National Research University Higher School Of Economics

International College of Economics and Finance

DIPLOMA THESIS

"CHANGE IN THE COMPETITIVE STRUCTURE OF THE BANKING SECTOR OF RUSSIA AFTER THE 2008 FINANCIAL CRISIS"

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ANNOTATION

ИЗМЕНЕНИЕ КОНКУРЕНТНОЙ СТРУКТУРЫ БАНКОВСКОГО СЕКТОРА РОССИИ ПОСЛЕ КРИЗИСА 2008 ГОДА

С. Пахчанян

Цель данной работы заключается в том, чтобы установить, что конкуренция тесно связана с экономическим и финансовым благополучием той или иной страны, в частности, когда речь идет о банковском секторе. Эти изменения структуры рынка являются как кратковременными, так и постепенными, но последние более интересны, потому что они выявляют скрытую динамику структуры рынка.

Предполагаемая в данной работе идея заключается в том, что при неблагоприятных экономических потрясениях финансовой системы, которая из-за специфики бизнеса крайне восприимчива к ним, происходит цепная реакция кредитных событий, возникают проблемы с ликвидностью, всплывает недостаточная капитализации и недостатки управления. Это в свою очередь приводит к финансовому давлению на банки. Крупные банки могут полагаться на государственное финансирование, также особое внимание уделяется их финансовому состоянию, что снижает риск банкротства банка. Однако мелкие банки испытывают все бремя финансовых проблем и их рыночная власть падает. Это приводит к постепенной монополизации банковского сектора, так как банки становятся неплатежеспособными и покидают рынок. Существует и обратный эффект: в то время как банковская отрасль становится все более и более концентрированной снижение ее устойчивость, что доказано существующими исследованиями. В конце концов, это само по себе может стать причиной финансовых проблем, проблем с ликвидностью и дальнейших экономических потрясений.

Данная работа использует данные по российской банковской системе для обеспечения эмпирического освещения проблемы, опираясь на два основных подхода, индекс Лернера и модель Панзара-Росса. В ней делаются выводы о динамике банковского сектора России годы после глобального финансового кризиса 2008 года, сравнивая значения индекса Лернера с теми, какими они были на основе доклада 2012 Ансоатеги и соавт. Используя панельные данные для периода 2009-2012, работа таким образом исследует связь между конкуренцией и кризисом.

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THE SCIENTIFIC PROBLEM

Introduction

Structure of competition in Russian banking sector has been a subject of interest previously, but this study will attempt to isolate the impact that 2008 financial global crisis had on the financial system and environments for banks in Russia. Following in the footsteps of some of the previous studies, here a statistical approach is employed in order to assess the structure of competition of Russia's banking sector, using the Lerner index and the Panzer-Rosse approach to establish a thorough picture of the market analyzing separately across peer-groups to detect significant, if any, variations, that would indicate an underlying difference in the structure of competition, while simultaneously contrasting the post-crisis figures with the pre-crisis levels, taken from a similar study by Diego Anzoategui, Maria Peria and Martin Molecky, 2012, hereinafter referred to as Anzoategui et al., from which this one borrows heavily, but also expands upon by using two methodologies instead of one.

For this study, an all-encompassing database of Russian banks has been taken, then thoroughly edited and trimmed to include only the data for the relevant period and to exclude banks for which most of the vital indicators or data are missing to avoid distorting estimators. The end result has been inserted into a regression to calculate the Lerner index and to apply various tests to confirm or refute homogeneity across bank groups. The initial study by Anzoategui suggests, with reasonable basis of common sense, that Russia as both an economy and financial system is extremely diverse and heterogenous. Thus, we would expect the Lerner index to demonstrate this variation, and by observing the nuance changes between what data post-2008 shows as compared to the pre-crisis levels we can have a certain degree of insight into how exactly the crisis transformed the competitive map, which banks became more powerful or less powerful in the market, and what factors could possibly influence the distribution of market power between banks in various regions and peer groups.

Generally, measurement of competition is divided in the literature into two main approaches, the so-called structural and nonstructural approaches. The structural approach has an underlying structure-conduct-performance (SCP) paradigm is concerned with investigating how and whether a low competitive market could induce collusive behavior among the big players that

achieves better market performance, while the efficiency hypothesis is concerned with the question whether it is the superior efficiency of large banks that can cause a better market performance. In this context concentration is viewed as a hindrance to competition, creating negative implications for social welfare. This method primarily operates a certain measure of concentration, the concentration ratio or the Herfindahl-Hirschman Index. However the competition analysis is not solely confined to this approach anymore; it assumed equal weights and a homogenous nature of the market, also focusing on concentration as the measure of competitiveness, two assumptions that have later on been dropped in the research. This paper considers the two non-structural approaches, the Lerner index and the Panzar-Rosse approach. This more recent development in economic analysis while not implicitly addressing the market structure in question measures the degree of competition and analyzes the competitive conduct of banks, using estimation of market power from observed behavior of banks.

The 2008 crisis is widely accepted as a critical financial event in recent history, if not one of the worst in the entire lifespan of financial system's existence. It originated in and shook to the foundation the banking system and the consequences set in motion then are still very much present and felt now. But to understand them is to quantify them; this paper sets out to find empirical evidence of long-lasting consequences of financial events on the example of the consequences of 2008 crisis for Russian banking sector. It speculates that such crises have adverse effects on the competition, and low competition in the banking sector in turn has a destabilizing influence on economic health of the country. It finds that competition expressed as market power of the average bank has fallen significantly when compared against the pre-crisis levels; that it rose back as the economy began to recover between the years 2009 at 2010, saw little change between 2010 and 2011 and rose yet more in the first three months ended March 2012; a similar pattern is reported by Panzar-Rosse. However the 2012 saw redistribution of market power toward the larger banks. Further, the paper reveals that certain groups of banks have significantly more inherent market power than others and it has different dynamics as well.

The paper is organized in this way: chapter one provides the introductory summary of the problem and describes the data; chapter two presents the brief theoretical explanation of both Lerner index and Panzar-Rosse approaches as well as elaborates on the main idea of the paper, detailing the history of the problem and relevant literature; chapter three concerns itself with the empirical approach, regressions and appropriate tests; chapter four analyzes the results and sums up the paper's important conclusions.

Data

```
Contains data
  obs:        11,507
 vars:           197
 size:    11,645,084
```

The information agency "Mobile" has provided this paper with the necessary data, containing extracts from both balance sheet and profit and loss statements for each bank for the observed period; however, not monthly but quarterly data was taken for the purposes of this research, due to the fact that only quarterly, semiannual and annual reports actually contain some of the figures necessary for proper estimation of both the Lerner index and Panzar-Rosse approach, such as the figure for the personnel expenses, some constituents of the operating income and expenses and various others. The missing data would have severely impaired the regression's explanatory power; hence every cross-section is spaced three months apart. Because various banks have different circumstances, for example some of them are public and others are privately owned, they also differ in the way they report their financial information, and while most of the banks do have a very detailed quarterly report for the required periods, some of them also reported every month, and some of them have existed only in specific periods within the scope of the observed years. This would naturally result in an unbalanced data set which would have implications for heteroskedasticity, which will be addressed as well. The total amount of periods it contains is equal to 18, maximum of 16 per each cross-section, with 924 banks, resulting in a total of 11,507 observations.

