs and the deposits, i.e. $g = (-g_x, -g_b, g_d, g_y) = (0,\ 0,\ \bar{d}, \bar{y})$.

We estimate efficiency using the three models: production, intermediation and substitution. We apply them to the same data set and employ the same directional vector *g*, so that the results of all models are derived from the same base and therefore comparable.

[43] We take one to one relationship here even though, as we mentioned above, deposits are in general more costly than other borrowed funds. But apart from being a source of funds, deposits generate other valuable, sometimes intangible, things, such as tight relations with customers, possibilities of selling other products, etc. These effects are hard to quantify, so we argue that even though deposits are more expensive, they are more 'profitable' and assuming perfect substitutability is justified.

2.3.2. Data Description

We obtained data for this research from Interfax Information Agency, Moscow, which covers the majority of Russian banks for the years 1999-2004. We eliminated banks that had no license to attract public deposits as well as newly established banks, since they cannot attract deposits for 2 years after registration. Major state-owned banks, like Sberbank, Vneshtorgbank and Vnesheconombank have different objectives than private banks and are therefore not included in the analysis.[44]

Descriptive statistics for the data are presented in the Appendix B. We see that in general banks have larger balances of other borrowed funds than those of deposits. This supports the assumption that deposits can be attracted only up to a certain level and that other borrowed funds are a more flexible category. Since we screened the banks and deleted those with zero deposit balances, the min for deposits is bigger than zero, while several banks still have null non-interest income balances.

2.3.3. Results

The results of computing the efficiency of the banks within the framework of the three models can be seen in the Tables 2.1 – 2.6. The score of 0.448 (intermediation model, 1999, Table 2.1), for instance, means that banks could scale up their average outputs by almost 45%. A bank is efficient if it attains a score of "0". So, the lower the score, the more efficient an observation is.

From Table 2.1 we can see that the computed efficiencies of the three models are very similar.

[44] The objectives of these banks are more of political and strategic nature, often determined by close connections with government. For instance, systemic properties of Sberbank may dictate maintaining offices in the rural areas or issuing loans to agricultural firms, even if it is not profitable.

In general, the intermediation model produced greater inefficiency scores than both production and substitution models (Table 2.1 and Figure 2.3). This can be explained by the fact that when deposits enter on the input side, they contribute to the input usage. Thus banks with higher balances of deposits are less efficient since they consume more resources.

Table 2.1. Efficiency Estimation Using Three Models: Main Results

Model	1999	2000	2001	2002	2003	2004
Intermediation	0.448	0.410	0.458	0.512	0.442	0.743
Production	0.243	0.266	0.428	0.467	0.414	0.662
Substitution	0.233	0.260	0.422	0.465	0.412	0.659
N obs	1273	1255	1248	1255	1257	1231

In addition, Figure 2.3 shows that Kernel density estimation of the efficiency scores obtained with the three considered models yields almost identical curves. We also tested the differences in the outcomes of the three models using statistics that are based on empirical distribution functions, contained in NPAR1WAY procedure.[45] These are presented in the Table 2.2. We compared the results of the three models in pairs. According to both Kolmogorov-Smirnov and Kuiper statistics, none of the p-values is even close to 10% confidence level. This indicates that the differences in the efficiency results produced by the three models are not statistically significant.[46]

[45] A procedure in SAS that essentially calculates several statistics to test whether distribution of variable has the same location parameter across groups (tests based on rank statistics) and/or whether empirical distribution function is the same across groups.

[46] Using bootstrap for a nonparametric frontier model in the spirit of Simar and Wilson (2007) would help to account for the bias, inherent in estimation of the frontier models. However, since all three models we compare are from the same class, accounting for bias is not necessarily practical.

Figure 2.3. Comparison of Efficiency Scores

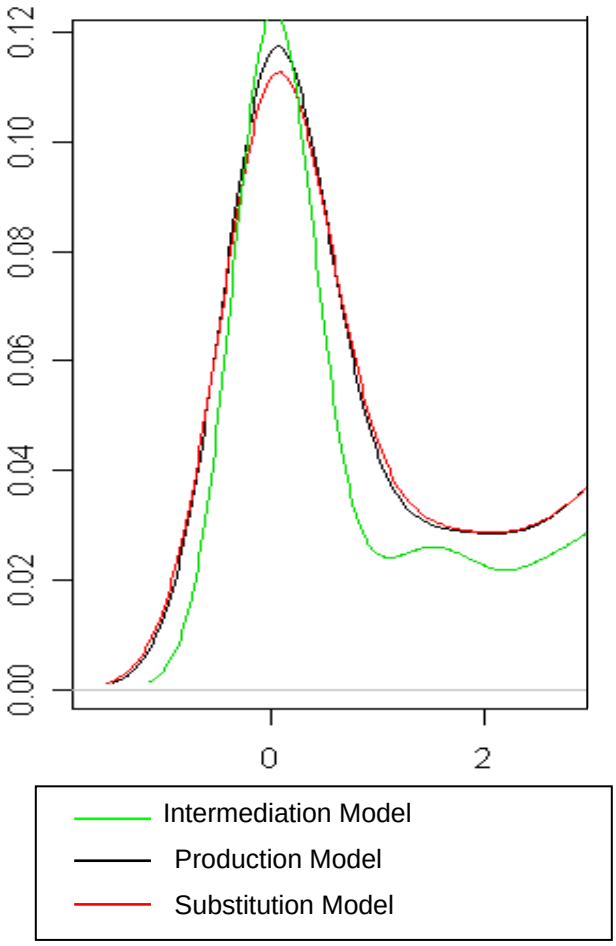


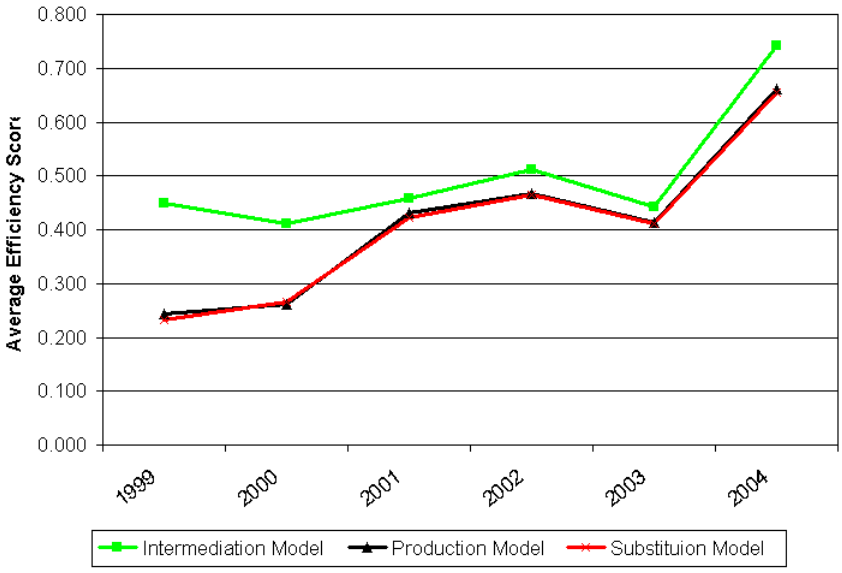
Table 2.2. Non-parametric Tests for Comparison of the Three Models

	Statistic	p-value
Intermediation vs. Production		
Kolmogorov-Smirnov Statistic	0.3654	0.2912
Kuiper Statistic	0.4356	0.4917
Intermediation vs. Substitution		
Kolmogorov-Smirnov Statistic	0.3208	0.2883
Kuiper Statistic	0.4134	0.4883
Production vs. Substitution		
Kolmogorov-Smirnov Statistic	0.2652	0.6907
Kuiper Statistic	0.3461	0.5956

Another dimension to look at comparing efficiencies is to track the changes over time. For the time period under investigation, inefficiency was rising from 1999 to 2002, then declined in 2003 and went up in 2004, based on the production and substitution models. Intermediation model showed decline in inefficiency from 1999 to 2000 and from 2002 to 2003, and rise from 2000 to 2002 and from 2003 to 2004 (Figure 2.4).

We can attribute the rise in inefficiency with the efforts of banks to overcome the consequences of financial crisis of 1998, when many of them were incurring additional costs to clean up their balance sheets. In addition, around that time banks became interested in expanding deposits and were willing to use extra resources to that end.

Figure 2.4. Average Inefficiency over Time



Interestingly, the decrease in inefficiency in 2003 coincided with the adoption of the law on deposit insurance in Russia. This signals that DI might have decreased banks costs in attracting deposits. In 2004, when the 'little' banking crisis occurred, it coincided with the rise in inefficiency, which we can attribute to the loss in depositors' confidence in the banking system.

We also grouped banks by several categories to see if there are efficiency differentials for different groups. It appears that failed banks were consistently less efficient than survived (Table 2.3) according to all three model results. Comparing Moscow banks with their peers from other regions suggests that banks from the capital are more efficient (Table 2.4).

There are several factors that explain this. Moscow banks have access to better technology and have more proficient workforce. They also benefit from the presence of the foreign banks, which are almost non-existent in other regions. This

advantage comes from a knowledge spill-over effect and a disciplining effect, brought about by competition with foreign banks.[47]

Table 2.3. Efficiency Results for Failed and Survived Banks

Model	Group	1999	2000	2001	2002	2003	2004
Intermediation	Failed	0.451	0.412	0.459	0.513	0.443	0.755
	Survived	0.339	0.293	0.346	0.377	0.418	0.373
Production	Failed	0.244	0.262	0.432	0.468	0.418	0.674
	Survived	0.211	0.143	0.218	0.324	0.252	0.306
Substitution	Failed	0.234	0.260	0.424	0.466	0.415	0.667
	Survived	0.210	0.140	0.216	0.320	0.250	0.306

We also compare banks based on their assets sizes. We used the categories for size as in Table 1.8 and Figure 1.5 from Chapter 1: Big banks are those with assets higher that $10 mln, small – with assets lower than $1mln, and medium – in between. Bigger banks appear to be more efficient than both medium and small ones (Table 2.5).

Table 2.4. Efficiency Results for Moscow and Non-Moscow Banks

Model	Group	1999	2000	2001	2002	2003	2004
Intermediation	Moscow	0.379	0.317	0.309	0.425	0.413	0.581
	Non-Moscow	0.497	0.517	0.641	0.602	0.472	0.923
Production	Moscow	0.213	0.186	0.227	0.285	0.131	0.422
	Non-Moscow	0.294	0.362	0.670	0.674	0.584	0.921
Substitution	Moscow	0.187	0.186	0.226	0.283	0.263	0.416
	Non-Moscow	0.278	0.361	0.654	0.669	0.569	0.915

[47] Chapter 1 contains detailed information on foreign banks and Moscow banks.

First, most of the big banks come from Moscow, and have higher efficiency for the reasons we have just explained. Also, bigger banks can gain efficiency from scale economies, scope economies and greater flexibility in funds allocation. For example, it only makes sense to trade in securities if certain amount of funds can be easily allocated to this activity. Otherwise, operational costs are too high.

Table 2.5. Efficiency Results for Banks Grouped by Assets Size

Model	Group	1999	2000	2001	2002	2003	2004
Intermediation	Small	0.788	0.688	0.722	0.792	0.768	0.907
	Medium	0.447	0.425	0.467	0.518	0.425	0.774
	Big	0.387	0.342	0.359	0.399	0.366	0.611
Production	Small	0.297	0.544	0.633	0.734	0.715	0.866
	Medium	0.256	0.271	0.457	0.489	0.412	0.655
	Big	0.232	0.215	0.389	0.375	0.332	0.567
Substitution	Small	0.286	0.532	0.611	0.728	0.704	0.856
	Medium	0.255	0.261	0.428	0.482	0.412	0.650
	Big	0.227	0.211	0.368	0.370	0.312	0.561

These results for different groups of banks are similar to the results of other studies. Wheelock and Wilson (2001) found large U.S. banks to be more efficient. In case of Russian banks, the results of Styrin (2005) are in line with our findings: big banks were more efficient. Comparing the efficiency of survived vs. failed banks, we found the same as Wheelock and Wilson (1995): in general, failed banks were less efficient than the ones that were staying in business.

2.4. Concluding Remarks

In this chapter we developed a model for estimating efficiency in the banking sector that accommodates both input and output features of the deposits.

We model deposits as an output that can be substituted with other borrowed funds, an input. Our theoretical model can be readily adopted for applications in other industries, such as universities. The general case also provides a way to deal with imperfect substitutability, which is often the case.

We contrasted the results of this new model, which we dub as substitution model, with the two other main approaches – intermediation and production approach. We did not find the evidence that for our data set of Russian banks in 1999-2004, the results of these three models are different. We also found that according to all three models failing banks were less efficient. Moscow banks fared better than their regional peers, and big banks were more efficient that smaller ones.

Thus, using three different models to compute the efficiency of the banks provides similar results. This, however, does not mean that the new substitution model is useless. Several researchers have found differences in results, similar to our case, when intermediation or the production model is used. For such data sets using the substitution model would be preferable since it provides a more general way of treating the deposits that incorporates their input and output features.

Chapter 3. Explaining Failures of the Russian Banks

3.1. Introduction

The profound effect that bank failures have on the economy has stimulated much of the research in banking, especially when bank runs occur or after a financial crisis. Bank managers, policymakers, regulators, depositors, the general public – all are interested in finding the explanation for failures. This question has also been on the agenda for both theoretical and applied economists.

The financial crisis of 1998 in Russia stimulated interest in investigating bank failure. The first studies contained mostly descriptive analysis (Matovnikov et al. (1999) and Entov (1999)), while more recent ones (Claeys et al. (2005) and Styrin (2004) for instance) represent attempts to econometrically evaluate the effects of different factors on bank failures. In general, most authors agree that banks that failed were not well capitalized, had lower profits and efficiency and higher balances of non-performing loans.

The goal of this study is to extend this literature by developing and testing a model that takes into account different risk components that determine failures. We think that not only bank-specific variables are important in explaining failures; elements of the broader business environment could be conducive to failures as well.

We begin by studying the previous research in the field – theoretical foundations for modeling a banking firm, applications and, in greater detail, empirical studies of the Russian banking sector. This constitutes Section 3.2. Section 3.3 is devoted to a general model of a banking firm as an intermediary. It emphasizes that the nature of their business is such that banks mostly deal with handling risks of different origins and levels. Then we describe broad risk categories and the way we will accommodate risks in our modeling framework. We consider three main categories of risks that a banking firm faces: bank-specific, industry-specific, and economy-wide risks. The set of the variables used to approximate these risks is described in Section 3.4. This section also discusses the

econometric specification for our empirical model in light of our data structure. Finally, Section 3.5 provides the estimation results and Section 3.6 concludes.