The data set itself comes from a different source than the one used by Anzoategui et al.; however since this data is basically exact extracts from financial statements, it is not subject to any significant deviation from the data set used by the authors of the original paper. This time period was chosen specifically because the study by Anzoategui et al. extends completely up to the end of 2008, and for reasons of consistency and to exclude any possibility of overlapping periods, I have not taken the year 2008 into consideration, though technically it was about it the middle of the year when the most important credit events started occurring and the financial stability of Russian economy took a sharp downturn. Instead, I opt to analyze the consequences as the crisis hit Russia's banking system, and might have provoked both instant and delayed reactions, and because change in market structure cannot be assumed to happen overnight, I paid particular attention to the next three years after the crisis to determine any possible specific patterns in which the degradation of competition occurred.

There are now almost one thousand financial institutions in the Russian banking system, but most of its assets are concentrated among a few of them. As at 2012, the top 50 banks by the size of their total assets summarily controlled more than 87% of the total assets of the banking system. While similar to banking sectors in other developing countries, has its own unique properties, mostly due to historical reasons. The long running leader in the industry Sberbank is the single largest financial intermediary responsible for about 30% of the countries credit loan portfolio, and the assets of the bank constitute no less than one quarter of the entire Russian banking system assets. Almost all the state-owned banks are within the top-20 category and, if one were to consider all the banks in the top-50 category they would observe that only a small fraction of those banks are domestically owned and private. 36.5% all the assets of Russian banking system are loans to resident nonfinancial organizations and another 3.8% are loans to nonresident nonfinancial organizations, so a little over 40% of all assets is corporate lending as per beginning of the year 2013. This numbers are 38.2% and 4.4% accordingly as per beginning of year 2012; for individuals, the percent of assets devoted to loans is 15.6% as per beginning of year 2013 and 13.3% as per beginning of the year 2012.

The 2008 events generated much turmoil; springing from the subprime mortgage crisis in the United States it spread throughout the world in a collapsing dominoes fashion. Within the span of six months, the Russian stock market fell by over 70%. The credit crunch and the financial markets downfall created a chain reaction, particularly damaging for the financial entities. To battle this, the Central Bank of Russia adopted some unprecedented measures; they prevented the Russian ruble from plummeting down and dealt reasonably with the consequences of the impeding budget deficit, triggered by the oil prices fall on which the government revenues were highly dependent. To prevent capital from leaving country, $200 billion were set aside for buying devalued stocks and providing emergency funding and bailout to banks, keeping the financial system operative. A large share of this money went to Sberbank and VTB, the two largest banks in the country, both belonging to the state. To stabilize the sector further and prevent some of the banks from closing wholly, the government implemented a nationalization procedure, which increased the overall state ownership in the financial intermediaries market quite significantly. It was suggested by the policymakers that much of this change was only temporary.

The market has been recovering since; but there are mixed expectations of the future.

Literature review

Competition and concentration: A large share of literature is dedicated to the dubious link between concentration and competition, as well as various factors that affect this relationship, and models that are based on the idea that this relationship is close enough that concentration can be used to measure competition. A lot of literature concerning competition, specifically in banking sector, employed some of this models and they all became obsolete with later findings that indicate that generally not only is there no observable positive relationship between these two notions, there may in fact be a negative one. This changed the usual approach to empirical studies of competition; new models with new theoretical basis were needed, and such emerged.

The Lerner index: The main paper upon which this study was closely founded and with which it compares most of empirical results, and from which it takes a large part of its theoretical basis is the 2011 study entitled "Bank Competition In Russia: An Examination At Different Levels" by Diego Anzoategui, Maria Peria and Martin Melecky, which is referred to as Anzoategui et al. throughout most of the paper. It analyzes the level of bank competition in Russia on the period from 2002 to 2008 on several levels of aggregation, meaning it compares various peer groups, regions of Russia, and then compares rushing to other countries, mostly developing ones as they are the closest match for Russia's economic level. It uses the nonstructural approach, namely the Lerner index, which is also used in this paper, and employs data from the Central Bank. It finds that some regions of Russia are severely more concentrated in terms of banks market power as opposed to other regions, for example Northwestern region is much less competitive than the Volga region; it finds that larger banks and banks owned by state generally have more market power than the smaller ones and significantly so; that Russia's banks are less competitive than those in Brazil, but more so than those in China and India. While this study is good basis for any future research on competition in Russia, it is a standalone work that when put into the context of crisis, can unveil some interesting inferences about the implications of 2008 global financial crisis on Russia's banking system. Specifically, the paper provides figures on which to fall back when comparing the post-crisis and pre-crisis figures, and the results that my research yields can be compared against those obtained by Anzoategui et al. to examine how competition changed on the very same level of aggregation: the peer groups, the regions, the share structure. The work itself is further based on Fungacova's paper of 2010 that demonstrates a similar analysis of Russian banking sector, but aggregating all banks into one

market (which is an unrealistic assumption) and does not test to evaluate differences between bank groups.

The Panzer-Rosse approach: A paper by Jacob Bikker and Katharina Haaf entitled "Competition, concentration and their relationship: An empirical analysis of the banking industry" provides the groundwork for applying the end-result of their formula. This approach is very common and many papers use it in relation to the financial intermediaries markets, especially in recent years. A few deviations that are adopted from the Bikker, Haaf paper are the use of interest rate revenue instead of total revenue and an additional explanatory variable that accounts for the influence of other income on the *H*-statistic. Using this approach, Claessens and Laeven finally established in 2004 in a large international research that competition and concentration are not negatively correlated which further instilled doubts as to whether old models that used concentration measures to describe competition were valid, providing an important result. In the same paper they find that presence of foreign banks tends to correlate with more competitive environments in banking sector, as well as less regulatory restrictions. This is an interesting point, since my paper provides significant proof that foreign-owned banks have more market power than domestic banks which should supposedly mean that they affect overall competition adversely.

While the methodological foundation for this paper is that of widely used models, its connection with the 2008 global financial crisis makes it unique. Further, this new data provides interesting inferences that challenge some of the existing studies and may create ground for future work.

C h a p t e r 2

THEORETICAL ASPECT

The idea

This paper expresses the opinion that understanding competition dynamics is crucial to understanding how the financial system functions in general; lack of competition often results in higher prices for financial products; reduces access to finance, which interferes with economy's growth; has implications for sector stability, especially when coupled with high concentration like in case of Russian financial intermediaries market. The issue however is not quite as clear-cut as it may seem at first glance. Some degree of competition is of course better than none as it is for all markets, but the financial intermediaries market is vastly different from most other markets. In examining the desirability of competition one must look at both sides of the coin: one is that higher competition means efficiency and lower intermediation costs, the other is that as it affects profitability adversely it increases the chance liquidity problems for the lesser banks and makes relationship between the bank and its client less personal and, therefore, less subject to controlled monitoring as the clients change banks often and banks, in turn, pay less attention to maintaining lasting relationships. This presents a problem of finding a balanced solution, compounded by the fact that banks are vastly varied entities and the market is non-homogenous in the sense that banks may react differently to various regulations or deregulating measures or banking system reforms, which Anzoategui et al. point out along with the fact that better understanding of the market structure provides better forecasting and better regulation.

In turn, financial events such as crises restructure and reshape markets by creating shocks, to which this heterogenous system reacts both inertly and momentarily. The momentary changes can be dramatic, or subtle or sometimes not even publicly observable. The gradual changes are the complete restructuring of the market. The idea is that these gradual changes can be observed on a period of several years following the crisis through observing market power of individual banks, the industry average values, and tendencies among specific groups.

In the grand scheme of things, these gradual changes are what eventually pushes the economy into the next event, be it a downturn or uplift. Conversely, the next event is going to shape how market structure develops and changes in the following years thereafter, which creates a

constant loop of interconnected events that can be indirectly observed through various measures of competition.

Lerner Index

The nonstructural approach to estimation of competition has the advantage that it does not rely on any assumptions about the market structure, nor does it infer it from proxies and observable variables, such as market parameters, which adds another degree of uncertainty as possible error to models. Lerner Index is one such approach, and the main tool by which I assess competition, although it has not seen as much popularity in application to the banking industry as the Panzar-Rosse model, which has been the main orthodox approach in the latest years. Its main drawback of Lerner index may be that while market power and competition can be used interchangeably, they are not precisely the same thing**.** Market power, as expressed through the Lerner index is conditioned by the firms or the banks individual pricing pattern; the degree of competition is a characteristic of the entire market and the simple market average Lerner index may not be as indicative of market structure as we may think.

The Lerner index is expressed as

$$LI = \frac{P - MC}{P},$$

where *P* stands for price and *MC* denotes the marginal costs of the firm or the bank.

The idea of this model is that the expression shows the extent to which an entity with certain monopolistic power can set a price above its marginal cost, and in perfect competition they would be equal to each other. So as the elasticity of the of demand decreases, the monopolistic power to set a higher price increases.

Because *MC* in practice is not directly observable on historic data, it needs to be derived from *TC,* the total cost function that is empirically estimated using the translog cost function.

The transcendental logarithmic cost function is the key instrument by use of which to estimate the Lerner index. It approximates the total cost function; in its general form it is presented as follows:

$$\begin{aligned}\ln(C_{it}) = a_{0i} + b_0 0.5[\ln(Q_{it})]^2 + a_1 \ln(W_{1it}) + a_2 \ln(W_{2it}) + a_3 \ln(W_{3it}) + b_2 0.5 \ln(Q_{it}) \\ \times \ln(W_{1it}) + b_3 0.5 \ln(Q_{it}) \times \ln(W_{2it}) + b_4 0.5 \ln(Q_{it}) \times \ln(W_{3it}) \\ + a_4 \ln(W_{1it}) \times \ln(W_{2it}) + a_5 \ln(W_{1it}) \times \ln(W_{3it}) + a_6 \ln(W_{2it}) \times \ln(W_{3it}) \\ + a_7 0.5[\ln(W_{1it})]^2 + a_8 0.5[\ln(W_{2it})]^2 + a_9 0.5[\ln(W_{3it})]^2 + \delta D_t + u_t,\end{aligned}$$

where total output *(Q)* is supplemented by a proxy of total assets of the bank's balance sheet, as it is an observable variable; *W1*, as the cost of funding, is equal to the ratio of interest expenses to total deposits, whereas *W2* and *W3* are input prices of labor and capital accordingly, approximated by wage and fixed administrative costs divided by the total output, which is once again supplemented by total assets; finally, *D* is the fixed effects of time variable, and *u* is the error term. We accept this approximation with the reasonable assumption that the output print used by the bank is proportional to its total assets.

The specificity of banks business is such that the administrative expenses of the banks largely consist of two main articles: the personnel expenses and the rent expenses; and the rest are negligibly small in comparison with these main costs. Hence, I proxied the cost of equipment, which for banks is mostly just the fixed rent by subtracting wage expenses from the administrative expenses.

The estimated translog function can now be used to calculate the marginal cost using the coefficients from the fixed effects model. Since the logarithmic form of the function provides values for elasticities of total costs and output, by definition:

$$\frac{\partial \ln (TC)}{\partial \ln (Q)} = \frac{\partial TC}{\partial Q} \times \frac{Q}{TC},$$

$$\frac{\partial \mathrm{TC}}{\partial Q} = MC = \frac{\partial \ln (TC)}{\partial \ln (Q)} \times \frac{TC}{Q},$$

$$MC = b_0 + b_1 Q + 0.5 \times \sum_{j=1}^{n} b_j \ln (w_{jit})$$

Panzar-Rosse approach

The Panzar-Rosse, a more traditional approach to competition assessment in banking industry, is constructed using an empirical regression that has flexible specification with respect to various bank-specific factors; it is then fitted to find the input price elasticities. The *H* statistic itself is the elasticity of revenue with respect to input factor prices:

$$H = \sum_j \frac{\partial R}{\partial w_j} \frac{w_j}{R},$$

where *w* indicate input factor prices; *R* is the revenue of the industry average bank when the market is in equilibrium. The *H*-statistic shows the percentage change in bank revenues in equilibrium if all input factor prices rise by 1%. Panzar and Rosse provided the following table of values that represent various degrees of competition of market:

Value of H	**Market structure**
H<0	Monopoly/oligopoly, barriers, profit maximization
0<H<1	Monopolistic competition, free entry
H=1	Perfect competition, free entry

Other studies have shown that *H*-statistic values above 1 are also viable in certain circumstances (de Rozas, 2007). In equilibrium the cost function for a profit maximizing firm is homogenous of degree one relative to the input factor prices, so when they all increase by 1%, so do the marginal costs. It the firm is a monopolist, this leads to a fall in output and an increase in prices, and the overall revenue falls, leading to the resulting *H<0*. In case of perfect competition this also means that profits fall below zero and some of the firms have to leave the market, reducing the industry's supply and leading to a new equilibrium, in which the price is lower than the previous equilibrium price precisely by the value of marginal costs increase; and in the end the output and revenues of each firm that still stayed in the market does not change, leading to *H* = 1. If the value is between one and zero, this indicates that the behavior of the market does not adhere perfectly to the one outlined above, and the closer the value comes to 1, the more competitive the market is.

The known disadvantage of this model is that it assumes long-run equilibrium, but this will be tested in the empirical section to verify whether the model is applicable. It is also applied to the market in general, and whereas it could be theoretically applied to certain segments of the market that would require the knowledge of precisely which labor and capital expenses could be attributed to various lines of business which presents a considerable difficulty.

The classic loglinear revenue function for this model has to be estimated then.

$$\ln(R_i) = \alpha + \sum_j \beta_j \ln(w_j) + \ln(G_i),$$

where R_i is the marginal revenue; $w_j$are the input factor prices; $G_i$are the bank-specific variables. The input factor prices used are the same approximations as in the Lerner index translog function estimation above. As the control variables the ones empirically found to be significant can be used, such as the total assets and various components of income and expense functions that I used.

The *H*-statistic is then calculated to obtain

$$H = \sum_i \beta_i$$

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EMPIRICAL RESULTS

Lerner Index

I fit the model using three different regressions: the pooled OLS, the random effects and the fixed effects model. The random effects model is not the first choice model to be applied in this case, since all variables are time-variant and hence there is no reason not to use the fixed effects model apart from certain loss of efficiency, but the appropriate regressions and tests were done for the purpose of all-roundedness.