3.2. Literature Review

3.2.1. Bank Failures in IO Context

In a seminal paper Klein (1971) developed a model of a banking firm that became a cornerstone of modern analysis in this field. He started by noting that the expected return on total funds is equal to the difference between the total revenue from granting loans and the total cost of attracting deposits. A bank can accumulate funds by either attracting deposits or issuing equity. The supply of deposits is an upward sloping function of the interest rate. Loans are viewed as securities of two types: government (risk-free) and private (subject to default risk). Banks maximize expected returns on equity taking into account necessary cash holdings subject to limited funds. The model predicts that banks would issue private loans until the marginal return on these loans is equal to the average expected return on government securities. Fellows (1978) argued that "an equilibrium will be reached when the marginal revenue obtained from any credit instrument is equal to the marginal cost of extending credit in general," depending on the asset mix since costs of acquiring assets differ by the asset type.

Santomero (1984) presents a detailed literature review of earlier attempts to model a banking firm, and provides a nice classification of models based on which part of a bank's decision-making process they focus on: asset choice, liability choice, or capital and reserve management.

Modern production theory of a banking firm provides a similar framework. Banks are viewed as intermediaries which obtain funds in the form of deposits and distribute them as loans, incurring costs (C) that originate during the process.[48] So, a bank's profit function is $\pi = r_L L - r_D D + r\, M - C(D, L)$, where r_L, r_D and r are

[48] Detailed theoretical developments are outlined in Frexias and Rochet (1997).

interest rates on loans (L), deposits (D) and the interbank market (M) (as well as refinancing by central bank), respectively. Under perfect competition, particular banks cannot influence interest rates, they can under monopoly or oligopoly. Taking first order conditions with respect to interest rates and manipulating them to find elasticities, Lerner's indexes are then obtained:

$$Lerner\ Index = \frac{r^*_L - (r + C'_L)}{r^*_L} = \frac{1}{\varepsilon_L(r^*_L)}, \text{ where } \varepsilon_L = -\frac{r_L L'(r_L)}{L(r_L)}.$$

The interpretation is simple: the greater the market power of the bank in the loans market, the smaller is the elasticity and interest on loans, the higher the Lerner index and the intermediation margins.

There is no clear-cut conclusion among theoretical studies on how failures are affected by industry structure, although market power is often associated with a lower probability of banking failure.

Industrial organization studies of the banking in 1980's and 1990's focused on "the links between theoretical and empirical research" and primarily adopted the Structure – Conduct – Performance paradigm, as reviewed by Neuberger (1998). She stressed that, the relevance of risk to the SCP paradign, it was usually omitted in these studies. With regard to the number and size of banks in a market, she argued that "from the view of public policy, a low number of competing banks may be preferable because it is easier to monitor them and, by reducing the intensity of competition, it lowers the risk of bank failures," (page 109). Also, a bank's reputation for solvency (probability of failure) helps explain "a natural oligopoly structure of banking markets". Safer banks ceteris paribus usually have a larger customer base and enjoy higher margins and market shares, according to Vives (1991) and Shaked and Sutton (1983).

Keeley (1990) viewed the decline in capital ratios[49] as a main factor contributing to increased failure rates in banking. Low capital[50] provided a thin

[49] By capital ratios we mean equity capital divided by total assets or another denominator, total deposits, for instance.

cushion against losses and in general drove banks to take on higher risks. Competition eroded the charter value of a bank and reduced incentives for bank management to act prudently. Consequently, banks with more market power were e more sound.

In the same vein, Bolt and Tieman (2004) suggested that banks compete for loans by choosing loan acceptance criteria. If the criteria were loose, which was usually the case in the competitive environment, a bank could attract more borrowers. At the same time the quality of the loan portfolio unambiguously deteriorated, which in turn leads to higher failure rates. They showed that if only one instrument – capital adequacy requirement (CAR) – was available to regulators, they still could successfully utilize it to reach desired failure probabilities of commercial banks: a higher CAR leads to lower failure rates.

Matutes and Vives (1996, 2000) showed that competition drives the interest rates on deposits up and reduces the margin, increasing the probability of failure. Expectations of depositors become key in explaining the fragility of banks: depositors have prior beliefs about soundness of banks and prefer safer banks, so safer banks would enjoy higher market share and margins and would be able to exercise some market power. In the dynamic model of Buchinsky and Yosha (1997) the probability of failure is endogenous as it largely depends on a bank's own strategies. Smaller banks have a low probability of survival and therefore must offer a high interest rate to depositors.

Caminal and Matutes (2002) argued that the relationship between market power and failures in banking is ambiguous due to the costs of monitoring borrowers. If monitoring costs were high, "banks do not monitor regardless of market structure, competitive banks are more likely to fail" (page 1343). With intermediate monitoring costs a monopoly bank would monitor but would not

[50] We call bank's capital the value of equity that has been invested by bank's original owners corrected for losses and/or retained profits.

credit ration[51] loan applicants. This leads to higher aggregate risk exposure, so a monopoly bank is more likely to fail. When monitoring costs are low, everybody monitors and thus market structure does not matter. This conclusion implies that banking industry deregulation that enhances competition does not necessarily bring about more failures.

The effect of market structure in specifically transition economies was modeled as a trade-off between efficiency and stability. Allen and Gale (2000) suggested that tightened competition promotes development of new banking products and leads to higher efficiency. But on the other hand, profit margins are reduced and fewer creditworthy borrowers are left without a loan. This could cause the share of weaker financial institutions to rise.

Gorton and Winton (1998) viewed inefficiency as synonymous with small size of the banking system: the level of intermediation and provision of payment and clearing services were initially very low in transition economies. They could be augmented if new banks were encouraged to enter, because existing banks often have connections and prefer to lend to state-owned enterprises, even if they do not pay back on time. De novo banks though would bear higher risks and could be more prone to failures, undermining the stability of the banking system. But this increased instability is balanced by a more efficient intermediation.

Pyle (2002) argued that information diffusion, which accompanies the appearance of new banks,[52] might be undesirable in the environment with weak contract enforcement. On the contrary, higher concentration may provide a better way of dealing with informational deficiencies.

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[51] Credit rationing is the process when banks refuse to make loans to certain borrowers, even though these borrowers may offer to pay higher interest. (Jaffe, 1999, p.296)

[52] It is information about bank customers that is being diffused when new banks appear. As entrants begin their operations, in transition economies they rarely have access to any data on the credit histories. And when some of new entrants go out of business, they take with them whatever they might have accumulated.

These theoretical developments and stylized facts suggest several important variables to consider while investigating failures. Neuberger (1998) hypothesized that stiffer competition (which can be expressed as a rise in the number of banks operating in the market) is associated with more failures. Competition erodes interest margins and profits, noted Matutes and Vives (1996, 2000). Keeley (1990) adds that bank capital is an important factor affecting bank viability. Consequently, capital adequacy requirements can be effectively used by regulators to control failure rates (Bolt and Tieman, 2004). Following this literature, in this study we offer several variables that could possibly reflect the effect of market structure and try to identify whether they are useful determinants in predicting failures.

3.2.2. Empirical Work on Bank Failures

Most of the empirical work on bank failures can be divided into two broad groups: 'micro' and 'macro'. The 'macro' studies used either cross-country (65-45 countries, 1980-1994 in Demirguc-Kunt and Detragiache (1998); 50 countries, 1976-1997 in Hardy and Pazarbasioglu (1998)) or time-series macroeconomic data (US quarterly financial series 1880-1914, Canova (1994)) and applied multivariate logit (or probit) to identify which factors have greatest influence on occurrence of a crisis.

The 'micro' group studies addressed banking crises in particular countries or even regions, and used cross-section, micro-level data. They usually follow the structure of CAMEL rating[53] by including variables that approximate capital adequacy (C), asset quality (A), managerial effectiveness (M), earnings (E), and liquidity (L). Wheelock and Wilson (1995) adopted a proportional hazard model to study state-chartered Kansas banks during 1910-1928. Together with micro variables, critical for bank's stability, they include a dummy variable for deposit insurance membership and a technical efficiency estimate as a proxy for the

[53] CAMEL rating is used by Federal Reserve to assess soundness of banks
.

managerial quality. Their estimation results show that insured banks were more likely to fail, supporting the moral hazard hypothesis, while more efficient banks were more likely to stay in business.

Molina (2002) used the same methodology to study a banking crisis in Venezuela. He found that surviving banks were more profitable and had a bigger share of their assets in government bonds. He used several variables to account for the poor information, intrinsic for a developing country. In particular, he included "window dressing" indicators, such as other assets, other liabilities, off-balance sheet accounts, that banks may use to mask bad loans and other problems.

Wheelock and Wilson (2000) explored the probability of being acquired along with failure probability. They used quarterly call reports data for 1984(3) - 1993(4), for a total of 38 quarters for all existing US banks to estimate a competing risks model for which one of the events – acquisition or failure – would cause a bank to disappear. This study incorporates two different measures of efficiency (cost efficiency and technical efficiency) and its results showed that less efficient banks were more likely to fail and less likely to be acquired.

Gonzalez-Hermosillo et al.(1997) made an important step forward, recognizing that not only bank-specific factors, but also macroeconomic conditions as well as potential contagion effects, determined by industry specifics, affect bank fragility. They used total banking sector risky loans, non-performing loans and loans/GDP ratio to proxy banking sector conditions and contagion effects. Following Cole and Gunther (1995), they recognized that the likelihood and timing of a failure are influenced by different factors. Applying multivariate logit and survival analysis, they established that for the case of the Mexican crisis of 1994 macroeconomic factors play a pivotal role" (p.307) in explaining time of failure, likelihood of a failure was more influenced by bank-specific factors, while the contagion effect was important to assess both.

Gonzales (1999) continued the search for "an integrated approach of the 'micro' and 'macro' camps" (p. 8). She started with rigorous theoretical arguments

and outlined the framework for probability of a bank becoming unsound being a function of liquidity risk, market risk and credit risk and suggested indicators for these variables along with some measures for efficiency. She concluded that "sound and unsound banks show different characteristics, largely as the result of different risk-taking behavior". This claim is supported with estimation of Cox proportional hazard models for three episodes of banking crises in the US, as well as in Mexico and Columbia.

In a very recent study Arena (2005) used cross-country data for eight East Asian and six Latin American countries to study bank failures in emerging markets. First he employed micro level data with a foreign ownership dummy and a regulatory environment index to capture country effects and ran models separately for East Asia and Latin America. The Regulation Index summarized effects of rule of law, corruption, risk of expropriation and contract repudiation in a single number. The higher the number, the better the regulatory environment and the smaller the risk of failure. This is one of the attempts to incorporate the features of developing economies. Both logit and proportional hazard models, were estimated, but environmental variables were significant only for East Asia, suggesting that country-specific conditions were important for the incidents of East Asian financial crisis.

These studies are quite extensive and represent diverse countries. Transition economies though were not among the countries often chosen for the research. This can be explained by data limitations and difficulties in accounting for the business environment that is not yet equivalent to a market economy. But as data become available and methodology is better established, hopefully more applied studies will be conducted. Failures of Russian banks were fairly well studied, but several issues remain. This is the subject of our next subsection.

3.2.3. Studies of Failures of Russian Banks

Several concurrent working papers consider failures in the Russian banking sector. They are summarized in the Table 3.1. below.

Styrin (2005) used quarterly 1998 data for the 250 largest Russian banks to test the hypothesis that past X-inefficiency predicts the probability of a failure of a financial institution. The author used data from the Interfax information agency without, however, specifying whether it excludes Sberbank. He used three default dummy variables to classify banks as failed based on when they ceased to exist in 2000, 2001 or 2003. These banks were present in the original data set. He computed efficiency scores using stochastic frontier analysis, then included them as an explanatory variable in logit regressions with dependent variables failed2000, failed2001, or failed2003. Other explanatory variables were government securities, dollar denominated and foreign liabilities, captiveness (share of total loans to owners), foreign ownership, interbank market exposure, Moscow vs non-Moscow location, and savings balances. He found no evidence to support his main hypothesis that X-inefficiency explains failures, although he found that captiveness was a significant determinant of failure. Since banks with larger market shares and some monopoly power have been shown to be more efficient, Styrin's conclusion about efficiency is not surprising.

Peresetsky et al. (2004) asked whether clustering of banks improved the predictive power of a similar logit model. For example, banks can be separated (or clustered) into two groups based on the equity/total assets ratio requirement imposed by the CBR. Banks with equity capital less that five million euro have to keep this ratio at 11% or more, while banks with more capital have a 10% minimum.

Table 3.1. Comparison of Failures of Russian Banks Studies

Authors	Period/Data	Main Focus	Results
Styrin (2005)	Quarterly data for 1998, 250 largest banks	Failed = license withdrawal; Does inefficiency explain failures?	No significant relationship between failures and inefficiency; affiliation with FIG was significant
Peresetsky et al. (2004)	Quarterly data, 1996-2002	Failure = license withdrawal = merger = placement under ARCO; Does inclusion of macro variables (CPI, exchange rate, real GDP, income, etc.) help to explain failures?	Macro variables had significant effect on failures (exchange rate, export/import)
Clayes et al. (2005)	Quarterly data, 1998-2003	Failure = delicensing; Lack of enforcement of prudential regulations by CBR may arise due to regulatory forbearance. Regional concentration (HHI) affects CBR's decision of license withdrawal. Market-specific indicators (regional market share in assets) included as controls. Costs/assets serves as efficiency proxy.	Concluded that regulatory forbearance does not play major role; failures are mostly due to economic reasons.
Lanine and Vander Vennet (2005)	Quarterly data, 1998-2003	Failure = insolvency; comparing failure prediction using logit and trait recognition model (TRM).	Logit model: Better capitalized banks are less likely to fail. Liquidity, size and quality of assets were not important. TRM: "unsafe" features include high profits, low capitalization and low liquidity.

Based on data for the first quarter of 1998, the authors established a bank's status as failed (LIVE=0) if by the first quarter of 2000

- its license was revoked by CBR;
- it was placed under ARCO administration; or
- it merged with another bank.

Otherwise, LIVE=1. According to the sample data, compared to live banks, failed banks appeared to have lower equity/total assets, government bonds/total assets and liquid assets/total assets ratios, but higher shares of reserves and non-working assets.