The results of the model that was most appropriate, the fixed effects model, are given in the table, along with the Breusch-Pagan test for pooled OLS regression inconsistency.

```
Fixed-effects (within) regression               Number of obs      =     11507
Group variable: id                              Number of groups   =       924

R-sq:  within  = 0.9894                         Obs per group: min =         1
       between = 0.9980                                        avg =      12.5
       overall = 0.9972                                        max =        16

                                                F(14,10569)        =  70448.29
corr(u_i, Xb)  = 0.4043                         Prob > F           =    0.0000
```

lnTC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnQ	.8711976	.0149521	58.27	0.000	.8418886	.9005066
lnQ_205	.0058126	.0010822	5.37	0.000	.0036914	.0079338
lnw1	-.963117	.0179438	-53.67	0.000	-.9982903	-.9279436
lnw2	.6935957	.0168551	41.15	0.000	.6605565	.7266349
lnw3	1.448024	.0128814	112.41	0.000	1.422774	1.473273
lnqw1_05	.0688806	.0013213	52.13	0.000	.0662905	.0714707
lnqw2_05	-.016226	.0013402	-12.11	0.000	-.018853	-.013599
lnqw3_05	-.0555671	.0009582	-57.99	0.000	-.0574454	-.0536888
lnw1w2	.00257	.0052402	0.49	0.624	-.0077017	.0128417
lnw1w3	-.2346532	.0043106	-54.44	0.000	-.2431027	-.2262036
lnw2w3	-.1586451	.0042957	-36.93	0.000	-.1670656	-.1502247
lnw1_205	.0830445	.0041611	19.96	0.000	.074888	.0912009
lnw2_205	.1034045	.0026316	39.29	0.000	.098246	.108563
lnw3_205	.2425456	.0025458	95.27	0.000	.2375553	.2475359
_cons	3.030796	.1085714	27.92	0.000	2.817975	3.243616
sigma_u	.10708002					
sigma_e	.07564494					
rho	.66708973	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(923, 10569) =    16.05          Prob > F = 0.0000
```

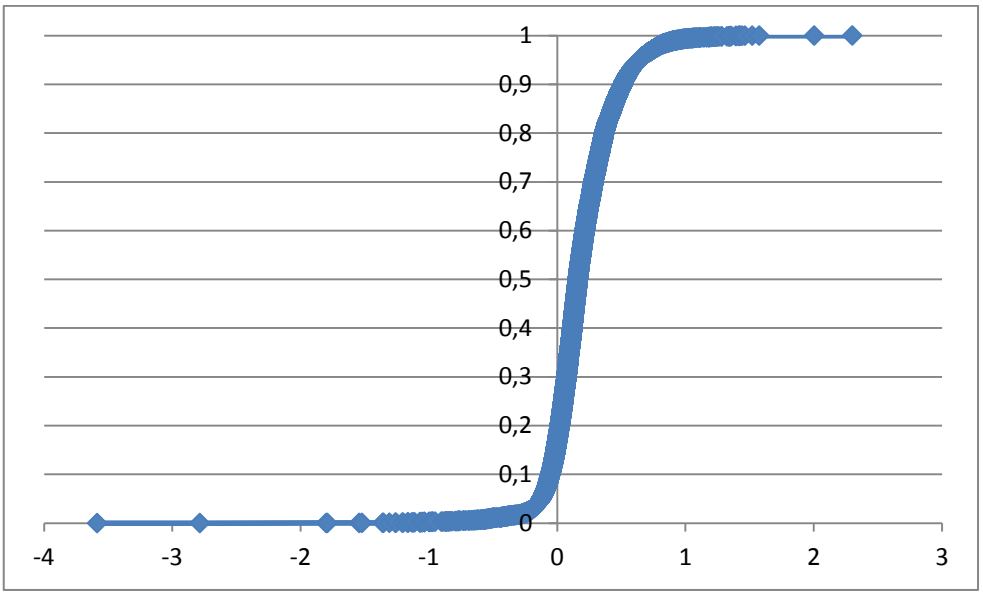
```
Breusch and Pagan Lagrangian multiplier test for random effects

        lnTC[id,t] = Xb + u[id] + e[id,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                 ---------+------------------------------
                     lnTC |   5.215334       2.283711
                        e |   .0057222       .0756449
                        u |   .0062186       .0788578

        Test:   Var(u) = 0
                                 chibar2(01) = 15664.91
                              Prob > chibar2 =   0.0000
```

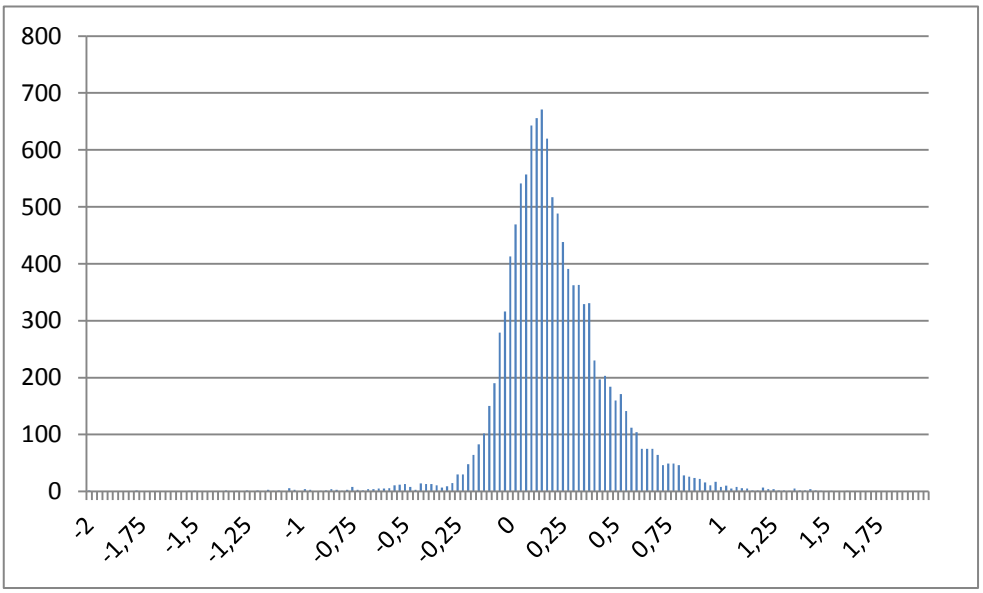
The significant results of Breusch-Pagan test indicate that the pooled OLS cannot be used here indeed as suspected. Next, to choose between fixed and random effects models would generally apply a Hausman test for differences in coefficients, but due to the unbalanced nature of the panel data set we would assume that one of the assumptions for the Hausman test – which concerns itself with the homoskedasticity of the residuals - is in fact violated, therefore the test cannot be used. To verify this, we employ of the modified Wald test for groupwise heteroskedasticity. Its output is presented in the table.

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (924)  =   4.5e+31
Prob>chi2 =      0.0000
```

As expected, the P value shows significant heteroskedasticity is present. This problem was brought to light by Arellano in 1993; Woolridge, 2002 also elaborated on the issue by specifying a more robust version of the Hausman test, where the random effects equation is expanded with additional variables that are specified as the original regressors less their mean. In practice, to get around this problem, a test of overidentifying restrictions was used in place of the Hausman test. Initially the test was designed to test instrumental variables for unnecessary restrictions, but it can also be applied to this situation of fixed versus random effects model specification. For the fixed effects model the assumption is that the independent variables are uncorrelated with the idiosyncratic error; for the random effects model an additional condition is introduced that the independent variables are also uncorrelated with the group specific error, or the random effect. Hence, the overidentifying restriction in this case would be the random effects restriction, and a rejection would mean that the fixed effects model is the better fit. This test is presented in table.

```
Test of overidentifying restrictions: fixed vs random effects
Cross-section time-series model: xtreg re
Sargan-Hansen statistic 402.629  Chi-sq(14)    P-value = 0.0000
```





The cumulative and the normal frequency distributions for the pooled Lerner index predictably show a skewed shape that looks somewhat lognormal. The general inference can be made that a massive share of banks cluster around the mean, but the right tail is heavier than the left one and more differentiated, and the market participants with more power also present a formidable share of the market.

The outliers I would expect to be the product of severe deviation from the estimated cost function that transferred itself upon the Lerner index. Such extreme values would suggest that

for these banks for the given period there was an underlying cost outlier event and this would not necessarily indicate, for example, that a very high Lerner index in this case could be attributed to a sudden growth in market power, in fact that would be an unreasonable conclusion given the nature of the market structure change. Likewise, very negative Lerner index values stand for periods in which there were large losses experienced by the banks.

The average pooled Lerner index for all banks and all time periods is 0,1946. Anzoategui et al. reported the average Lerner index value for the 2002-2008 period as being equal to 0.101. Such figures are consistent with the idea that post crisis monopolization of the market occurred, with subsequent gradual reinvigoration of competition. Specifically, keeping time constant, the average Lerner index was 0,2695 for 2009; 0,1641 for 2010; 0,1647 for 2011; and 0,1450 for the three months ended 2012. This result implies that there is a general decline in the average bank's market power. The fall was particularly sharp between the years 2009 and 2010, which can be explained by the recovery of the economic system from the shocks of 2008, which was a gradual process. Further decrease of the index in the first quarter of 2012 would not suggest anything definite since the seasonal effects are not accounted for, but it could potentially indicate further relaxation of the monopolistic hold on the market which would offer healthier competitive environment for the banks and is consistent with the supposition that poor economic health induces higher Lerner index values and vice versa.

Because Lerner index is in itself an abstract figure it requires a backdrop figure to be compared against. L. Weill, 2011 calculated the average index (as well as the H-statistic) for several European countries, and with reference to it Russia would me among the higher ones, but not extremely so; both Estonia and Latvia have index values above 0.2, as well as Portugal. Ireland, Netherlands and Ireland due to their legislative nature are target countries for many of Russian banks' holding companies, hence their near-zero values of the index. In general, since Russia has an overwhelmingly concentrated banking sector even when compared to other developing countries, the calculated figures are rather plausible.

An interesting point could be invoked with relation to the 2004 paper by Stijn et al. who find that the presence of foreign banks affects competition favorably. They do not provide any intuitive elaboration for the result, suggesting simply that the nature of ownership matters for competition, without explaining precisely for what reason. Since in Russia, as already pointed out, foreign ownership correlates heavily with size, it may or may not be a country specific result. Either way, such findings suggest that further research in this area could be looked upon.

Tests

While the general tendencies in competitive structure of the market present the overall picture, it can be further investigated to determine whether specific factors affect the way the Lerner index changes. Specifically, the next objective was to test whether different groups of banks in fact experienced different distributions of Lerner index, so that some were initially and then continued to be holders of significantly more market power than others. There were four main categories that were tested against each other: the government owned versus private owned banks, the foreign owned versus domestic owned banks, the top 20 largest banks versus others, and the corporate lending oriented banks versus individual lending oriented banks. It should be noted, that by government owned or foreign owned by defined banks that had a major share either owned by government or by a foreign entity, respectively. Likewise, if the bank was owned by an intermediate entity that in turn belonged to a foreign entity, that the bank was also considered to be foreign owned within the specification of this study for greater consistency of results. The bank was determined to be either corporate lending oriented or individual lending oriented depending on whether corporate loans or individual loans were a larger article on the bank's balance sheet.

Previous research has found that government owned banks are often different from others in terms of their business goals, as they engage in state-important activities, sponsor state programs and have a proactive role in the development of the financial sector. Specifically, the government owned banks would be expected to provide government corporations with exclusively cheap funding for purposes associated with varying levels of risk and may thus demonstrate behavior that comes into conflict with profit maximization. This seems to suggest that an increase in the share of market controlled by the government results in worse competition with poor consequences.

The test I used to compare these groups of banks with each other is the two-sample Kolmogorov-Smirnov test for equality of distribution functions, which produces a D-statistic that follows a specific distribution *K* for which a table of cutoff values was created by Kolmogorov and Smirnov. The null hypothesis is formulated as follows:

$$\sqrt{n}D_n > K_\alpha,$$

where K_α is given by the expression

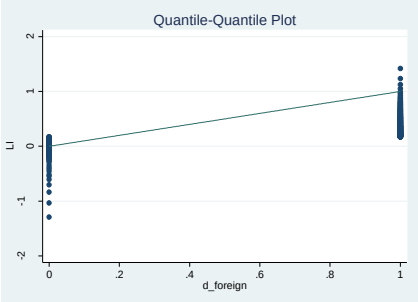
$$\Pr(K \leq K_\alpha) = 1 - \alpha,$$

and α is the level of rejection.

The tests were constructed using four dummy variables with a sample of fifty banks, which summarily own more that 87% of the banking system's assets. The outputs of the tests are presented below along with quantile-quantile plots for visual representation of data.

The output of the tests for foreign owned banks versus domestically owned banks:

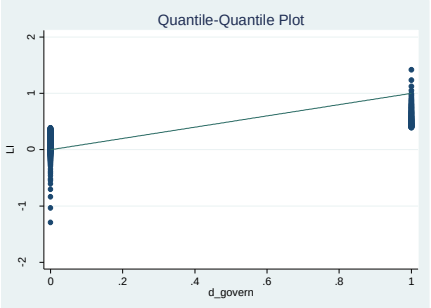
```
Two-sample Kolmogorov-Smirnov test for equality of distribution functions

Smaller group       D       P-value  Corrected
---------------------------------------------
0:                  0.1493    0.001
1:                 -0.0036    0.996
Combined K-S:       0.1493    0.001      0.001
```



The distribution indicates rather clearly that there is a trend for foreign owned banks to have higher index values. Moreover, there are little to no outliers in the foreign group that are significantly below the cluster and the same true for the domestically owned banks, which suggests that the pattern is very definitive.

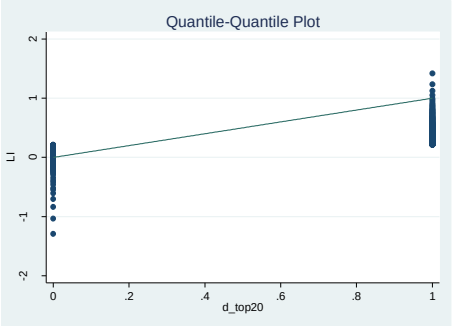
For government owned versus private owned banks:

```
Smaller group       D       P-value  Corrected
---------------------------------------------
0:                  0.2936    0.000
1:                 -0.0401    0.736
Combined K-S:       0.2936    0.000      0.000
```



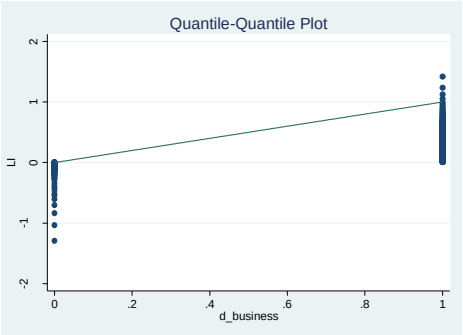
The top-20 versus non top-20 banks:

Smaller group	D	P-value	Corrected
0:	0.2082	0.000	
1:	-0.0191	0.892	
Combined K-S:	0.2082	0.000	0.000



And the corporate lending versus individual lending oriented banks:

Smaller group	D	P-value	Corrected
0:	0.1207	0.061	
1:	-0.0903	0.209	
Combined K-S:	0.1207	0.122	0.099



The P-values are significant at any reasonable level for all the dummy variables, except the one that differentiates between corporate lending and individual lending oriented banks. All other groups have significant differences, as shown by the quantile-quantile plots, in that one group has Lerner index values significantly offset to one side relative to the other group. The foreign owned banks, the government owned banks, and the top 20 banks all have, generally, more market power as shown by the Lerner index than their counterpart group. This by itself should come as no surprise, is there is indeed a large degree of correlation between the fact that the bank is government owned and being among the top banks in terms of size: in fact, all of the government owned banks are in the top 20 group as well. As for the foreign participation, the observed effect might be a result of the underlying tendency for larger banks to create elaborate schemes that exploit legislative specificities of countries such as the Netherlands and Cyprus, as

the issue becomes more relevant for bigger banks. Hence, these factors are deeply interconnected. The quantile-quantile plot for the forth variable, the business orientation dummy, also shows visual clues that one group's values are offset relative to the other group, hinting at the possibility of a type II error; while the data itself may be inadequate to reject the null hypothesis, it seems that the plot is similar to three other ones to a large extent. Moreover, Anzoategui et al. in their work find that all four variables are strongly significant at 1% and show the same patterns for index values between groups.