In order to construct clusters, banks were compared based on four indicators: total assets, share of government bonds in total assets, capital adequacy ratio and loans to non-financial enterprises to total assets ratio. They found that the best parameters for clustering are equity/total assets ratio and total assets. In the second part of the paper they investigated the effect of macroeconomic variables on the failure probabilities. Using quarterly data for the period 1996-2002 from Mobile information agency, they found that inclusion of macro variables proved significant in explaining failures. From a set of possible macroeconomic candidates--CPI, exchange rate, real income, GDP, unemployment, export/import -- they found, for many variable pairs, quite significant correlation. Eventually they used only the exchange rate and export/import in separate versions of the logit model.

A series of papers exploring Russian banking has recently emerged from a group of researchers at University of Ghent, ranging from compiling a comprehensive data set of Russian banks (Schoors, 2000, Karas and Schoors 2005) to analyzing regulatory design of CBR (Claeys Lanine and Schoors, 2005). The most interesting papers for us are Lanine and Vander Vennet (2005) and Claeys, Lanine and Schoors (2005).

The first paper attempts to develop a failure prediction model for the Russian banking sector utilizing logit and trait recognition models. The authors

referred to Russian legislation and defined failures as insolvency. Accordingly, they included only banks that faced compulsory or voluntary bankruptcy from the set of failed (de-licensed) banks. They excluded banks de-licensed due to compulsory or voluntary liquidation and merger since the reasons for these actions often had nothing to do with bankruptcy. They also highlighted the importance of their failure prediction model by noting that over October 2004 – April 2005 23 banks lost their licenses due to compulsory bankruptcy. We think though that this could have happened due to close evaluation of the applicant pool to be admitted to the deposit insurance scheme by CBR. As a result, weak institutions did not pass the test and were pressed to exit.

Data for this research from Mobile and was manipulated in several ways. They split the sample into two parts: main and holdout. The main sample included observations over January 1997 – March 2000, and the holdout sample over April 2000 – November 2003. Observing that the total proportion of registered banks that failed was around 17%, for every failed bank in the holdout sample five other banks were randomly drawn without adopting any matching criteria such as size, region, owner, etc. The analysis was done for 3, 6, 9 and 12 months before failure and there were at most about 600 observations in every specification. The authors focused on bank-specific characteristics, ignoring macroeconomic shocks and local conditions entirely. Motivation for the inclusion of variables in the logit regression was based on measuring three types of risks: liquidity, borrower default, and capital (or leverage) risk. For the logit model the main conclusion was that better capitalized banks were more viable. Contrary to expectations, banks with high liquidity were less stable and coefficients on bad loans and size were not significant.

The second part of the paper uses a trait recognition model. The main idea here is to implement an algorithm that extracts traits common to failed or non-failed banks taking into consideration two or three explanatory variables simultaneously. The results are somewhat conflicting with the logit: “unsafe” traits

were lower profit, capitalization and liquidity, while the logit model predicted high liquidity for failing banks.

The main contribution of this work, aside from identifying factors that influence failures, is its attempt to predict failures and evaluation of those predictions. The criteria used to this end are MSE (mean squared error) and a variation of hit-and-miss statistics. MSE is lowest and reaches about 0.05 three months prior to failure for the trait recognition model and 0.06 for logit in the main samples and 0.07 and 0.09 respectively in the holdout samples.

The focus of study of Claeys, Lanine and Schoors (2005) is different: they evaluate the CBR's approach to bank regulation and consider a conflict that arises from the clashing goals of ensuring individual bank stability and stability of the entire banking system. As a result, regulatory forbearance – lack of enforcement of prudential regulation – may arise. So the goal is to see if de-licensing is based on strict adherence to supervisory standards or is driven by "tacit objectives". The authors linked license withdrawals with three sets of variables that captured:

1. compliance with regulatory standards;
2. tacit objectives of CBR; and
3. economic variables.

The degree of compliance is measured by evaluating the number and severity of breaches of regulatory norms. Tacit objectives of the Central Bank of Russia were connected with systemic stability, political influence, bank size and region – the indicators that CBR supposedly considers when it revokes licenses. Systemic stability is linked to contagion, which is often channeled through the interbank market, so interbank market/total liabilities ratio and market share in total interbank liabilities are explanatory variables. In addition, public deposits/capital may serve as a measure of protection from runs on the bank and is also added to the regression. Political influence is mainly measured by involvement with government through holdings of government securities. The bank size variable reflects the "too big to fail" hypothesis, meaning that large banks are more likely to be rescued in

case of crisis. The regional concentration measure represents the regulator's concern about the degree of competition in the local market and expresses the idea of why de-licensing in highly concentrated markets is less likely. Mostly it is due to the fact that competition would be even further suppressed with fewer firms on the market.

Emphasizing regulatory failure, this research includes economic variables as controls. Among these are return on assets, costs/assets (reflecting efficiency), non-performing loans/total loans, regional market share in assets, reserves/loans.

The empirical estimation showed that most economic variables were significant, unlike variables from other categories. Even though there are signals of forbearance, they are not very pronounced and very often de-licensing is well based on economic grounds. In addition, calculations of the regional Herfindahl-Hirshman Index and regional market shares are questionable. As far as we are aware, the data sources (mainly CBR) provide only consolidated information for banks with branches. Therefore it is unclear whether regional HHI includes numbers from branches of banks from other regions. It is not uncommon that a Sberbank subsidiary is the main player on a local market, so accounting for their presence is desirable.

Claeys et al. (2005) use the same data sources as Lanine and Vander Vennet (2005). Reasons for license withdrawal are grouped into five categories that are a bit differently stated, but have the same meaning:

Lanine and Vander Vennet (2005)	Claeys, Lanine and Schoors (2005)
Compulsory liquidation	Violation of bank legislation
Compulsory bankruptcy	Compulsory bankruptcy
Voluntary bankruptcy	Voluntary bankruptcy
Voluntary liquidation	Voluntary liquidation
Merger	Merger

Since Claeys, Lanine and Schoors (2005) were mostly concerned with CBR's de-licensing activity based on adherence to regulations, it seems that only violations of

bank legislation and compulsory bankruptcy should belong to the scope of their investigation. But the authors included all categories and only considered the effect of inclusion/deletion of mergers.

Results of these studies can be summed up as follows. Failures are more frequent among banks with lower capitalization and profits. Other important determinants include non-performing loans and size. The direction of liquidity influence is not clear. Banks with high liquidity were less viable in the study of Lanine and Vander Vennet (2005). Others - Claeys et al. (2005), Styrin (2005) and Peresetsky et al. (2004) – found it to be an important feature of surviving banks. Styrin included the effect of efficiency calculated using stochastic frontier approach, while the ratio of costs to total assets of Claeys et al. is an alternative way to account for efficiency. Only Peresetsky et al considered he effect of macroeconomic variables, and that was inconclusive. Claeys et al. incorporated industry conditions and concluded that the CBR sometimes does pay attention to the regional market condition when withdrawing licenses.

Although substantial work has been done investigating failures of Russian banks, several key issues though remain. Development of a structural theoretical model to assess failures has to be done. This challenge applies to studies of failures of other countries as well, since often an ad hoc set of variables in the logit models were used with little or no theoretical justification. Consideration of the transition environment is another feature that is often overlooked. Quite frequently, authors do not provide a clear definition of a failure, which is a fundamental component of model building. In addition, the fact that failures represent rare events has not been recognized and adjusted for in the literature.

In this paper we aim to contribute to bringing together theoretical modeling of bank failures and empirical applications. We pay special attention to incorporating industry-specific and macroeconomic conditions into a failure model, as they help to account for the business environment in which banks operate. We also include among the explanatory variables efficiency metric, which has been

shown to provide insights on the connection between failures and managerial quality. We will build a theoretical model based on Klein (1971), Bolt and Tieman (2004) and Gonzalez-Hermosillo (1999), and justify logit estimation as an appropriate technique. In addition, we adopt the correction method of King and Zeng (2001a, 2001b) to account for the low frequency of failures in our data set. In this paper we are interested in economic reasons for failures and attribute the parts that remain unexplained by our model to the discretion of the Central Bank of Russia, omitted from the model factors and random errors.

In this work along with bank-specific conditions, we will account for the industry-wide and macroeconomic conditions that can influence failures. While our theoretical model might not be completely structural, it incorporates neoclassical profit-maximization and failures to risk and transition dynamics. In addition, in our empirical logit estimation we account for panel data effects and rare events. Among other bank-specific variables we also include efficiency scores calculated according to the substitution model developed in Chapter 2.

3.2.4. Defining Failures

In general, failure occurs when a firm suffers losses and eventually goes out of business. Walter (2004) distinguishes several steps. First, a financial firm suffers losses. Observing this, creditors demand debt repayment or raise their interest rates. Then the firm, unable to raise sufficient funds, stops honoring its liabilities (defaults).

Several definitions of a failure have been used in the literature. The Canadian Deposit Insurance Corporation (www.cdic.ca) states that “a failure occurs when an institution becomes insolvent or is in immediate danger of insolvency”. FDIC researchers emphasize that a failure is often defined by the regulator. Nuxoll (2003) strongly believes that a failure is “a legal, not economic event” and that a bank fails when the supervisor says so, not when the bank becomes insolvent.

Oshinsky and Olin (2005) also define failure as a bank closure solely resulting from an action of the regulator or a merger assisted by the regulator.

The Fitch Rating Agency in its recent Bank Failures Study (Fitch Ratings, 2005) assumed a bank had failed if it was kept going only by state support from a (deposit) insurance fund or by being acquired by some other corporate entity or by an injection of funds by its shareholders.

In general, researchers used various events to pin down failures and what usually follows it: recapitalization, license withdrawal, merger or even an arbitration court procedure. It is worth noting, however, that in addition to such indications of failure, one may consider using a primary reason for such actions to denote a failure.

We define a bank failure as the inability of a bank to honor its contracts, whether they are contracts with depositors or with business entities and government. Therefore, in our study we consider bank a failure if it is subjected to the license withdrawal by CBR or if it has negative equity capital.

Timing of a failure event is another important dimension to consider. When regulators assess a bank's financial situation, it usually uses information from a previous period.[54] Therefore, if a license is withdrawn at time *t*, it is frequently the case that failure occurred at *t-1*. In constructing the data set in this study we followed this assumption: we use explanatory variables from a period ago while considering de-licensing from the current period. In addition, often after a bank fails it disappears from the data set, thus lagging is practical in an empirical application.

[54] This does not imply that performance 2 or 3 periods ago does not affect failures. Rather, we suggest that since balance sheet information, to a significant extent, carries over from past, it inherits the problems which occurred in previous periods. Bad loans would be an example of such carryover.

3.3. Theoretical Model

3.3.1. Integrating Failures in the Model

In our study we adopt the basic set up from the classical model of the banking firm from Klein (1971). We also add some features from Bolt and Tieman (2004) and attempt to account for special features relating to transition banking.

The general maintained assumption in this study is that banks, among other financial firms, are intermediaries that transform deposits into loans. Banks convert equity and borrowed funds into reserves, loans, government securities and interbank loans. This is represented in the simple bank balance sheet below:

Bank's Balance Sheet

Assets	Liabilities
Reserves *R* (incl. Cash)	Time deposits *TD*
Loans *L*	Demand Deposits *DD*
Government bonds *G*	Equity *W*
Interbank loans *M*	

Liabilities

1. Banks have two major sources of funds: equity (*W*) and borrowed funds – time and demand deposits (*TD* + *DD*). So, total funds available for intermediation are equal to $F = TD + DD + W$.
2. The supply of both types of deposits are increasing functions of their yields, so that $TD = TD(r_T)$, $TD'(r_T) > 0$, and $DD = DD(r_D)$, $DD'(r_D) > 0$. For demand deposits, we follow Klein's argument for yield. Even though the explicit yield is zero, a bank incurs costs to provide transaction services which should be viewed as an implicit yield.
3. The Central Bank's regulation of the liability side manifests itself as the capital adequacy requirement (CAR) which actually regulates the level of leverage that a bank can afford without violating the law. Expressed as a constraint,

$CAR = u \geq \frac{W}{TD + DD + W} = \frac{W}{F}$, or equivalently, $uF = u(TD + DD + W) \geq W$,

where $F = TD + DD + W$. In order to have a convenient solution, we assume that the CAR constraint holds with equality. This can be justified in the following way. Since equity is the most expensive source of funds, no profit-maximizing bank would keep more than the required minimum. Tieman (2004) suggested a similar explanation for having a binding CAR constraint.

4. In addition, equity holders require a premium, as in Bolt and Tieman (2004), since equity is riskier then deposits. In case of losses it is depleted and owners cannot get back as much as they originally invested. Let δ represent the premium over the cost of deposits, so the operational cost of equity becomes $r_T + \delta$.

In addition to costs incurred to attract funds, other costs include labor, premises and equipment, stationery, transportation costs, etc., which we will call overhead costs. We will represent them as $C(K,H)$ where K represents physical capital such as premises and equipment and H denoted labor costs. We assume constant marginal cost.

Assets

1. Banks allocate assets among loans to firms and households (X_l), interbank loans (X_m) and government bonds (X_g) and reserves (X_c). X_l and X_m are in imperfect elastic supply (marginal return is decreasing), while X_g is perfectly elastic. E_j is the expected return on the j^{th} asset and X_j is the amount of funds allocated to a particular asset, where $j = l, g, m, c$. Then, total revenue (earnings) = $E = \sum_j X_j E_j$.

2. The demand curve for loans is downward sloping and is a function of interest rates on loans and other variables exogenous to a bank. Expected return on loans $E_l = h(X_l)$ and $h'(X_l)<0$, where X_l is the value of funds allocated to

loans. For simplicity, we assume that borrowers are identical and default risk is exogenous to bank.

3. Government bonds are assumed to be free of default risk.[55] This asset is similar to a reserve holding and can be easily sold should a bank need liquidity fast in case of a sudden deposit outflow.[56] Since the time of sale in such circumstances is not known in advance, $E_g = \int_{-1}^{\infty} p\phi(p)dp$ represents the expected rate of return on government securities, with random variable p denoting rate of return for the holding period and $\phi(p)$ its density function.

4. The interbank market is modeled similarly to the government bonds market, because banks may use it as an outlet for quick funds, whether they are in excess or deficit. For simplicity, we assume that a bank is a net lender and can recover its loans quickly. Since banks can not always predict what interbank market balance they will have, $E_m = \int_{-1}^{\infty} q\varphi(q)dq$, where E_m is expected rate of return on interbank balances.