It should be noted that logically corporate lending oriented banks should also be bigger than their counterparts, and therefore also be connected to the other three variables, since most large banks are universal, but have corporate loans be a larger share of their asset portfolio than the individual loans, as they are generally considered to be of higher quality; as well as the fact that most large banks that are not universal are corporate lending oriented.

	Top-20	State	Foreign	Corporate	**Total average**
2009	0,17482	0,0896	0,22056	0,33885	**0,2695**
2010	0,14906	0,07022	0,17406	0,23319	**0,1641**
2011	0,14442	0,06418	0,17802	0,23398	**0,1647**
2012	0,21044	0,07879	0,2241	0,30622	**0,1450**

The table shows the pooled average values of Lerner index per year within each specific group as denoted at the top of the column. The general tendency seems to conform with the overall average value pattern of a sharp decrease between 2009 and 2010 and a slight decrease between years 2010 and 2011. However, while the total average value continued to decrease in 2012, for each of these groups it rose instead. This observation leads to believe that in fact, there can be significant pattern deviation for specific groups of banks from the general trend. Here, once we rule out the possibility that unusually many new banks entered the industry in 2012, it follows from these numbers that the distribution of market power changed between the existing banks, relocating to the larger ones. This can be indicative of several possible factors; the simplest explanation is that the large banks simply recover faster from economic downturns, so in the periods following such events they would grow in market power relative to others. This is, however, just one theory that would connect the figures to the 2008 crisis, and there may be other unobserved or unaccounted for factors at play, so no definitive inference can be made

aside from the observation that while competition may have bettered in general, this redistribution of market power hardly bodes well for the stability of the financial sector. Such tendencies are precisely the reason why competition and market structure must be observed carefully and thoroughly in the banking sector.

Panzar-Rosse approach

The marginal revenue function was estimated separately for year 2009, 2010 and 2011 using the fixed effects model (the appropriate tests can be found in the appendix). Due to the fact that 2012 only has one observable reporting period there is not enough data for consistent fixed effects model estimation, so no data is presented for 2012.

The reduced-form loglinear revenue equation is as follows:

$$\ln(INTR) = \alpha + \beta \ln(AFR) + \gamma \ln(RSA) + \delta \ln(OPR) + \sum \theta_j \ln(BSF_j) + \mu \ln(OI) + e,$$

INTR denotes total interest revenue to total assets; AFR is the interest price proxy calculated as the ratio of interest expenses to the sum of total deposits, loans and other funds; RSA is the labor price proxy calculated as the ratio of wage expenses to total assets; OPR is the capital price proxy calculated as the ratio of capital costs to total assets (here capital expenditures are proxied, as previously, by subtracting personnel expenses from administrative costs). BSF stands for banks specific factors that are not empirically determined and OI is the ratio of other income to total balance sheet; e is the error term. *H*-statistic in this terms is given by $H = \beta + \gamma + \delta$.

In the section of the paper that discussed the theoretical foundation, the dependent variable was mentioned as the logarithm of total revenue, but in practical specification here I use only the interest revenue, following the approach of Molyneux et al., 1994, and in accordance with specification of Bikker et al., 2002 non-interest income is separated into a regressor here to account for its influence. Interest revenue is used instead of total revenue because it is, in case of banks, what is generated by their core business, and the model is therefore more logically sound as it should focus only on the core business when considering the revenues elasticity with respect to input factor prices in order to best estimate the *H*-statistic.

The output of the regressions are as follows:

For year 2009,

```
Fixed-effects (within) regression               Number of obs      =      3226
Group variable: id                              Number of groups   =       840

R-sq:  within  = 0.8908                         Obs per group: min =         1
       between = 0.0458                                        avg =       3.8
       overall = 0.1882                                        max =         6

                                                F(8,2378)          =   2424.20
corr(u_i, Xb)  = -0.7721                        Prob > F           =    0.0000
```

lnINTR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnAFR	.2289384	.0085242	26.86	0.000	.2122227	.2456541
lnOPR	-.1269486	.0181786	-6.98	0.000	-.1625962	-.0913011
lnOI	.3872303	.01839	21.06	0.000	.3511681	.4232924
lnDac	.0107936	.0036932	2.92	0.004	.0035514	.0180358
lnDbp	.0049236	.0040026	1.23	0.219	-.0029253	.0127725
lnROCB	.0113031	.0040368	2.80	0.005	.0033871	.019219
logRSA	.2303601	.0146323	15.74	0.000	.2016666	.2590536
lnRUB	.2128565	.015457	13.77	0.000	.1825459	.2431671
_cons	-4.990789	.2261372	-22.07	0.000	-5.434236	-4.547343
sigma_u	.92052587					
sigma_e	.18119863					
rho	.96269835	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(839, 2378) =    18.79           Prob > F = 0.0000
```

For 2010,

```
Fixed-effects (within) regression               Number of obs      =      3293
Group variable: id                              Number of groups   =       830

R-sq:  within  = 0.9006                         Obs per group: min =         1
       between = 0.0293                                        avg =       4.0
       overall = 0.2144                                        max =         4

                                                F(8,2455)          =   2780.48
corr(u_i, Xb)  = -0.7097                        Prob > F           =    0.0000
```

lnINTR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnAFR	.1158579	.0071423	16.22	0.000	.1018524	.1298635
lnOPR	-.1171431	.0144501	-8.11	0.000	-.1454787	-.0888075
lnOI	.5747997	.015997	35.93	0.000	.5434307	.6061686
lnDac	.0061836	.0043043	1.44	0.151	-.0022568	.014624
lnDbp	.0033743	.0040661	0.83	0.407	-.0045991	.0113478
lnROCB	.0153062	.0041495	3.69	0.000	.0071693	.0234432
logRSA	.0801792	.0155715	5.15	0.000	.0496446	.1107137
lnRUB	.2265777	.011632	19.48	0.000	.2037683	.2493872
_cons	-3.058907	.2055682	-14.88	0.000	-3.462012	-2.655802
sigma_u	.86642529					
sigma_e	.1869229					
rho	.95552609	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(829, 2455) =    15.52           Prob > F = 0.0000
```