5. Cash holdings and reserves required by the Central Bank are grouped in the reserves category X_c and represent an asset that does not earn explicit interest. Analogously to treatment of demand deposits, following Klein, the implicit yield on this asset comes from a reduction in the expected loss that arises due to a cash deficiency. Let a random variable z with density $k(z)$ denote a possible cash deficiency expressed in dollars. If we assume that a bank should pay a penalty n for every dollar of cash deficiency, the loss in case of zero cash

[55] Even though government did default on its debt in 1998, we model and estimate equations for the period starting 1999. And as it was mentioned above, international rating agencies upgraded Russian sovereign risk rating to investment category, which implies a low level of risk on government securities.

holdings would be $n\int_0^C zk(z)dz$, where A is the largest necessary disbursement to which a bank assigns nonzero probability. Nonzero cash holdings X_c imply that the loss will be $n\int_{X_c}^C (z-X_c)k(z)dz$. Assuming uniform density $k(z)=1/(A-B)$, where B is lowest foreseeable deficiency, the expected loss becomes $n\int_{X_c}^C (z-X_c)\frac{1}{A-B}dz = n\frac{(z-X_c)^2}{2}\cdot\frac{1}{A-B}\Big|_{X_c}^{A} = n\frac{(X_c-A)^2}{2(A-B)}$.

Now, we define net earnings as

$$NE=\sum_j X_j E_j - TD\cdot r_T - DD\cdot r_D - (r_T+\delta)\cdot W - C(K,H) \tag{3.1}$$

Putting all the pieces together we can state the bank's optimization problem as

$$NE = X_l h(X_l) + X_g E_g + X_m E_m - n\frac{(X_c-A)^2}{2(A-B)} - TD\cdot r_T - DD\cdot r_D - (r_T+\delta)\cdot W - C(K,H)$$

subject to the balance sheet constraint $\sum_j X_j = TD + DD + W$

and the CAR constraint $uF = u(TD+DD+W) = W$. (3.2)

If we were to find a solution to this profit-maximization problem, we would take FOC with respect to choice variables X_j, representing types of assets or *r*s, representing interest on borrowed funds. Our focus though is how a bank's production can be linked to failures. The idea of Bessis (2002) is instrumental here. He states that "banking risks are defined as adverse impacts on profitability of several distinct sources of uncertainty." (page 11). Our *NE* is nothing but a profit function. So we only need to identify how risks manifest themselves in the *NE* equation. Bessis stipulates further that according to the capital adequacy principle the bank's capital should match risks: "Solvency risk is the risk of being unable to absorb losses generated by all types of risks, with the available capital. … [It is] equivalent to the default risk of the bank. Solvency is a joint outcome of available

[56] Of course, when many banks experience difficulties and try to get rid of their government securities, their prices drop and can affect their liquidity characteristics.

capital and of all risks"(page 20). Utilizing this idea allows us to adopt a framework of Bolt and Tieman (2004) to state that probability of failure $\Pr(\textit{failure}) =$

$$= \Pr\left(\left[\sum_j X_j E_j - n\frac{(X_c - A)^2}{2(A-B)} - TD \cdot r_T - DD \cdot r_D - (r_T + \delta)\cdot W - C(K,H)\right] < -(r_T + \delta)\cdot W\right) \tag{3.3}$$

As long as a bank obtains positive profits and is able to satisfy equity holders' return requirements, it will stay in business and be able to raise additional capital on the capital market, should this need arise. If we rearrange the terms,

$$\Pr(\textit{failure}) = \Pr\left(\sum_j X_j E_j < n\frac{(X_c - A)^2}{2(A-B)} + TD \cdot r_T + DD \cdot r_D + C(K,H)\right). \tag{3.4}$$

Whether this inequality holds or not, depends on how managers handle the risks that affect the bank activity. We can reformulate this as bank's fragility (how easily a bank can fail) being a function of risks:[57]

$$\Pr(\textit{failure}) = f(\textit{risk factors}) \tag{3.5}$$

These risks are not observable directly. We assume here that a bank fails if the risks are above a certain critical level. We can only observe if a bank fails or not. To construct an index function, we model y_i^*, the aggregate measure of riskiness of a bank's activity, as a function of different types of risks. If $y_i^* > y_{critical}$, then $y_i = 1$, if $y_i^* < y_{critical}$, then $y_i = 0$, where y_i denotes whether a bank fails (1) or not (0):

$$\begin{aligned} y_i = \Pr(\textit{failure}) &= 1 \textit{ if } y_i^* = f(\textit{risk factors}) > y_{critical} \\ &= 0 \textit{ if } y_i^* = f(\textit{risk factors}) < y_{critical} \end{aligned} \tag{3.6}$$

To evaluate this relationship we will use logit estimation which can be applied precisely for this type of model. But before we do so, we need to describe a comprehensive risk framework. This will help us identify necessary variables for inclusion in the regression.

[57] This formulation was suggested by of Gonzalez-Hermosillo (1999).

3.3.2. Banking Is A Risky Business

Since "the management of risks can be seen as the major activity of banks" (Freixas and Rochet, 1997), it is logical to begin by looking at how different risks can be modeled for a banking firm.

Van Greuning and Brajovic Bratanovic (2005) defined a comprehensive risk framework that includes the four major categories of risks represented in Table 3.2, most of which are self-explanatory.

Table 3.2. Risk Classification

Financial risk Risk of primary banking operations	**Operational risk** Bank's organization and functioning of internal systems	**Business risk** Bank's business environment	**Event risk** Exogenous risks
Pure Risks: Assets and liabilities and profits structure Capital adequacy Credit risk Liquidity risk	Fraud Employment practices Technology failures Execution, delivery and process management	Macro policy Financial infrastructure Legal infrastructure Regulatory compliance Reputation Country risk	Political events Contagion Banking crisis Natural disaster
Speculative risks: Interest rate risk Market risk Currency risk			

Source: van Greuning and Brajovic Bratanovic (2005)

For the purpose of our study we distinguish three facets of risks:

- bank-specific risks
- industry-level risks
- macroeconomic risks.

Bank-specific (often also referred to as microeconomic) risk includes financial and operational categories from the table above.

Financial risk is the most important category of risks, because it involves the essence of banking business, starting with allocation of funds on both the assets and liabilities sides. Establishing loose conditions for loans, weak monitoring or overinvesting in risky projects is expected to cause the share of bad assets to increase. Financing investments with funds attracted from the public can be sensitive to expectations of certain types of depositors. In addition, maturity and/or currency mismatches between assets and liabilities can cause distress. All of these situations can lead to failure.

As for *pure risks*, they include liquidity, solvency and credit risks. *Liquidity risk* appears when a bank is not certain whether it can repay its depositors on time. Banks transfer liquid deposits into illiquid loans and a maturity mismatch between the two is aggravated if many depositors suddenly withdraw their funds. A bank faces *solvency risk* when the total value of its assets falls below its liabilities and equity turns negative. *Credit (or default) risk* occurs when a borrower is not able to repay a loan (default risk). *Speculative risks* are present when a bank plays on differences in prices. *Currency* and *interest rate risks* appear due to volatility inherent in currency rates and debt instruments that a bank decides to hold. *Market risk* is often referred to as a risk that affects banks through the mix of their assets and liabilities or risk that originates in a particular market (e.g. short term deposits, loans to light industry, etc) where a bank is active.

Operational risk includes a bank's exposure to the overall risk of conducting business and is connected with internal facilities to aid the main functions of a bank. It reflects the quality of general management. In our case we

will consider the efficiency estimates developed in Chapter 2 as measures of this type of risk.

Industry-level risk is a representation of market conditions under which banks operate. It is usually associated with the business environment and industry structure and is connected to **business risk** from Table 3.2. Such risks are a part of the bank's business environment. We will consider the following factors in this category: deepness of the market (total volume of issued loans relative to gross regional product), concentration (number of banks and branches per 1000 people), and risk of contagion (level of deposits).

Macroeconomic risks are often considered to be an important component of overall risk environment. Shocks, stemming from business cycles, inflation, changes in of terms of exports, exchange rate fluctuations – all these factors can influence the viability of a banking institution. Adverse macroeconomic conditions could trigger unmanageable contagious runs on the banks. Recessions usually bring waves of loan defaults. In Table 3.2 both **business risk** and **event risk** have elements of this type of risk. We will account for this type of risk by including such variables as GDP growth, rouble/dollar exchange rate, and level of exports. In addition to these variables, banking regulation, which does not vary by region, will be included here. We pay special attention to a very influential change in the legal framework – adoption of a deposit insurance scheme in Russia in 2003. This is one of the components of business risk which is also a manifestation of a transition economy environment: events such as this could only happen once during the reformation of the banking system. We will provide a more extended discussion on this issue when we justify our empirical model.

Going one step further, a broader consideration of the transition environment can prove useful in defining and structuring risk factors. Legal changes are only one facet of such a framework. The EBRD (2003, 2005) has extensively documented progress in transition.. In Section 1.3 we discussed the EBRD's index of banking sector reforms and scores for the quality of banking

legislation in Russia. Both good candidates for capturing risks related to institutional development during transition. We include the bank index in our model.

Having identified major elements of risk environment, we now turn to approaches to measuring risks in a way that fits our modeling framework.

3.3.3. Measurement of Risks

In the finance literature, three quantitative indicators of risks can be distinguished:[58]

- sensitivity, capturing the deviation of a target variable due to a unit movement of a single market parameter ;
- volatility, capturing the variations around the average of any random parameter; and
- downside measures of risks which focus on adverse deviations only.

These measurements usually work best for speculative groups of financial risks such as stock and bond and foreign exchange instruments where data are abundant and frequent.

Risk exposure generally increases with the share allocated to a particular risk-generating asset or liability. That is why ratios that measure such shares are often utilized to account for different risk factors. An example of this methodology is the CAMEL rating system used by the Federal Reserve System. CAMEL stands for Capital adequacy, Asset quality, Management ability, Earnings level and Liquidity adequacy. Banks receive ratings from one to five in each of these categories. In the case of Russia, the CBR specifies a set of ratios and corresponding limits that closely follows the CAMEL outline to monitor the condition of banks. Adoption of this procedure for our analysis is helpful, since we are able to control for effects of a groups of variables, rather than looking

[58] Based on Bessis (2002, p. 77).

exclusively at single variable effects. In the next section we turn to our empirical model and empirical risk measures.

3.4. Empirical Model

3.4.1. Logit Formulation

As we have discussed in Section 3.3.1, a bank fails if its cumulative risk factor y_i* crosses an unobservable threshold, $y_{critical}$. Econometric models for the binary dependent variable, which in our case indicates either failure (1) or success (0) of the observed bank (see Amemiya (1981) and Greene (1998)), conveniently lend themselves for our estimation. The outcome is modeled as a function of x: $\Pr(Y = 1) = F(\beta' x)$ and $\Pr(Y = 0) = 1 - F(\beta' x)$.

Here the risk factors enter in the following way:

$$\begin{aligned} &\Pr(\textit{failure}) = f(\textit{risk factors}) \\ &= f(\textit{bank} - \textit{specific risk}, \textit{industry} - \textit{specific risk}, \textit{macroeconomic risk}) \end{aligned} \tag{3.7}$$

Now the regression model – conditional expectation – is

$$E(y \mid x) = 0*[1 - F(\beta' x)] + 1*[F(\beta' x)] = F(\beta' x). \tag{3.8}$$

After F is selected, maximum likelihood estimation is executed. The two most popular choices for F are normal and logistic distributions, resulting in probit and logit models respectively. Often these formulations are routinely applied without explicitly considering observed data characteristics, which can result in inconsistent estimates. In our modeling exercise, we need to take into account two important data properties.

First, we deal with panel data. Moreover, our panel is quite short (only a few time periods) and wide (many banks in each period). We need to account for this effect in our modeling. Second, the frequency of failures compared to non-failures is relatively low, so it is hard to approximate the distribution of ones in the sample.

Addressing the first issue, we note that panel data in the binary response models are treated similarly to the linear regression case. The two approaches – fixed effects and random effects – have been fairly well studied.[59] In the binary response case, the situation is different. The choice of fixed or random effects formulation dictates specification of the distribution for maximum likelihood estimation.

In the logit case, MLE for individual fixed effects are consistent only when the number of periods $T \to \infty$. The problem here is that since T is usually fixed, the estimates for fixed effects α_i are not consistent and this inconsistency transfers to other parameter estimates as well. Luckily, logistic distribution permits 'differencing out' fixed effects estimates from the non-linear likelihood function. This idea was first developed by Chamberlain (1980). His suggestion was to maximize the likelihood of y_i conditioned on $\sum_{t=1}^{T} y_{it}$, which happens to be a sufficient statistic[60] for α_i. In the case of logistic distribution, such conditioning causes incidental parameters to drop out.

Finally, marginal effects here differ from observation to observation and are given by the formula

$$\frac{\partial E(y \mid x)}{\partial x} = \left(\frac{\partial \Lambda(\beta' x)}{\partial x} \right) \beta = \frac{e^{\beta' x}}{(1+e^{\beta' x})^2} \beta = \Lambda(\beta' x) \cdot [1 - \Lambda(\beta' x)] \beta. \qquad (3.9)$$

The average of marginal effects for each observation is computed to obtain an analog to the marginal effects estimates for the linear model.

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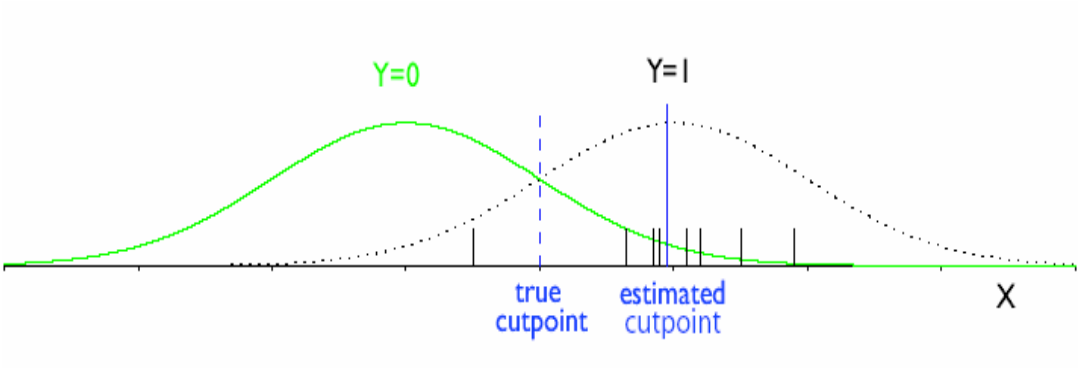
[59] Maddala (1987) is one of the first attempts to summarize the results of the panel data studies using binary response formulation. Other useful references with comprehensive coverage of the panel data and reference to limited dependent variable cases include (but are not limited to) Nerlove (2002), Hsiao (2003), Frees (2004).

[60] If a sufficient statistic τ_i exists for incidental parameter α_i and does not depend on β, then conditional density $f^*(y_i \mid \beta, \tau_i)$ does not depend on α_i. For detailed explanation and definition of sufficient statistic see Hsiao (2003).

Another feature that needs further attention is that bank failures are relatively infrequent in our data set. When this happens, maximum likelihood estimation is bound to produce inconsistent estimates. King and Zeng (2001a, 2001b) encountered a very similar problem in their study of international conflicts. They explain that due to the limited number of observations that represented conflicts (comparable to failures in our case), the distribution of this effect is not correctly specified. The explanation for this is the following. Consider Figure 3.1.[61]

Figure 3.1. Distributions for Y=0 and Y=1, conditional on X



Observations are ordered according to the value of X (say, banks ranked by total assets). The solid line represents the density from which non-failed banks were randomly drawn. The dotted line represents density of the failed banks. The distribution of zeros is well defined, while the distribution of ones cannot be well approximated. Logit will choose a cut point to minimize incorrect classifications. But with few ones, it will place the cutpoint too far to the right, because the true cutpoint would misclassify many zeros. This will cause logit parameter estimates related to the location of cutpoint to be inconsistent. If the distribution parameters were corrected to reflect the true cutpoint, then logit estimates would continue to be

[61] This figure is borrowed form the 2005 lecture notes of Christopher Adolph, Department of Political Science, University of Washington, Seattle.

consistent.[62] To correct for this, King and Zeng (2001a) offered two options: prior correction and weighting. Both of them allow them to adjust for the difference in the proportion of failures in the sample and population, using available out of sample information.

3.4.2. Rationale for Choosing the Variables

We use several criteria for variable selection. First, we want our variables to represent the balance-sheet categories that our formal model stipulates. Second, since we model failures as events caused by excessive risk taking, we need measures of risks as explanatory variables. We group explanatory variables by the risk type (bank-specific, industry level or macro level) and discuss what hazard they are approximating. Another criterion is success in previous work. For example, most researchers followed categories of the CAMEL rating (see section 3.1.3) in selection of bank-specific variables. We proceed in the same fashion. Finally, accounting for the developing banking system and transition environment that Russia represents is called for. We describe how our selected variables can be used for this purpose as we go along.

3.4.3. Bank-Specific Variables

While selecting microeconomic or bank-specific variables, we have drawn on several previous studies. We approximated categories from the CAMEL rating system in a way similar to Wheelock and Wilson (1996, 2000), Demirguc-Kunt and Detragiache (1998) and Molina (2002). The idea is to find a variable that would approximate the CAMEL category and thus represent the same risk dimension. In Table 3.3 CAMEL's component abbreviations are assigned to all variables except SIZE. Both assets and liabilities are important in describing bank activity. On the

[62] King and Zeng (2001b) provide a detailed discussion on this issue. Their proof is based on the work of McCullagh and Nelder (1991).

liabilities side, banks have to strike a balance between obtaining funds through issuing equity or attracting deposits. If a bank relies heavily on borrowed funds, its liquidity risk (and a chance of failure) is higher, since depositors can withdraw their funds on short notice, despite possible withdrawal penalties. On the other hand, counting heavily on equity is not wise because equity is a relatively expensive source of funds. In addition, attracting deposits is the core of banking business. Banks seek deposits to enlarge the clientele base for strategic reasons – capturing higher market share, selling additional services and issuing loans. So, a successful and stable bank should have considerable deposit balances. Therefore complex forces are at play when we consider deposits. This makes prescribing the sign for DEPP (public deposits over assets) and DEPB (other deposits over assets) difficult: the sign should reflect the trade-off described above and depend on which effect is more powerful.

Table 3.3. Bank –Specific Factors

Variable	CAMEL	Description	Expd Sign
DEPP	L	Public deposits/Total assets	-/+
DEPB	L	Other banks deposits/Total assets	-/+
LIQA	L	Liquid assets/Total assets	-
CAPT	C	Equity /Total assets	-
PROF	E	Profits before tax/Total assets	-
GKOT	A	Government securities/Total assets	+/-
INBL	A	Interbank loans/Total assets	+/-
LNRD	A	Loans to residents/ Total assets	+/-
LNNR	A	Loans to non-residents/Total assets	+/-
NPLN	A	Non-performing loans/Total loans	+
SIZE		Log (Total assets)	-
EFFD	M	Efficiency score	-

A measure of *liquidity risk* is LIQA, the share of liquid assets in total assets. If a bank can transform an asset into cash fast, it is a useful way out in case of shortage of funds. Banks in transition economies usually hold higher balances of

liquid assets, since there is more uncertainty associated with changes these countries are going through. We expect highly liquid banks to have lower chances of failure.

Solvency risk is on the flip side of the deposit-equity balance. Better capitalized banks – those whose capital to assets ratio (CAPT) is higher – are more resilient since their 'cushion' for losses is larger. Another rationale: customers may watch this ratio as a sign of stability. In the case of transition environment this could be used as a sign of a good reputation. Pyle (2002) confirmed that reputation effect may substitute for institutional development: in a country without a well-functioning legal system, building a good name could be a way to signal adherence to future contracts. In addition, bank owners should be seriously concerned with the bank's viability and may watch operations more closely, if their stake in the institution is significant. Hence we expect this variable influences failure negatively.

Another way to trace the effect of institutional environment is to analyze measures of performance. In poor institutional environments firms that possess superior information can achieve a higher return (Hainz, 2004). So, besides the usual interpretation of profitability (PROF) as an indicator of a more viable bank, this variable helps distinguish banks that can better cope with information imperfections and therefore have higher chances of survival.

On the assets side, *credit risk*, approximated by ratios of different types of investments to total assets, is higher for banks with larger ratios since this implies higher exposure to a certain risk-generating factor. Ratios of loans to residents and non-residents to total assets (LNRD and LNNR) are control variables in this model.. We are not able to distinguish higher risk vs. lower risk assets here. High balances of a safe asset with a stable return do not necessarily mean a higher risk level. So, we do not expect a particular outcome. The ratio of non-performing loans to total loans (NPLN) helps to address asset quality, which deteriorates with an increase in the share of non-performing loans. This works equally well for both

transition and developed economies. That is why the coefficient on NPLN is expected to be positive.

We have also included interbank market loans (INBL) and government securities balances (GKOT) as alternative ways to allocate assets. In a developed economy with stable government, risk of default on government securities is virtually absent, while in Russia, as a transition economy, it is not always the case. The banking crisis of 1998 showed that government default could be detrimental to the health of the banking system. The situation has improved markedly since the crisis; recently international rating agencies have raised Russia's rating to investment level. That is why the sign on GKOT could be negative, indicating a low-risk asset. INBL is a measure of activity on the interbank market and may indicate sensitivity of a bank to contagion. Therefore INBL may have a positive sign. On the other hand, interbank market provides a quick access to funds and could be a good tool to overcome temporary liquidity shortages. Thus INBL may as well have a negative sign. Claeys, Lanine and Schoors (2005) suggest though that the CBR may protect money center banks that are particularly active on the interbank market. These would be mostly bigger banks located in Moscow. We think though that controlling for size (see below) and region should capture this effect quite well.

Bank size is important for several reasons. Usually, large banks are considered to be less likely to fail due to diversification of their operations and geographical markets. The Central Bank is often inclined to support a big bank for various reasons, from preventing bank panics to ownership considerations. (Russia's biggest bank Sberbank is owned by CBR which obviously protects it from failure.) In addition, a big bank often can engage in operations that require substantial levels of capital and trust. For example, stock market operations only makes sense if sufficient financial capital is available. Issuing eurobonds or even equity to be traded in the Russian market are operations usually reserved to big

banks. To capture these effects, the log of total assets (SIZE) is used to control for size.

We pay special attention to efficiency (EFFD). Efficiency has been used as a proxy for managerial quality and was shown to be significant in failure models in studies by Wheelock and Wilson (1995, 2000). Earlier Barr, Seiford and Siems (1994) found that only a small fraction of efficient banks were among failures, while most failed banks were inefficient. Intuitively, we expect more efficient (low-cost) banks to be less likely to fail. To compute efficiency scores as in Wheelock and Wilson (1995, 2001), we use Data Envelopment Analysis (DEA) in Chapter 2.[63]

3.4.4. Industry-Specific Risk and Macro Risks

Generally speaking, it is quite hard to account for the environment that a particular bank operates in. Nuxoll (2003) argued that market conditions that may affect a bank are very complex and, surprisingly enough, often bank-specific. This conclusion came from consideration of the geographic and structural characteristics of the bank's operations. Some banks operate on more than one geographical or product market. Therefore they are affected by the conditions in all markets simultaneously. It is quite hard to find two banks that face exactly the same environment. He suggested that a bank's balance sheet already encompasses all of these peculiarities. Even though this statement may be well justified for the US, in a transition economy this might not be the case.

Going back to the information problem, we hypothesize that a model for developing country where markets do not operate as efficiently and smoothly as in a developed economy, inclusion of the economy-wide and industry-specific

[63] Parametric approaches, such as stochastic frontier, could also be applied. Several studies have shown that both methods yield similar results, for example Ferrier and Lovell (1990) and Resti (1997).

variables may improve a failure model. We specify several industry level and macro level variables and add them to bank-specific indicators (Table 3.4).

Industry-specific risk includes several components, which are constructed for each of the seven Russian regions. These regions differ with respect to many factors - resources, population, gross regional product, number of banks and availability of banking services, so it is important to distinguish their banking markets.

Table 3.4. Industry-Specific and Macro Variables

Industry-specific factors		
BGDP	Total banking system loans/GDP	-
NPTL	Total banking system non-performing loans/Total banking system loans	+
NUMB	Number of banks and branches per 1000 people	+
DEPR	Average deposits per person	+/-
CONC	Share of banks that control 80% of assets	+
HHI	Herfindahl-Hirshman Index	-
Macroeconomic factors		
INTR	Real interest rate	+
GDPR	Real GDP rate of change	-
INFL	Inflation rate	+/-
EXRT	Exports/GDP	+
INST	EBRD's index of banking sector reforms	-
DI	Deposit insurance dummy	+/-

First, the deepness of the local market is measured by total volume of issued loans relative to gross regional product (BGDP). Regions where banks have well-developed skills to assess borrowers and where a share of creditworthy enterprises is significant, would have a deeper market. We think there should be fewer failures in these regions.

The total amount of non-performing loans relative to total banking system loans (NPTL) is higher for more fragile markets, since such losses deplete banking capital and make markets more vulnerable for banking panic. This variable is expected to have a positive effect on the probability of bank failure. Gonzalez-Hermosillo (1999) used both BGDP and NPTL and found them significant.

We also hypothesize that concentration affects failure due to the effects of the market power and information economies that accrue to large banks. We use three measures of concentration: Herfindahl-Hirshman Index (HHI), the number of banks per 1,000 population (NUMB) and the *fraction* of banks that control 80% of the assets in the region (CONC).

A conventional measure of concentration, used in Claeys, Lanine and Schoors (2005), is the Herfindahl-Hirshman index (HHI). HHI is the sum of squares of market shares (in terms of assets) of all firms in the industry. According to the authors, this measure comes from the CBR's web site, but it is not clear whether it was calculated using only the information on local banks, excluding the branches from other regions which in some regions hold dominant positions. We were able to locate official Herfindahl-Hirshman indices (HHI) on the CBR's web site by region only for 2002, 2003, 2004. So, we tried separate regression on a subset of the data for only those years. As mentioned above, an industry with higher concentration and consequently more market power (higher value of HHI) would experience fewer exits.

The number of banks is often used as a proxy to measure industry's competitiveness (Hainz (2003), Neuberger (1998)). Our proposed measure does include both local banks and their branches as well as branches of banks from other regions, adjusted for the population by region. So, NUMB, represents the number of banks and branches per 1000 people. We expect that the higher this number, the tougher the competition and the higher the exit rates. Further, in a transition environment where information about borrowers is scarce and imperfect, a large number of banks implies diffusion of the existing stock of information

(Pyle, 2002). When banks do not share information, borrowers can default on loans with little negative effect on their reputation. So, banks will eventually suffer from large balances of non-performing loans. Therefore, more banks and more competition will bring about more failures. In the same vein, Cetorelli (1997) noted that higher levels of monopoly power in banking in developing countries can help overcome problems of incomplete and asymmetric information and weak contract enforcement.

We also tried another measure of concentration: CONC, the *fraction* of banks that control 80% of the assets in the region.[64] The expected sign of CONC is positive: the higher the fraction, the more competitive the market, the greater the failure rate.

Deposits person (DEPR) is another variable we think can contribute to understanding local markets and bank failure. DEPR also measures market depth, or, more precisely, the ease of attracting funds. While on the one hand it is congenial to have a rich clientele base, on the other hand such a market may be prone to more severe bank runs. Hence it is hard to sign DEPR, but its inclusion seems very relevant.

Alternatively, to distinguish banks from different regions, we can include a regional dummy variable (REGD). We expect to see more failures among Moscow banks. Since about one half of the banks are located there, the market is densely populated. Banks compete for borrowers more aggressively and therefore, even a lower quality borrower can obtain a loan. It is true that some Moscow banks benefit from superior expertise and technologies, but many are very similar to their regional peers. In addition, the tight market for qualified personnel in Moscow might also leave average and small banks with inferior workers.

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[64] The variable CONC might suffer from the same flaw as HHI. It is very likely not to include the assets of subsidiaries of banks from other regions, mainly Moscow banks. Even though imperfect, this measure exhibits the differences in the level of concentration in different regions. It is probably roughly overstates the fraction of *regional* banks that control 80% of banking assets in the region.

Macroeconomic risks are often linked to bank boom and bust. Influence runs through different channels. First, fast GDP growth (GDPR) brings better expectations, more income and better borrowers. Overall, it signals a healthy economy and should reduce the probability of failure. Rising inflation often works "in a bank's favor [as] their assets are re-priced faster than their liabilities and inflation reduces the real value of non-performing loans."[65] But on the other hand, inflation, particularly rapid inflation, often goes hand-in-hand with bad economic times. So, INFL could influence failures in either direction. Exports often grow after depreciation, "eating up" foreign currency reserves and aggravating bank fragility. We adjusted exports by GDP to obtain EXRT. Interest rate (INTR) increases could foreshadow recession and macroeconomic instability. Bad loans will require more funds to write them off and would make banks more vulnerable. So we expect that the coefficient on INTR will have a positive sign. Given that interest rates move together, we use the interest rate on interbank loans. INST reflects the development of institutions vital for banking system progress, here measured by the EBRD's index of bank reform.. The EBRD bank reform index measures how far the Russian bank system as evolved in the direction of a fully fledged financial intermediary infrastructure, as we described in detail in the Section 1.3. The higher the value of index, the closer a banking system is getting to the standards of developed economies. We expect that INST has a negative influence on failures. As institutions develop, new more sophisticated practices are adopted, expertise is acquired, and fewer banks would fail.