For 2011,

```
Fixed-effects (within) regression               Number of obs      =      3339
Group variable: id                              Number of groups   =       841

R-sq:  within  = 0.9460                         Obs per group: min =         1
       between = 0.3008                                        avg =       4.0
       overall = 0.6066                                        max =         6

                                                F(8,2490)          =   5455.41
corr(u_i, Xb)  = -0.1594                        Prob > F           =    0.0000
```

lnINTR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnAFR	.0487887	.0056843	8.58	0.000	.0376423	.0599351
lnOPR	-.2294861	.0137839	-16.65	0.000	-.2565152	-.2024571
lnOI	.7282437	.0151786	47.98	0.000	.6984797	.7580077
lnDac	.0027441	.0033959	0.81	0.419	-.0039149	.0094031
lnDbp	-.006584	.0031335	-2.10	0.036	-.0127285	-.0004395
lnROCB	-.0013395	.0029202	-0.46	0.646	-.0070658	.0043868
logRSA	.4295838	.0154435	27.82	0.000	.3993003	.4598672
lnRUB	-.0256029	.0107249	-2.39	0.017	-.0466337	-.0045722
_cons	-2.004028	.1935844	-10.35	0.000	-2.383631	-1.624425
sigma_u	.43272937					
sigma_e	.13442592					
rho	.9119916	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(840, 2490) =    25.25           Prob > F = 0.0000
```

The coefficients *lnAFR*, *lnOPR* and *lnRSA* are the proxy for the price of funding, price of fixed capital and price of labor respectively. Summarized in the table below are the estimators for the elasticities and the *H*-statistic for each year:

	2009	2010	2011
lnAFR	0,11586	0,04879	0,06466
lnOPR	-0,1171	-0,2295	-0,009
lnRSA	0,08018	0,42958	0,14762
H	**0,07889**	**0,24889**	**0,20331**
Ω	**0,3173961 (0,1366875)**	**0,0761438 (0,1420922)**	**0,7334651 (0,1867497)**

The model has one important underlying assumption: that the market is in the state of the long-run equilibrium. This is not a given, so to test for equilibrium, another regression is run with the same independent variables, but with the dependent variable of return on assets instead of interest revenue on the left-hand side. This is justified by the fact mentioned in the theoretical section above that in equilibrium the market equalizes the risk-adjusted returns across individual firms or banks, in this case. The values of resulting elasticity are presented in the table below the *H*-statistic denoted Ω, standard errors given in parenthesis. The null-hypothesis for the test

is (H=0) and would indicate equilibrium. For year 2009 and 2010 the results are insignificant and the hypothesis cannot be rejected on the 1% significance level, but in 2011 it is strongly significant and we must reject the equilibrium assumption and Panzar-Rosse methodology.

This output closely follows the pattern that was demonstrated in the section of the paper concerned with the Lerner index. It shows very low level of competition in the market in 2009 and subsequent rise in 2012, more than threefold in fact, with a slight change in 2011. Here the H statistic demonstrates that in 2011 the sector becomes slightly more monopolized yet again. However, since the equilibrium test failed, we must assume that the data cannot tell anything conclusive. The value of H is consistent with the assumption of monopolistic competition, which means the equilibrium is not efficient because individual banks do not maximize profits, and produce more output at suboptimal price. Monopolistic competition is however acknowledged as a realistic model for banking sector behavior as it accounts for interaction between banks, as well as such characteristics as product differentiation, advertising and so forth (Bikker, Haaf, 2002).

The elasticities of revenue towards individual factors are varied throughout the periods: due to the empirical nature of the model it is impossible to precisely indicate which of the changes can be attributed to the underlying market structure changes and which of them are simply a result of misspecification of the model and omitted variable bias. However, only the sign for elasticity with respect to capital price is consistently negative while the others are positive, so the costs of capital, assuming all else equal, tend to incur significant shifts in supply that diminish output and revenue, accordingly.

The value of H-statistic itself is merely a proxy for determining the competitive structure of markets, of course, but it provides adequate ground for relative comparison. The table with H-statistics for some European Union countries was given by L. Weill, 2011 as a result of a large international research. Russian banking sector for the observed period is once again among the most monopolized according to this table.

C h a p t e r 4

THE SIGNIFICANCE OF RESULTS

Summary

The Lerner index average indicates that the competition has worsened since before 2008. This is consistent with the idea of the "weakest link" effect. This predictably occurs no matter which sector the crisis hits, but for banking sector the impact of this can be quite significant, as the financial system is by its very definition extremely vulnerable to financial crises, specifically because it was where the crisis originated in 2008, but also due to the fact that banks are highly leveraged organizations that, while being subject to extreme scrutiny from the controlling agencies, are still prone to failure more so than real-sector entities due to the delicate nature of their business.

General empirical results show a very volatile value of Lerner index for all years for the average bank, ranging from the unremarkably average 0,14 in 2012 to comparatively high 0,26 in 2009 and creating an interesting phenomena for dynamics study. The distribution for the individual banks is somewhat skewed to the left, showing a pattern characteristic for lognormal distributions. These values are in consistency with the Panzar-Rosse approach results that show a sharp increase towards competitiveness between 2009 and 2010.

Due to the fact that the generic data taken from the balance sheets and profit and loss statements does not include information on whether the bank is owned by foreign or Russian private investors or Russian state, fifty largest banks were taken as they summarily account for the overwhelming portion of the banking system's assets and ran the two-sample Smirnov-Kolmogorov test for Lerner index similarity for them. For each bank I noted whether it was individual lending oriented or corporate lending oriented. As per data of the Central Bank of the Russian Federation, during the last several years there has been a significant downturn in corporate lending, with many banks preferring to shift to individual lending. This has been explained by the downturn of the economical development. Individual lending is considered to be riskier and generally more profitable, hence smaller banks with a large gearing ratio prefer it as a rule. Foreign capital is involved in most of the large banks in the country directly or indirectly, through secondary banks or companies of various elaborate schemes. State

ownership that increased in the crisis due to the stabilization needs also drives up concentration as state-owned banks tend to be superior in size and exercise more market power.

To summarize the results achieved by this paper, it found itself on the "concentration-fragility" side of the fence with the argument that destabilizing effect of low competitiveness on the banking sector creates bleak outlook on the future of economy. It discovered that competition measured through market power index suffered significantly compared to the pre-crises levels; that in the post-crisis period it rose abruptly and continued showing a tendency for increase as judged by the Lerner index approach. Similarly, Panzar-Rosse showed this pattern without the inclination for further increase as at the end of 2011 The year 2012 was marked by significant redistribution of market power towards some groups of banks from others; these groups are the ones that had comparatively higher levels of individual market power from the onset. Finally, the paper concluded with a discussion of the significance of the results and speculation for future study.

Results

As speculated in the beginning of the paper, some research has looked favorably on competition as a driver of market efficiency, others – less so. There are two main approaches to the issue: the "concentration-stability" approach and the "concentration-fragility" approach; the former suggests banks on concentrated markets are more profitable and better monitored (Allen and Gale, 2000); the latter states the opposite is true due to moral hazard issues concerning the "too big to fail" banks and more expensive funding. This can be put in practical perspective by observing mergers: if a merger goes through, concentration increases which could alternatively lead to higher prices (lowers consumer surplus) or, on the other hand, could result in more efficient operation that leads to lower costs and lower prices (increases consumer surplus).

However, concentration and competition have a complex relationship with each other. As found by Beck, Demirguc-Kunt and Levine in 2003 higher competition and higher concentration both lead to a higher degree of financial stability. It is then suggested by the authors that concentration is a poor measure of competitiveness of the banking system and that competition is favorable. In general, research seems to agree with the viewpoint that competition is indeed desirable and restrictions such as state ownership and regulations impede growth and cause negative consequences, but a certain degree of ambiguity remains. Further, regulations such as entry restrictions do not only hinter competition but also have a negative influence on the net interest margins of banks through increase in intermediation costs, and through it their profitability, which in turn invites destabilization (Demirguc-Kunt et al., 2004). The same paper expresses the view that regulations in the banking sector cannot be viewed apart from the general policies and competition freedoms in the entire economy, so they are interconnected deeply; this would suggest that any reformations and regulation changes in the banking sector can afflict the economy itself and this should be kept in mind by the policymakers. A similar view was expressed in Anzoategui et al., 2012, and supports the idea of this paper as well, suggesting that while authorities may try to stabilize the sector through regulation, they may create undesirable implications through the mechanism of the 'consequences loop' between the financial market's competitive structure and economic health of the country.

In application to the Russian banking sector, however, the detailed-above dilemma of concentration and competition is somewhat less relevant. It might be prudent to note that since empirical data shows very low level of competition, it would be beneficial to increase it anyway to attain some levels close to average at the very least, since the implications for sector

instability may be much worse than they commonly are even at the risk of incurring social welfare decline as some arguments suggest.

Conclusion

Financial system is at the heart of the economy and, as many showed, their dynamics are correlated and intertwined. This paper attempted to isolate some of economy's influence on the banking sector through the 2008 crisis by analyzing the post-crisis years starting 2009 and comparing values to those calculated previously by Anzoategui et al. for the period 2002-2008 on the observed competition in the financial system. It found, using the Lerner index and the Panzer-Rosse approach, that competition following the years after crisis was on average first higher than before, then started to drop gradually. However in 2012 we observe that while the average value for the market drops, the redistribution of it creates higher values for representatives of the three groups of banks, among which it is not hard to find high correlation: foreign banks, government owned banks, top 20 banks in size. All these banks also have, on average, higher Lerner index than the rest of the market. This can also be extended to corporate lending oriented banks, that, while not showing significant coefficients, still have a similar pattern of difference.

The Panzer-Rosse approach presented a more whole view of the market and showed the same patterns, though it was not possible to compute it for the year 2012 due to inadequate number of data, and the year 2011 showed that there was sufficient evidence to undermine the key assumption of the model that is the market long-run equilibrium.

A lot of changes can be observed in recent history of Russian financial markets, and a lot of it is tied to the political and economic issues. Regarding the politics, it can be suggested that the 2012 elections might have had something to do with the market structure change, or it may have been some other unobserved event, and the notion that it may be something that takes root in the events of 2008 cannot be ruled out completely. This invites further speculation, and even more importantly future empirical research. Likewise does the fact that the presence of foreign banks seems to have a contradictory effect on the competitiveness of the market.

What the paper does show quite apparently, however, is that the data for the given time period is in concurrence with the supposition that crises by putting banks under financial duress cause damaging consequences for the banking industry by cutting off their funding, raising their costs, and causing bank failures. As these weak banks leave the market and the strong ones remain, the average market power in the industry goes up, hence the post-2008 higher values of Lerner index that the data showed; following that, as the economy begins to rebound back to the natural state, it recovers also. Thus, the long-term consequences of the crisis may stretch out

further into future and even as the Lerner index falls there is continued speculation over whether this is truly a good sign or it may yet lead into another critical event in the loop.

Panzar-Rosse OLS

Source	SS	df	MS		
Model	3729.74704	8	466.218381	Number of obs	= 10698
Residual	1735.9626	10689	.162406456	F(8, 10689)	= 2870.69
				Prob > F	= 0.0000
Total	5465.70965	10697	.510957245	R-squared	= 0.6824
				Adj R-squared	= 0.6822
				Root MSE	= .403

lnINTR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnAFR	.0812014	.0027354	29.69	0.000	.0758396	.0865632
lnOPR	-.0607106	.0058851	-10.32	0.000	-.0722464	-.0491747
lnOI	.6870011	.0066536	103.25	0.000	.6739588	.7000435
lnDac	.008105	.0014028	5.78	0.000	.0053553	.0108547
lnDbp	-.0121758	.0015931	-7.64	0.000	-.0152985	-.0090531
lnROCB	.0091671	.0015325	5.98	0.000	.0061631	.0121711
logRSA	.2393748	.0054308	44.08	0.000	.2287295	.2500202
lnRUB	-.1413853	.003611	-39.15	0.000	-.1484635	-.134307
_cons	-.9191449	.0453764	-20.26	0.000	-1.008091	-.8301987

Fixed effects

Fixed-effects (within) regression — Number of obs = 10698
Group variable: id — Number of groups = 863

R-sq: within = 0.8313 — Obs per group: min = 1
between = 0.2030 — avg = 12.4
overall = 0.4989 — max = 16

F(8,9827) = 6051.97
corr(u_i, Xb) = -0.3983 — Prob > F = 0.0000

lnINTR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnAFR	.1408551	.0034617	40.69	0.000	.1340694	.1476407
lnOPR	-.0588795	.0071533	-8.23	0.000	-.0729015	-.0448575
lnOI	.5278269	.0079712	66.22	0.000	.5122017	.5434521
lnDac	.00986	.0015898	6.20	0.000	.0067438	.0129763
lnDbp	.0011076	.0021357	0.52	0.604	-.0030788	.0052941
lnROCB	.0046402	.001552	2.99	0.003	.0015979	.0076825
logRSA	.3143163	.0061672	50.97	0.000	.3022274	.3264052
lnRUB	-.0416485	.0041858	-9.95	0.000	-.0498535	-.0334434
_cons	-3.299321	.0949907	-34.73	0.000	-3.485522	-3.11312
sigma_u	.48857695					
sigma_e	.2428802					
rho	.80184366	(fraction of variance due to u_i)				

F test that all u_i=0: F(862, 9827) = 22.74 — Prob > F = 0.0000

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (863)  =   1.5e+31
Prob>chi2 =      0.0000
```