Last but not least we incorporate the effect of deposit insurance on the probability of failure by distinguishing two periods: without DI (1999, 2000, 2001, 2002) and with DI (2003, 2004). Certainly, such a dummy would capture not only the effect of DI, but also that of all other factors not elsewhere in the regression.

[65] The Economist Intelligence Unit (2004, page 47).

Changing legislation is characteristic of a transition economy. As we described in Chapter 1, several laws concerning banking activities and regulation were adopted in the last five years. But we consider the establishment of deposit insurance plan the pre-eminent change.[66] It had far-reaching effects,[67] including more stringent regulation of depository banks, changing expectations of depositors towards more confidence in private banks and diminished chances of bank runs. Therefore inclusion of a DI dummy seems to be a reasonable way to account for this effect.[68] But given the ambiguities of past work on the effect of deposit insurance on failures expected sign is undetermined.

3.5. Data Sources and Results

3.5.1. Data

We obtained bank-specific data on an annual basis from Moscow's Interfax Information Agency[69] consisting of balance sheet and income statements information for the end of the year (fourth quarter, Q4) 1999-2004. We randomly compared numbers from our data set with balance sheets of several banks available on CBR's web site[70] and found them to be identical. The information on regional GDP and population comes from the Russian Federal State Statistics Service web site[71]. The CBR web site provided information on license withdrawals. Along with

[66] Establishment of Deposit Insurance in Russia is described in detail in Section 1.1.4.

[67] For this reason, DI and INST should not be used in the same model run, since we expect both of them to capture institutional features of the Russian banking industry.

[68] Econometrically, a deposit insurance effect can be evaluated in several ways. Cross-country studies often pool the data on banking sectors of different countries and use a dummy to distinguish entries with DI in place (Demirgüç-Kunt and Kane, 2001 and Cull, Senbet and Sorge, 2002). Single-country studies used the same dummy variable approach to identify individual banks – DI members (Wheelock and Wilson, 1995).

[69] www.interfax.ru

[70] www.cbr.ru

[71] www.gks.ru

this, various issues of *Bulletin of Banking Statistics* (on the CBR web sit in both in Russian and English) were used to derive the figures on regional banking markets. This data set also originally contained information on non-bank organizations, such as clearing houses and cash collecting firms. These entities have different production functions and were deleted. We have also excluded banks with incomplete information. Among deleted banks was also the largest, Sberbank, whose data was incomplete. Deletion of this bank together with a couple of others (Vneshtorgbank and Vnesheconombank) is also justified by the fact that CBR would rarely consider letting these banks go under due to their ownership structure and systemic importance. We can be almost sure that these banks are not going to fail. The number of banks included and main descriptive statistics for the regression variables are given in Appendix C.

Even though Russian banks are universal by definition, some of them chose not to attract deposits. We excluded such non-depository banks, which includes new banks which are prohibited from accepting deposits for two years after registration.

As mentioned above (section 3.1.5), we matched explanatory variables to failures with a one year lag. This is a very common procedure, adopted among others adopted by Nuxoll (2003), Peresetsky et al (2004), Styrin (2005).

We have chosen for the research the 1999-2004 period for two reasons. First, the quality of data is better, since more bank-specific indicators are available and more banks are covered. In addition, regional data, crucial for our work, is available only from the end of 1999. Second, during this period banks became more like Western financial institutions[72] and therefore application of a model build for developed economies is more readily justified for a transition economy.

Simple correlation coefficients reveal other data features. Microeconomic variables and their coefficients are contained in Table 3.5.

[72] The EBRD's Index of Banking Sector Reforms improved for Russia from 1.7 to 2.3 during this period (EBRD (2005)).

Table 3.5. Pearson[73] Correlation Coefficients for Bank-Specific Variables

	DEPP	DEPB	LIQA	CAPT	PROF	GKOT	INBL	LNRD	LNNR	NPLN	SIZE	EFF
DEPP	1											
DEPB	0.287	1										
LIQA	-0.064	-0.253	1									
CAPT	-0.245	-0.702	-0.068	1								
PROF	-0.015	-0.282	-0.010	0.381	1							
GKOT	-0.083	-0.204	0.236	-0.098	0.012	1						
INBL	-0.099	-0.277	0.152	-0.130	-0.007	0.515	1					
LNRD	0.233	0.153	-0.117	0.026	-0.288	-0.323	-0.307	1				
LNNR	-0.130	-0.062	0.181	-0.076	-0.024	0.021	0.494	-0.211	1			
NPLN	0.018	0.011	-0.002	0.023	-0.059	0.013	-0.009	-0.023	-0.016	1		
SIZE	0.045	0.022	-0.246	-0.315	-0.015	0.227	0.370	-0.087	0.315	0.007	1	
EFF	0.022	0.007	0.007	0.003	-0.030	-0.257	0.001	0.419	-0.048	-0.003	0.068	1

[73] Other commonly used measures of relation produced very similar results and are not reported here. All coefficients are significant at 1%.

Most of the variables do not show signs of high correlation. The fact that non-public bank deposits (DEPB) are correlated with capital adequacy suggests that corporate clients might indeed watch capital adequacy when entering a borrowing-lending relationship with a bank, as noted above. Correlation of interbank loans (INBL) with government securities (GKOT) and loans to non-residents (LNNR) may indicate that these operations are performed by the same certain subgroup of banks – mostly larger banks from Moscow and St. Petersburg.

Correlation coefficients for industry and macro variables are given in Table 3.6 (without HHI) and Table 3.7 (with HHI only for 2002-2004). Measures of market structure NUMB, CONC, DEPR and HHI are all significantly related. This suggests that we should run alternative versions of the model using only one measure of market structure at a time.

Table 3.6. Correlation between Industry and Macro Variables, 1999-2004[74]

	BGDP	NPTL	NUMB	DEPR	CONC	INTR	GDPR	INFL	EXRT
BGDP	1								
NPTL	-0.223	1							
NUMB	0.754	-0.113	1						
DEPR	0.968	-0.194	0.817	1					
CONC	-0.225	-0.124	-0.794	-0.886	1				
INTR	-0.353	-0.326	0.093	-0.172	-0.047	1			
GDPR	0.007	-0.649	0.101	0.007	-0.225	-0.353	1		
INFL	-0.006	0.796	0.082	0.006†	-0.079	0.717	-0.714	1	
EXRT	0.196	-0.545	-0.121	0.144	0.035	0.807	0.410	-0.772	1

Table 3.7. Correlation between Industry Variables, 2002-2004[75]

	NUMB	DEPR	CONC	HHI
NUMB	1			
DEPR	0.813	1		
CONC	-0.794	-0.886	1	
HHI	0.746	0.419	-0.882	1

[74] All coefficients are significant at 1%.

3.5.2. What Is Different About Failing Banks?

Table 3.8 illustrates some basic differences between failed banks and survivors in our sample. On average, failed banks have less equity, profit and interest income and more overdue loans than survivors. Failed banks were actually larger than survivors for 1999-2002, somewhat unexpectedly given the presumed inefficiency of small banks. Some of these failures were likely banks of substantial size that got into trouble during the crisis of 1998 or banks de-licensed for regulatory violations (e.g., money laundering). The proportion of failed Moscow banks (not shown in Table 3.8) increased considerably over the sample period; close to two-thirds of all failed banks in 2003 and 2004 were from Moscow as overbanked Moscow market lost its weakest players.

Table 3.8. Comparative Statistics of Failed and Non-failed Banks in the Sample*

Year	Equity		Assets		Profit		Interest Income		Overdue loans		Number of banks	
	Surv.	Fail	Surv.	Fail	Surv.	Fail	Surv.	Fail	Surv.	Fail	Surv.	Fail
1999	150.53	-1928.08	750.10	2190.18	14.17	-1125.12	11.8	10.7	13.65	342.32	1244	29
2000	258.07	-6491.89	1239.77	3037.46	24.87	-2517.87	7.3	5.0	9.13	1177.25	1238	17
2001	426.74	-4594.24	2301.88	3185.07	54.37	560.11	13.5	10.3	19.63	1062.44	1238	10
2002	432.99	-4740.19	2152.79	3814.26	55.79	132.04	5.1	4.2	17.28	1320.00	1245	10
2003	529.54	441.88	2997.64	1938.19	73.55	154.79	1.4	1.0	20.04	11.54	1223	34
2004	628.55	332.85	3862.59	1172.63	103.56	23.09	1.1	1.1	33.29	16.31	1191	40

** Nominal average values (except for the last two columns), mln roubles.*

[75] All coefficients are significant at 1 %.

3.5.3. Estimation Results

The dependent variable in the logit model is binary: 1 denotes failure and 0 denotes survival. We classify banks with revoked licenses or negative equity as failed, as stipulated in Section 3.1.4. We ran six models, first using only micro level variables and then adding industry and macro level variables. Tables 3.9 - 3.11 contain the results of estimation of logit model for the full panel: Table 3.9 – parameter estimates, Table 3.10 – model diagnostic statistics, and Table 3.11 – marginal effects values.

In general, failed banks were undercapitalized and slightly less profitable. They could not attract a considerable deposit base, were inefficient and probably small. We found no evidence that industry conditions contributed to explaining failures. Macroeconomic situation appeared to have some influence: higher inflation made banks more prone to failures. Other macro variables in our runs (GDP growth, oil prices, exchange rate, for instance) did not have as a pronounced of effect on failures as inflation did. This suggests that economic conditions measured by inflation provide a better measure of macroeconomic influence on failures.

The signs of all bank-specific variables are as we expected. Overall, signs, levels of significance and marginal effects of bank-specific variables were fairly stable throughout all specifications. Negative signs on DEPP and DEPB indicate that the risk of bank runs that accompanies high balances of deposits is far outweighed by the advantages of obtaining cheaper funds. Liquidity (LIQA) turned out to be significant and had a significant effect on failures. Very often banks get into critical situation because of liquidity shortages, and later from being illiquid turn into being insolvent.

The negative and significant coefficient on capital adequacy (CAPT) supports the idea that better capitalized banks are more stable. Owners may exercise better control if large amounts of their capital are invested in the bank. Also, banks want to signal their reputation by having a stronger capital position,

which is especially appealing in a transition environment. The effect of profitability turned out to be insignificant.

On the assets side, loans to residents (LNRD) positively affect failures. This indicates that disbursing loans is by far the riskiest activity. Loans to non-residents (LNNR) though appeared to affect failures negatively, which could have been an indication that banks that deal with foreign borrowers have acquired better skills to manage their business. But both these variables are not significant, so their impact is immaterial. The positive sign on government securities (GKOT) tells us that the risk of holding GKO is still present, even when Russia's economic situation is stable. Interbank market balances (INBL) significantly affect bank viability. This is probably due to a fact that the interbank market is subject to contagion.

The positive and universally significant sign on the share of non-performing loans (NPLN) suggests that this is a strong influencing force that affects failures, and that asset quality plays an important role in balancing high level of exposure to certain assets.

As for the bank size, our results do not provide strong evidence that small banks are more likely to fail, even though the sign of SIZE is negative but significant only in two regressions.

EFFD – last but not least among bank-specific variables – has a negative and significant effect on failures, suggesting that banks under superior management are less likely to fail, other things being equal.

Table 3.9. Logit Estimation Results for the Full Panel, 1999-2004

Variable	Description	**Model 1** (micro only)	**Model 2** (micro,DI, NUMB, INFL)	**Model 3** (micro, DI, CONC, INFL)	**Model 4** (micro, DI, DEPR, EXRT)	**Model 5** (micro, DI, INFL, region dummies)	**Model 6** (micro, CONC, INFL, INST)
Intercept		-2.501**	-2.454**	-3.169**	0.589	0.911	1.457*
Bank-specific factors							
DEPP	Public deposits/Total assets	-3.340***	-3.324***	-3.447***	-3.329***	-3.371***	-3.462***
DEPB	Other banks deposits/Total assets	-2.001***	-2.015**	-2.097***	-1.842**	-2.039**	-1.874**
LIQA	Liquid assets/Total assets	-0.020***	-0.029***	-0.018**	-0.032**	-0.028***	-0.032***
CAPT	Equity /Total assets	-7.286***	-7.290***	-7.3038***	-7.190***	-7.011***	-7.003***
PROF	Profits before tax/Total assets	-0.001	-0.001	-0.001*	-0.002	-0.003	-0.002
GKOT	Government securities/Total assets	1.705	1.699	1.734	1.631	1.132	1.102
INBL	Interbank loans/Total assets	-3.246	-3.355*	-3.378*	-3.048*	-3.622*	-3.391*
LNRD	Loans to residents/ Total assets	1.749	1.855	1.993	1.625	2.253	1.956
LNNR	Loans to non-residents/Total assets	-1.012	-1.030	-1.087	-0.776	-1.324	-1.123
NPLN	Non-performing loans/Total loans	3.879***	3.923***	3.917***	3.969***	3.754***	3.847***
SIZE	Log (Total assets)	-0.074	-0.086	-0.093*	-0.048	-0.139*	-0.103
EFFD	Efficiency score	-0.07**	-0.001**	-0.003**	-0.005**	-0.001*	-0.001**
Industry-specific factors							
NUMB	Banks and branches per 1000 people	---	1.298	---	---	---	---
CONC	Share of banks with 80% assets	---	---	-2.079*	---	---	-2.930**
DEPR	Average deposits per person	---	---	---	-3.261**	---	---
Macroeconomic factors							
INFL	Inflation rate	---	0.049**	0.037**	---	0.045**	0.065**
EXRT	Exports/GDP	---	---	---	-0.0001*	---	---
DI	Deposit insurance dummy	---	2.551***	2.017***	3.047***	2.044***	---
INST	Index of banking sector reforms	---	---	---	---	---	-1.028**

Table 3.9. continued

Regional Dummies							
Regdum1	Dummy for Central region	---	---	---	---	-0.983	---
Regdum2	Dummy for North-Western region	---	---	---	---	-1.472	---
Regdum3	Dummy for Southern region	---	---	---	---	-1.212***	---
Regdum4	Dummy for Volga region	---	---	---	---	-0.985**	---
Regdum5	Dummy for Ural region	---	---	---	---	-0.523	---
Regdum6	Dummy for Siberia region	---	---	---	---	-0.826	---
Regdum7	Dummy for Far Eastern region	---	---	---	---	-0.263	---
RegdumS	Dummy for St. Petersburg	---	---	---	---	-0.515*	---

*** - significant at 1%; ** - significant at 5%; * - significant at 10%.

Table 3.10. Logit Results for Full Panel: Model Diagnostics

	Model 1 (micro only)	**Model 2** (micro, DI, NUMB, INFL)	**Model 3** (micro, DI, CONC, INFL)	**Model 4** (micro, DI, DEPR, EXRT)	**Model 5** (micro, DI, INFL, region)	**Model 6** (micro, INST, CONC, INFL)
Model fit (intercept and covariates)						
AIC	959	960	960	959	960	960
SC	967	967	968	967	967	967
- 2 log L	957	958	958	958	957	958
Global Null Hypothesis : β = 0 (p-value in par.)						
LR	326 (0.0001)	327 (0.0001)	334 (0.0001)	334 (0.0001)	342 (0.0001)	335(0.0001)
Score	1130 (0.0001)	1131 (0.0001)	1138 (0.0001)	1135 (0.0001)	1147 (0.0001)	1131 (0.0001)
Wald	167 (0.0001)	168 (0.0001)	170 (0.0001)	170 (0.0001)	171 (0.0001)	165(0.0001)
Pseudo R^2	0.355	0.355	0.363	0.363	0.372	0.361

Table 3.11. Logit Estimation Results for Full Panel: Marginal Effects

Variable	Description	**Model 1** (micro only)	**Model 2** (micro, DI, NUMB, INFL)	**Model 3** (micro, DI, CONC, INFL)	**Model 4** (micro, DI, DEPR, EXRT)	**Model 6** (micro, CONC, INFL, INST)
Bank-specific factors						
DEPP	Public deposits/Total assets	-0.056	-0.036	-0.032	-0.040	-0.034
DEPB	Other banks deposits/Total assets	-0.117	-0.133	-0.123	-0.158	-0.130
LIQA	Liquid assets/Total assets	-0.957	-0.971	-0.952	-0.969	-0.972
CAPT	Equity /Total assets	-0.124	-0.133	-0.130	-0.128	-0.140
PROF	Profits before tax/Total assets	-0.345	-0.318	-0.409	-0.415	-0.398
GKOT	Government securities/Total assets	0.089	0.103	0.176	0.196	0.132
INBL	Interbank loans/Total assets	-1.150	-1.035	-1.134	-1.047	-1.027
LNRD	Loans to residents/ Total assets	2.162	2.392	2.338	2.082	2.491
LNNR	Loans to non-residents/Total assets	-1.319	-1.357	-1.337	-1.460	-1.261
NPLN	Non-performing loans/Total loans	2.231	2.584	2.287	2.972	2.312
SIZE	Log (Total assets)	-0.887	-0.917	-0.920	-0.953	-0.870
EFFD	Efficiency score	-0.218	-0.198	-0.203	-0.208	-0.212
Industry-specific factors						
NUMB	Banks and branches per 1000 people	---	3.055	---	---	---
CONC	Share of banks w/80% assets	---	---	-0.215	---	-0.208
DEPR	Average deposits per person	---	---	---	-2.224	---
Macroeconomic factors						
INFL	Inflation rate	---	1.050	1.038	---	1.200
EXRT	Exports/GDP	---	---	---	1.000	---
DI	Deposit insurance dummy	---	2.843	2.524	2.051	---
INST	Index of banking sector reforms	---	---	---	---	-2.349

Table 3.11 is helpful in identifying the relative importance of our explanatory variables.[76] Combined with significance level, quality of assets (NPLN), liquidity and capital adequacy are the most influential components of the model. So, for example, for every additional percentage point increase in capital adequacy ratio (CAPT), the odds of failing are reduced by about 12 %.

We added industry-level and macro variables to the model in different combinations (Models 2-6).[77] Included in the tables are variables that reflect industry structure on the regional level. We found no evidence supporting our arguments that more banking outlets (banks and branches) adjusted for population (NUMB) affect failures: it is insignificant, even though its sign is positive as expected. Now were we able to conclude that higher concentration (lower value of CONC) affects bank exits as expected: the sign of this variable unexpected though significant at 10% level. Only one industry variable had both the expected sign and an acceptable level of significance: Banks in the regions with more 'generous' depositors (DEPR) win, perhaps because they have lower costs of attracting funds.[78] Substitution of industry-specific variables with regional dummies (Model 5) left the model coefficients largely unchanged.

As for macro level variables, we picked inflation for approximating the influence of macroeconomic conditions. Given high correlation of macro variables, and lower explanatory significance of other variables, INFL showed superior performance. High inflation is often treated as a sign of deteriorating

[76] We evaluated marginal effect at means. For a large sample, average of individual marginal effects is identical to marginal effects, evaluated at means (Green, 1998, page 876).

[77] Inclusion of BGDP and NPTL as well as interest rate INTR did not produce significant coefficients and improve model diagnostic statistics and therefore are not included in the results tables. We tried inclusion of other variables, such as exchange rate, CPI, real interest rate, oil prices but they have not been significant in our specifications. The effect of export rate of growth is very similar to the effects of exports/GDP. (Runs are available on request from author.)

[78] Even though DEPR does not reflect market structure, it is highly correlated with NUMB and CONC, as shown above. Including DEPR together with CONC, NUMB or HHI did not yield practical results: DEPR was only significant at 10% together with HHI, while significance of HHI did not improve. These results are available on request.

macroeconomic conditions and therefore is associated with more bank failures. According to the model diagnostics from Table 3.10, inclusion of industry variables together with deposit insurance effect and inflation, did somewhat improve explanatory power of the model

In an effort to understand the influence of the industry structure, we ran additional regressions to assess the effect of the Herfindahl-Hirshman index. Tables 3.12 and 3.13 present the results for the years 2002-2004, when HHI numbers are available. We contrast inclusion of this factor with other specifications, which have other market structure proxies – NUMB, CONC and market depth measure - DEPR.

It turns out that the effect of HHI in the reduced panel is not significant. Even though all our proxies for industry structure are not perfect, HHI does not seem to capture the effect of industry structure well.

Our model diagnostics for both full and reduced panel vary insignificantly, suggesting that even though macroeconomic variables do affect failures, the influence of bank-specific factors is more important, reinforcing the view that ultimately banks themselves are responsible for their success (or failure).

Table 3.12. Logit Estimation Results for 2002-2004: Effects of the Different Concentration Measures

Variable	Description	**Model 1** (micro, DI, NUMB, INFL)	**Model 2** (micro, DI, CONC, INFL)	**Model 3** (micro, DI, HHI, INFL)	**Model 4** (micro, DI, DEPR, INFL)	**Model 6** (micro,CONC, INFL, INST)
Intercept		-2.453**	-2.168**	-1.057*	-1.506*	-1.804*
Bank-specific factors						
DEPP	Public deposits/Total assets	-3.324***	-3.447***	-3.497***	-3.462***	-3.291***
DEPB	Other banks deposits/Total assets	-2.015**	-2.096***	-2.045*	-2.843**	-2.143**
LIQA	Liquid assets/Total assets	-0.295***	-0.281***	-0.295***	-0.318***	-0.253***
CAPT	Equity /Total assets	-7.290***	-7.304***	-7.310***	-7.111***	-6.989***
PROF	Profits before tax/Total assets	-0.001	-0.001*	-0.001*	-0.001*	-0.001*
GKOT	Government securities/Total assets	1.699	1.738	1.722	1.479	1.242
INBL	Interbank loans/Total assets	1.355*	1.376	1.224	1.391*	1.598
LNRD	Loans to residents/ Total assets	1.855	1.993	1.695	1.957	1.507
LNNR	Loans to non-residents/Total assets	-1.030	-1.087	-0.880	-1.156	-1.142
NPLN	Non-performing loans/Total loans	1.923***	1.917***	1.861***	1.196**	1.583***
SIZE	Log (Total assets)	-0.864	-0.880	-0.676	-0.705	-0.785
EFFD	Efficiency score	-0.130**	-0.124**	-0.164**	-0.145**	-0.166**
Industry-specific factors						
NUMB	Banks and branches per 1000 people	2.295	---	---	---	---
CONC	Share of banks w/80% assets	---	-2.079*	---	---	-2.499*
HHI	Herfindahl-Hirshman Idex	---	---	-1.622	---	---
DEPR	Average deposits per person	---	---	---	2.630**	---
Macroeconomic factors						
INFL	Inflation rate	0.491**	0.733*	0.385*	0.514*	0.616*
DI	Deposit insurance dummy	2.552***	2.016***	2.224***	2.308***	---
INST	Index of banking sector reforms	---	---	---	---	-1.578**

*** - significant at 1%; ** - significant at 5%; * - significant at 10%.

Table 3.13. Logit Results for 2002-2004: Model Diagnostics

	Model 1 (micro,DI, NUMB, INFL)	**Model 2** (micro, DI, CONC, INFL)	**Model 3** (micro, DI, HHI, INFL)	**Model 4** (micro, DI, DEPR, INFL)	**Model 6** (micro, DEPR, INFL, INST)
Model fit (intercept and covariates)					
AIC	959	960	958	959	960
SC	966	967	967	966	968
- 2 log L	957	958	958	957	958
Global Null Hypothesis : β = 0 (p-value in par.)					
LR	327 (0.0001)	327 (0.0001)	327 (0.0001)	334 (0.0001)	293 (0.0001)
Score	1131 (0.0001)	1128 (0.0001)	1129 (0.0001)	1135 (0.0001)	1294 (0.0001)
Wald	167 (0.0001)	167 (0.0001)	166 (0.0001)	170 (0.0001)	160 (0.0001)
Pseudo R^2	0.356	0.355	0.354	0.363	0.347

3.6. Conclusions

In this Chapter we modeled bank failures in Russia. We started with the classical theory of a banking firm and then turned to bank failures by specifying them as a function of risks inherent in virtually all banking operations. A multivariate logit model is used to estimate the probability of a bank's failure empirically and to identify key explanatory factors influencing it. In addition, an auxiliary model to estimate efficiency of each individual bank is utilized.

We then reviewed failure definition and developed our empirical model, building on previous studies and adding several modifications. We included in variable descriptions the features that a transition economy such as Russia exhibits. For instance, poor information availability can be inferred from banks signaling their stability through higher equity or signaling good management through profits. We also added proxies of industry structure whose impact we think should be more pronounced in a transition economy. The influence of macroeconomic environment was also recognized: we added macro variables which accounted for the risks of overall business environment. In particular, deposit insurance appears to be an influential factor that affects the failures.

Our results indicate that bank-specific factors play an important role in explaining failures. Industry variables and macroeconomic factors appear to be essential in the analysis as well.

Our findings are different from the results reported by Molina (2002) for Venezuelan banking system. He found that higher government securities holdings together with greater profitability were significant determinants of soundness, while our results are silent about this. Styrin (2005) did not find significant evidence that X-inefficiency is useful in predicting failures. He used a different technique - stochastic frontier - to estimate individual efficiencies and data for only 250 largest Russian banks. Since banks with bigger market shares and some monopoly power have been shown to be more efficient, this result is not surprising. Most of the banks in his data set must be very efficient, and, therefore, other factors

for such a sample influence failures more considerably. Based on our sample, more efficient banks are less likely to fail.

Peresetsky et al. (2004) found macro variables to be significant in determining failures, which coincides with our results.

Contrary to what we found, in the paper of Claeys, Lanine and Schoors (2005) HHI is significant. In other instances their results are similar to our findings: share of non-performing loans and capital adequacy are significant variables, influencing failures. Their proxies for profitability – returns on assets, and efficiency – costs to assets ratio, are also useful in explaining failures.

The current work attempted to build on a theoretical model before coming to empirical application. More work in this direction would be beneficial. Better data, as always, would be helpful, especially regarding the industry and term structure of loans. With improved data and developments of methodology we should see more applications of failure models to transition economies.

Conclusions and Directions for Further Research

In this work we investigated two issues related to the banking sector. In Chapter 2 we offered a new way to model deposits in banking production theory. Chapter 3 dealt with modeling bank failures. We applied both models to a data set of Russian banks covering 1999-2004 and including over 7,500 observations. Chapter 1 surveys of key aspects of Russia banking development, structure and transition, providing essential background for the empirical analysis carried out in Chapters 2 and 3.

Chapter 2 takes up the problem of accommodating both input and output characteristics of deposits in the banking industry. Deposits are outputs because they represent bank-provided services, but they are also inputs in that funds provided by deposits are used to finance loans. Traditionally, researchers justified using deposits as either inputs (intermediation model) or outputs (production model), one or the other, depending on the research issue. We suggest reflecting both of these qualities by explicitly allowing for substitution between deposits (an output) and other borrowed funds (an input).

We applied our new "substitution" model as well as the traditional production and intermediation models to our sample of Russian banks and compared the resultant efficiency scores. In our sample, differences in the scores among the three models are insignificant. Still, we believe our model has merit because it is more general than the traditional models, subsuming both. It could be applicable to a host of settings beyond banking where out-input substitution is prominent, e.g., in higher education or teaching hospitals where some outputs (graduate students) substitute for some inputs (professors).

We also compared efficiencies of banks of different types. Failed banks appeared to be less efficient that survived banks. Moscow banks performed better than banks from other regions. Moscow has bigger banks with better technology and workers, better able to exploit economies of scale and scope. Big and medium sized banks performed better than small banks in terms of efficiency.

These results could be explained by the fact that during the time that our study covered, mostly small banks failed.[76]

In Chapter 3 we investigated bank failures in Russia. We posited that failure is a function of certain general types of risks: bank-specific, industry-specific and macroeconomic. Then we argued that a bank failed if the aggregate level of risks exceeded a certain (unobserved) threshold. This allowed us to use logit model to empirically estimate failure model. Having estimated efficiency for every bank in our sample in Chapter 2, we added this variable to the set of bank-specific variables. Recognizing the fact that failures were rare in our data set, we corrected for this as well.

We found that bank-specific factors play a major role in explaining failures. Capital adequacy, balances of liquid funds, share of non-performing loans and efficiency were significant in evaluating failures in all model specifications. Surprisingly, we did not find evidence that concentration affected viability with the exception of deposits per capita.