Random effects

```
Random-effects GLS regression                   Number of obs      =     10698
Group variable: id                              Number of groups   =       863

R-sq:  within  = 0.8267                         Obs per group: min =         1
       between = 0.3787                                        avg =      12.4
       overall = 0.6320                                        max =        16

                                                Wald chi2(8)       =  46043.45
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

lnINTR	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnAFR	.1353646	.0032587	41.54	0.000	.1289777	.1417515
lnOPR	-.1074453	.00646	-16.63	0.000	-.1201066	-.094784
lnOI	.6169991	.0068776	89.71	0.000	.6035192	.630479
lnDac	.0088711	.0015271	5.81	0.000	.0058781	.0118642
lnDbp	-.0043402	.0019994	-2.17	0.030	-.0082589	-.0004214
lnROCB	.0036706	.0015166	2.42	0.016	.0006982	.006643
logRSA	.3053552	.0058895	51.85	0.000	.2938119	.3168985
lnRUB	-.0739644	.003872	-19.10	0.000	-.0815535	-.0663754
_cons	-1.955401	.0724276	-27.00	0.000	-2.097357	-1.813446
sigma_u	.30451074					
sigma_e	.2428802					
rho	.61118026	(fraction of variance due to u_i)				

```
Test of overidentifying restrictions: fixed vs random effects
Cross-section time-series model: xtreg re
Sargan-Hansen statistic 621.203  Chi-sq(8)    P-value = 0.0000

Breusch and Pagan Lagrangian multiplier test for random effects

        lnINTR[id,t] = Xb + u[id] + e[id,t]

        Estimated results:
                     |       Var     sd = sqrt(Var)
             ---------+------------------------------
              lnINTR |    .5109572       .7148127
                   e |    .0589908       .2428802
                   u |    .0927268       .3045107

        Test:   Var(u) = 0
                              chibar2(01) = 20374.20
                          Prob > chibar2 =   0.0000
```

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