Among the macroeconomic variables inflation and the introduction of deposit insurance appeared to have the most pronounced effect on failures. Transition in banking as measured by the EBRD's bank reform index was also significant.

Notwithstanding the volume of research in banking, many interesting research questions remain. Adopting theoretical developments to empirical research is a particularly fruitful direction: many insightful models developed for the banking sector are too abstract for applied research. Explicitly accounting for features of economies in transition is another area where more efforts are required.

With regard to Russian banking, mergers and acquisitions are becoming more common and analysis of the economic foundations for mergers would be

[76] Even though according to the Table 3.8. failed banks were larger on average than survivors, but a few failures of big banks brought up the average for first three sample years.

valuable. A related issue is the nature and extent of competition in the Russian banking industry. Even though the data of suitable quality is usually available, it is not specifically collected to address the needs of research. Important information is missing or hard to get. For example, employment is not reported by banks. Disaggregated data for big banks present in many regions would be helpful in assessing market structure. Information on ownership would make it possible to draw conclusions about whether state involvement in the sector should be limited or whether presence of foreign capital is beneficial. These items remain on our agenda for the future research.

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APPENDICIES

Appendix A.

Proof of Proposition 1.

i) Non-empty *T*: Choose some $k' \in \{1,\ldots,K\}$. Let $(x,b,d,y) = (x_{k'}, b_{k'}, d_{k'}, y_{k'})$. Then, (*x, b, d, y*) satisfies all the constraints in (1) with $\lambda_{k'} = 1$ and $\lambda_k = 0$ for $k \neq k'$. Since the found $\lambda \geq 0$, this solution is feasible, and the set *T* is non-empty.

ii) Closed *T*: Let x^l, b^l, d^l and y^l be sequences in *T* such that $x^l \to x^0, b^l \to b^0, d^l \to d^0, y^l \to y^0$. This also implies that. Moreover, there exists a sequence λ^l such that

$\sum_{k=1}^{K} \lambda_k^l y_{km} \geq y_m^l, m = 1,\ldots,M; \quad \sum_{k=1}^{K} \lambda_k^l x_{kn} \leq x_n^l, n = 1,\ldots,N; \sum_{k=1}^{K} \lambda_k^l d_k \geq d^l$
and $\sum_{k=1}^{K} \lambda_k^l (d_k + b_k) \leq b^l + d^l$, since $(x^l, b^l, d^l, y^l) \in T$.

Since x^l, b^l, d^l and y^l are convergent, the sequences are bounded. But then there exist $\bar{x}, \bar{b}, \bar{d}$ and $\bar{y}$ such that $\bar{x} \geq x^l, \bar{b} \geq b^l, \bar{d} \leq d^l, \bar{y} \leq y^l$ and where $\bar{b}$ and $\bar{d}$ also satisfy $\bar{b} + \bar{d} \geq b^l + d^l$ for all *l*. Consider now the set

$\left\{ \lambda \in \Re_+^K : \bar{x} \geq \sum_{k=1}^{K} \lambda_k^l x_{kn}, \bar{d} \leq \sum_{k=1}^{K} \lambda_k^l d_k, \bar{y} \leq \sum_{k=1}^{K} \lambda_k^l y_{km}, \bar{b} + \bar{d} \geq \sum_{k=1}^{K} \lambda_k (b_k + d_k) \right\}$
This set is compact and there exists therefore a subsequence λ^{lk}, such that $\lambda^{lk} \to \lambda^0$ and

$\sum_{k=1}^{K} \lambda_k^0 y_{km} \geq \bar{y}_m, m = 1,\ldots,M; \quad \sum_{k=1}^{K} \lambda_k^0 x_{kn} \leq \bar{x}_n, n = 1,\ldots,Q; \sum_{k=1}^{K} \lambda_k^0 d_k \geq \bar{d}$
and $\sum_{k=1}^{K} \lambda_k^0 (d_k + b_k) \leq \bar{b} + \bar{d}$.

Since $\sum_{k=1}^{K} \lambda_k^0 y_{km}, \sum_{k=1}^{K} \lambda_k^0 x_{kn}, \sum_{k=1}^{K} \lambda_k^0 d_k$ and $\sum_{k=1}^{K} \lambda_k^0 (d_k + b_k)$ are continuous functions,

$\sum_{k=1}^{K} \lambda_k^0 y_{km} \geq y_m^0, m = 1,\ldots,M; \quad \sum_{k=1}^{K} \lambda_k^0 x_{kn} \leq x_n^0, n = 1,\ldots,N; \sum_{k=1}^{K} \lambda_k^0 d_k \geq d^0$
and $\sum_{k=1}^{K} \lambda_k^0 (d_k + b_k) \leq b^0 + d^0$.

This means that $(x_0, b_0, d_0, y_0) \in T$ and the set *T* is therefore closed.

iii) Convex T: All the constraints in (1) are linear and therefore define convex sets. The technology T is then defined as an intersection of finite number of such convex sets, and is therefore convex.

□

Appendix B.

Descriptive Statistics for Efficiency Estimation, 1999-2004.

Year = 1999	Mean	Std. Dev.	Min	Max
y_l = total loan balances, mln roubles	306.38	1752.84	0.75	41749.13
y_i = non-interest income, mln roubles	76.39	322.55	0	6818.17
b = other borrowed funds, mln. roubles	640.60	34.16	0.56	56631.09
d = attracted deposits, mln roubles	54.88	266.06	0.18	6689.69
x_l = labor input, mln roubles	9.20	45.26	0.44	1167.24
x_p = physical capital, mln roubles	52.59	228.51	1.38	3583.97
x_e = equity, mln roubles	111.35	1281.41	2.11	22055.65
N obs = 1273				

Year = 2000	Mean	Std. Dev.	Min	Max
y_l = total loan balances, mln roubles	509.55	2666.04	0	52231.64
y_i = non-interest income, mln roubles	109.34	543.68	0.13	14035.83
b = other borrowed funds, mln. roubles	1051.71	5150.37	0.34	69550.63
d = attracted deposits, mln roubles	83.53	355.21	0.02	5668.44
x_l = labor input, mln roubles	14.43	120.84	0.18	1204.85
x_p = physical capital, mln roubles	66.35	315.71	1.55	6046.61
x_e = equity, mln roubles	193.53	2216.65	2.84	44271.71
N obs = 1255				

Year = 2001	Mean	Std. Dev.	Min	Max
y_l = total loan balances, mln roubles	1118.38	11914.37	0.12	395276.91
y_i = non-interest income, mln roubles	214.47	2597.18	0.55	39297.21
b = other borrowed funds, mln. roubles	1906.33	20222.07	0.44	676035.44
d = attracted deposits, mln roubles	540.96	13856.33	0.04	489019.96
x_l = labor input, mln roubles	47.97	711.18	0.22	24869.73
x_p = physical capital, mln roubles	99.37	1163.84	2.17	39836.98
x_e = equity, mln roubles	402.61	3376.57	3.11	96382.08
N obs = 1248				

Year = 2002	Mean	Std. Dev.	Min	Max
y_l = total loan balances, mln roubles	1083.34	5587.17	0.11	95202.35
y_i = non-interest income, mln roubles	165.21	723.43	0.49	13779.09
b = other borrowed funds, mln. roubles	1761.58	8388.41	0.60	128342.51
d = attracted deposits, mln roubles	267.43	1379.30	0.38	25498.54
x_l = labor input, mln roubles	40.46	152.41	0.30	2872.73
x_p = physical capital, mln roubles	77.75	348.43	2.11	4997.65
x_e = equity, mln roubles	412.38	2211.02	3.07	52516.24
N obs = 1255				

Year = 2003	Mean	Std. Dev.	Min	Max
y_l = total loan balances, mln roubles	1552.06	7386.17	0.07	119782.22
y_i = non-interest income, mln roubles	214.84	908.66	0.45	15304.88
b = other borrowed funds, mln. roubles	2486.12	11588.61	0.63	199329.96
d = attracted deposits, mln roubles	442.71	2096.65	0.36	38135.19
x_l = labor input, mln roubles	54.88	218.47	0.28	3863.01
x_p = physical capital, mln roubles	100.04	457.91	2.55	7123.18
x_e = equity, mln roubles	527.65	2262.95	3.13	52720.32
N obs = 1257				

Year = 2004	Mean	Std. Dev.	Min	Max
y_l = total loan balances, mln roubles	2096.82	11111.69	0.09	226698.89
y_i = non-interest income, mln roubles	289.16	1242.11	0.49	23225.77
b = other borrowed funds, mln. roubles	3250.72	16722.03	0.58	333256.08
d = attracted deposits, mln roubles	633.45	2856.22	0.11	52031.54
x_l = labor input, mln roubles	73.70	277.26	0.22	4755.42
x_p = physical capital, mln roubles	123.892	552.04	2.88	9109.71
x_e = equity, mln roubles	625.18	2545.14	2.11	56574.19
N obs = 1231				

All Years	Mean	Std. Dev.	Min	Max
y_l = total loan balances, mln roubles	1106.12	7754.64	0	395276.91
y_i = non-interest income, mln roubles	289.16	1242.11	0	23225.77
b = other borrowed funds, mln. roubles	1842.26	12445.71	0.34	676035.44
d = attracted deposits, mln roubles	335.37	5857.82	0.02	489019.96
x_l = labor input, mln roubles	39.92	331.19	0.18	24869.73
x_p = physical capital, mln roubles	86.45	596.52	1.38	39836.98
x_e = equity, mln roubles	400.75	2254.26	2.11	96382.08
N obs = 7519				

Appendix C.

Descriptive Statistics for the Main Regression Variables, 1999-2004.

Variable		Year						
		1999	2000	2001	2002	2003	2004	All
DEPP	Definition	Public deposits/Total assets						
	Mean	0.1	0.09	0.11	0.13	0.16	0.19	0.13
	Max	0.75	0.98	0.78	0.87	0.78	0.82	0.98
	Min	0	0	0	0	0	0	0
	Median	0.07	0.06	0.08	0.1	0.12	0.14	0.09
	Std	0.1	0.1	0.11	0.13	0.15	0.17	0.14
DEPB	Definition	Other banks deposits/Total assets						
	Mean	0.65	0.69	0.68	0.69	0.71	0.73	0.69
	Max	11.76	6.16	5.53	2.04	1	1.01	11.76
	Min	0	0	0	0	0	0	0
	Median	0.67	0.74	0.74	0.75	0.78	0.79	0.75
	Std	0.45	0.32	0.26	0.22	0.21	0.19	0.29
LIQA	Definition	Liquid assets/Total assets						
	Mean	0.46	0.5	0.49	0.49	0.48	0.42	0.47
	Max	0.85	0.99	0.96	0.93	0.88	0.93	0.99
	Min	0.1	0.1	0.2	0.18	0.15	0.12	0.1
	Median	0.44	0.49	0.47	0.47	0.45	0.37	0.45
	Std	0.2	0.19	0.18	0.18	0.19	0.17	0.19
CAPT	Definition	Equity /Total assets						
	Mean	0.31	0.29	0.31	0.31	0.29	0.28	0.3
	Max	1	1	1.01	1.01	1.04	2.23	2.23
	Min	0	0	0	0	0	0	0
	Median	0.29	0.25	0.26	0.25	0.23	0.22	0.25
	Std	0.18	0.16	0.13	0.15	0.16	0.17	0.16
PROF	Definition	Profits before tax/Total assets						
	Mean	0.03	0.02	0.02	0.02	0.02	0.02	0.02
	Max	0.46	0.58	1.53	0.69	0.52	0.31	1.53
	Min	-1.09	-4.76	-5.72	-0.27	-0.77	-0.22	-5.72
	Median	0.02	0.02	0.01	0.01	0.01	0.02	0.02
	Std	0.1	0.15	0.18	0.04	0.04	0.03	0.11
GKOT	Definition	Government securities/Total assets						
	Mean	0.05	0.04	0.03	0.02	0.02	0.02	0.03
	Max	0.73	0.89	0.87	0.88	0.62	0.57	0.89
	Min	0	0	0	0	0	0	0
	Median	0.01	0	0	0	0	0	0
	Std	0.09	0.09	0.08	0.07	0.05	0.05	0.08

INBL	Definition	Interbank loans/Total assets						
	Mean	0.05	0.05	0.05	0.07	0.07	0.08	0.06
	Max	0.99	0.84	0.87	0.88	0.71	0.77	0.99
	Min	0	0	0	0	0	0	0
	Median	0.01	0.01	0.01	0.03	0.03	0.03	0.02
	Std	0.09	0.08	0.09	0.1	0.1	0.12	0.1
LNRD	Definition	Loans to residents/ Total assets						
	Mean	0.41	0.4	0.45	0.46	0.48	0.51	0.45
	Max	0.98	0.97	0.98	0.99	0.97	0.97	0.99
	Min	0	0	0	0	0	0	0
	Median	0.41	0.41	0.47	0.48	0.51	0.54	0.47
	Std	0.21	0.21	0.21	0.21	0.21	0.22	0.22
LNNR	Definition	Loans to non-residents/Total assets						
	Mean	0.44	0.43	0.48	0.49	0.51	0.53	0.48
	Max	0.83	0.78	0.88	0.89	0.83	0.87	0.87
	Min	0	0	0	0	0	0	0
	Median	0.43	0.43	0.49	0.5	0.54	0.57	0.49
	Std	0.23	0.26	0.27	0.22	0.23	0.23	0.24
NPLN	Definition	Non-performing loans/Total loans						
	Mean	0.03	0.02	0.01	0.01	0.01	0.01	0.02
	Max	0.81	0.82	0.78	0.75	0.77	0.69	0.82
	Min	0	0	0	0	0	0	0
	Median	0	0	0	0	0	0	0
	Std	0.09	0.09	0.04	0.06	0.05	0.05	0.07
SIZE	Definition	Log (Real total assets)						
	Mean	4.63	5.17	5.52	5.83	6.17	6.41	5.62
	Max	11.31	11.62	13.56	12.06	12.46	12.9	13.56
	Min	1.61	0.48	0.19	0.08	0.07	1.07	1.61
	Median	4.59	5.15	5.5	5.85	6.21	6.42	5.59
	Std	1.84	1.83	1.86	1.81	1.84	1.79	1.92
EFFD	Definition	Efficiency score						
	Mean	0.32	0.19	0.12	0.24	0.92	0.21	0.33
	Max	4.52	7.38	14.41	23.86	24.49	5.98	24.49
	Min	0	0	1.01	0	0.36	0	1.01
	Median	0.15	0.07	0.03	0.07	0.27	0.07	0.08
	Std	0.49	0.4	0.54	0.87	2.11	0.54	1.05